MINISTRY OF ELECTRICITY, DAMS, IRRIGATION & WATER RESOURCES (MEDIWR)

THE REPUBLIC OF SOUTH SUDAN

PROJECT FOR IRRIGATION DEVELOPMENT MASTER PLAN (IDMP) IN THE REPUBLIC OF SOUTH SUDAN

FINAL REPORT (MAIN)

DECEMBER 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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ORIENTAL CONSULTANTS GLOBAL CO., LTD.
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THE REPUBLIC OF SOUTH SUDAN

MINISTRY OF ELECTRICITY, DAMS, IRRIGATION & WATER RESOURCES

WATER SECTOR

IRRIGATION DEVELOPMENT MASTER PLAN

(FINAL REPORT)

MAIN DOCUMENT

NOVEMBER 2015

THE PROJECT FOR IRRIGATION DEVELOPMENT MASTER PLAN IN THE REPUBLIC OF SOUTH SUDAN (RSS)
LOCATION MAP (LM)

Map of the Republic of South Sudan

Location Map: Adopted from African Development Bank

FOREWORD

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One of the mandates of the Ministry of Electricity, Dams, Irrigation and Water Resources (MEDIWR) of the Republic of South Sudan (RSS) involves facilitation of the development, operation & management of water infrastructure for irrigated agriculture and other productive uses of the sector. This includes crop, livestock, forestry and fisheries subsectors, which are the subject of the Comprehensive Agriculture Master Plan (CAMP). The Irrigation Development Master Plan (IDMP) is "a comprehensive programmatic approach to address policy, institutional, capacity development and infrastructure issues and requirements of the agriculture sector in relation to water resources across the country, without jeopardising the needs of other sectors or stakeholders".

The IDMP is a road map to address existing challenges & making use of available opportunities in a strategic manner through: (1) setting up of guidelines and establishment of information network and (2) mobilisation of resources for investment & recurrent costs pertaining to human resources and institutions; carrying out of outreach & extension services; development, operation, maintenance & management of water control and delivery facilities at farms and other production projects. The IDMP therefore, describes the proposed nine (9) programmes, with their identified components, projects & activities pertaining to irrigation development. This is in order to translate the established strategic approaches into actual actions, ranging from small-scale to large-scale schemes and projects with cost, location & planning horizon in a prioritised manner.

The rationale being that currently irrigated agriculture is practiced only on less than 5% of the cultivated land, which is contrary to the fact that natural conditions of the country are characterised by a diverse range of geographical regions, with annual rainfall ranging from less than 500 to 1500 mm. Floods & droughts occur, threatening national food & nutrition security. Hence, fluctuation in production is significant due to the unstable climate that causes large inter-annual and annual variations in precipitation, leading to either dry spells or droughts. Scarcities of water are pronounced due to lack of storage facilities, irrespective of the fact that there are substantial water resources; yet the country experiences water shortages because they are unevenly distributed across the territory; and vary annually & seasonally. On the other hand, when peak of rainfall coincide with high river inflows, extensive flooding occurs downstream due to river spills, local rainfall & flatness of the land over vast areas. Thus the dual problem of dry spells & floods causes hazards to agricultural activities.

Under those conditions, irrigation planning and development become crucial, in order to stabilize availability of water; and effectively utilize & manage efficiently water resources for agricultural production & productivity. This is also to enhance food and nutrition security, resilience and contribute to meeting of the national needs and goals. With this background, the Government of RSS (GRSS) presented a request in November 2011 to the Government of Japan (GOJ) for the formulation of IDMP on the basis of technical cooperation. The Ministry and Japan International Cooperation Agency (JICA) then agreed on the contents and process of the project for the formulation of IDMP in April 2012.

Given the fact that achieving the agricultural development objectives in all its facets requires provision and management of water to a greater extent, IDMP is therefore formulated in close collaboration with the Ministry of Agriculture, Forestry, Cooperatives and Rural Development (MAFCRD); the Ministry of Livestock and Fisheries Industries (MLFI), other development partners and other government stakeholders. In line with CAMP, IDMP will continuously provide information on hydrometeorology, topography, land use and other engineering aspects pertaining to water control and delivery infrastructure of specific crop, fish farming, forestry and livestock schemes'/projects' sites. The information network system establishment programme will ensure standardized nation-wide monitoring and forecasting of water resources occurrence and other related data. This will continuously inform water users and managers in taking informed decisions, e.g. in relation to early warning systems in case of droughts, floods and other climate variability scenarios. Thus, making "support to agricultural production and productivity, an ultimate goal in the assessment and management of water resources in South Sudan", without jeopardising the needs of other sectors and stakeholders.

The overall goal of IDMP therefore, is “to achieve sustainable irrigated agriculture and other productive uses thereby improving food security and resilience, reduce poverty and contribute to economic growth and sustainable development”. In fact, it has been concluded that irrespective of terrain, soil type, source of water and weather conditions, irrigation should be introduced and practiced using different models and techniques in order to: (1) address the inevitable climate and seasonal changes; (2) ensure food and nutrition security through selecting of specific crops for growing in certain seasons and areas; and (3) diversify and scale up crop production and stimulate agribusinesses and agro-industries.

Indeed, IDMP process, as a project, commenced in September 2012 and finalised in September 2015. The 3-year working period covered intensive tasks in three phases, commencing with: Situational analysis of the water sector and the irrigation subsector in phase one (1); followed by different types of assessments and related formulation processes in phase tow (2); and concluded with preparation of a number of implementation guidelines, arrangements and plans in phase three (3). It has now achieved its three main objectives, i.e. (i) enabling the GRSS carryout studies and examines irrigation potential across the country, (ii) strengthening of the capacities of South Sudanese counterpart personnel through its formulation, and (iii) production of IDMP framework and its guiding documents.

I wish at this juncture, on behalf of GRSS, to thank the Government and people of Japan for their prompt response and invaluable support towards the formulation of IDMP. Also, I would like to thank the other development partners, state governments, county authorities and the communities for responding positively towards embracing the initiative and immensely contributing in data collection; and during reviews and consultation processes.

I am especially grateful to the South Sudanese members of the IDMP Task Team for the hard work and for leading the process tirelessly in collaboration with JICA as well as the international, regional and national consultants. My appreciation also goes to the states, local governments, communities, and stakeholders; the other development partners, the private sector; and civil society, for their appropriate and various contributions. Their efforts made it possible for IDMP to reflect the whole country's wishes and aspirations. I acknowledge with appreciation the due diligent guidance from colleagues, national ministers and counterparts; the state ministers through the Inter-Ministerial Steering Committee, and the Technical Committee (TC) led by the undersecretaries, and JICA representatives in South Sudan for their close supervision and administration of the process.

I trust that the well demonstrated participation by all the stakeholders will continue to be maintained at all critical stages, including planning; decision-making; resources mobilisation; execution; and monitoring and evaluation, to ensure the realisation of the projected outcomes. This is a great achievement and we are proud of the collective efforts exerted; hence each and every one of us remains an important stakeholder whose participation and contribution count to keep up the momentum. The implementation of the IDMP will enable us overcome the food and nutrition insecurity situation in our beloved nation, achieve reduction of poverty and promote development and prosperity among our citizens. It will also enhance resilience against seasonal and annual variability in water occurrence as a result on climate change that usually leads to crops failure.

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ACKNOWLEDGEMENT

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IDMP is formulated under the same CAMP coordination mechanism that is composed of: An Inter-Ministerial Steering Committee (IMSC), as a forum for national and state ministers; Technical Committee (TC), as a high level professional scrutiny body; Task Teams (TTs), as core groups of experts leading the process; State Focal Points (SFPs), the personnel coordinating the formulation activities at the state, local and community levels; and participating stakeholder institutions and partner organisations.

The lead Ministry in IDMP formulation is the Ministry of Electricity, Dams, Irrigation and Water Resources (MEDIWR) in close collaboration with the Ministry of Agriculture, Forestry, Cooperatives and Rural Development (MAFCRD) and the Ministry of Livestock and Fisheries Industries (MLFI) that are leading CAMP process, with MAFCRD as a lead and MLFI as an alternate.

It is worth mentioning that MAFCRD, MLFI, and MEDIWR leadership, both at the Ministerial and technical levels, rallied and provided needed official support and necessary guidance for successful completion of the master plan.

Scope of work and schedule of IDMP formulation required participation and contribution of different people, community associations and individual members, institutions, firms and organisations across the country. Special thanks go to MEDIWR IDMP Task Team Members; and the assigned and collaborating core experts from the Crop, Forestry, Fisheries and Livestock Subsectors; and the JICA Consultancy Firms.

Core staff team and the involved National, Regional and International Consultants steered the most technical part of the IDMP; and ensured involvement of stakeholders. The State Focal Points; and the specialised staff and practitioners of the other concerned related Ministries and Institutions are much acknowledged for facilitating the process and contributing to the formulation.

The data collected and information gathered; and references, insights and wealth of knowledge received from the mandated and specialised collaborating institutions and organisations at national, state and local levels during study; and TC and stakeholders' review and consultation meetings, provided concrete basis for the guiding documents and implementation.

Indeed, we appreciate the invaluable comments and suggestions made on the IDMP proposals and outputs by these institutions, including ministries; commissions; the academia (universities and research/training institutes/centres); the other development partners (donors, i.e. multi-laterals, bi-laterals and implementers, e.g. UN Systems, NGOs and private companies/firms); the civil society; and farmers and regional organisations. The role played by each participant/representative made it possible to accomplish IDMP tasks within the given timeframe and the set phases.

Following the eruption of crisis in RSS, mid December 2013, which affected the work progress, the cited timeframe for the IDMP Project was amended during CAMP and IDMP consultation meeting in Kampala, Uganda, March 2014, between JICA Chief Representative in South Sudan; members of the technical committee (represented by the three undersecretaries); the TTs' leaders); and JICA Consultants facilitating formulation of the two master plans.

At this juncture, we are thankful to JICA that stood firm and confirmed relevance of continuing in formulating CAMP & IDMP, on ground that GRSS needs to prepare itself for the rehabilitation and development while dealing with emergency situation at the moment. Hence, a need for JICA to continue supporting CAMP & IDMP was justified; and in accordance: The scope of planning was maintained and the timeframe of completion was adjusted; and new operation modalities were devised and agreed.

RSS TTs continued to operate in South Sudan, based in Juba; and the consultants in Kampala, thanks to the electronic world that aided that type of remote working relationship.

Frequent reporting and reports compilation meetings in a get together in Kampala between Japanese partners and their associates on one hand; and their South Sudanese counterparts on the other, were then being organised periodically during the period when Japanese experts and affiliated personnel were not allowed to come to south Sudan.

The joint decision taken to continue with CAMP and IDMP on-going programmes in RSS in a different mode while respecting the travel alert of Japanese Government for JICA and associated personnel not to enter RSS, which remained the same for some months, led to revision of the "Records of Discussions (RD) pertaining to the detailed planning.

Therefore, CAMP and IDMP continued focusing on short, medium and long term development-orientation of the two master plans as planned, making provisions for resilience in medium to long term while prioritizing appropriate programmes and projects in the short term.

For IDMP one of the critical points surmounted was the carrying out of surveys at selected priority projects' areas and sites, which was agreed to be done through procurement process of local sub-contractors; and the activities were rescheduled and the records of discussions were updated accordingly. Thanks to the knowledge and skills imparted by Japanese experts that enabled IDMP RSS TT Members to prepare technical specifications and scope of works, which were completed after reconnaissance surveys got carried out diligently by our TT Members, my appreciation to them.

This approach helped in removing all the doubts about performing this vital component of IDMP formulation, which form a part and parcel of the capacity building and preparation of priority projects towards testing feasibility of the IDMP. On this achievement, I thank JICA and the consultants, for the team work spirit and trust built among the partners and counterparts, which led to the success of such undertaking.

Furthermore, I would like to extend our gratitude to the entire range of other participants who directly and indirectly participated in and contributed to IDMP process, in a way or another. The individual leaders, elders and experienced/knowledgeable resource persons who offered advices, encouragements and provided inputs; and the individual assistants who extended a hand of support, including logistics and catering during performance of the IDMP formulation assignments and activities are equally acknowledged.

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The Republic of South Sudan

ABBREVIATIONS

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ABCE	Access Bottlenecks Costs and Equity
ABSS	Agricultural Bank of South Sudan
AEO	Agricultural Extension Officer
AfDB	African Development Bank
AG	Agriculture in Terrestrial and Aquatic/Regularly Flooded Land
AGRA	Alliance for Green Revolution for Africa
AIRP	Aweil Irrigation Rehabilitation Project
AIRS	Aweil Irrigation Rice Scheme
AMS	American Meteorological Society
ARFC	Aweil Rice Farmers Cooperative
ARS	Aweil Rice Scheme
ASPF	Agriculture Sector Policy Framework
AU	African Union
AWLR	Automatic Water Level Recorder
B/D	Basic Design
BRIDGE	Building Resources in Democracy Governance and Election
BSc	Bachelor of Science
BSF	Basic Services Fund
CAADP	Comprehensive Africa Agriculture Development Programme
CAMP	Comprehensive Agriculture Master Plan
CAMP-TT	CAMP Task Team
CBEW	Community Based Extension Worker
CD	Capacity Development
CEA	College of Engineering and Architect
CES	Central Equatoria State
DFADT	Department of Foreign Affairs, Development & Trade Canada
CIDA	Canada International Development Agency
CLA	County Land Authority
CAN	Capacity Need Assessment
CNRES	College of Natural Resource and Environmental Studies
CPA	Comprehensive Peace Agreement
CPs	Counter Parts
CRMA	Crisis and Recovery Mapping and Analysis
D/D	Detail Design
DEMs	Digital Elevation Models
DG	Director General
DP	Development Partners
DWL	Dynamic Water Level
EC	Electric Conductivity
EC	European Commission
EEC	European Economic Community
EES	Eastern Equatoria State
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
ENTRO	Eastern Nile Technical Regional Office
ERR	Economic Rate of Return
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FFS	Farmer Field School
F/S	Feasibility Study
GDP	Gross Domestic Product
GIS	Geographical Information System
GIZ	Deutsche Gesellschaft für Internationale. Zusammenarbeit
GLS	Global Land Survey

GOJ	Government of Japan
GRSS	Government of Republic of South Sudan
GPS	Global Positioning System
HQ	Head Quarter
HWSD	Harmonized World Soil Database
HYCOS	Hydrological Cycle Observation System
IAHS	International Association of Hydrological Sciences
ICSS	Interim Constitution of Southern Sudan
ICT	Information Communication Technology
IDMP	Irrigation Development Master Plan
IDMP-TT	IDMP Task Team
IDP	Internally Displaced People
IEE	Initial Environmental Examination
IFD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Centre
IGAD	Intergovernmental Authority on Development
IIASA	International Institute for Applied Systems Analysis
IMT	Irrigation Management Transfer
ISC	Inter-Ministerial Steering Committee
IT	Information Technology
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
JS	Jonglei State
LA	Land Administration
LC	Land Cover
LIS	Land information system
LS	Lakes State
LTS	Land taxation system
LU	Land Use
LZ	Land Zoning
M&E	Monitoring and Evaluation
MAF	Ministry of Agriculture and Forestry
MAFCRD	Ministry of Agriculture, Forestry, Cooperatives, and Rural Development
MAFTARF	Ministry of Agriculture, Forestry, Tourism, Animal Resources and Fisheries
MARF	Ministry of Animal Resources and Fisheries
MDGs	Millennium Development Goals
MDTF	Multi-donor Trust Fund
MED	Ministry of Electricity and Dams
MEDIWR	Ministry of Electricity, Dams, Irrigation and Water Resources
MEST	Ministry of Education, Science and Technology
MFCIEP	Ministry of Finance, Commerce, Investment and Economic Planning
MFEP	Ministry of Finance and Economic Planning
MGCSW	Ministry of Gender, Child, Social Welfare, Humanitarian Affairs and Disaster
MIPP	Micro-Irrigation Pump Promotion Project
MIWC	Ministry of Interior and Wildlife Conservation
MLFI	Ministry of Livestock and Fisheries Industries
MLHPP	Ministry of Lands, Housing and Physical Planning
MOE	Ministry of Environment
MOFNE	Ministry of Finance and National Economy
MOH	Ministry of Health
MPI	Ministry of Physical Infrastructure
MPIPU	Ministry of Physical Infrastructure and Public Utilities
MPMI	Ministry of Petroleum, Mining and Industry

MSc	Master of Science
MSY	Maximum Sustainable Yield
MTII	Ministry of Trade, Industry and Investment
MTRB	Ministry of Transport, Roads and Bridges
MWRI	Ministry of Water Resources and Irrigation
NBGS	Northern Bahr el-Ghazal State
NBI	Nile Basin Initiative
NBS	National Bureau of Statistics
NBTF	Nile Basin Trust Fund
NEPAD	New Partnership for Africa's Development
NERICA	New Rice for Africa
NFMCG	Ngoth Farming Mult-Purpose Cooperative Group
NGOs	Non-Governmental Organizations
NIDPS	National Irrigation and Drainage Policy and Strategy
Nile DST	Nile Decision Support Tool
NLC	National Land Commission
NUNIS	Northern Upper Nile Irrigation Schemes
O&M	Operation and Maintenance
OC	Organic Carbon
PACT	Program Agency Collaborate Together
PC	Personal Computer
pH	potential Hydrogen
PhD	Doctor of Philosophy
PLA	Provision of Land for Agriculture
PLC	Payam Land Council
PPP	Public Private Partnership
Pre-F/S	Pre-feasibility Study
RD	Record of Discussion
RM	Regular Meeting
RSS	Republic of South Sudan
RSS-TT	RSS Task Team
RWSS	Rural Water Supply and Sanitation
SDC	Swiss Development Cooperation
SIDA	Swedish International Development Cooperation Agency
SPCRP	Sudan Productive Capacity Recovery Programme
SGB	Sudan Gezira Board
SPLA	Sudan People's Liberation Army
SPLM	Sudan People's Liberation Movement
SPOT	System Probatoired' Observation de la Teraa
SQL	Structured Query Language
SS	South Sudan
SSAB	South Sudan Agricultural Bank
SSCCIA	South Sudan Chamber of Commerce, Industry and Agriculture
SSDI	South Sudan Development Initiative
SSDP	South Sudan Development Plan
SSDWG	South Sudan Domestic Water Guideline
SSIA	South Sudan Investment Authority
SSLC	Southern Sudan Land Commission
SSM	Synthetic Storage Model
SSP	South Sudan pound
SSRF	South Sudan Relief Fund
STRM	Shuttle Radar Topography Mission
SUWASA	Sustainable Water and Sanitation in Africa
SWL	Static Water Level
SWSR	Safe Water Supply and Sanitation Services Regulatory Boards
TC	Technical Committee

TCRSS	Transitional Constitution of the Republic of South Sudan
TDEM	Time Domain Electro-Magnetic
TOR	Terms of Reference
TSP	Triple Super Phosphate
TT	Task Team
UK	The United of Kingdom
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
UNS	Upper Nile State
USD	United State Dollar
UWSS	Urban Water Supply and Sanitation
US	Unity State
WASH	Water, Sanitation, and Hygiene Sector
WATSAN	Water Supply and Sanitation
WB	World Bank
WBGS	Western Bahr el-Ghazal State
WES	Western Equatoria State
WFP	World Food Programme of the United Nations
WG	Working Group
WHC	Water Holding Capacity
WIMS	Water Information Management Services
WIMS	WASH Information Management System
WMO	World Meteorological Organization
WRM	Water Resources Management
WRMA	Water Resources Management Authority
WUA	Water Users Association
WS	Warrap State
WUIS	Water Use and Irrigation Survey

EXECUTIVE SUMMARY

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INTRODUCTION

The Ministry of Electricity, Dams, Irrigation and Water Resources (MEDIWR) of the Republic of South Sudan (RSS) is a governmental organization whose mandate involves facilitation of the development, operation, and management of water infrastructure for irrigated agriculture and other productive uses of the sector. This involves crop, livestock, forestry and fishery subsectors, which are the subject of the Comprehensive Agriculture Master Plan (CAMP).

The Irrigation Development Master Plan (IDMP) Framework is a comprehensive programmatic approach to address policy, institutional, capacity development and infrastructure issues and requirements of the agriculture sector in relation to water resources across the country without jeopardising the needs of other sectors or stakeholders.

It is a road map for addressing existing challenges and making use of available opportunities through: 1) the setting of guidelines and establishment of an information network; and 2) the mobilisation of resources for investment and recurrent costs pertaining to: human resources and institutions; the carrying out of outreach and extension services and the development, operation, maintenance and management of facilities at irrigation schemes/farms; fisheries and livestock production; and tree plantation projects.

IDMP formulation process comprises 8 chapters and 9 annexes:

1. Presentation of the rationale;
2. Full consideration of the general features and natural conditions (presented in Chapter 1);
3. Comprehensive analyses of the existing policy, institutional, legal and strategic framework (documented under Annex 1);
4. Assessment of the existing schemes within the country through field surveys and learning from the exposure visits to the other countries (Annex 2);
5. Physical assessment of the irrigation development potential (Chapter 2), with a detailed report attached as Annex 3;
6. Conducting of the capacity needs assessment (Annex 4);
7. Identification of the issues for irrigation development and management (Chapter 3), with preliminary guidelines for irrigation development and management compiled under Annex 5;
8. Zoning for irrigation development and identification of irrigation models (Chapter 4);
9. Setting of the formulation logical flow, steps, goals, targets and approaches in Chapter 5;
10. Identification of the programmes (Chapter 6), with comprehensive profiles in Annex 6 and cost estimates in Annex 7;
11. Establishment of the implementation mechanism and workflow (Chapter 7);
12. Records of discussions and meetings (Annex 8); and
13. Processing of the implementation plan for the priority projects (Chapter 8), with elaborated plans in Annex 9.

The above sequential presentation of the master plan topics adopted by the IDMP TT is depicted in the diagram below:

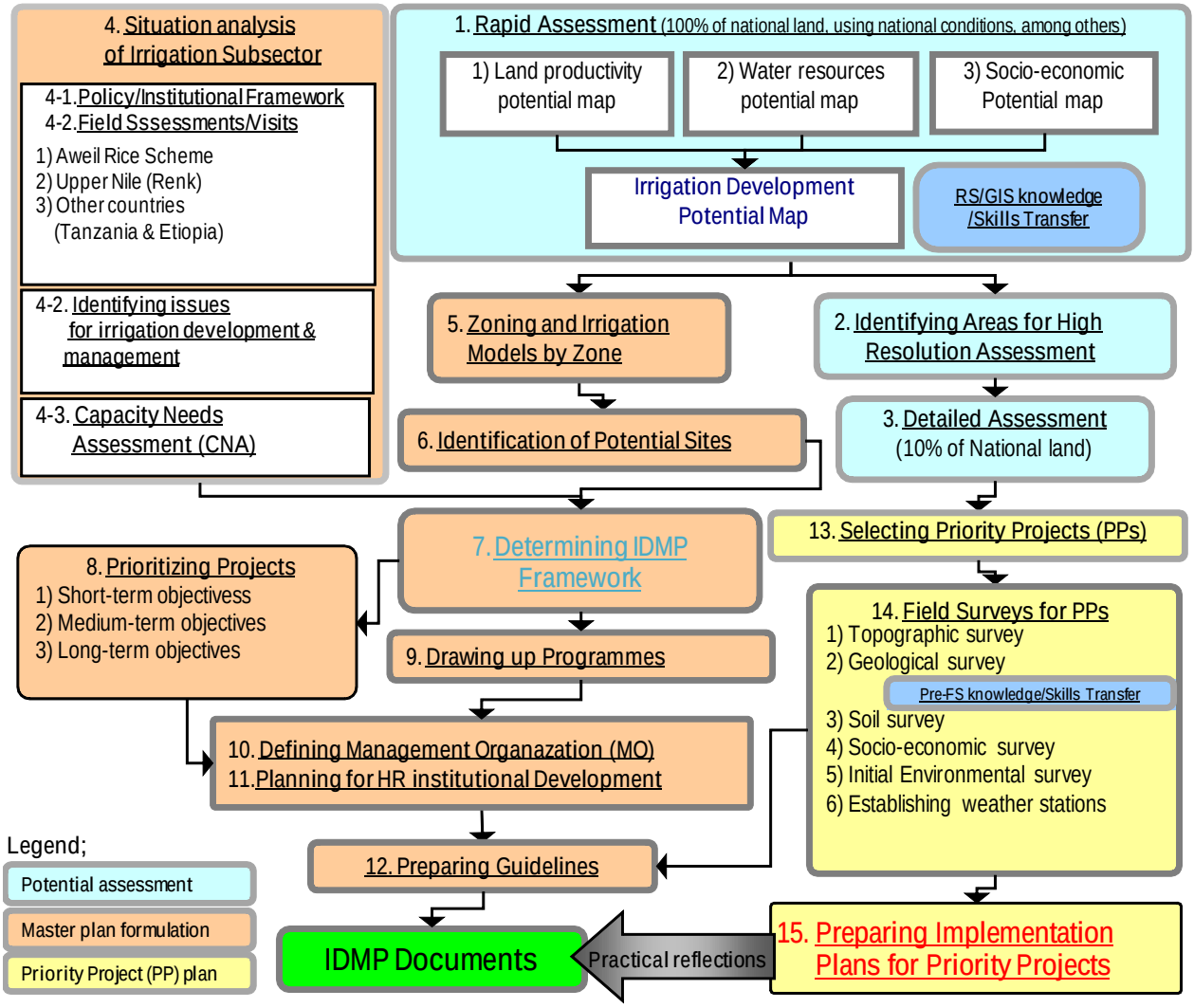

Figure 0.5.1: IDMP Framework Formulation Process

The Framework is the output of the IDMP-Task Team TT work, from September 2012 to November 2015; it consists of the following in a sequential manner as introduced above.

From the above documentation (1 through 12), the IDMP structure and documents have been concluded with full consideration of the issues and lessons learned: results of analyses, surveys, assessments and practical reflections. All the outputs were presented sequentially in eight (8) chapters, for which highlights of the features contained and summarised information have been provided below.

Rationale

In the RSS, currently irrigated agriculture is practiced only on less than 5% of the cultivated land [National Bureau of Statistics (NBS), 2010]. The natural conditions of the RSS are characterised by a diverse range of geographical regions, with annual rainfall ranging from less than 500 mm in the far north and far southeast to up to 1,500 mm in the southwest. Flood and drought occurs occasionally, threatening national food security.

Fluctuation in annual production is significant due to the unstable climate that causes large inter-annual and annual fluctuations of precipitation; hence, irrespective of the fact that South Sudan has substantial water resources, the country experiences water shortages due to uneven distribution across the territory and substantial variation between years and seasons.

On the other hand, when the peak of rainfall in July and August coincides with high river inflows from the upper catchments, extensive flooding occurs downstream due to river spills, local rainfall, and flatness of the land over vast areas. Irrigation development is therefore crucial, in order to stabilize agricultural production and productivity through effective utilization and efficient management of water resources, to enhance food security and resilience, and to contribute to the meeting of the other national needs and goals. With this background, GRSS presented a request to the Government of Japan for the formulation of IDMP on the basis of technical cooperation; and the then MWRI and JICA agreed on the contents and process of the project for the formulation of IDMP (see Annex 8).

CHAPTER 1 IRRIGATION DEVELOPMENT PROSPECTS IN SOUTH SUDAN

This chapter gives the country overview: geographical and demographic features; natural conditions, e.g. general climatic attributes and the meteorology. It highlights the livelihood zones that emerged along the agro-ecological divisions across the country. It extensively describes the hydrology and the hydrogeology with the associated features and the existing water uses and utilisations, e.g. for drinking, agricultural production (including existing irrigation practices), hydropower and other industries. The chapter then further discusses conflicts over water and aspects of land use as well as the existing policy, institutional, strategic, planning and legal frameworks in relation to water and irrigation in particular and the national outlook in general. Apart from the rather comprehensive content of this chapter, an extensive detail of the findings on the policy and institutional review has been attached as Annex 1, giving analyses and inventory of the plans in place, on-going activities, projects, programmes and the lead players within the overall water sector (including the irrigation subsector) in South Sudan.

CHAPTER 2 IRRIGATION DEVELOPMENT POTENTIAL ASSESSMENT

This chapter documents the overall methodology followed by the IDMP-TT in conducting an irrigation development potential assessment with the available data; and shows current potentiality of water resources and location of priority areas, compared to the other Nile Basin neighbouring countries, as well as African countries in the future. It began with data acquisition, e.g. historical and real-time data on rainfall, river discharges, evapotranspiration, vegetation, soil, etc.; which were supplemented by remote sensing (RS) and GIS technologies, among others. The assessment was conducted in two (2) stages, i.e. stage-1: rapid (using low-resolution satellite imageries) for assessing 1) land productivity, 2) socio-economics and 3) water resource potentials nation-wide, to define high potential areas; and stage-2: detailed (using high-resolution satellite imageries) for assessing the potential for irrigation planning at selected areas based on high-precision satellite data, etc. for verifying priority areas and potential project sites. The criteria and flow of irrigation potential assessment are shown in Table 2.1.1 and Figure 2.1.1 respectively.

Table 2.1.1 Criteria for Assessing the Irrigation Development Potential

Assessment	Layer
Land Productivity Potential with prospects for gravity irrigation	Land cover, Slope, Temperature, Wetness, Soil, River Accessibility, Grazing area, Water bodies, etc.
Water Resources Potential	Rainfall, River discharge, Groundwater, Water use, etc.
Socio-economic Potential	Road accessibility, Population density, Protected area, Oil & gas concessions, Accessibility to market/capital advantage, etc.

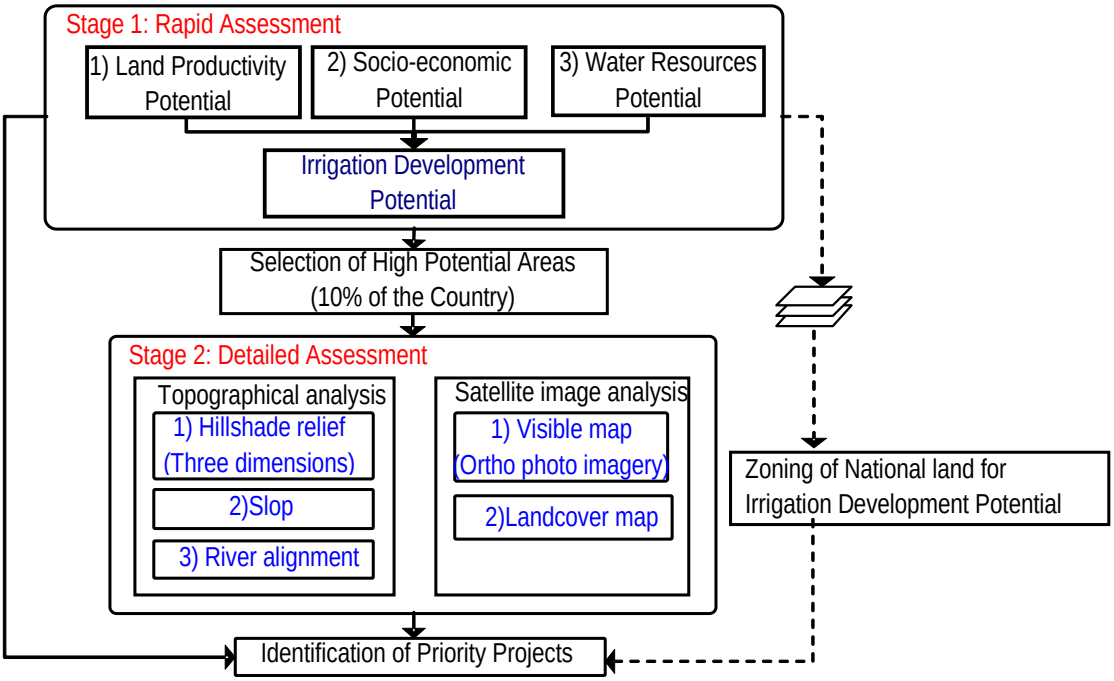

Figure 2.1.1 Flow Chart of Irrigation Development Potential Assessment

Stage 1: Rapid assessment of irrigation development potential (nation-wide): after collecting and sorting the above data, assessments for nation-wide land productivity and socio-economic potentials were conducted through overlay, using GIS technology.

Thirteen (13) layers where matters to be assessed through the weighing of each layer were selected. The assessment was decided on the assumption of eventually available data and through discussion among TT members. Then the high potential areas were agreed to be 10% of the country area for identifying the short-term projects as well as priority projects.

Stage 2: Detailed assessment for the selected irrigation high potential areas: Stage 2 work of the detailed assessment at the selected high potential areas is positioned as a part of the implementation plan formulation for priority projects. After this assessment, priority projects were identified through discussions among TTs, using a set of criteria.

Section 2.2.1 of the chapter presents layers applied and procedures for land productivity and socio-economic assessments. A strategic and analytical approach of assessment can be summarized as: 1) to collect nation-wide data for land productivity; 2) to examine, fix and analyse each piece of data; 3) to employ the most accurate, detailed and latest data; 4) to rescale a spatial resolution of 90 meters; 5) to evaluate each data (layer) in terms of land productivity and irrigation potential and give a score between the values of 1 (low suitability) to 10 (high suitability); 6) to evaluate the importance of each layer and give them the weighted scores; and 7) to overlay all layers to get rapid review of nation-wide land productivity potential.

Data source of each layer for rapid land productivity potential assessment is summarized in Table 2.2.1 and Figure 2.2.1.

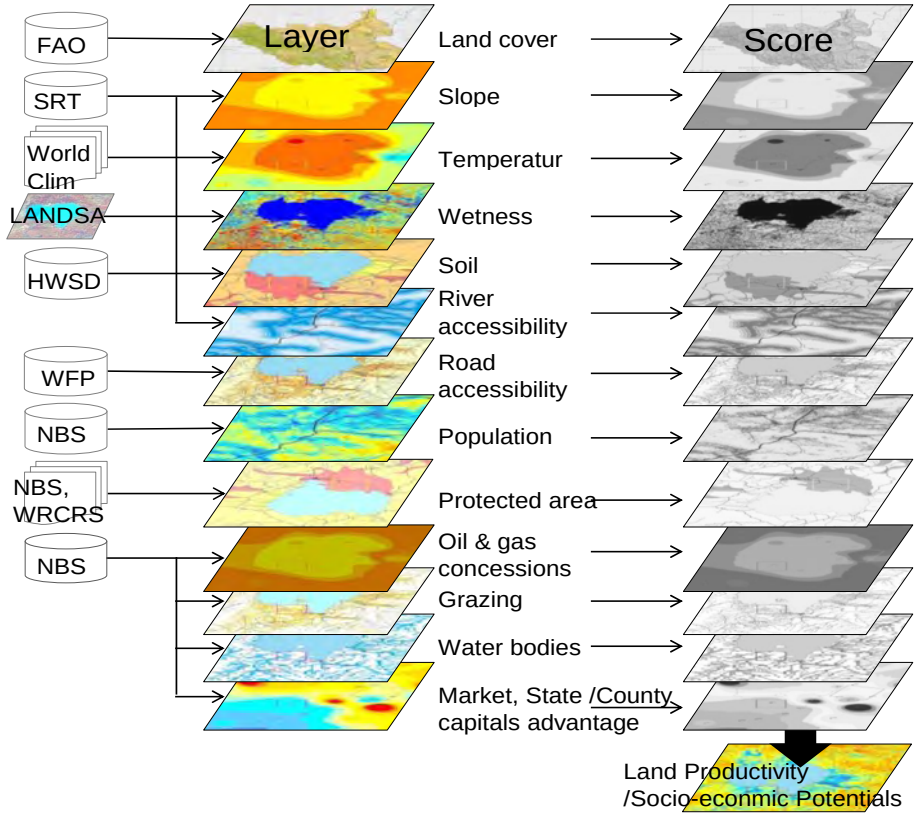

Figure 2.2.1 Creation of Land Productivity/Socio-economic Potential Maps

Table 2.2.1 Layers for Land Productivity and Socio-economic Potential Assessments

	Layer		Source	Remarks
Land productivity	01	Land cover	Land cover atlas – SIFSIA produced by FAO	Issued in 2011
	02	Slope	SRTM-DEM produced by USGS	Spatial resolution: 90m
	03	Temperature	WorldClim-Global Climate Data	Spatial resolution: 1km
	04	Wetness	LANDSAT produced by USGS	Spatial resolution: 30m
	05	Soil	Digital Atlas produced by NBS, Harmonized World Soil Database (HWSD)	Map scale: 1/2,000,000, Spatial resolution: 1km, Issued in 2009
	06	River accessibility	SRTM-DEM produced by USGS	Spatial resolution: 90m
	07	Grazing	Digital Atlas produced by NBS, MARF	Updated in 2010/11
	08	Water bodies	Digital Atlas produced by NBS, FAO	Updated in 2004
Socio-economic	01	Road accessibility	Transport overview map of assessed and un-assessed roads produced by WFP	Updated in May, 2013
	02	Population density	Population data produced by NBS	Updated in 2013
	03	Protected area	Digital Atlas produced by NBS, International Resource Group, Digitized by CRMA/Wildlife Research Centre Remote Sensing Authority	Map scale: 1/1,200,000, Updated in 2007
	04	Oil & gas concessions	Digital Atlas produced by NBS, ECOS	Updated in 2007
	05	County capital advantage	Digital Atlas produced by NBS	Location confirmed from the topographic map

Land Productivity Potential Assessment

Ten (10) layers in total out of thirteen (13) were used for the assessment of the land productivity potential. The IDMP-TT discussed and categorized them into two by groups, i.e. Step-1 and Step-2, in the viewpoint of impact to land and crop productivity with a weighting rate of 5:3 for each of the two (2) steps respectively, as shown in Table 2.2.1 above: 1) Step-1: Direct impact comparatively high to the land and crop productivity; and 2) Step-2: Direct impact comparatively low to the land and crop productivity.

Table 2.2.2 Weighting for Each Layer

	Group of Step-1 Weighting: 5	Group of Step-2 Weighting: 3	Step-3 (Socio-economic Potential)
Layers	1.Temperature for Non-rice	6. Land cover	Refer to "Socio-economic Potential Assessment"
	2.Temperature for Rice	7. Wetness	
	3.Slope	8. River accessibility	
	4.Soil for Non-rice	9. Grazing area	
	5.Soil for Rice	10.Water bodies	

Factors, which give impact to socio-economic features such as road accessibility, population, market, etc., are categorized into under Step-3 based on the discussions among the TT members.

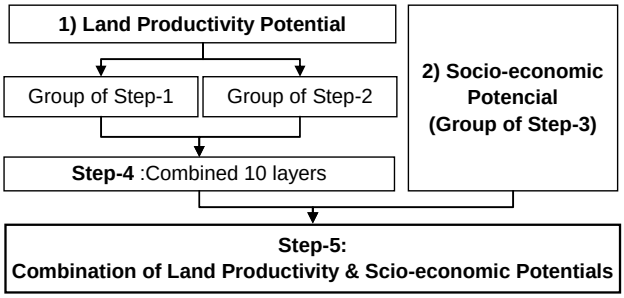

Figure 2.2.2 Procedure of Step 1 to 5 Evaluation

The procedure of assessment in Figure 2.2.2 shows the potentials of 1) Land Productivity and 2) Socio-economics were combined after the evaluation of Step-1 and Step-2 as Step-5. Step-4 combined Step-1 and Step-2 without adding Step-3 for socio-economic evaluation (the actual result of the Land Productivity Potential).

The approach adopted in data collection and analysis, in addition to the factors that influenced the process, are narrated, discussed, and culminated in results upon which irrigation potentiality is based, e.g. maps on land productivity potential, socio-economic potential, and the national high-potential area by overlaying land productivity with socio-economic were produced (Figures 2.2.3 through 2.2.6).

Section 2.3 describes procedures followed in a water resource potential assessment, for which results are summarized therein. The assessment consists of:

1) rainfall and runoff analyses [resulting in annual rainfall distribution contour map (Figure 2.3.1)];
2) runoff analyses (through establishing of river network diagrams (Figures 2.3.2 through 2.3.5);
3) assessment of surface water potential [culminating in a river and associated watershed delineation map (Figures 2.3.6 & 2.3.7)];
4) river discharge analisis (Figure 2.3.8); and
5) groundwater analysis (Figure 2.3.9).

In section 2.4, irrigation development potential maps are produced on the basis of 1) land productivity, 2) socio-economic levels, and 3) water resource potentials maps.

The maps are overlayed in one to produce an "irrigation development potential map", i.e. irrigation development potential map with surface water (Figure 2.4.1) and irrigation development potential map with groundwater (Figure 2.4.2).

Section 2.5 gives accounts of the steps taken by the TT members, in carrying out detailed assessment for identifying target areas for priority projects and potential future sites within the high potentiality area.

The detailed assessment area was narrowed down to approximately 10% of national land, selected by following procedures in line with the results of the rapid assessment, including water resources, land productivity and socio-economic potentials.

Description of the steps followed and analyses carried out to: 1) identify high potential areas for the detailed assessment; 2) select target high- potential areas for the detailed assessment; and 3) carry out the detailed assessment for the high irrigation development potential areas is given in subsecttions 2.5.1 through 2.5.3.

Finally, under section 2.6, it was concluded that irrespective of terrain, soil type, source of water and weather conditions, e.g. amount and distribution of rainfall; and farm size, e.g. small, medium or large, due to the following reasons, among others, irrigation should be introduced and practiced using different models and techniques:

1. Climate & seasonal changes, which are unpreventable;
2. Food & nutrition security through selection of specific crops for certain seasns/areas; and
3. Diversification & scaling up of crop production, to stimulate agribusinesses & agroidustries.

Besides the main chapter in brief, the complete report pertaining to the irrigation development potential assessment is attached as Annex 3.

CHAPTER 3 ISSUES FOR IRRIGATION DEVELOPMENT AND MANAGEMENT

This chapter gives an in-depth analysis of the policy and institutional issues upon which the IDMP is formulated. The analyses include the existing and planned policy, and the strategic, institutional and legal frameworks in addition to experiences in relation to the overall water sector in general and the irrigation subsector in particular.

It therefore elaborates on the irrigation planning policy and the analyses of the roles and responsibilities of the institutions involved.

In particular, it zooms in on the water resource management policy as well as the strategic and legal frameworks and their implications for irrigation development and management, under which irrigation has been mentioned as a part. Hence, a pre-condition for irrigation development and management to comply with provisions can be found therein.

The three (3) documents, namely Water Policy (2007), WASH Strategic Framework (2011) and the Draft Water Bill (2014/15) are formulated consistently by classifying the water sector into two (2) major categories, namely the Water Resources Management and the Water Supply and Sanitation (see the figure below).

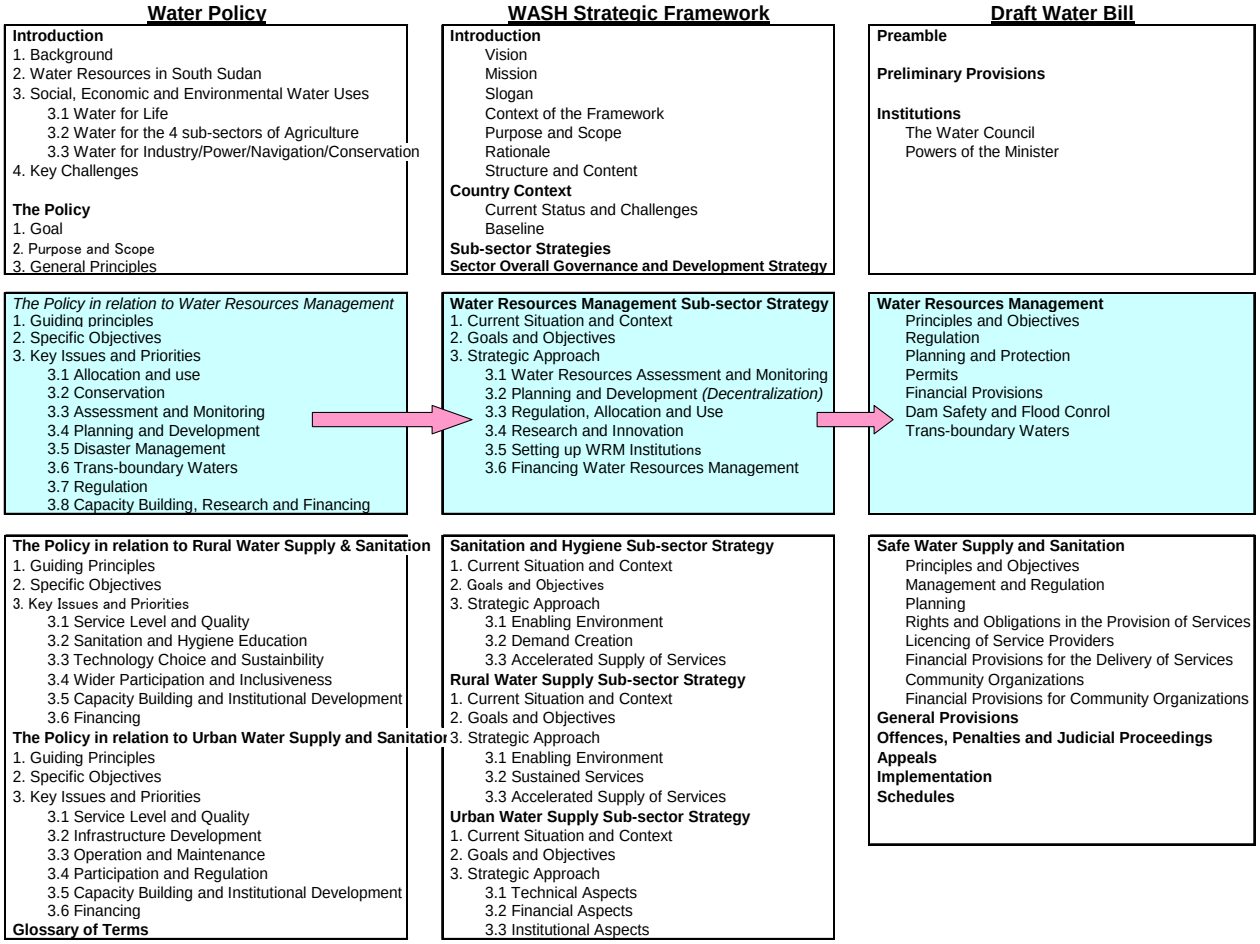

Figure 3.1.1Contents and Prospects of Water Policy, WASH Strategic Framework and Draft Water Bill

The chapter further details land policy, in the light of agricultural and irrigation investment, including 1) land administration and investment promotion; 2) issues related to land right, acquisition and grabbing; and 3) the institutional weakness. It then proceeds to scrutinize the human resources situation for irrigation development/management and suggests remedial measures; and it evaluates irrigation development potential assessment results and addresses factors affecting it, with emphasis on 1) lack of information and its mitigation plus future measures and 2) data storing and management considerations.

Also, it considers Irrigation Systems Establishment aspects, e.g. means of involving various stakeholders, namely 1) participatory irrigation management; 2) irrigation management transfer (IMT); 3) research and extension services; and 4) financial arrangements such as beneficiary cost sharing). After that it reviews requirements for 1) feasibly planning irrigation development, by considering factors of viability such as dependable sources of water; 2) rehabilitating the existing irrigation schemes; ensuring availability of spare-parts; 3) financial viability of irrigation schemes; and enabling marketing, i.e. the infrastructure, including a feeder linking to main roads and direct access roads to markets, storage facilities, agro-processing facilities, etc.

In conclusion, it emphasises the high potential for smallholder irrigation schemes/farms, based on the lessons learned from irrigation practices in other countries across the world, as per the knowledge of the Literature Study and exposure visits abroad.

Concerning this chapter, in addition to its main summarised text, reference is made to 1) the comprehensive analyses of the existing policy, institutional, legal and strategic framework (Annex 1); 2) assessment of the existing irrigation schemes/farms through field surveys, literature study and learning from the exposure visits to other countries (Annex 2); 3) detailed report of the physical assessment of the irrigation development potential (Annex 3); and 4) capacity needs assessment and proposed remedial measures (Annex 4: human resources and institutions).

CHAPTER 4 ZONING FOR IRRIGATION DEVELOPMENT AND IRRIGATION MODELS

This chapter aims to suggest an applicable irrigation methodology to each of the zones determined through their characteristics. In the IDMP formulation process, proposed irrigation schemes have been therefore, categorized by zones according to their locations. The chapter therefore, explains information used on zoning for irrigation development, which include 1) topographical information from a digital elevation model (DEM); 2) rainfall contour map (prepared by IDMP-TT); and 3) groundwater potential map (prepared by IDMP-TT). The relation between elevation and terrain slope was verified and the RSS was classified into four (4) zones in consideration of topographical features as shown in Table 4.1.1 below. The chapter then outlines and summarizes characteristics of each of the four (4) Irrigation potential Zones as shown in Table 4.2.1, depending on elevation, terrain slope, applicable irrigation development mode/model, and the scale of potential irrigable land.

Table 4.1.1 Characteristics by Zone

Name of Zone	Characteristic
1. Mountainous Area	Elevation is more than 600 m, comparatively steep terrain with slope 1/500 to 1/1,500.
2. Intermittent Area	Elevation from 400 to 600 m, terrain with slope 1/2,000 to 1/5,000.
3. Plains	Elevation around 400 m, very gentle terrain with slope 1/5,000 or less.
4. Wetlands and River Corridors	Elevation (less than the plains around it) and terrain slope less than 1/5,000.

Table 4.2.1 Characteristics and Suitable Irrigation Modes/Models by Zone

Zone	Elevation	Terrain Slope	Irrigation Modes			
			Types	Techniques/Methods	Sources of Water	Scale
Mountainous Area	More than EL.600m	1/500 – 1/1,500	Dominated by pressurised irrigation	Furrow, Terracing	Springs, aquifers and reservoirs	Micro/Small
Intermittent	EL.400 –600m	1/2,000 – 1/5,000	Mix of gravity, pressurised irrigation	Basin, Furrow	Rainfall, rivers, lakes, reservoirs and groundwater	Micro/Small/Medium
Plains	Around EL.400m	Less than 1/5,000	Dominated by gravity irrigation	Basin, Furrow	Lakes, rivers and reservoirs	Micro/Small/Medium /Large
Wetlands and River Corridors	Less than elevation of the plains around it	Less than 1/5,000	Mixed of gravity pressurised irrigation	Basin	soil moisture, rivers and lakes	Micro/Small

Note 1) Soil Type: LP; Leptosols, LX; Luvisols, RG; Regosols, VR; Vertisols, FL: Fluvisols
2) Landcover: TCO; Forest, SCO; Woodland, HCO; Grassland

Afterward, it continues, giving more reasons for delineating each zone alone, defining irrigation types and techniques (including possible sources of water and the purpose for assigning each of them to specific zones); and it finally discusses the analogy between irrigation potential zones and livelihood zones.

CHAPTER 5 THE IDMP STRATEGIC FRAMEWORK

This chapter sets the formulation logical flow (Figure 5.1.1) steps, namely 1) current situation and context, 2) setting of goals and targets, 3) strategic approaches, 4) elements and formulation of programmes (inclusive of projects and activities); delineation of roles and responsibilities; and specifically linked to the Comprehensive Agriculture Master Plan (CAMP), the IDMP framework is formulated.

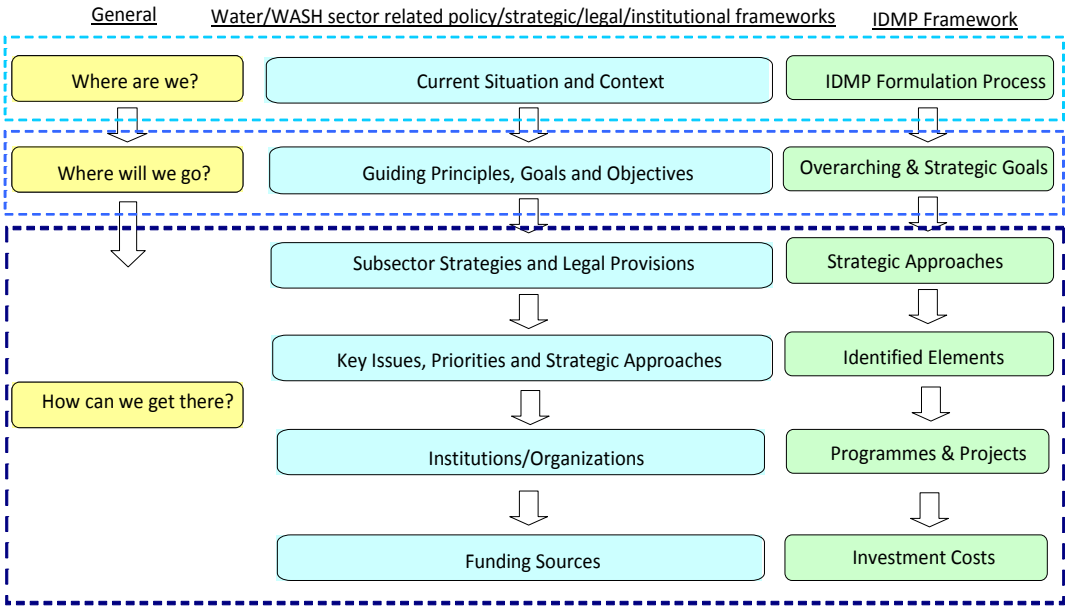

Figure 5.1.1 IDMP Framework Logical Flow

As such, from the water sector point of view, the IDMP's overarching goal has been set as "to achieve sustainable irrigated agriculture and other productive uses, thereby improving food security and resilience, reducing poverty, and contributing to economic growth and development".

Consistent with CAMP development themes and time horizons, the IDMP set and defined its strategic goals in three (3) phases, as: "1) to promote irrigated agriculture and other productive uses"; "2) to expand irrigated areas and improve productivity"; and "3) to ensure efficient and sustainable irrigation management" in the short term, medium term and long term respectively.

In order to set measurable indicators to evaluate the achievement of short, medium and long term strategic goals, the target development number of irrigation schemes is projected based on the population and cereals production forecast. In order to maintain the consistency with CAMP process, the basis of the projection was taken from the 25-year cereals production forecast of CAMP report. Table 5.2.2 shows the projections and setting of the targets in consistent with the CAMP forecast of population projections; and demands for cereals and their net production.

The number of schemes and the average size of small, medium and large-scale irrigation schemes are all provisional and hence the table can be revised and updated with the new set of schemes development projection.

Table 5.2.2 Cereals Production Projections and Irrigation Development Targets

S/#	Year	Unit	Yield (Net)	2015	By 2021	By 2027	By 2040	Remarks
1.	Population forecast (CAMP)			11,022,000	12,411,889	13,977,803	18,081,778	
2.	Cereals demand: CAMP forecast	ton		1,201,398	1,352,896	1,523,580	1,970,914	
3.	Projection of (Net) production by CAMP process	ton		800,000	1,268,510	1,879,681	3,113,457	
4.	**Target ratio of cereals production (ton) by irrigation to projected farmland**			**5%**	**10%**	**20%**	**40%**	
5.	Assumed farmland to fulfil production by CAMP forecast	ha		773,333	1,183,943	1,629,057	2,283,202	
6.	Required farmland to fulfil production **by rain-fed**	ha	1-t/ha (Net)	760,000	1,141,659	1,503,745	1,868,074	
7.	Required farmland to fulfil production difference **by irrigation**	ha	3-t/ha (Net)	13,333	42,284	125,312	415,128	Cumulative
8.	**Target ratio of irrigation area to projected farmland**			**2%**	**4%**	**8%**	**18%**	Cumulative
9.	Percentage to country potential land (190,000 km^2)			0.07%	0.22%	0.66%	2.19%	Cumulative
10.	Percentage to national land (640,000 km^2)			0.02%	0.07%	0.20%	0.65%	Cumulative
11.	Projected farmland to come under irrigation development/production in each time horizon	ha	3-t/ha (Net)	-	42,284	83,028	289,816	Periodic Increment
12.	Target number of irrigation schemes to be developed by time horizon			Time period	2015-2021	2022-2027	2028-2040	
				Small-scale	S: 338	S: 476	S: 1,261	Periodic Increment
				Medium-scale	M: 25	M: 100	M: 456	
				Large-scale	L: 3	L: 14	L: 66	

Note: Assumed cereals yield (Forecast by CAMP report, Annex III) under irrigation is 3-t/ha (target of ASPF, 2012-2017).

With the assumed cereals yield of 3-t/ha on average under irrigation (Forecast by CAMP report, Annex III), the target of ASPF, 2012-2017. In row 7 of Table 5.2.2 above, target areas for irrigation are the per cents of projected production in row 3 divided by this assumed yield.

Also, in the table, production difference is calculated by subtracting the current net cereals production from the projected production by 2040, which is equal to the assumed area to come under rain-fed with an assumed average yield of 1-t/ha. Then the required irrigated area to produce the difference to fulfil the projected production is calculated with the same assumed average yield of cereals with irrigation (3-t/ha). With these assumptions, it is estimated that developing 415,128 ha of irrigated agriculture would support achieving the projected cereals production by 2040. This size is just 0.65% of the national land (2.19% of the totally assessed irrigation potential of the country).

This leaves great opportunities for irrigated rangelands; fish farming; afforestation; agro-industries and agribusiness based crops production; and the other sectors and stakeholders. The following are provisional irrigated agriculture projections for demonstrating the targets assumed to fulfil the forecast of CAMP process (Table 5.2.3 below).

Table 5.2.3 Target percentage of Types of Schemes by Assumption

Type of Scheme	Ave. Size (ha)	Planning Horizons									Remarks
		By 2021			By 2027			By 2040			
		%age	Area (ha)	no	%age	Area (ha)	no	%age	Area (ha)	no	
Small-scale	100	80%	33,827	338	65%	81,453	814	50%	207,564	2,075	Cumulative
Medium-scale	250	15%	6,343	25	25%	31,328	125	35%	145,295	581	Cumulative
Large-scale	750	5%	2,114	3	10%	12,531	17	15%	62,269	83	Cumulative
Total		100%	42,284	366	100%	125,312	957	100%	415,128	2,740	Cumulative

Source: IDMP-TT

Table 5.3.1 summarizes the results of the situation analyses, categorised into four categories with associated challenges and available opportunities as: (1) policy and institutions; (2) natural resources and their utilization; (3) human resources; and (4) information base.

Table 5.3.1 Summary of the Current Situation in Irrigation Sub-sector

Category	Challenges	Opportunities
Policy and Institutional Framework	• Absence of irrigation policy • Unclear demarcation of responsibilities and roles among institutions • No specific guidelines for policy adoption (land policy, environmental policy, water policy) • No clear demarcation of responsibility for the existing schemes (e.g. Aweil Irrigation Rice Scheme) • O&M system in Aweil scheme is dependent on the government.	• Water Resources Management framework is in progress • Recognition of joint responsibility of MEDIWR and MAFCRD
Natural resources & their utilization	• Erratic rainfall • Flood and drought occurs (control of water is required) • Less investment in irrigation (collapsed irrigation schemes left without comprehensive operation, maintenance and rehabilitation)	• Abundant irrigation development potential has been identified from the several points of view: water resources, land productivity and socio-economic potentials.
Human resources	• Limited number of capable human resources for irrigation • Limited HRD institutions (training & research centres & universities) • Limited capacity of farmers for irrigated agriculture	• Irrigation and Agriculture administrative structures in place
Information base	• Limited number of hydro-meteorological measurement stations • Absence of nationwide water resources planning, monitoring and assessment system	• Long history and experience of hydro-meteorological measurement in certain locations across the country • The first nationwide hydro-meteorological information mapping has been made with available data through IDMP formulation process

The challenges in each category were further analysed and discussed and approaches stated and adopted as follows:

1. On Policy: Formulating a guideline for irrigation development and management in accordance with the on-going national water resource management framework;
2. On Natural Resources & their Utilization/Management: Exploiting the potential for irrigation development (using an appropriate technology) through participation & cooperation among stakeholders (governments, farmers, communities, DPs & the private sector);
3. On human resources: Developing capacity of existing staff/professionals/technicians/farmers;
4. Establishing training/education/research institutions to supply generations of knowledgeable and skilful human resources; and
5. On Information Base: Establishing of nationwide Hydromet information M&E system by increasing actual measurement stations.

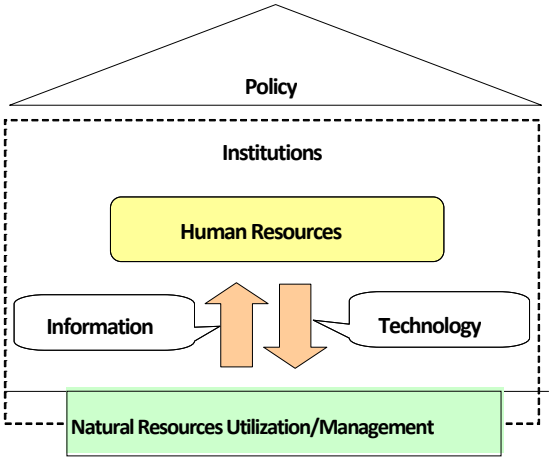

Figure 5.4.1 Dimensions of the Strategic Approaches

Considering available opportunities together with the four (4) categories and the associated challenges, further categorisation was made in a building blocks form as 1) policy on the top, followed by 2) institutions, 3) human resources, and 4) information and technology respectively in the middle, and 5) natural resources and their utilization as the base (depicted in Figure 5.4.1). The five building blocks were further analysed, discussed and regrouped as IDMP elements, introduced in section 5.5, namely:

(1) Policy, Legal and Regulatory Framework: To deal in an elaborated manner with the policy part of the first category, expanding on the basis of the stated approach, to include legal and regulatory issues;

(2) Institutions and Capacity Development: To tackle institutional and human resource aspects; and
(3) Irrigation facilities development and management: To combine information base, technology and natural

resources utilization and management.

As IDMP adopted a programmatic approach, section 5.6 introduces the nine (9) programmes that have been prepared under the elements, in order to translate the strategic approaches into actions. In section 5.7, delineation of responsibilities among organisations involved was addressed. Different types of participants and their roles, including through consultation, an approval process, supervision, coordination, reporting, and different means of contributions are demonstrated in the matrix below. In section 5.8, the relation between IDMP and CAMP is demonstrated, as IDMP will continuously provide information on hydrometeorology, topography, land use and other engineering aspects pertaining to water control and delivery infrastructure at some farming, aquaculture, forestry and livestock project/scheme sites.

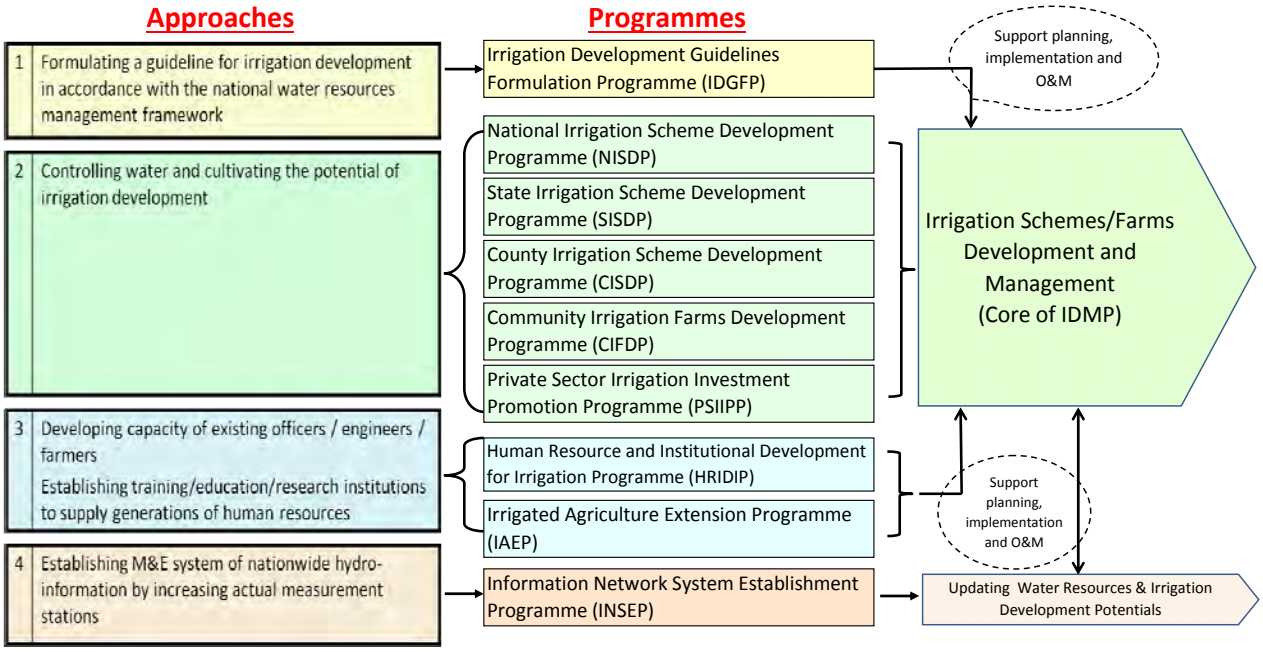

Figure 5.6.1 Strategic Approaches and Corresponding Programmes and their Synergies

CHAPTER 6 PROGRAMMES

This chapter outlines the nine (9) programmes that have been identified to achieve the strategic goals of irrigated agriculture and other productive uses of water without jeopardising needs of the other sectors and stakeholders. Table 6.1.1 summarises the outline of each programme for which details are shown in the Programmes' Profiles (Annex 6).

Among the nine (9) programmes, in relation to physical establishment, the programmes pertaining to irrigation schemes'/farms' development, are defined as "five (5) with different ownerships, namely; national irrigation scheme; state irrigation scheme; county irrigation scheme; community irrigation farms; and private sector irrigation investment promotion.

The other four (4) programmes, namely "irrigation development guidelines formulation, irrigated agriculture extension, human resources and institutional development and information network system establishment", are defined as "soft component programmes", to enhance and promote development and management of the irrigated agriculture and other productive uses of schemes/farms efficiently and effectively.

Table 6.1.1 Outline of the Programmes: Irrigation Scheme/Farm Development Programmes

Programme	ID	Outline
National Irrigation Scheme Development Programme (NISDP)	02	To establish Irrigation Schemes by the National Government as the main owner and operator of irrigation facilities. The Programme covers the irrigation potential areas all over the country.
State Irrigation Scheme Development Programme (SISDP)	03	To establish Irrigation Schemes by the State Governments as main owners and operators of irrigation facilities. SISDP will deal with water delivery and control systems for small to medium scale farming. SISDP covers the irrigation potential areas in all the states and the administrative areas, excluding the areas cutting across their boundaries.
County Irrigation Scheme Development Programme (CISDP)	04	To establish Irrigation Schemes by the County (LG) as the main owner and operator of irrigation facilities. The Programme covers the irrigation potential areas in all the counties, excluding the areas cutting across their boundaries.
Community Irrigation Farms Development Programme (CIFDP)	05	To establish smallholder Irrigation Schemes by the communities as main owners and operators of irrigation facilities. The programme will focus on facilitation and capacity development of communities, to be able to establish small-scale irrigation farms using available and accessible resources. Specifically, the Programme is to provide technical assistance to the community farmers on how to plan irrigation farm development and management; and on O&M requirements i.e. on how to perform and carry out good land and water control practices for crops production.
Private Sector Irrigation Investment Promotion Programme (PSIIPP)	06	To formulate a system for providing an enabling environment for private sector investment in irrigated agriculture and other productive uses of water, while complying with relevant policies, laws, regulations and standards. The guiding documents and associated procedures will be periodically reviewed in the course of promoting business enterprises in irrigation development.

Note: ID corresponds to the Programme Profiles

Table 6.1.2 Outline of the Programmes: Soft Component Programmes

Programme	ID	Outline
Irrigation Development Guidelines Formulation Programme (IDGFP)	01	To develop guidelines for irrigation development and management of irrigation schemes at all levels. Preliminary guidelines will be developed within the master plan and will be updated afterwards.
Human Resource and Institutional Development for Irrigation Programme (HRIDIP)	07	To capacitate human resources (staff/professionals/technicians/farmers) and to establish training/education/research/management/governance institutions, to provide training opportunities and to establish a human resource and institutional development (HRID) monitoring and feedback system. The training can be divided mainly into two categories: on-the-job and off-the-job training. Opportunities of advanced formal education will also be provided for specified technical officers. HRID monitoring and feedback system will be established for ensuring HRIDIP to be accomplished as expected for ensuring the effectiveness and efficiency.
Irrigated Agriculture Extension Programme (IAEP)	08	To develop extension programme for irrigated agriculture and disseminate innovative farming methods to farmers with regards to irrigation, drainage and other water control/conservation measures. Particularly this programme focuses on the capacity development of farmers for "on-farm water management". Stable water supply and control will enable diversification of crops and improve productivities through good land and water management practices. Therefore, the programme also covers dissemination of innovative farming methods of various crops.
Information Network System Establishment Programme (INSEP)	09	To establish information network system and measurement facilities by the National Government for hydro-meteorological and land use monitoring, among others. Hydromet information/data measuring stations will be installed at appropriate locations within some river basins/watersheds. A centralized system to collect, analyse and manage data from all the stations will be established to support planning/design, O&M and decision-making.

Note: ID corresponds to the Programme Profiles

Besides the other participating stakeholders and development partners the lead implementing national institutions have been distinguished and their respective roles and responsibilities have been defined (Figure 6.1.1). Irrigation schemes/farms have been classified and their ownership has been defined, depending on the ability and extent of responsibility for a stakeholder.

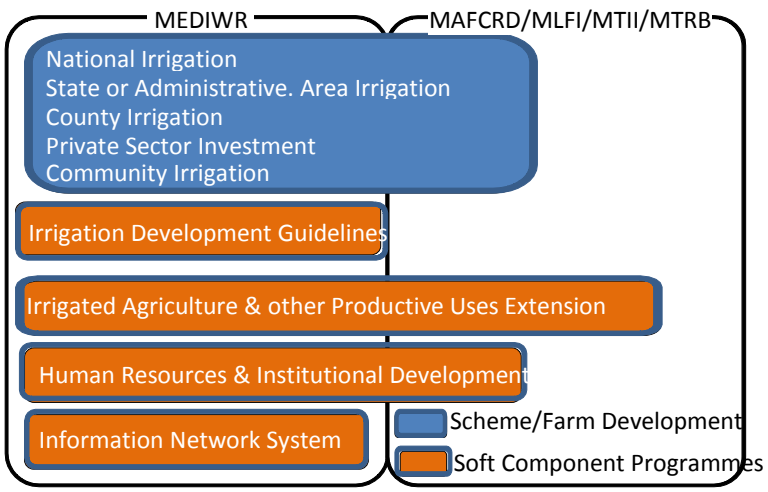

Figure 6.1.1 Division of Responsibilities & Collaborating Implementers

For instance, the capability to make the investment and to carry out other related interventions and perform associated duties in irrigation development and management as efficiently and effectively as possible were put into consideration. Table 6.1.3 summarises the classification of the programmes and projects in addition to the assignment of roles and responsibilities among organisations and stakeholders involved.

Table 6.1.3 Classification of the Programmes and Projects

Programme	Scheme/ Farm Size	Definition	Responsible Organization for Land Allocation	Ownership	Technical Assistance	Capital Investment i.e. funding source for implementation	O&M (Short-term)/a	Supervision of Scheme/Farm Management (Short-medium term)/b
National Irrigation Scheme Development Programme (NISDP)	500 ha or more	Large scale	National/ Community	Land property acquired by National Government	National/ DPs	National/Private Sector (Bank)/ International Development Bank/DPs (grant)	National/IB/ WUA	National
State Irrigation Scheme Development Programme (SISDP)	Up to about 500 ha	Medium scale	State/ Community	Land property acquired by State Government	National/ DPs/	State/ National/ Private Sector (Bank)/ International Development Bank/DPs (grant)	National/ State/IB/ WUA	State/ National
County Irrigation Scheme Development Programme (CISDP)	Up to about 200 ha	Small scale	County/ Community	Land property acquired by Local Government	National/ State/DPs	County/State/ National/ Private Sector (Bank)/DPs (grant)/ NGOs	National/ County/IB WUA	County/ State/ National
Community Irrigation Farms Development Programme (CIFDP)	Up to about 200 ha	Small scale	Community	Land property acquired by Community group	National/ State/ County/ DPs/ NGOs	Community/County/State/National/ Private Sector (Bank)/DPs (grant)/ NGOs	National/ State/ County/ Community/ IB/WUA	Community/ County/State/ National
Private Sector Investment Promotion in Irrigation Development Programme (PSIPIDP)	Undefined	Undefined	National/ State/County/ Community	Land property acquired by Private Sector Organization	Private Consultants/ Government Facilitation	Private Sector, Government Support and Community Contribution	Private Sector WUA, IB, BW & C/SC	Private Sector

Note:
a/ Operation and maintenance of irrigation schemes/farms could transfers to Irrigation Boards (IBs), Waters Users' Associations (WUAs), Farmers, in medium to long-term, depending on their capabilities.

b/ Supervision of scheme/farm management could transfers to states' governments, local governments and community development committees in the long-term, depending on their capabilities.

The implementation process has been laid out, e.g. according to the irrigation development potential, the irrigation

scheme/farm area will be identified, and the planning, design and investment will be facilitated as schematised in Figure 6.1.2. The process of identification of an irrigation development area, decision of investment, and implementation would differ by the category of the programme. The process of identification of an irrigation development area, decision of investment, and implementation would differ by the category of the programme.

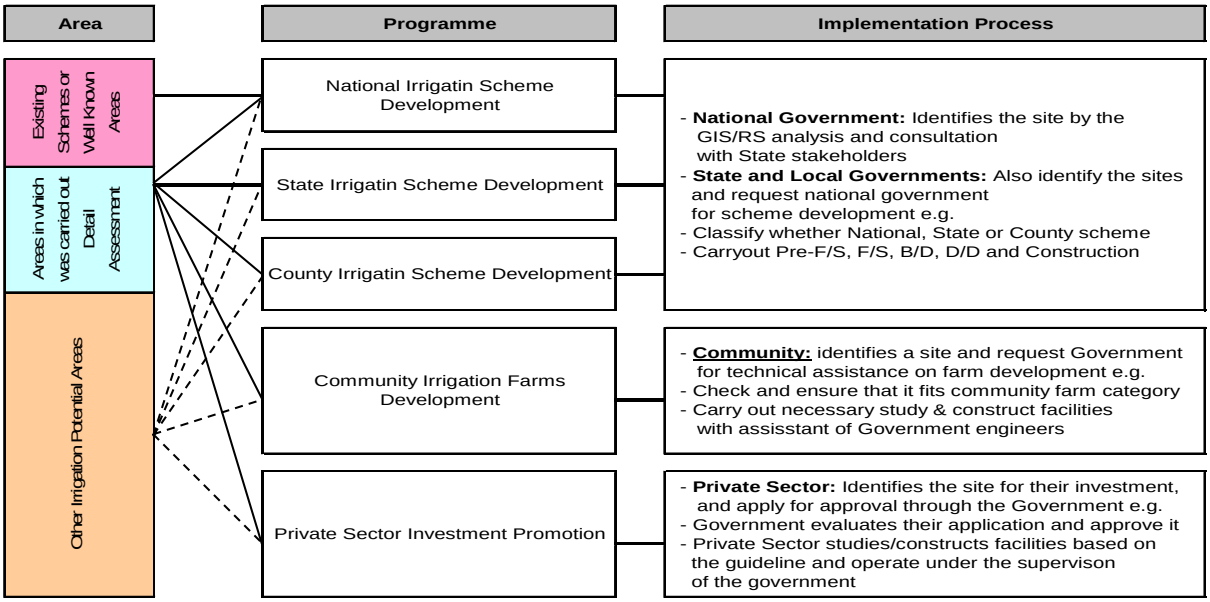

Figure 6.1.2 Implementation Process of the Programmes

Implementation matrix by programme & time horizon has been provided as summarised in Table 6.1.4.

Table 6.1.4 Programmes Implementation Matrix by Time Horizon

S/#	Programme	Short-term (2015/16-2021/22)	Medium-term (2022/23-2027/28)	Long-term (2028/29-2039/40)
1	Irrigation Development Guideline Formulation Programme (IDGFP)	• Guideline formulation based on the preliminary ones formulated during IDMP	• Revision of guideline	• Revision of guideline
2	National Irrigation Scheme Development Programme (NISDP)	• Implementation of priority area • F/S for schemes in priority watershed • High resolution analysis in other watershed	• Implementation of priority schemes • F/S for schemes in priority watershed • High resolution analysis in other watershed	• Implementation of priority schemes • F/S for schemes in the watershed with high resolution analysis done
3	State Irrigation Scheme Development Programme (SISDP)			
4	County Irrigation Scheme Development Programme (CISDP)			
5	Community Irrigation Farms Development Programme (CIFDP)	• Pilot (Model) project Implementation	• Expansion of implementation	• Expansion of implementation
6	Private Sector Irrigation Investment Promotion Programme (PSIIPP)	• System and guideline formulation • Promotion of private sector investment	• Revision of system • Promotion of private sector investment	• Revision of system • Promotion of private sector investment
7	Human Resource and Institutional Development for Irrigation Programme (HRIDIP)	• Training programme • Training centre establishment	• Training programme • Monitoring and feedback	• Training programme • Monitoring and feedback
8	Irrigated Agriculture Extension Programme (IAEP)	• Pilot (model) project in relation to CIFDP • Extension to the irrigation farms/schemes	• Extension to the irrigation farms/schemes	• Extension to the irrigation farms/schemes
9	Information Network System Establishment Programme (INSEP)	• Planning & designing the measuring, M&E system • Strengthening function of the centre	• Establishment of measuring stations • Establishing the information network and M&E system	• Renewal of water resources potential assessment

Also, an implementation schematic by time horizon/project/activity has been provided (Figure 6.1.3).

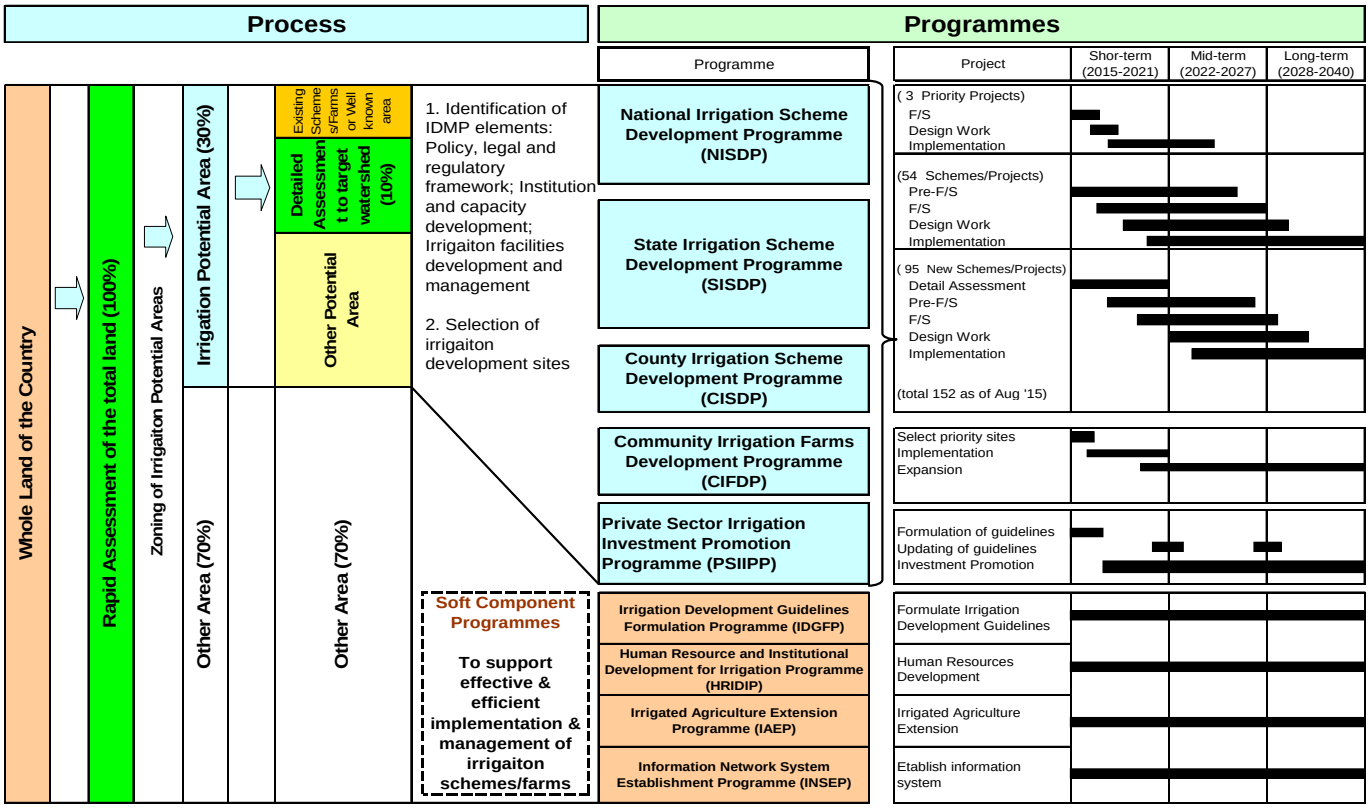

Figure 6.1.3 Implementation Horizon according to the Degree of Information Available

The synergetic effects of the programmes with one another during the implementation has been elaborated and depicted in Figure 6.1.5. The chapter then further gives major outputs and cost estimates in subsection 6.1.5, outcomes & impacts in 6.1.6 and implementation aspects in section 6.2. In addition, complete programmes' profiles are attached as Annex 6 and the cost estimates are attached as Annex 7.

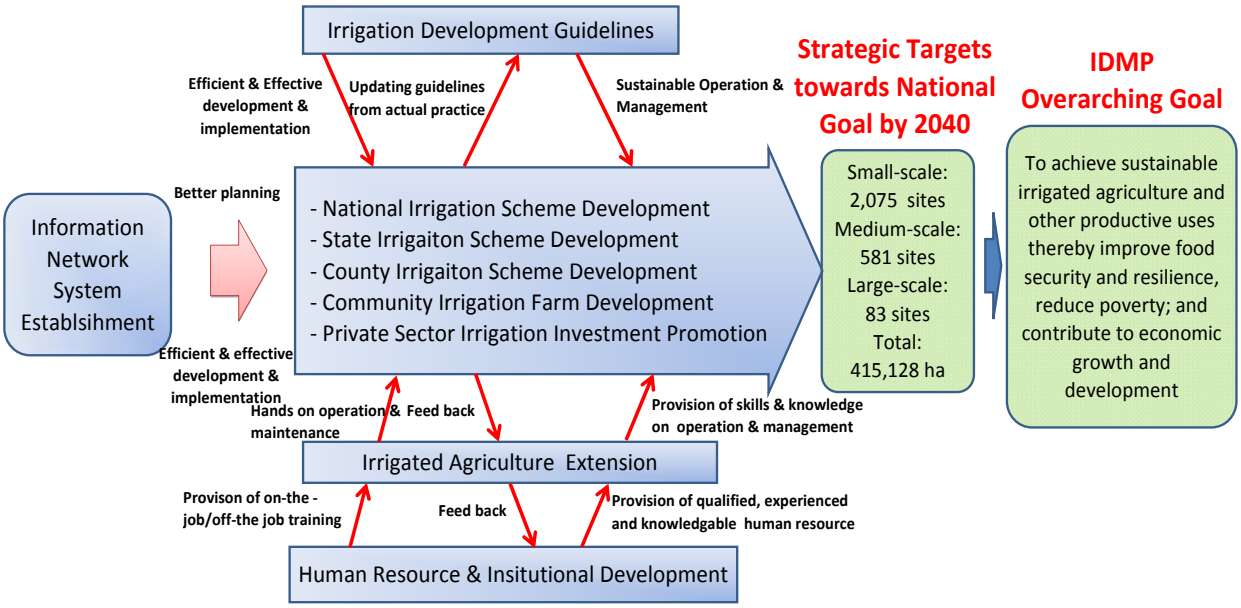

Figure 6.1.5 Synergetic Effects of the Programmes Implementation

CHAPTER 7 IMPLEMENTATION MECHANISM

This chapter describes the CAMP/IDMP Implementation Coordination Structure (ICS) as shown in Figure 7.1.1, including national, state, and local levels of legislative, executive and technocratic bodies that will have overall responsibility for CAMP/IDMP implementation coordination and facilitation.

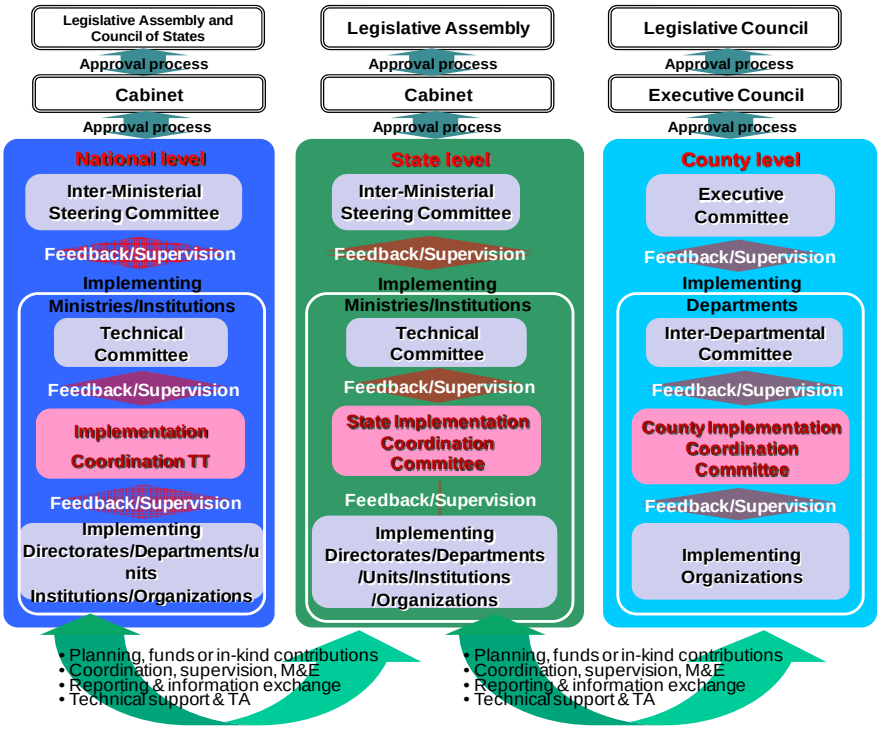

Figure 7.1.1 CAMP/IDMP Implementation Coordination Structure (adopted from CAMP-TT)

The CAMP/IDMP ICS defines levels of authority and functions given to each CAMP/IDMP-related entity within a defined decision-making process of the overarching government establishment.

The CAMP/IDMP Implementation Coordination Task Team (ICTT) is responsible for the overall coordination and facilitation of the implementation at the national level; and the state implementation coordination committees (SICCs) and county implementation coordination committees (CICCs) are responsible for the coordination and facilitation of the implementation at the state and local levels respectively. ICTT, SICCs and CICCs coordinate and facilitate mobilisation of resources internal and external investment to promote the implementation. They coordinate, monitor and share information on the implementation of CAMP & IDMP at respective levels and in an interface between levels. MEDIWR and the state/county line ministries, directorates, departments and units will assign personnel into ICTT, SICCs & CICCs, to coordinate and facilitate the implementation of IDMP in conjunction with CAMP.

Reference is made to the Inter-Ministerial Steering Committee Meeting held on 4th of August 2015, among representatives of the ministries in charge of the sectors related to CAMP and IDMP from national and state levels. The meeting discussed the final draft IDMP and the proposed CAMP/IDMP ICS at national, state and county levels, which was presented as shown below (Figures 7.1.2, 7.1.3 and 7.1.4 for national, state and county levels respectively). After discussion the participants agreed to the proposal as advisable compositions.

ICTT, SICCs and CICCs will have similar compositions for similar functions. The basic structure comprises of members from MAFCRD, MLFI, MEDIWR, MTII and MTRB at national level; and from their state/county line ministries, directorates, departments and units as implementing institutions; in addition to members from community

organs, consultants and secretaries. Secretaries are expected to support basically administrative functions; and the logistical tasks, which include handling of communications and documentation. The Technical Assistants (TAs) or the consultants are to help in technical aspects of the ICTT, including preparation of annual work plan and budget (AWPB); and carrying out of M&E.

It is anticipated that development and implementing partners (donors, International Banks and NGOs, UN Systems, etc.), together with the government would support and finance recruitment of the secretaries and consultants; and DPs can directly provide technical assistants (TAs). ICTT, SICCs and CICCs, as a team, will establish a good relationship with DPs, participating and coordinating authorities and organisations, from whom they will get inputs.

At national level, ICTT was established in August 2015; and the SICCs and CICCs at state and county levels respectively will be gradually established according to the progress of programmes/projects implementation and actual situation in each state or county. The compositions presented here are flexible; and can be modified, based on the convenience or capacity of the government at respective levels.

The chapter further describes the IDMP workflow under the CAMP/IDMP Implementation Coordination Mechanism, which should be aligned with the government's public financial management system (PFMS), Figure 7.2.1.

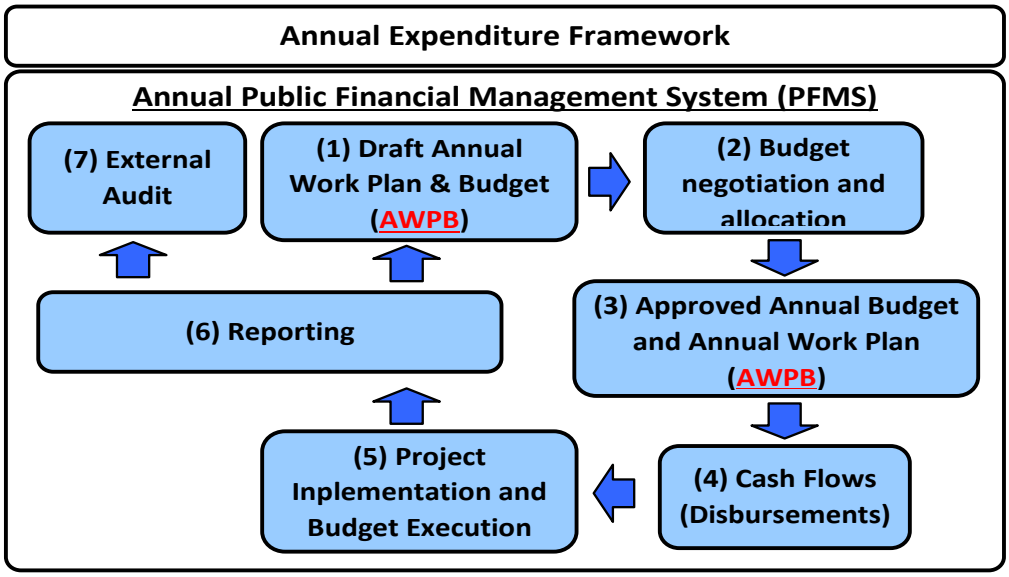

Figure 7.2.1 Public Financial Management System (PFMS): Adopted from CAMP-TT

Figure 7.2.2 describes the workflow of IDMP in its implementation under the CMAP/IDMP implementation mechanism, consisting of the annual work plan and budget (AWPB) and periodical reviews and updates.

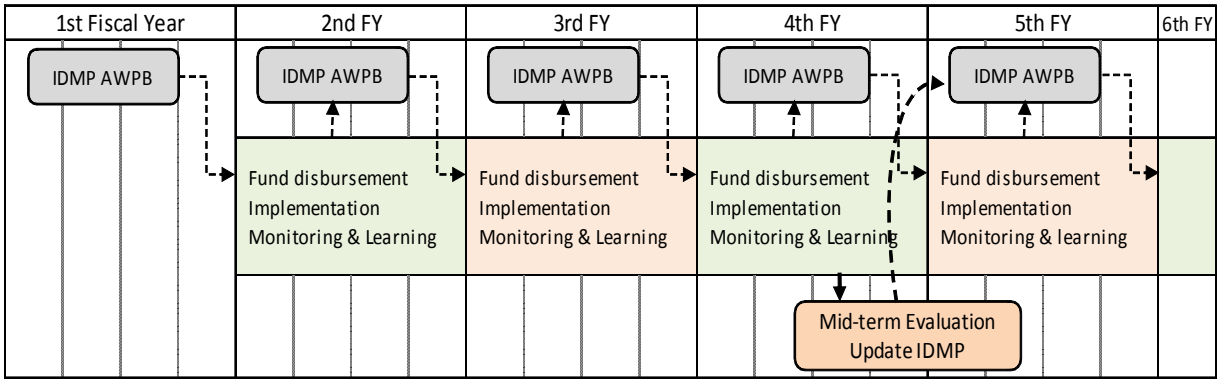

Figure 7.2.2 Proposed IDMP Basic Workflow

CHAPTER 8 IMPLEMENTATION PLAN FOR PRIORITY PROJECTS

This chapter highlights and summarizes the implementation plan for the three (3) priority projects' sites, namely Wau, Jebel Lado and Rejaf East. It begins with the objectives for the preparation of priority projects, followed by the presentation of the situation of the projects' areas, namely 1) natural conditions; 2) socio-economics; 3) agricultural practices and plans; and 4) development constraints and potentials. The profiles of the three project sites have been given in table 8.2.1.

Table 8.2.1 Profile of the Projects' Areas

Site Name	Wau	Jebel Lado	Rejaf East
Location	Just east of Wau city.	20 km north of Juba, left bank of Bahr el-Jebel	Just south of Juba, on the right bank of Bahr el-Jebel
Water Source	River Jur	Bahr el Jebel	Bahr el-Jebel
Command Area	500 (ha)	1,330 (ha)	960 (ha)
Land Tenure	Government and community	Nyuwa and Peiti communities	Guduge, Migiri and Mugoro communities
Population (Related Community)	About 24,000 (Total population of Panamet Kuanya and eastern part of Wau Municipality)*Kuanya is located near the proposed dam site and Panamet is located north of Command area and Wau municipality is south.	About 2,800 (Total population of Nyuwa and Peiti)	N/A (Total population of Guduge, Migiri and Mugoro)
Surrounding Situation	Located close to Wau city, where there is much demand for agricultural produce. Land development for agricultural production project in Wau and Aweil, supported by UNDP and FAO, was started in 1974. One of the target crops was paddy. However, no activities in Wau irrigation scheme have been carried out, because Aweil Irrigation scheme did not yet worked properly.	Located close to Juba, where there is high demand for food supply due to its large population. Hence, there is a high potential to generate cash income by producing cash crops. Especially, leafy vegetables, which are not imported because of its perishability, are likely to make a good profit.	Also, located in the vicinity of Juba, where there is high demand for food supply due to its large population. Hence, there is a high potential to generate cash income by producing cash crops. There are some farmers who have already been cultivating crops by irrigation using portable pump. Land holding there is complicated hence needs careful consideration.

Natural condition surveys consisting of topography, geology and soil were carried out in the target project's areas; Table 8.2.2 summarizes the natural conditions of the project areas.

Table 8.2.2 Natural Conditions of the Project Areas

Area / Feature	Wau	Jebel Lado	Rejaf East
Topography	Command area is located beside Wau town, and has the feature of bare land without planting in the flood plain. The land is approximately flat and the land gradient toward right bank of River Jur shows around 0.2% slope. Dam site is located 9.5-km from Wau town at the eastern banks of Jur and River Swe. The land cover in the site is bushes and grasses. Pump station and canal line are located between the command area and the dam site. There are trees, small communities, farms, etc. along the line.	Command area is located 3.5-km from Bahr el-Jebel. Bushes, trees and grasses dominate in the site. Generally, the terrain is almost flat and the land gradient toward the west from left bank shows around 0.9% slope. Pump station site is located beside Bahr el-Jebel. The land is almost bare, but some trees exist. In the pipeline and canal line, there are community roads among some small communities, bushes and trees, etc. along the lines.	Command area is located at the right bank of Bahr el-Jebel and stretch 2-km toward the hillside. The terrain between riverside and Juba-Rejaf-Nimule Road is flat, and many small irrigation farms are scattered along the river. The terrain of hillside is undulant, and many bushes, trees and grasses dominate in the site. Pump station site has some big trees. In the pipeline and canal line, the conditions are almost the same as the command area.
Geology	In the dam site, dense/ very dense layer such as sand, gravel and rock are distributed below the depth of 6-m at dam centre and right side. The soils are classified into silty sands (SM) and Clay loam (CL), which are useful for dam embankment materials. In the canal line, clay or silt layer covered the ground surface and the subsurface soils are predominantly sand. According to N value (as per soil penetration test, SPT), these soils are generally suitable for the foundation of structures.	In the pump station site, the subsurface soils are predominantly sandy clays (SC) and poorly graded sands (SP). Bearing capacity, ranges from low to middle for the foundation structures. In the canal line, the subsurface soils vary by area, such as sands (SP and SC) to gravels (GW), inorganic clays of high plasticity (CH)) and silty sands (SM). Bearing capacity is high for the foundation of structures.	The pump site area is covered by thick (3 m - 8 m) layer of soils（ML, CL, SM, SC, SP）, the River deposit along the river bank and the base rock is Gneiss. The command area is covered by relatively thin (2m- 3m) layer of soil (SW). There are outcrops of sound bedrock in the command area. The rock underlying the thin soil layer is moderately weathered Gneiss and is found out slightly weathered and well-jointed Granite.
Soil	Its texture ranges mainly from Loam to clay loam. Orange coloured mottles of oxidized iron were observed on the section, indicating the area has been flooded and dried up repeatedly. High clay soil in deeper layer can help maintain water in rooting zone. Phosphorus and Magnesium are not contained enough, which should be supplemented by fertilizer. Soil pH is relatively low. It should be modified because soil acidity can constrain nutrient absorption by crop.	Its texture ranges from Clay loam to high clay, while soil near small streams, ranges from Sandy loam to Silt loam. Soil pH is relatively high, tends to be alkaline. It should be modified because pH directly affects the availability of nutrients in soil. Relatively fertile with high content of humus and cation exchange capacity (CEC). It allows cultivation of various crops with appropriate control of soil pH.	Its texture mainly ranges from Sand to Loam, which relatively tends to be sandy in texture compared to the other 2 sites. Soil pH values were mainly from 6.0-7.1, which is suitable for common vegetables, however, one point showed 8.9 so that some points in the area would have to be managed by pH modification. Humus content ratio and other nutrient contents vary; however Phosphorus, Magnesium and potassium contents tend to be low at some points.
Hydrology	Annual rainfall is about 1100mm, and annual river discharge of R. Jur is about 5,100 MCM. In rainy season, irrigable area is flooded by water from the river.	Annual rainfall is about 1000-mm. Bahr el-Jebel has dependable source of water for irrigation water, as it is a perennial river.	Annual rainfall is about 1000-mm. Bahr el-Jebel has dependable source of water for irrigation water, as it is a perennial river.

A socio-economic survey, including an agricultural survey, was carried out by the RSS-TT. The survey was carried out through interviews with key-informants of the projects' areas and through a questionnaire-based survey distributed to the community members in the areas. Table 8.2.3 summarizes the socio-economics in and around the project areas.

Table 8.2.3 Farmers' Capacity in the Projects' Areas

Wau	Jebel Lado	Rejaf East
Farmers in the community have an experience of irrigated farming along river using buckets in dry season cultivating tomato, eggplant and okra. They are currently cultivating cereals such as maize, millet, sorghum and rice and cash crops such as sesame and vegetables. Their produce is sometimes not enough even for their own consumption due to tiny farmland.	There are 2 communities; and one of them has an experience of irrigated agriculture using buckets near the river. They are currently cultivating staple crops, such as maize and sorghum mainly for consumption, while vegetables mainly for selling. It seems they have potential to cultivate cash crops in dry season.	There are 3 communities. Some farmers are practicing irrigated agriculture using small pump along the Bahr el-Jebel and they are cultivating banana and vegetables, which are mainly for selling. It seems they have potential to cultivate cash crops in dry season.

On the other hand, the agricultural practices survey included 1) farming area and land use, 2) present cropping pattern, 3) productivity, and 4) profitability.

From the sample farmers for the socio-economic survey, existing development constraints raised included: 1) damage from pests, diseases, and animals as major concerns of the farmers in the three (3) areas; in addition to 2) water shortage, drought damage, and drainage problem that are recognized as common issues in the three (3) projects' areas. Irrigated agriculture is not much practiced in the three (3) areas; therefore, awareness creation activities for irrigation development may be required as a solution for water problems.

The chapter then further explains planning of the three (3) priority irrigation schemes, including: 1) institutional set-up; 2) agricultural planning; 3) irrigation and drainage plan, i.e. irrigation water requirements (Table 8.3.8); 4) preliminary facility plan and design; 5) operation and maintenance plans, e.g. the establishment of a scheme management office and financial management plan; 6) investment and O&M cost estimates; 7) implementation plan; 8) environmental and social considerations; and 9) project evaluation (financial and economic analyses).

Table 8.3.8 Summary of the calculated Irrigation Water Requirement at each Project Site

Site	Wau	Jebel Lado	Rejaf East
Target Area	500 ha	1,330 ha	960 ha
Water Source	Dam or River	River	River
Irrigation Facility	Dam/Reservoir and Pump	Pump	Pump
Required Flows	Dam/Reservoir: 5,000,000 m^3/year (0.005BCM) (Vegetables, dry season) Pump: 0.70 m^3/s (Rice, rainy season)	Pump: 1.92 m^3/s	Pump: 1.32m^3/s
Irrigation Scheme/Farm Design Factor	q= 1.400 l/s/ha	q = 1.444l/s/ha	q = 1.430l/s/ha
Annual Irrigation Water Requirement	10,121,760 m^3 (0.01 BCM)	29,790,115 m^3 (0.03 BCM)	20,444,535 m^3 (0.02 BCM)

The projects' investment costs per hectare are estimated at 134,000 USD/ha; 25,600 USD/ha; and 24,000 USD/ha for Wau, Jebel Lado and Rejaf East respectively. Although the command area of Wau is smaller than the other two sites, the cost per ha of Wau is much higher due to the cost of the required water harvesting and storage construction. Therefore, depending on works involved for sourcing/delivering/controlling water, the indicative investment cost per hectare, for bringing acreage of land under irrigation development, ranges from 24,000 USD/ha to 134,000 USD/ha. The annual recurrent costs are projected as 2,523,434 USD for Wau; 3,338,397 USD for Jebel Lado; and 2,948,499USD, which are very relative to the areas (3,158 USD/ha on average). As usual, when the initial costs may be deliberately high, e.g. by considering future expenditure or most feasible technology, Wau turns out to be the least

cost recurrence wise.

Detailed plans, including field and socio-economic surveys analyses and results and initial environmental evaluations (IEE), are attached as Annex 9.

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INTRODUCTION

The Ministry of Electricity, Dams, Irrigation and Water Resources (MEDIWR) of the Republic of South Sudan (RSS) is a governmental organization whose mandate involved facilitation of the development, operation and management of water infrastructure for irrigated agriculture and other productive uses of the sector. This involves crop, livestock, forestry and fisheries subsectors, which are the subject of the Comprehensive Agriculture Master Plan (CAMP). The Irrigation Development Master Plan (IDMP) is a comprehensive programmatic approach to address policy, institutional, capacity development and infrastructure issues and requirements of the agriculture sector in relation to water resources across the country without jeopardising the needs of other sectors or stakeholders.

It is a road map in addressing existing challenges and making use of available opportunities through: 1) setting of guidelines and establishment of an information network; and 2) mobilisation of resources for investment and recurrent costs pertaining to human resources and institutions; carrying out of outreach and extension services; and development, operation, maintenance and management of facilities at irrigation schemes as well as for other production projects that require provision and management of water. IDMP therefore, describes proposed programmes/projects/activities of irrigation development and other productive uses of water, ranging from small-scale to large-scale with cost, location and planning horizon (short, medium and long), from 2015/16 to 2039/40 in a prioritised manner.

1. Rationale

In RSS, currently irrigated agriculture is practiced only on less than 5% of the cultivated land (National Bureau of Statistics (NBS), 2010)[i]. The natural conditions of the RSS are characterised by a diverse range of geographical regions, with annual rainfall ranging from less than 500 mm in the far North and far South-east to up to 1,500 mm in the South-west. Flood and drought occurs occasionally, threatening national food security, for instance, grain production in the year 2010 was 70% of the national requirement (FAO, 2010)[ii].

Fluctuation in annual production is significant due to the unstable climate that causes large inter-annual and annual fluctuations of precipitation, leading to either dry spells or droughts. Also, scarcity and lack of water are caused by low storage and low infiltration capacities, in addition to high evaporation and evapotranspiration demand. Hence, irrespective of the fact that South Sudan has substantial water resources, yet the country experiences water shortages; because they are unevenly distributed across the territory and vary substantially between years and seasons.

On the other hand, when peak of rainfall in July and August coincides with high river inflows from the upper catchments, extensive flooding occurs downstream due to river spills, local rainfall and flatness of the land over vast areas. This dual problem of dry spells and floods causes hazards to cultivation at its growing stage; destruction of trees due to inundation or drought; and impeding of livestock access to pasturelands and obstructing of fishing activities.

Under such circumstances, irrigation development is crucial, in order to stabilize the availability of water for the different livelihoods of the people in the country: crops, forestry, livestock and fisheries; and effectively utilize and efficiently manage the endowed water resources for agricultural production and productivity to enhance food security and resilience; and contribute to meeting of the other national needs and goals.

With this background the Government of RSS (GRSS) presented a request to the Government of Japan (GOJ) to provide the technical cooperation for formulating IDMP, with the then Ministry of Water Resources and Irrigation (MWRI), which was merged into MEDIWR representing GRSS. MWRI and JICA then agreed on the contents of the project for formulating the IDMP through "Minutes of Meetings pertaining to the detailed planning survey and Record of Discussions (RD) on the Project for IDMP" in April 2012 (Annex).

Given the fact that achieving the agricultural development objectives in all its facets requires provision and management of water to a greater extent; hence IDMP is positioned as a support plan to CAMP that is also formulated under JICA's technical cooperation. IDMP is, therefore, formulated under the same CAMP coordination mechanism that is composed of the Inter-Ministerial Steering Committee (IMSC), Technical Committee (TC), Task Teams (TTs) of CAMP and IDMP formulation, State Focal Points (SFPs) and participating stakeholder institutions and partner organisations.

The lead Ministry in IDMP formulation is MEDIWR in close collaboration with the Ministry of Agriculture, Forestry, Cooperatives and Rural Development (MAFCRD) and the Ministry of Livestock and Fisheries Industries (MLFI) that are leading CAMP process, with MAFCRD as a lead and MLFI as an alternate.

2. Objectives

2.1 Overall goal

IDMP's Strategic Goal is to achieve sustainable irrigated agriculture and other productive uses of water, thereby improving food security and resilience, reducing poverty and contributing to economic growth and sustainable development.

2.2 Specific objectives

Through the formulation and implementation of IDMP, the following targets, outputs, impacts and outcomes will be realised:

1. Promotion of irrigated agriculture;
2. Area under irrigation is increased;
3. Expansion of irrigated areas;
4. Agricultural production and productivity are enhanced;
5. Utilization and management of water resources in irrigated agriculture and other productive uses of the sector effectively;
6. Ensured efficient and sustainable development and management of irrigation schemes and other agricultural sector production and productivity projects; and
7. Undertaking of new approaches to irrigation and drainage systems.

2.3 Project targets

The following statement has been defined in the RD as the objectives of the Project for formulating the IDMP:

1. To formulate IDMP and
2. To strengthen the capacity of South Sudanese counterpart personnel through its formulation

process.

IDMP-TTs have also translated the above into more overarching target as follows:

3. To enable GRSS to carry out studies and examine irrigation potential across the country.

3. Scope of Work and Schedule of IDMP Formulation

The Project of IDMP covered the following tasks by the timeframe shown below:

Phase 1 (September 2012 - December 2012)
- Current situation analysis of the water sector
- Preparation of Inception Report

Phase 2 (March 2013 - December 2014)
- Assessment of water resources potential
- Formulation of strategic framework on irrigated agriculture development
- Zoning for irrigation development and identifying irrigation models by zone
- Formulation of procedures for environmental and social consideration for irrigation development.
- Preparation of topographical and geological surveys by sub-contractor

Phase 3 (January 2015 - November 2015)
- Proposing institutional management structures for irrigation schemes (O&M)
- Assessment and planning for human resources development
- Formulation of implementation plans for prioritized projects
- Formulation of IDMP

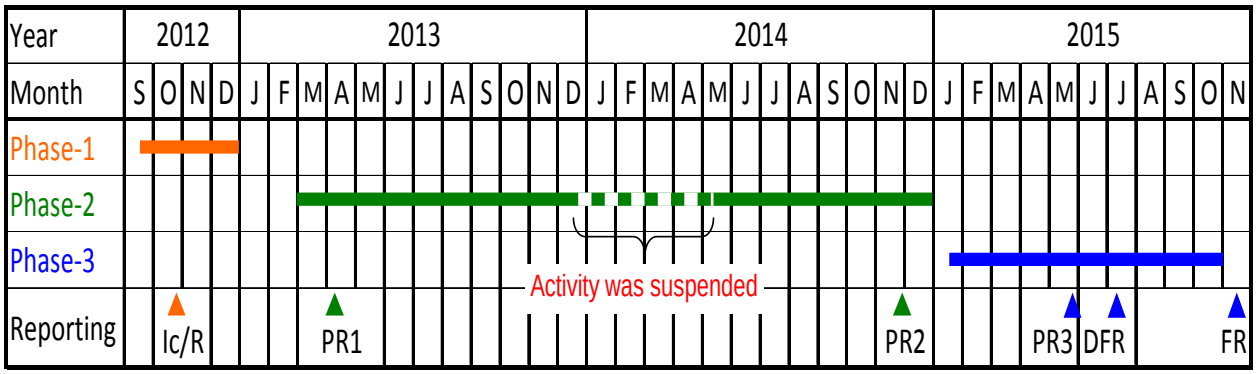


Figure 0.3.1: IDMP Formulation Timeframe

The timeframe for the Project for formulating IDMP was amended during the CAMP/IDMP meeting in Kampala March 2014 following the eruption of crisis in the RSS in December 2013, which affected the work progress. Finally, timeframe of the formulating IDMP was clarified as shown in Figure 0.3.1.

4. Basic Approach of IDMP Formulation Process

Participation and capacity development will ensure holistic preparation and design of IDMP as explained below:

4.1 Integrated water resources management

RSS has abundant water resources, but available waters are unevenly distributed across the country; and vary considerably from year to year and within a season.

Besides, drivers such as demographic and climatic changes water demand for domestic, productive and industrial uses is expected to grow rapidly in the near future. Thus further increase the stress on water resources, and therefore the conventional sectorial approach is no longer viable and a more holistic multi-sectorial approach to water resources development and management is essential.

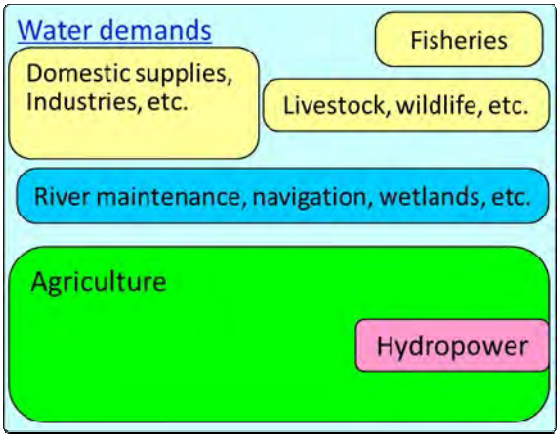


Figure 0.4.1: Different Water Uses/Users

Therefore, the Project for formulating the IDMP in its approach will comply with the Integrated Water Resources Management (IWRM) concept. The rationale for the IWRM approach has been accepted internationally as the way forward for efficient, equitable and sustainable development and management of water resources and for coping with conflicting demands.

The IWRM is a process that promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (Global Water Partnership, 2010)[iii]. This approach will ensure effective management; and appropriate development and utilisation of water resources that could be a key driver for poverty reduction and economic growth in RSS.

4.2 Stakeholders' participation

It has been realized that natural resources management-related policies including water requires the use of knowledge, experience and opinions of all the stakeholders, including local communities who are the key stakeholders in resource conservation.

This could be ensured through wider stakeholder participation, with special involvement of public/communities. Therefore, the IDMP process as stated in the implementation coordination mechanism will take into account participation whereby all the stakeholders at all levels will be involved in the process.

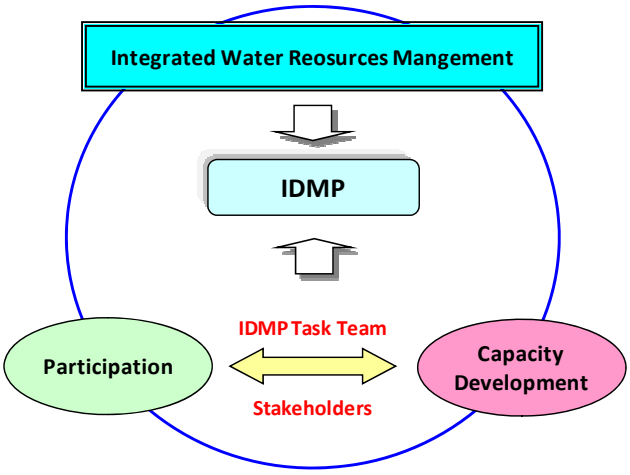


Figure 0.4.2: Basic Approach of IDMP

Focal points will be appointed in each state to coordinate the process at a local level, where stakeholders' consultation meetings/workshops will be conducted and field visits will be carried out.

This approach will ensure the considering of views and concerns of all the stakeholders and partners, hence ensuring approval, recognition and ownership of the IDMP by the government authorities at all levels, the public/communities, private sector and the development partners in RSS.

4.3 Capacity development

The Project for formulating the IDMP in its approach will make sure that the capacity of the national staff is strengthened by being fully engaged in the process and through trainings, technical seminars and exposure visits to other countries. Furthermore the IDMP-TTs (nationals, Regionals and the internationals) are working in thematic groups that systematically operate and manage the process together, which ensure full collective engagement and imparting of skills and knowledge to one another.

4.4 Coordination mechanism and operation management for IDMP formulation

The implementation coordination of formulating IDMP as a support plan to CAMP is built into the coordination mechanism of the CAMP formulation process shown in the figure below, which was originally presented in the 1st TC meeting held in September 2012 and updated later due to the restructure of GRSS involving the undersecretaries of MAFCRD, MLFI, MEDIWR and the representatives of JICA South Sudan office.

The IMSC is the highest decision-making body for formulating CAMP including IDMP. It provides political support, policy direction and takes actions to pass final drafts of CAMP and IDMP to the Cabinet p and Parliament. TC supervises the work of CAMP and IDMP TTs, which undertake all the activities and tasks necessary for formulating the two master plans. SFPs are bridges between national and state governments and stakeholders' participation are providing useful inputs into the works of the two (2) TTs. For TC, MAFCRD is the chair for both CAMP and IDMP process; however, when discussing IDMP documents, MEDIWR moderates the discussions due to the technicality of the issues being discussed.

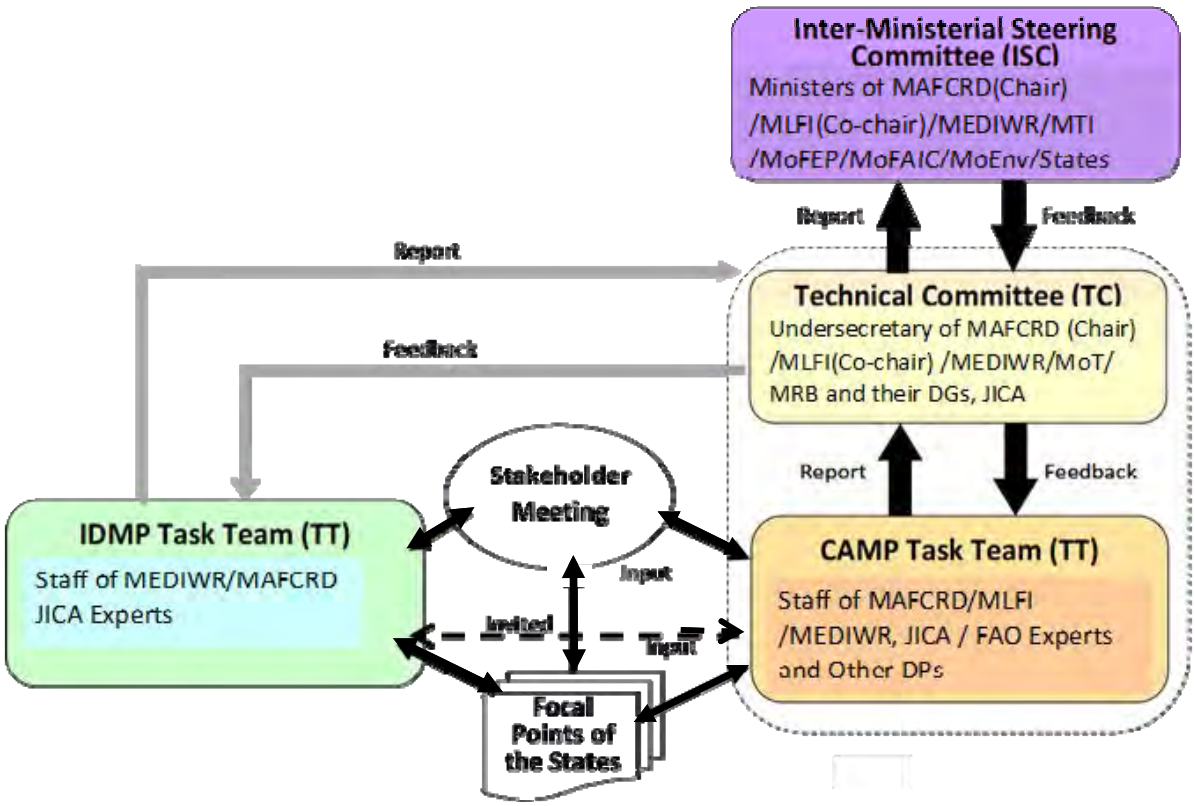


Figure 0.4.3: Structure of Coordination Mechanism

5. Structure of the Framework

The IDMP Framework is the output of IDMP-Task Team (TT) work, from September 2012 to August 2015; and it consists of 1) potential assessment for the development of irrigated agriculture and other productive uses of the sector, 2) master plan formulation ("the programmes/projects/activities") of IDMP and 3) priority projects (PPs) planning (Figure 0.5.1 below):

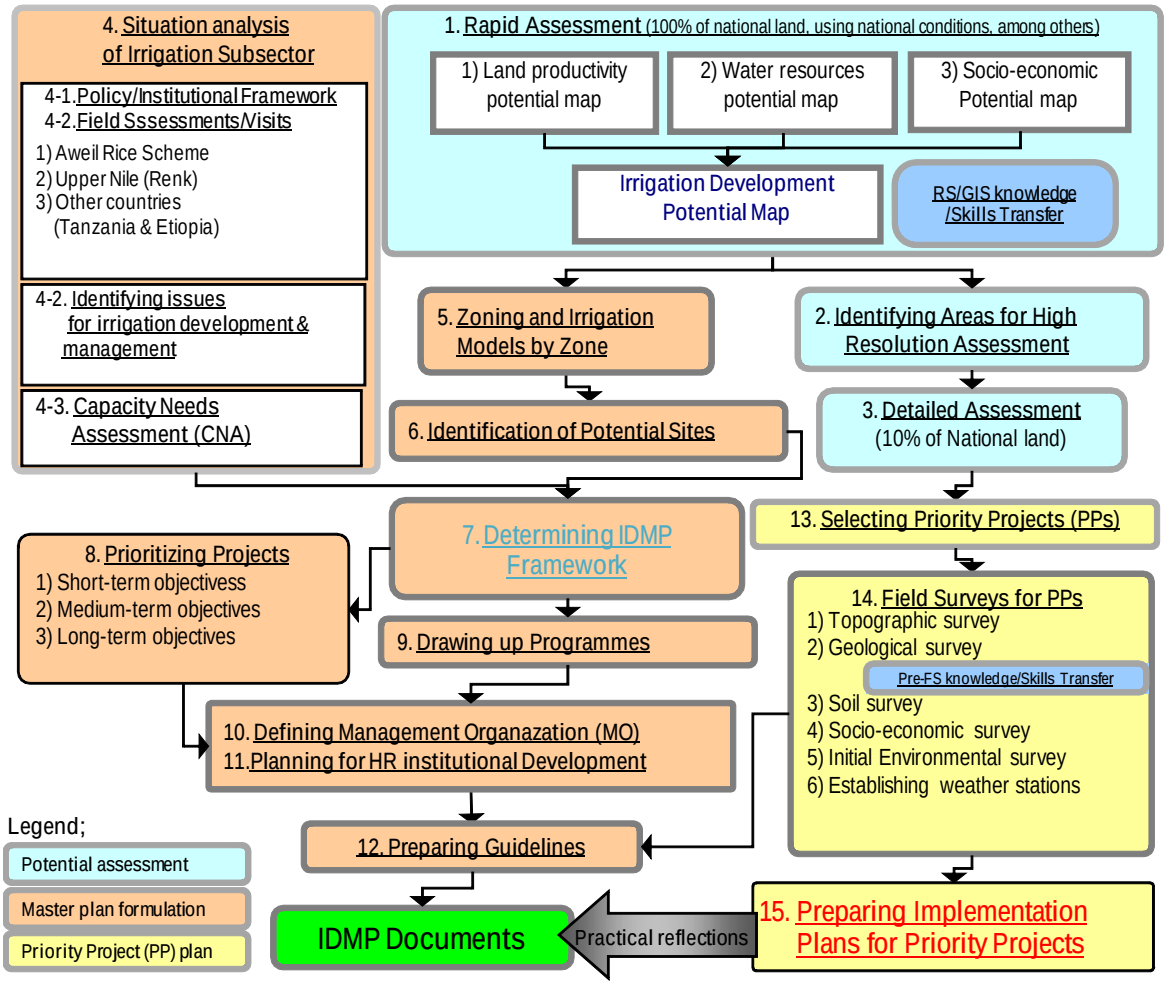


Figure 0.5.1 IDMP Framework Formulation Process

"Potential assessment" is composed of "1.Rapid assessment" and "2./3.Detailed assessment". The rapid assessment targeting the entire national land of RSS was aiming to create the irrigation development potential map of RSS; and the detailed assessment covering 10% of the national land on the basis of results of the rapid assessment was carried out prior to the selection of the priority project areas.

"Master plan formulation" started with conducting "4.Situation analysis of irrigation subsector"; and "7.Strategic framework of irrigated agriculture and other productive uses of the sector". These were the key tasks to set up strategic approach towards formulating IDMP master plan in consideration with "5.Zoning and irrigation models by zone"; and "6.Listing of irrigation schemes" proposed by each state through the State Focal Points (SFPs). In the process of finalization of IDMP, the IDMP-TT conducted "8.Prioritization of projects"; "9.Suggesting strategic programmes"; "10.Proposing organization management": "11.Planning human resources development"; and "12.Preparing guidelines".

"Priority Project (PP) planning" was carried out in three (3) areas, namely; 1) Wau Rice Scheme, 2) Jebel Lado and 3) Rejaf East in parallel with "Master plan formulation". "13.Selecting PP areas" was conducted by using maps created through "3.Detailed assessment"; and then "15.Preparing implementation plans for PPs" was carried out after "14.Field surveys for PPs" based on 1) Topographic survey and 2) Geological/soil mechanical investigation through sub-contracting works; and 3) Soil, 4) Socio-economic, 5) IEE surveys and 6) Establishing weather stations by IDMP-TT.

Finally IDMP has been formulated by reflecting lessons learnt through "15.Preparing implementation plans for PPs"; and then all these outputs were presented in the Framework. The Framework in relation to Figure 1.6.1 is presented with the chapters as follows:

Chapter 1: General Feature of Irrigation Sector in South Sudan: summarised 4.Situation analysis of irrigation sector

Chapter 2: Irrigation Development Potential Assessment: summarised from 1.Rapid assessment to 3. Detailed assessment

Chapter 3: Issues for Irrigation Development: abstraction of issues identified from Chapters 2 & 3 and supplemental situation analysis

Chapter 4: Zoning and Identification of Irrigation Models by Zone: summarised 5.Zoning and irrigation models/modes

Chapter 5: Strategic Framework for Irrigated Agriculture: summarised 7.Strategic framework and 9.Suggesting strategic programmes

Chapter 6: Strategic Programmes: summarised 6.Listing irrigation schemes after defining programmes to accommodate the list by the strategic framework, 8.Prioritizing projects, 10.Organisation management, 11. Human resource development and 13.Selection of priority projects

Chapter 7: Workflow under CAMP/IDMP Implementation Mechanism: proposed the workflow of implementing the strategic programmes in line with the CAMP/IDMP Implementation Mechanism

Chapter 8: Implementation Plan of Priority Projects: summarized 14. Field survey and 15.Implementaiton plan for priority projects

Conclusion and Recommendations: summarized the conclusion and listed the recommendations as Task Team to further move towards the implementation

The detail information studied and formulated through the IDMP formulation process are compiled in Annexes as follows:

6. Annexes

Part I: Annexes 1-8

Annex 1: Policy & Institutional Frameworks in relation to the Water Sector & Irrigation Subsector (details of Chapter 3)

Annex 2: Existing Irrigation Schemes (details of Chapters 2 & 4)

Annex 3: Irrigation Development Potential Assessment (details of Chapter 2)

Annex 4: Human Resource Development (details of Chapters 3)

Annex 5: Preliminary Irrigation Development Guidelines (12.Preparing guidelines in Fig.1.6.1)
Annex 6: Programme Profiles (descriptions in form on the programmes presented in Chapter 7)
Annex 7: Cost Estimate for Master Plan
Annex 8: Records of Discussions

Part II: Annex 9 (Implementation Plans for Priority Projects)

Annex 9-1: Pre-Feasibility Study of Wau Irrigation Scheme
Annex 9-2: Pre-Feasibility Study of Jebel Lado Irrigation Scheme
Annex 9-3: Pre-Feasibility Study of Rejaf East Irrigation Scheme

7. References

i. The then Southern Sudan Centre for Census, Statistics and Evaluation (now National Bureau of Statistics), 2010, *Statistical Yearbook for Southern Sudan.*

ii. FAO, 2010, *the Joint Baseline Survey Report on the Agriculture and Animal Resources in Southern Sudan.*

iii. Global Water Partnership *(http://www.gwp.org/The-Challenge/What-is-IWRM/).*

CHAPTER 1 IRRIGATION DEVELOPMENT PROSPECTS IN SOUTH SUDAN

1.1 Country Overview

The Republic of South Sudan became an independent new country on July 9, 2011. The population is largely rural (about 80%), depending on ordinary forests, practicing subsistence crops production, rearing of livestock & fishing as main livelihood systems. Despite the richness in natural resources, poverty and vulnerability are widespread.

1.1.1 Geographical Features

Bordering Sudan to the north, South Sudan has a wide range of geographical attributes, expanding on clay plains that extend to the south with gradual uphill slopes to the mountains on the frontier with Ethiopia (eastwards), Kenya (to the southeast) and Uganda (southwards); and to the water divide which represents the southwest boundary with D. R. Congo (to the southwest) & Central African Republic (westwards). It approximately extends from latitude 03º 27′ 29″ N to latitude 12º 11′ 40″ N & from longitude 23º 03′ 29″ E to longitude 35º 57′ 14″ E; and it covers a land area of more than 640,000 km2.

At the southern frontier, the mountain series of the Imatong, Didinga and Dongotono rise to more than 3,000 meters. The highest peak in South Sudan is Mt. Kinyeti (Imatong) located in Eastern Equatoria State near the border with Uganda, and it has an elevation of 3,187 m. On the other hand, the lowest elevation in South Sudan is around 400 m near Renk, Upper Nile State. South Sudan inclines gently toward the north-eastern parts from the south-western parts.

The White Nile, one of the main tributaries of the Nile River passes through the country; and the region is also characterised by the vast wetlands region of the White Nile Valley, including the Sudd formed by the spills of the Bahr el-Jebel, one of its main tributaries; and the remaining central parts are covered by grassland with the western parts being covered by tropical forest.

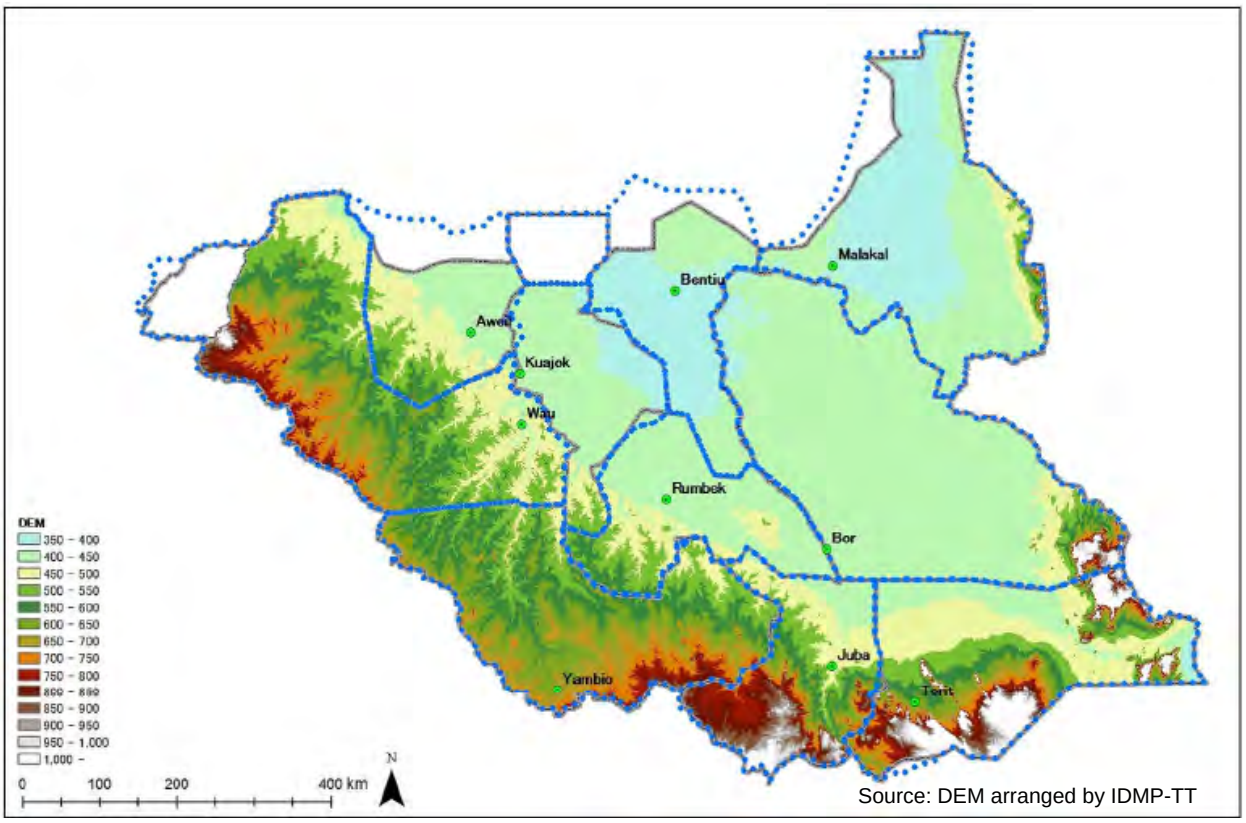


Figure 1.1.1 Topographic Map of South Sudan

1.1.2 Demographic Features

The total population in South Sudan as of the population census in 2008[i] is 8,260,490. Not only the natural growth but also the returnees have been coming back to the country and therefore, the National Bureau of Statistics (NBS) projects rapid population growth for the mid-year up to 2015. The population projection in 2015 by NBS is estimated at 11,892,934, whose average annual growth rate from 2008 to 2015 reaches 4.96%. The growth rate on a longer term would be lower than this, or assumed to grow at 2.39%, which is the national annual average growth rate as calculated in the South Sudan Rural WASH Sub-sector Action and Investment Plan (2012-2015).

1.2 Natural Conditions[1]

The climate of South Sudan is typical of a humid region, with strong seasonal annual variations and a strong latitudinal wetness rising with increasing rainfall to the southwest and to a limited portion in the east. The mean temperature is greater than 25^{o}C; hence generally a warm thermal zone. It is characterised by a single rainfall season, therefore a pattern of one growing period that becomes shorter northwards. As a result, in the semiarid and dry sub-humid zones, precipitation exceeds half the potential (or open water) evaporation for six months, which allows for a maximum growing period of around 180 days (6 months). And in the moist sub-humid zone, precipitation exceeds half the potential evaporation for nine months, allowing for a growing period of about 270 days (Liabwel, 2007).

1.2.1 Meteorology

Rainfall ranges from more or less than 500 mm in the northern and south eastern parts (dry sub-humid and semiarid, with extensive grazing and potential for tropical rain-fed annual crops); to about 1,500 mm in the south western and limited eastern parts (predominantly moist sub-humid and humid of wide range of perennial tropical crops and extensive areas under forest).

Temperatures do not change greatly with the seasons; the most significant meteorological variables/ parameters are rainfall and the length of the dry season. Variations in the length of the dry season depend on the dominance of airflows, the dry north easterly winds or humid south westerly winds. Temperatures range from a minimum of around 18°C to around 40°C a maximum on a daily scale, with the highest temperatures at the end of the days of the dry seasons when cloudless skies and dry air allow them to move. Temperatures generally increase from south to north.

Humidity is generally high throughout the year with a minimum of around 40% and a maximum of 80%. The least humid months are January and February in the middle of the dry season. The temporal pattern of the average monthly evaporation of the country correlates well with the monthly mean maximum temperature distribution over it. The average monthly maximum evaporation occurs from February to May and the minimum from June to September. As may be expected, potential evapotranspiration is the lowest over the highlands and increases progressively towards and onto the lowlands. The rate of 1,450 mm/yr occurs in the southern mountains and increase northwards to 2,500 mm/yr (SMEC, 2010)[ii].

1.2.2 Livelihoods' Zones

Following geographical features, soil attributes and the distribution of annual precipitation, South Sudan is divided into agro-ecological zones, which translate into seven (7) livelihoods' zones, namely: i) the Greenbelt, ii) Ironstone Plateau, iii) Hills and Mountains, iv) Western Flood Plains, v) Eastern Flood Plains, vi) Bahr el-Jebel, White Nile and Sobat River Corridors and vii) Eastern Semiarid. The South

[1] Related maps such as rainfall distribution, watersheds and river delineation maps are shown in Chapter 3.

Sudanese have led their lives in accordance with the features of each zone.

The following describes the outlines of those features in relation to water occurrence (WFP, 2010)[iii]:

1) Greenbelt: the Greenbelt, whose annual rainfall is more than 1,000 mm, has basic conditions that have allowed prevailing rain-fed farming; but the state of rainfall is unstable in recent years, which is considered to be an effect of climate change.

2) Ironstone Plateau: It has been said that the demand for irrigated agriculture development in the Ironstone Plateau is high, since the rainfall is less than 1,000 mm; but there are a number of major rivers, which flow through it.

3) Hills & Mountains: It has been remarked that the major problem to be solved in Hills & Mountains is to secure water for people and cattle, to enhance their settlement.

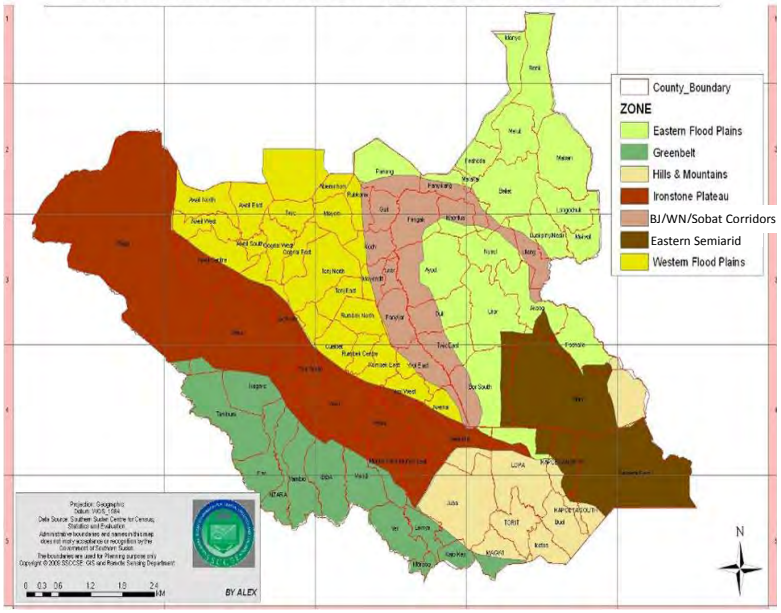


Figure 1.2.1 Livelihoods' Zones

(Adopted from *Annual Needs and Livelihoods Assessment 2009/2010)*

4) Western Flood Plains; Eastern Flood Plains; and the Bahr el-Jebel (BJ), White Nile (WN) and Sobat River Corridors: The prevention and mitigation of damages caused by floods have been one of the crucial issues to be solved in each zone of these zones. Also, there is a need to pay enough attention from the viewpoints of environment and social issues to those areas when infrastructure is constructed, since there are many environmental protection areas, game reserves and wildlife migratory routes.

5) Eastern Semiarid: The zone is predominantly pastoral and many of its rivers dry up after the wet season. How to conserve water for a longer period has been the question in this zone. People in this zone do feed their animals in grazing lands, which occur after the recession of floods.

1.3 Hydrology

South Sudan is where the main White Nile tributaries meet; and it contributes to the Nile waters by flows from Bahr el-Ghazal, Bahr el-Jebel, River Sobat & the seasonal streams that flow into the White Nile within the territory. It possesses large areas of land underlain by rich & renewable aquifers, including the Umm Ruwaba formation and some of the fractured & weathered zones of the Basement Complex.

1.3.1 Hydrological Position of South Sudan in the Nile River Basin

The Nile River is the longest river in the world with a length of about 6,650 km, measured from Lake Victoria. The major starting points of the Nile are Lake Victoria for the White Nile and Lake Tana for the Blue Nile, running from south to north up to the Mediterranean Sea. The territory of South Sudan lies within the centre of the White Nile basin. Hence, the principal water resources of South Sudan are the White Nile and its tributaries in addition to aquifers. The country has four (4) major river basins, namely Bahr el-Ghazal; Bahr el-Jebel; River Sobat; and the White Nile main stem segment within South Sudan (see the detail in 1.3.2).

The White Nile main stem segment runs from the most central location of the country northwards; and receives water from the other three (3) major basins at Lake No (from Bahr el-Jebel and Bahr el-Ghazal), from Bahr el-Jebel through Bahr el-Zeraf and above Malakal (from Sobat). Based on the discharge records from 1912 to 2005, the total annual average discharge of the White Nile at Malakal northward of the country is calculated as 28 billion m^3 (A. Salih, 2011)[iv]. The figure below shows the whole watershed of the Nile River basin and the position of South Sudan.

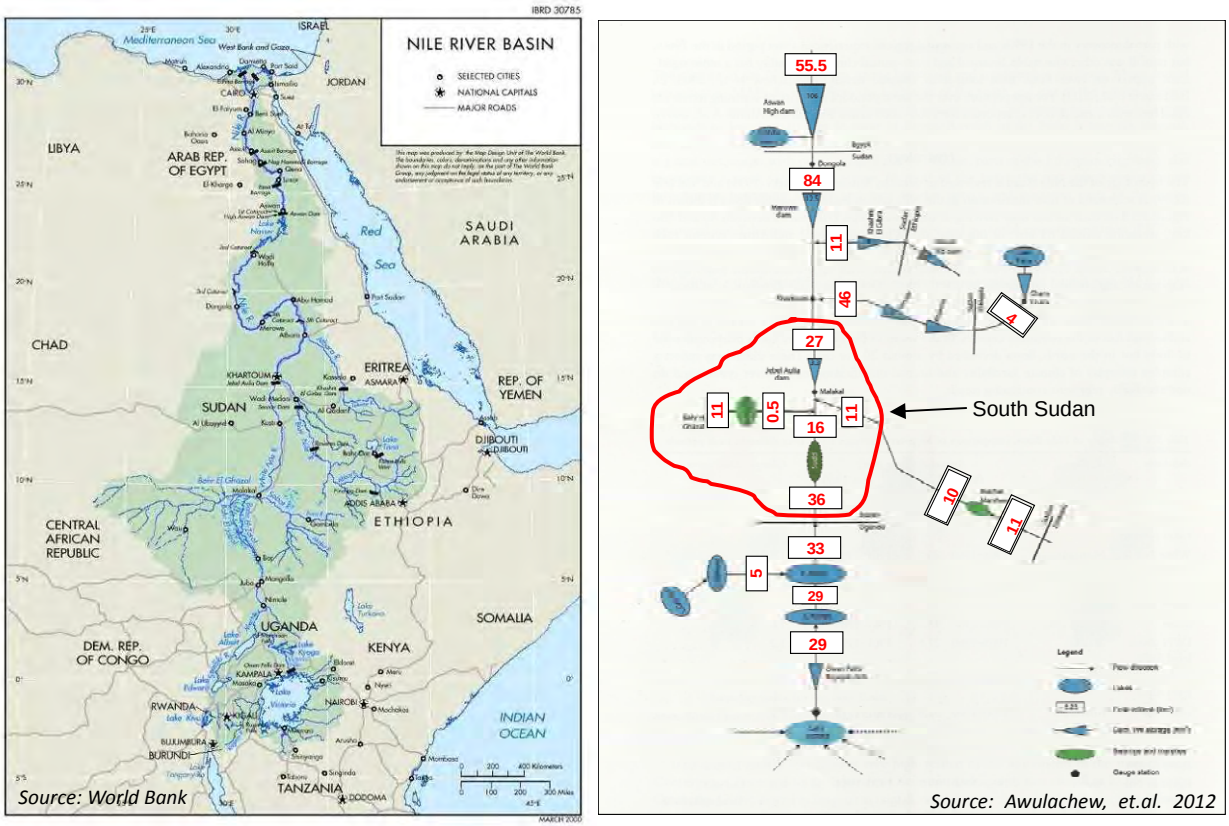


Figure 1.3.1 The Nile Basin and its Schematic Flows

A recent study (Awulachew, et. al. 2012)[v] compares the flow of the Nile in the different periods, namely pre-1960 and post 1960 as shown in the table below. The comparison indicates the increase of flow in recent years in the upper reaches of the White Nile, while there is a slightly declining trend of flow in the Blue Nile. The Study explains that these differences reflect a complex interplay of climate variability and human modification of the river system. Although the study remarks that the analysis does not necessarily represent continuous trends, this study may give awareness on climate change issues and hence importance of the continuous hydrological information measurement & monitoring.

Table 1.3.1 Variability of Nile Flows: Comparison of Long-term Averages over Different Periods

Sub-basin	Station	Annual Discharge (km3)				Change
		Pre-1960		Post-1960		
White Nile/Equatorial Lakes Region	Lake Victoria	1901 - 1960	20.6	1961 - 1990	37.5	182%
White Nile (Bahr el-Jebel) above Sudd	Mongalla	1905 - 1960	26.8	1961 - 1983	49.2	184%
White Nile below Sudd (Bahr el-Jebel + Bahr el-Zeraf)	Sudd outflow	1905 - 1960	14.2	1961 - 1983	20.8	146%
Sobat	Doleib Hill	1905 - 1960	13.5	1961 - 1983	13.7	101%
White Nile above Jebel Aulia	Malakal	1905 - 1960	27.6	1961 - 1995	32.8	119%
White Nile below Jebel Aulia	Mogren	1936 - 1960	23.1	1961 - 1995	28.1	122%
Blue Nile	Khartoum	1911 - 1960	52.8	1961 - 1995	48.3	91%
Atbara	Atbara at mouth	1911 - 1960	12.3	1961 - 1994	8.6	70%
Main Nile above Aswan	Dongola	1911 - 1960	86.1	1961 - 1995	73.1	85%
Main Nile below Aswan	Aswan	1952 - 1960	89.7	1970 - 1984	56.9	63%

Adopted from The Nile River Basin, editied by Awulachew, Smakhtin, Molden and Peden, International Water Management Institute 2012, Page 65

1.3.2 Surface water

South Sudan is rich with surface water resources, mainly of the White Nile and its tributaries, which are indicated with four (4) well-known basins, namely Bahr el-Jebel, Bahr el-Ghazal, River Sobat and the main White Nile stem. Figure 1.3.2 below depicts features of the four (4) basins based on existing hydrological studies.

1) Bahr el-Jebel Basin

Bahr el-Jebel rises from the equatorial lakes and it receives additional waters from the torrential rivers of the southeast plateau. Between Nimule and Mongalla, the river has a relatively steep slope of about 100 cm per kilometre, and flows in one channel. North of Mongalla the river is divided into several channels, in a broad flood plain, the level of which is lower than the high water levels. Huge areas are inundated from high river discharges forming wetlands. Nearly 50% of Bahr el-Jebel discharge spills into the swampy region (World Bank (WB), 2012).

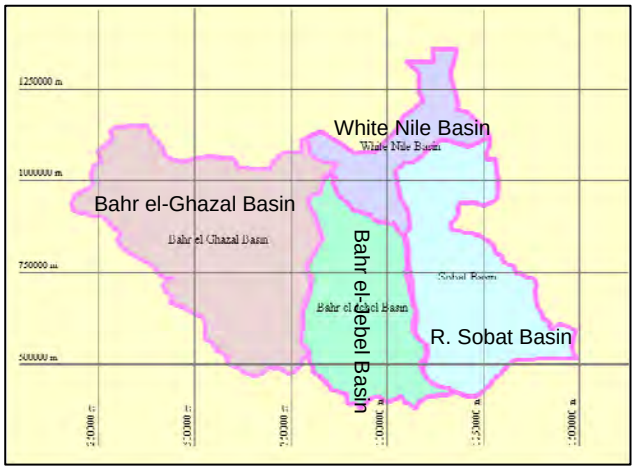


Figure 1.3.2 The Main River Basins of South Sudan
(Source: FAO & the then MWRI)

The total annual average discharge of Bahr el-Jebel Basin is 28 billion m^3 at Mongalla; but due to huge spread into the swamps, the volume reaching Malakal is only 14 billion m^3 for the period from 1912 to 1983, which is almost half the total volume of inflow (A. Salih, 2011). Due to the fact that only part of the river discharges entering the area flow out, the region was termed Sudd (barrier in Arabic). The swamps and marshlands of South Sudan known as the Sudd region/wetlands were described by Sir William Garstin (1908-1909), a hydrological engineer and colonial administrator of the time: As “a huge area of vegetation, which can absorb and dissipate half or more (16.9×10^9 m^3) per year on average, of the water it receives.”

2) Bahr el-Ghazal Basin

The rivers of Bahr el-Ghazal Basin start from the Nile-Congo divide at an elevation of around 600–1200 m, and flow in the north-eastern direction. Out of the total inflow of 11.3 billion m^3/yr measured at the upstream stations, only a small fraction of 3% emerges at the basin exit just upstream Lake No. It is probable that during high flows, the gauging stations underestimate flows that bypass the gauge over the inundated land (A. Salih, 2011).

The basin covers the catchments of several tributaries that end in the swamps area. The total average annual discharge of these rivers is around 14.0 billion m^3/yr, out of which only about 0.5 billion m^3/yr reaches the White Nile for the period from 1965 to 2005. The rest spreads into the swamps/wetlands (Salih, 2011).

3) River Sobat Basin

The Sobat River originates in the far southeast as the Pibor River on the highlands; the water from the headstream reaches the Pibor in years of very high rainfall. The Pibor joins the Akobo and Baro along the South Sudan-Ethiopian border. From the Akobo/Pibor-Baro junction the river becomes the Sobat. Just before joining the Sobat the Baro spills into the Machar Marshes. The water from the Machar Marshes, together with that from small streams originating from the Ethiopian Highlands, occasionally reaches the

White Nile at town of Malut via the stream (Khor) Adar. The total annual average discharge of the Sobat basin at Hillet Dolieb is 13.5 billion m^3/yr, with the daily discharge fluctuating between 8.7 million m^3/day in month of April to 64.7 million m^3/day in month of November (Sutcliffe, J. V., and Y. P. Parks, 1999)[vi].

4) White Nile Basin

The White Nile essentially begins from the confluence of Bahr el-Jebel and Bahr el-Ghazal at Lake No. Between Lake No and Malakal, it is joined by two main sources of additional waters, the Bahr el-Zeraf (one of the main branches of Bahr el-Jebel) and River Sobat); in addition to seasonal streams of Lolle, Yergol and Atar that flow into it above Malakal; and a number of Khors that join it below Malakal such as Khor Adar and Khor Achier.

At Malakal, the total annual average discharge of the White Nile is calculated at 28.0 billion m^3/yr; and on average, it varies from 46 to 106 million m^3/day. The minimum discharge is in March or April and the maximum discharge is in October or November (A. Salih, 2011).

5) The Sudd Wetlands:

The Sudd Wetland is one of the hydrological features, characterizing RSS. Located in the middle of the country, the Sudd wetland is created when water spills over banks of rivers spread over an extensive area (30,000 to 40,000 km^2) for the permanent & seasonal swamps (Sutcliffe, J. Y., and Y. P. Parks, 1999). The rainfall estimate is around 800 to 900 mm/yr (Mohamed et al., 2004)[vii]; and the average evaporation over Sudd is around 1,800 mm, and due to uneven rainfall distribution, evaporation is lower in the northern part of the image (600–700 mm/yr), as well as on the south-eastern corner (see Figure 1.3.3).

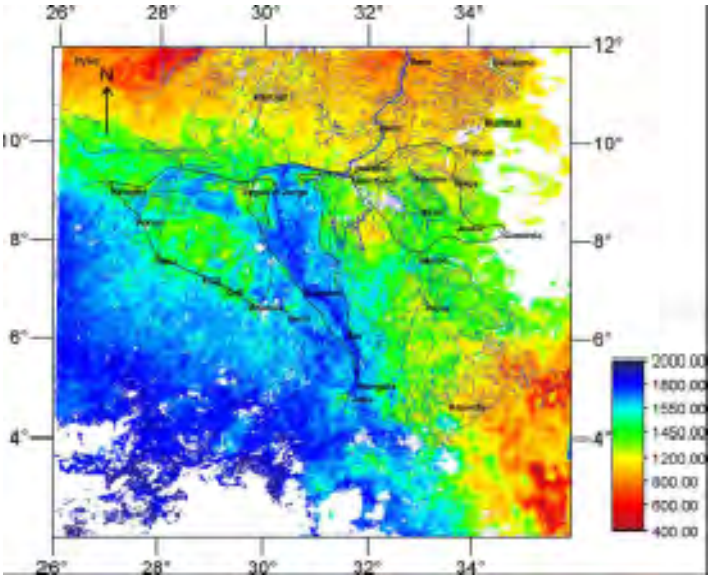


Figure 1.3.3 Annual Evaporation Map in mm/yr

(Source; Mohamed et al, 2004)

1.3.3 Groundwater

In the country, there are four (4) major aquifers, namely; 1) Alluvial Aquifer and 2) Umm Ruwaba Aquifer, both which extend to form the Sudd Basin; 3) Nubian Sandstone Aquifer; and 4) Basement Complex Aquifer, from upper to lower. Basement Complex is a kind of important aquifer, but at the same time it is completely impervious basement to the other aquifers overlying it and in it water occurs in cracks. The basement outcrops is in one-third of the country, in the southwest and along northeast and southeast hedges of the territory. It forms a vast concave like a ship bottom in the west and northwest (WNW)-the east and south east (ESE) directions, between both outcrops. The concave was formed through geo-tectonic movement in very old times, and then, the trough was filled by huge volumes of sediments through long geological times, at first by Nubian Sandstone at North-west end, then by Umm Ruwaba formation, which is almost covering the whole basin and alluvial deposits over the Umm Ruwaba, especially along the main river routes. This is the hydrogeological explanation of the Sudd Basin, as the only one groundwater basin in RSS (details are discussed in Chapter 2, Section 2.3.5). These water-bearing geological formations extend to external areas of the territory; and they are generally not yet well-studied, especially in RSS.

1.4 Water Use

IDMP-TT carried out an interview survey on water use and irrigation in all ten (10) states' capitals in December 2012 [water use and irrigation survey (WUIS)][2]. The general feature of water use is described based on WUIS and the study of other available information.

1.4.1 Drinking Water and Sanitation

In the water sector, providing safe drinking water and sanitation to the people of South Sudan has been focused naturally as its preceding priority, and considerable public investment in potable water supply and improved sanitation development, e.g. drilling of boreholes and construction of toilets, has been implemented by the then MWRI and also in support of the development partners, e.g. through Multi-donor Trust Fund (MDTF), Basic Services Fund (BSF) and a number of bilateral programmes. As per the 2010 South Sudan Health & Household Survey (source: NBS), the overall use of improved drinking water sources and improved sanitation facilities are 67.7 % and 14.6% respectively.

But, the 2011 WASH Strategic Framework indicates that the then MWRI database of existing facilities for each County identified approximately 10,000 water points in the country, of which 30–50% are non-functional at any time (source: WASH Strategic Framework document). This translates to a "de-facto" low coverage rate of about 40% among the rural population. However, it should be noted that these figures do not take into account water quality impacts due to uncontrolled human excreta disposal and other bio-chemical factors. Furthermore, according to the WHO definition of access to improved sources of water, which recommends a maximum of 30 minutes for a round trip to collect water, the level of access in rural areas decreases to approximately 34%. Distance to the water source is an issue. It is estimated that half of the households still take more than 30 minutes to reach the water sources, including unimproved ones. Especially women suffer from taking water from a distance. Those who have water on their premises count merely 2.1% in the whole country and 0.8% in case of rural areas alone.

Nevertheless, the recent WASH Sector progress report (2005-13) on achievements, put the percentage of the population with access to safe water sources at 40.1%; and that is with access to improved sanitation facilities at 13.3%. Rural water supply points, in addition to some urban water supply stations have been maintained, rehabilitated and developed throughout the country by the government, together with the support of development partners, e.g. MDTF has contributed to the constructing of 528 community water points from 2005 to 2012; and BSF constructed and rehabilitated 570 boreholes and 530 boreholes respectively from 2006 to 2012. MEDIWR has established WASH Information Management System (WIMS) to be the updated database of the WASH Sector in the country and information can be accessed through the website of the Ministry. Although not yet efficiently functioning to the required capacity, the number of registered wells that were reported in 2012 during the water use and irrigation survey is 11,196.

1.4.2 Irrigation (Crop/Timber Production) & Other Productive Uses of Water (Livestock/Fisheries)

In parallel with investing in improved domestic water sources, "Water for Productive Use" is coming to focus as well. Water harvesting and storage reservoirs, including *haffirs* mainly for animals have been planned across the country and some of them have been implemented, e.g. under MTDF in Jonglei, Eastern Equatoria and Western Equatoria States; and through UNDP in Eastern Equatoria, Lakes and Warrap States executed by UNOPS and PACT. Also, before the eruption of the December 2013 crisis, some were under implementation in Jonglei State with the assistance of CIDA[3] through FAO. Improvement of the design and construction of water harvesting and storage structures/facilities, to

[2] The result of water use and irrigation survey (WUIS) is attached in Annex 1.
[3] CIDA has been restructured as Department of Foreign Affairs, Development & Trade (DFADT) of the Government of Canada.

address principles of IWRM has been initiated by the then MWRI and continued by the present MEDIWR Water Sector, with the emphasis being: Establishment of combined water facilities for safe and integrated utilization and management of seasonal waters, for multiple use, including horticultural and vegetation plantations.

As for the agriculture sector, though the majority of farmers are still practicing rain-fed, some advanced farmers are purchasing portable pump sets for irrigation farming. Aweil Irrigation Rice Scheme (AIRS) has been partly rehabilitated and reactivated by GIZ with assistance funds from EU. The Netherlands has been preparing to pilot water for productive use to introduce the concept of integrated water resources management in Lakes and Eastern Eqatoria States. IDMP formulation is therefore a major initiative to launch the activities of water for productive use.

Irrigated agriculture in South Sudan is said to be limited as there are only two (2) government-supported irrigation schemes, namely AIRS and Northern Upper Nile Irrigation Schemes (NUNIS) and there are practices of small-scale pump or bucket/can irrigation by smallholders but they are still minor. The table below summarises the results of the water use and irrigation survey, which verifies the limited practices of irrigation in the country.

Table 1.4.1 Current Irrigation Situation in South Sudan

State	Current Irrigation Scheme/ Farm		Irrigation Scheme Involved Institutions / People		Beginning Year	Beneficiary		Water Sources for the Irrigation Scheme/ Farm		Other Water Sources for Irrigation		Water Intake Method
	number	%				HH number	Area ha					
CE	0	0	-	-	-	-	-	-	-	-	-	-
EE	0	0	-	-	-	-	-	-	-	-	-	-
JS	0	0	-	-	-	-	-	-	-	-	-	-
LS	2	6	Farmers	-	2007, 2009	1,000	67	Well	-	-	-	Electric pump
UN	23	66	Farmers	-	1940' -	-	37,319	River	-	Pond	-	Engine pump
US	4	11	Farmers	-	2006 - 2012	7,000	-	-	-	-	-	-
WS	2	6	Farmers	Returnee/IDP	2012	480	N.A	Well	-	River	-	Foot pump
NBG	1	3	National Gov't	Cooperative	1945	-	1,150	River	-	Hafir	Well	Open canal
WBG	2	6	State	Association	2007, 2011	N.A	433	River	Well	-	-	Hand pump
WE	1	3	Farmers	-	2008	260	N.A	River	-	Spring	-	Bucket
Total	35	100	-	-	1944 -2012	-	-	-	-	-	-	-

Source: WUIS with additional information collecton by IDMP-TT

Out of the ten (10) states, irrigation schemes and farms have been practiced only in seven (7) states. The total number of the reported irrigation schemes/farms is 35, out of which 23 schemes are under NUNIS. The state that reported the second biggest number of irrigation schemes/farms is Unity with four (11%). The other five (5) states reported only one or two irrigation schemes/farms to have been recognized or under preparation. For the remaining three (3) states, namely Central Equatoria, Eastern Equatoria and Jonglei, there was no report about the existing irrigation schemes/farms. Most of the newly reported irrigation schemes/farms were established after 2006 and they seem to be under establishment; except for AIRS and NUNIS, which have been established since the 1940s.

Although no formal census has been carried out, there is evidence of emerging small-scale irrigation activities located within over 30 watersheds of the White Nile and its tributaries. These activities are based on lifting water either manually using a bucket or by harnessing a portable treadle or petrol pump. The irrigated area per farmer is fairly modest and ranges from 0.05 ha (1/8 feddan) for bucket irrigation to 1.26 ha (3 feddan) for petrol pumps. To illustrate the significance of small-scale irrigation, some 177 pump-sets were bought through the Agricultural Bank of South Sudan (ABSS) in 2011 alone. These pumps were located around urban centres, with Juba accounting for 62.1% of the purchases while the remainders were shared among Malakal, Wau and Renk towns as shown in the table below.

Table 1.4.2 Number of Pumps Bought through ABSS in 2011

Branch	Juba	Malakal	Wau	Renk	Total
Number of pumps	110	25	27	15	177
Percentage	62.1%	14.1%	15.3%	8.5%	100.0%

Adopted from: Agricultural Bank of South Sudan

In 2009, MWRI purchased more than 50 irrigation pumps of different sizes/capacities (supplied by Allweiller-Farid Pumps Company, a German Egyptian Joint-venture based in Cairo, Egypt) with an aim of supporting irrigated agriculture entrepreneurs. MWRI then prepared guidelines for distributing them, but to date with exception of a Prison Farm at Rejaf East, there is no any other applicant qualified. The underlying reason for lack of distribution is due to the fact that the initiators do not have necessary resources to finance pre-investment preparation activities and the required civil works; hence the pumps remained in the store.

1.4.3 Existing Irrigation Schemes

Irrigation activities in South Sudan may be divided into Government-supported medium and large-scale developments and small-scale individual farmer initiatives. The following describes the two (2) existing government-supported irrigation schemes. The detailed field reports on these schemes are attached in Annex 2.

(1) Northern Upper Nile Irrigation Schemes (NUNIS)

Initiated in the 1940s as part and parcel of the White Nile pumps irrigation schemes, NUNIS are huge and complex and consist of 23 schemes, which may be categorized as follows:

- Nine (9) private/government schemes (ranging from 100 to 1,000 ha each) which account for over 50% of irrigated area in the schemes. MEDIWR supplies irrigation water up to the major canal from where the private owner conveys and distributes to his tenant-farmers
- 14 public schemes, which occupy slightly less than 50% of irrigable area in the schemes. MEDIWR delivers irrigation water down to the feeder canal (Abu Ishirin) from where the then MAF distribute to individual small-scale cultivators (2.1 ha (5 feddan) each).

Private owners operate on the basis of 15-year leases that are issued by the State Ministry of Agriculture. In their turn, the private owners have placed tenant farmers on their land under a sharecropping arrangement. Similarly, in public schemes, the Government through MAFCRD has a sharecropping agreement with its small-scale tenants.

For both categories of irrigation schemes, the Government bears the cost of operating and maintaining the pumps as well as major irrigation infrastructure. However, in actual situation, the disbursement of operation cost has been suspended due to high fuel cost and the pumps have not been working.

The private owner and the Government are supposed to provide production services and inputs (land preparation, irrigation water, seed, fertilizers and crop protection, marketing) to their respective tenants. Later, they (private owner and Government) reimburse themselves from joint accounts, which they maintain with individual tenants. The main characteristics of NUNIS are presented in the table below.

Table 1.4.3 Main Features of Northern Upper Nile Irrigation Schemes (NUNIS)

Location	Source of water	Water lift Technology	Gross Area	Net Irrigable Area	2012 Irrigated area
Upper Nile State, Renk Manyo, and Malut	White Nile through controlled intake into a wide channel/reservoir parallel to command area	20 lift pumps located at intervals on right and left banks of the wide channel/reservoir	654,700 ha (1,558,800 feddan)	196,410 ha (467,640 feddan)	Not Available

Adopted from: then Ministry of Water Resources and Irrigation (MWRI, 2011)[viii]

(2) Aweil Irrigation Rice Scheme (AIRS)

AIRS is the oldest irrigation development in South Sudan having been initiated in 1945 as a prison farm of 1.6 ha (4 feddan). Since then, it has expanded to the gross area of 9.240 ha (22,000 feddan). The infrastructure of the scheme was destroyed and abandoned during the civil unrest but was partially rehabilitated by GIZ IS through EU's 5 million Euros funding in the period 2008-2012. In October 2012, GIZ IS handed over the Scheme formally to MAFCRD, together with 300 tenant farmers (both large and small-scale) and 92 staff members. Key features of the Scheme are given in the table below.

Table 1.4.4 Main Features of Aweil Irrigation Rice Scheme (AIRS)

Location	Source of water	Water lift Technology	Gross Area	Net Irrigable Area	2012 Irrigated Area
Northern Bahr el-Ghazal State, Aweil West and Aweil Centre Counties	Lol River (until recently through uncontrolled entry points into fields; recently some control gates installed)	Seasonal floods during June-October	9,240 ha (22,000 feddan)	4,620 ha (11,000 feddan)	672 ha (1,600 feddan) under rice

Adopted from: then MWRI, 2011 and Ministry of Agriculture and Forestry in Northern Bahr el Ghazal State (NBGS)

AIRS is owned by the National Government, namely MAFCRD and is managed through the AIRS office in Aweil. The role of State Ministry of Agriculture and Forestry (State MAF) is to coordinate, advise and assist what the national Ministry requests them to do. The Scheme is run under the tenancy system. The Scheme's role is land preparation, providing seeds, sowing, water management, providing empty sacks, and transporting produce. Tenant farmers are to weed, manage water and harvest. Contracts between farmers and the Scheme are on a one-year basis. Every year farmers have to renew the contract. As long as the performance of the farmers is good, they will be provided with the same plot. The Scheme sets aside an area of 16 ha (37 feddan) for an experimental farm.

The Scheme and farmers share the harvest according to each one's contribution of cost. The shares of the Scheme and farmers in 2008/09 and 2009/2010 were 40% and 60% respectively but the shares in 2010/2011 changed to 48% for the Scheme and 52% for the farmer. Farmers are not happy about it.

1.4.4 Crop Subsector

(1) Farming Practices and Types of Farming

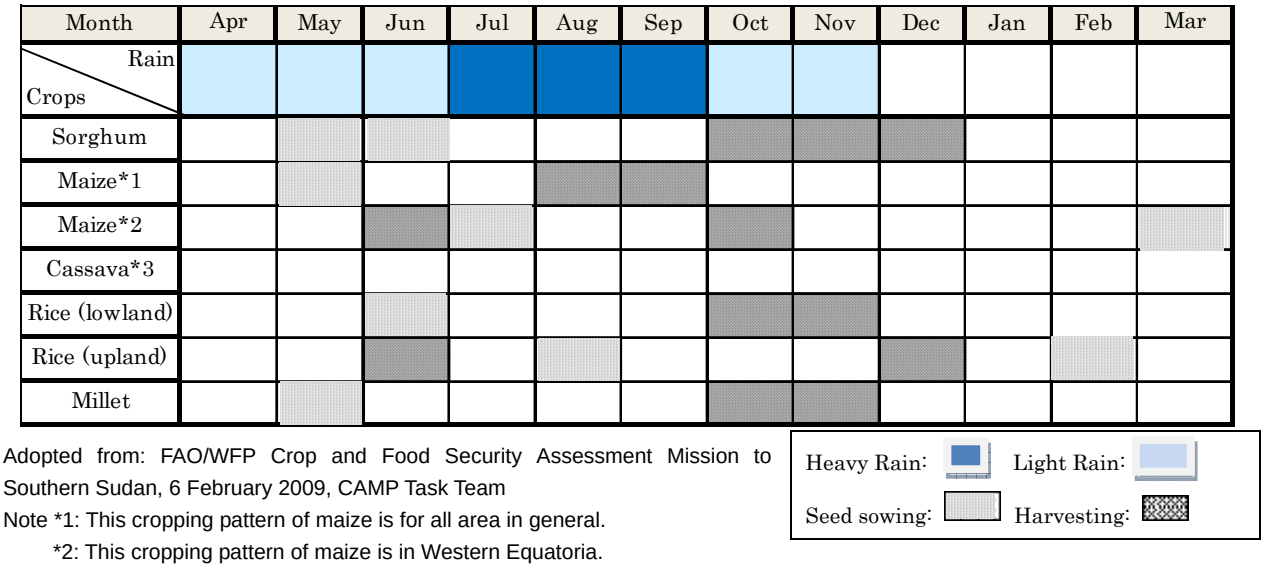
The farming practice in most parts of the country is subsistence farming. Subsistence agriculture is self-sufficiency farming in which the farmers focus on growing enough food to feed themselves and their families. The typical subsistence farm has a range of crops along with either pigs/chickens and bee-keeping or some livestock/animals needed by the family to feed and clothe themselves during the year. Planting decisions are made principally with an eye toward what the family will need during the coming year, and secondarily toward market needs.

Approximately 78% of households in the country are engaged in agriculture (NBS, 2012)[ix] and the average farm size per household is about 1.12 ha (FAO/WFP, 2013)[x]. The total cereal area harvested has gradually increased since 2008 from 853,000 ha in 2008 to 1,085,000 ha in 2012. The area harvested per capita, however, has been at the same level throughout this period since the population growth rate was almost the same as the expansion rate of the cereal area harvested. The cereal area harvested per capita has been about 0.1 ha. The net cereal yield has remained at a low level since 2009, ranging from 0.8 t/ha to less than 1.0 t/ha.

Generally, the rainy season is from May to November. The rainy season in the Green belt areas (in Eastern, Central and Western Equatoria states) starts in March or April, earlier than other states. It is one

of the factors that the overall period, interval and amount of rainfall influences the unstable productivity of crops caused by the climate and seasonal variability, manifested in dual occurrence of floods or droughts.

The crop calendar of major staple crops that are sorghum, maize, cassava, rice, and millet in RSS is shown in Figure 1.4.1. According to the data on the number of households producing major staple crops in 2009[4], seven (7) states ranked sorghum as the first crop. The States ranked maize as the second crop, although it has a long history of cultivation in the Equatoria states. Cassava is the third important crop that is a relatively new crop in South Sudan. Upland rice (non–irrigated/rain-fed) is mainly grown in Western Equatoria State and lowland rice in northern flooding areas especially in Northern Bahr el-Ghazal, Aweil rice scheme and other small-scale cultivations. Millet is grown mainly in Lakes and Western Equatoria States.



Adopted from: FAO/WFP Crop and Food Security Assessment Mission to Southern Sudan, 6 February 2009, CAMP Task Team

Note *1: This cropping pattern of maize is for all area in general.

*2: This cropping pattern of maize is in Western Equatoria.

*3: Cassava is planted during the rainy season and is harvested after a year or later.

Figure 1.4.1 General Crop Calendar in South Sudan

(2) Irrigated Agriculture for Commercial Production

The above crop calendar shows no agricultural activities in the dry season since almost all farming areas are rain-fed. The diversification of cultivated crops per household is very limited as 77% of households harvested only one (1) or two (2) crops. Then sorghum and maize that have the drought tolerance (C4 plants in scientific term) would be chosen as staple crops. If adequate irrigation facilities were developed, farmers would be able to increase the productivity by cultivating crops in the dry season.

Irrigated agriculture has been practiced in some parts of South Sudan, which include traditional irrigation for tobacco and vegetables, basin irrigation for maize and cowpeas in wet soils when the river recesses after flooding, flush irrigation for rice fields during flood periods, and cultivation on the dikes that surrounds fishing camps including sugar cane and banana, etc.

1.4.5 Livestock Subsector

The livestock population data currently used officially at the policy level by MLFI is an estimate by FAO for the whole of South Sudan. The national herd of cattle, goats and sheep estimated by FAO would place

[4] The data was obtained from NBS/CAMP Task Team (Table 10-16, The CAMP Annex IV Situation Analysis).

the South Sudan national herd ranks as the seventh (Musinga et al., 2010)[xi][5] largest in Africa. And South Sudan has the highest livestock per capita ration in Africa with an average 25 livestock per household (FAO, 2012)[xii].

Table 1.4.5 Livestock Water Requirements in South Sudan

	Cattle			Goats			Sheep		
State	Number	Total (Litter)	Total (m3)	Number	Total (Litter)	Total (m3)	Number	Total (Litter)	Total (m3)
Central Equatoria	878,434	13,754,958,789	13,754,959	1,153,283	4,251,577,780	4,251,578	1,265,977	4,667,024,211	4,667,024
Eastern Equatoria	888,278	13,909,101,063	13,909,101	1,132,541	4,175,112,397	4,175,112	1,025,297	3,779,757,391	3,779,757
Jonglei	1,464,671	22,934,550,854	22,934,551	1,207,214	4,450,394,411	4,450,394	1,400,758	5,163,894,367	5,163,894
Unity	1,180,422	18,483,637,887	18,483,638	1,754,816	6,469,129,184	6,469,129	1,487,402	5,483,307,473	5,483,307
Upper Nile	983,027	15,392,728,280	15,392,728	439,741	1,621,105,197	1,621,105	640,209	2,360,130,479	2,360,130
Western Equatoria	675,091	10,570,912,424	10,570,912	1,153,283	4,251,577,780	4,251,578	1,169,705	4,312,117,483	4,312,117
Lakes	1,310,703	20,523,642,926	20,523,643	1,464,421	5,398,588,017	5,398,588	1,232,282	4,542,807,593	4,542,808
Warrap	1,527,837	23,923,635,665	23,923,636	1,369,005	5,046,836,933	5,046,837	1,290,045	4,755,750,893	4,755,751
Western Bahr el Ghazal	1,247,536	19,534,542,456	19,534,542	1,120,095	4,129,230,218	4,129,230	1,265,977	4,667,024,211	4,667,024
Northern Bahr el Ghazal	1,579,160	24,727,276,860	24,727,277	1,630,361	6,010,325,827	6,010,326	1,285,231	4,738,004,082	4,738,004
Sub Total			**183,754,987**			**45,803,878**			**44,469,818**
Total (m3)									**274,028,683**

Adopted from: (FAO, 2009)[xiii] and (FAO, 2010)[xiv]

Note: Litres/day/animal (Cattle:42.9, Goats and Sheep:10.1), Litres/year/animal (Cattle:15658.5, Goats and Sheep:3686.5)

Livestock drinking water requirement as to cattle, goats, and sheep, which are the main livestock in RSS, has been estimated to clarify the water use of livestock based on FAO data.

As shown in Figure 1.4.2, among the ten (10) states, the Northern Bahr El Ghazal (35,475,606 m^3) was the highest in the amount of the drinking water requirement for three kinds of livestock, which was followed by Warrap (33,726,223 m^3) and Jonglei (32,548,839 m^3). The total amount of water requirement in whole country is 274,028,683m^3.

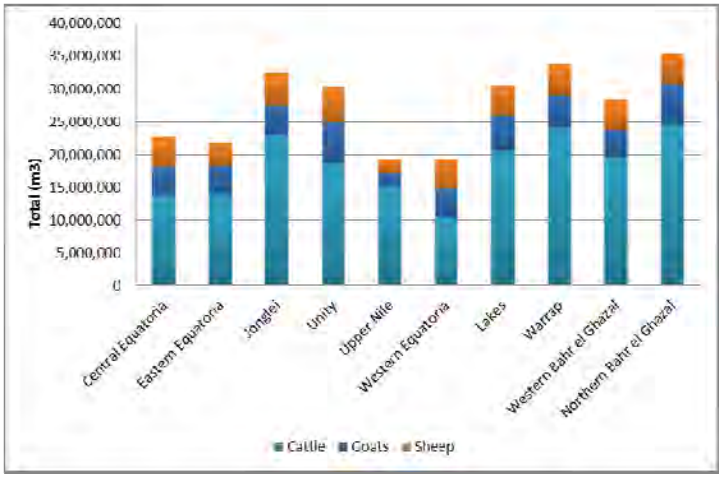


Figure 1.4.2 Livestock Water Requirements

1.4.6 Fisheries Subsector

Most of fishing households are not full time fishing communities. They are also engaged in other economic activities such as animal husbandry. Generally speaking the best fishing season in flowing waters is the wet season, when the "toic"[6] is flooded and it is during this period that people living near the Nile and its associated rivers fish the most and catch the most. In the dry season, people fishing in the static water, oxbow and lakes are at their most active (having been planting during the wet season).

There is no reliable estimate of the fisheries resources of South Sudan. FAO gives between 75,000-140,000 (Max) tonnes/year as the possible size of the potential fisheries resources of the 'Sudd region and adjacent areas" (FAO, 2013)[xv]. Assuming[7] another 60,000 tonnes/year for those areas outside the "Sudd and adjacent areas" a maximum sustainable yield of 200,000 tonnes/year is probably realistic[8].

5 Musinga et al. 2010 in their report rank the South Sudan national herd as the 6th largest on the African continent, ahead of Kenya; however, a comparison of data for the two countries would rank South Sudan 7th on the basis of both numbers and livestock units.

6 Toic (a Dinka word): area that floods during the wet season but in the dry season retains enough water to provide pasture for livestock.

7 CAMP Fisheries Specialist, based on subjective opinion influenced by observations and data collected by CAMP, GIZ, NBS & others.

8 This is the figure CAMP has used in the absence of alternative figures (which are universally based on little more than wild guess work).

Taking figures from the Sudan Productive Capacity Recovery Programme by GIZ for fish catches per commercial fishing unit, along with an assumed figure for catch per subsistence fisherman, the total catch is calculated to be 86,485 tonnes/year. Assuming a potential for the whole country of about 200,000 tonnes/annum (140,000 tonnes for Sudd region and adjacent areas and plus an estimated of 60,000 tonnes/annum for areas outside the Sudd and adjacent areas), this particular estimated catches indicates that fisheries production is capable of more than a doubling of total catches over the whole country.

1.4.7 Industrial Subsector

Currently water use regulation for industrial use has not been issued and plans to establish industrial zones as such have not been prepared by the related ministries yet, though the private sector investment in industry has been gradually taking place in and around the major cities in the country.

According to the water use and irrigation survey (WUIS) by IDMP-TT, six (6) states reported on the water use in industry and mining though Northern Bahr el-Ghazal only provided information on the water source. The maximum water volume for industry and mining is reported at 90 m^3/day in Jonglei. The water use in Central Equatoria is 10 m^3/day; however, the current demand is estimated at 100 m^3/day in the rainy season and 200 m^3/day in the dry season.

Most of the States would have high prospects for the future demand of water in the industrial sector since it is considered that the population will grow a lot and urbanization will be progressed. In terms of water quality, contamination by oil is reported in Unity, whereas three states replied that the water quality was acceptable, compared to their water quality standards. The water sources in Lakes and NBG are wells and other states take the water from rivers for the industrial use.

Table 1.4.6 Water Volumes and Quality in relation to Industry and Mining in South Sudan

State	Water Volume	Water Demand cu.m/day		Water Source	Name of the Water Quality Standard	Water Quality in Comparison with the Standard	Water Fee	
	cu.m/day	Rainy	Dry				SSP/month	collector
CE	10.0	100.0	200.0	River	-	-	-	Urban Water Corporation
JS	90.0	-	-	River	South Sudan Water Standard	Acceptable	0	-
LS	4.8	low	high	Well	-	Acceptable	2,600	Tax Office, MoF
US	-	-	-	River	South Sudan Standard	Contaminated by oil	0	-
NBG	-	-	-	Well	-	-	-	-
WBG	-	-	-	River	WHO Standard	Acceptable	-	Urban Water Supply

Source: WUIS

1.4.8 Hydro-power Subsector

(1) Potential Sites

The Republic of South Sudan has significant hydropower potential, that can be generated from the White Nile between Nimule and Juba along Bahr el-Jebel (see Figure 1.4.3), and also some mini-hydropower projects may be feasible in many other parts of the country like Eastern Equatorial State (Kinyeti) and Western Bahr el-Ghazal State (Swe) .

Table 1.4.7 Hydropower Potential Sites in South Sudan

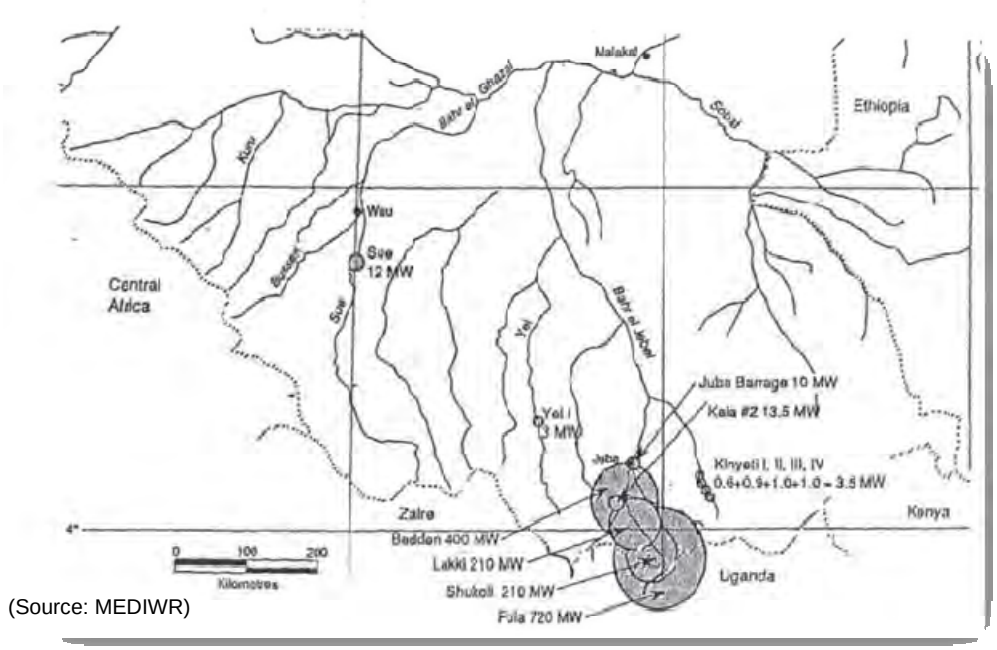
Site	Basin	River	Discharge at proposed site (m^3/s)	Dam storage capacity (Mm^3)	Power (MW)	Source
Badden	Bahr el Jebel	Bahr el Jebel	2,043	1,412	530	MED/RSS
Fulla	Bahr el Jebel	Bahr el Jebel	1,213	580	865	MED/RSS
Shukoli	Bahr el Jebel	Bahr el Jebel	1,110	0.8	150	MED/RSS
Lakki	Bahr el Jebel	Bahr el Jebel	1,181	38.4	300	MED/RSS
Swe K7	Bahr el Ghazal	Sue	93.8	1.051	15	Egypt study team
Katire	Kinyeti	Kinyeti	2 m^3/s		8	NILE V III

Adopted from: MEDIWR

The total existing power generation capacity in South Sudan is about 25 MW of thermal capacity only within some big towns and some states' capitals (Juba, Wau, Malakal, Yei, Bor, Rumbek, Yambio, Maridi and Kapoeta) where there is limited distribution network, a combination of government efforts and donor support (USAID, MDTF &Egypt). Renk town is connected through power interconnection with the Sudan; and the rest depend on individual generators.

(2) Future plans

MEDIWR has two plans one for a short and medium period of 2 to 3 years and another for a long period of 5 to 8 years as shown in the table below:



(Source: MEDIWR)

Figure 1.4.3 South Sudan Potential Hydropower Sites

Table 1.4.8 Hydropower Development Plans in South Sudan

Plan	Power target	Status of plan	Target time
1. Short and medium term projects			
Extension of the Ethiopian power Grid	50 to 100 MW	- Feasibility study completed - EIA study still	2 to 3 years
Fulla hydropower project	40 MW	- Feasibility study completed - EIA study completed	2.5 to 3 years
Tharjath thermal power project	200 MW	- TOR for feasibility study prepared	
Upgrading of Kinyeti River Power project		- Feasibility study competed	
Swe River Hydropower project	12 to 15 MW	- Feasibility study completed	
2. Long term projects			
Bedden Hydropower project	540 MW	- Feasibility study completed - EIA completed	5 to 7 years
Lakki Hydropower project	200 MW	- Feasibility study completed - EIA completed	5 to 7 years
Garand Fulla Hydropower project	1080 MW	- Feasibility study completed - EIA completed	8 to 12 years

Adopted from: MEDIWR

1.4.9 Conflicts over Water

Conflicts over water are one of the key concerns towards implementing the formulated irrigation development master plan. Through the water use and irrigation survey, the cases of conflicts reported by the State officers are categorized into three (3). Abbreviated designations of the states whose officers raised the issues/conflicts are indicated after each answer.

a) Conflict between farmers and pastoralists
- Problems between farmers and cattle keepers (LS, UNS, WES)
- Cattle and goats eat crops (WS)
- Fighting over feeding of animals (CES)
- Farmers do not allow pastoralists to keep cattle around their farms/to use their water points (JS)
- Conflict between famers and pastoralists due to shortage of water (WBGS)
- Pastoralists look for water but few water points (WS)
- Conflict between farmers and pastoralists around water points (NBGS)

b) Conflict among farmers
- Conflict on water points among farmers (EES, LS)
- Many people take water from one point (UNS)
- Low yield of water and shortage of points (WBGS, WES)
- Displacement was caused by fighting over water (CES)
- Fighting over withered crops between upstream and downstream (CES)

c) Other conflicts
- Pastoralists comes from Sudan, looking for grass, water, etc and loot cattle (NBGS, US)

1.5 Land Use

RSS lacks proper land use mapping and is yet to define its land use types or categories properly. However, there are related activities; satellite imagery based maps of the Land Cover; mainly from the Food and Agriculture Organization of the United Nations (FAO), firstly under the Africover project and most recent mapping, compilation of Land Cover Database and production of Land Cover Atlas of the RSS in year 2011.

Under this mapping, 43 single classes used for the interpretation of land followed by aggregating them into seven (7) main land cover classes, namely (i) Agriculture in terrestrial and aquatic/regularly flooded land (AG), (ii) Trees closed to very open in terrestrial and aquatic/regularly flooded land (TCO), (iii) Shrubs closed to sparse in terrestrial and aquatic/regularly flooded land (SCO), (iv) Herbaceous closed to sparse in terrestrial and aquatic/regularly flooded land (HCO), (v) Urban areas (URB), (vi) Bare Rocks and Soil and/or other Unconsolidated Material(s) (BS), and (vii) Seasonal/perennial, natural/(artificial) Waterbodies (WAT), which is illustrated in Figure 1.5.1.

Table 1.5.1 Current Land Use/Land Cover of South Sudan

Land Use Types	Area Sq. Km. (rounded figure)	Percentage
Cropland	24,777	3.80
Grass with Crops	3,251	0.50
Trees with Crops	17,073	2.60
Grassland	96,338	14.90
Tree land	405,269	62.60
Flood land	94,976	14.70
Water and Rock	4,827	0.70
Urban	370	0.10
Total	646,883	100

Source: World Bank, 2012. Strategic Choice for Realizing South Sudan's Agricultural Potential (Table 1, p. 4) (Agreegated from FAO 2009. Land Cover Database)

The classes reflect, besides others, mainly the nature of vegetation cover of the land area, thus difficult to call them land use.

In the absence of concrete information on Land Use, various institutions are using one or another source of data to describe it as illustrated in the Table 1.5.1. The table shows the FAO land cover database[xvi] was aggregated with emphasise on particular class of land use, in this case Cropland. As it can be seen in the table, the aggregated Agricultural land (Cropland, Grass with Crops and Trees with Crops) stands to 6.9 %.

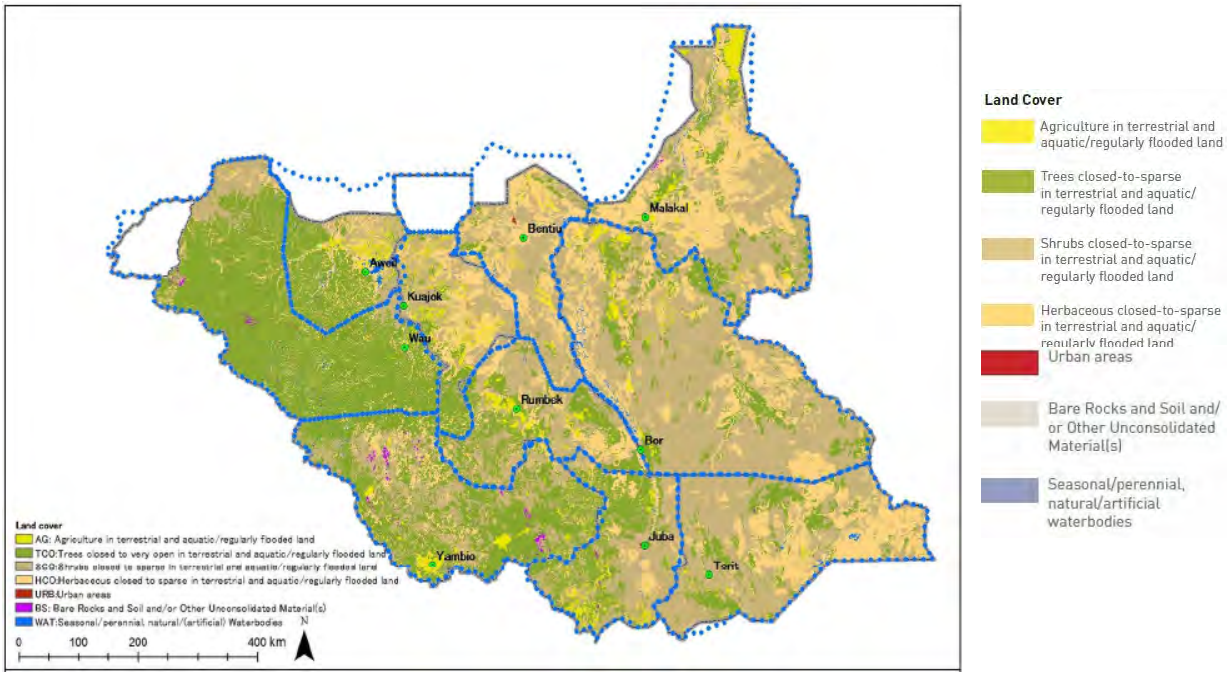


Figure 1.5.1 Land Cover Map of South Sudan (Source, FAO, 2011)[xvii]

1.6 Policies & Institutional Framework in Relation to Water Sector & Irrigation Subsector

1.6.1 Overview

IDMP is formulated on the basis of the existing relevant policies and development plans. The source of guidance for formulating IDMP is the national development plans; and the sectorial and institutional policies, strategies, strategic plans, laws and regional frameworks in relation to the water sector are also the primary guiding documents. Agriculture, environment and land policies are important guidelines for IDMP, as well. Following are the documents, which would be related to IDMP, and the outlines of major ones are described below.

- South Sudan Development Plan/South Sudan Development initiative
- Water Policy, Water Sanitation and Hygiene Sector Strategic Framework, and Draft Water Bill (led by MEDIWR)
- Agriculture Sector Policy Framework 2012-2017 (MAFCRD), Policy Framework and Strategic Plans 2012-2016 (then the Ministry of Animal Resources and Fisheries)
- South Sudan National Environmental Policy (the Ministry of Environment)
- Land Act 2009, Investment Promotion Act 2011, and Draft Land Policy 2013
- Local Government Act 2009, Investment Act 2008, and others

At the policy level, the then MWRI published “Water Policy” in November 2007, which outlines the vision of the country for the water sector and establishes basic principles and objectives to guide future water sector development. As “a major step for putting into practice the principles laid out in the Water Policy”, the Ministry also published “Water, Sanitation & Hygiene (WASH) Sector Strategic Framework” in August 2011.

In line with this policy and strategy, "Water Act" is currently under preparation (Currently Draft Water Bill Jul. 2015 is the latest edition) to be enforced as Legal, Institutional and Regulatory framework of Water Sector.

These three (3) documents are formulated consistently by classifying the two (2) major categories, namely Water Resources Management; and Water Supply and Sanitation. Irrigation sector is not specifically described in these documents but it is intimately related to Water Resources Management. Irrigation development, therefore, has to be formulated in accordance with the Water Resources Management subsector policy, strategy and regulatory framework.

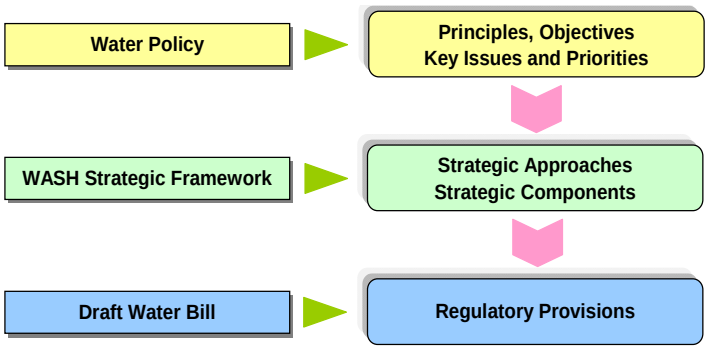


Figure 1.6.1 Policy, Strategy and Draft Bill for WASH/Water

From the side of agriculture sector, the then Ministry of Agriculture, Forestry, Cooperatives and Rural Development (MAFCRD) established "Agriculture Sector Policy Framework (ASPF) 2012-2017" in October 2012. ASPF is also the legitimate policy to guide the future irrigation development in South Sudan, hence constituting the foundation of IDMP along with above water resources management subsector guiding documents.

Other policies such as "Cooperatives Act in 2011, the then Ministry of Animal Resources and Fisheries, Policy Framework and Strategic Plans 2012-2016" in January 2012, "South Sudan National Environment Policy" in March 2012 by the Ministry of Environment, "Land Policy (Draft)" being prepared by the South Sudan Land Commission, Investment Promotion Act 2011, Local Government Act of 2009, the States' Government Strategic Plans, and Regional frameworks are also the sources of guidance for formulating IDMP.

Along with such institutional and sectorial policy making and strategy documents, the GRSS has initiated the comprehensive national development plan right after the independence, namely "South Sudan Development Plan (SSDP) 2011-2013" in August 2011, which has prioritized the agriculture sector and infrastructure for economic development. As part of the operationalisation process of SSDP, the "South Sudan Development Initiative (SSDI) 2013-2020" has been drafted. The following sections describe major existing plans and each of the sectorial policies, strategies and plans in relation to irrigation.

1.6.2 South Sudan Development Plan/South Sudan Development Initiative

South Sudan Vision 2040
By 2040, South Sudan will be educated and informed; prosperous, productive and innovative; compassionate and tolerant; free, just and peaceful; democratic and accountable; safe, secure and healthy; united and proud. (Press statement by the President of South Sudan, 15th Dec. 2011 in Washington D.C.)

The South Sudan Development Plan 2011-2013 (SSDP) was published in August 2011 right after the birth of the Republic of South Sudan as the first national development plan to embark on achieving the country's longer term vision, namely South Sudan Vision 2040, which was emphasized by the President of RSS at the end of the International Engagement Conference for South Sudan on 15th December 2011 in Washington DC.

SSDP identified the national priority programme areas with four (4) pillars that were Governance, Economic Development, Social and Human Development, and Conflict Prevention and Security. In relation to IDMP, the agricultural sector and water & sanitation sector were prioritized under the programme of economic development.

With the understanding that capacity and infrastructure challenges place constraints on all the sectors of the economy, the South Sudan Development Initiative (SSDI) 2013–2020 is being formulated as an implementation framework for the SSDP. SSDI has an aim at finding the means through which the African Union and key development partners can assist the RSS in transforming its economy from post-conflict to sustainable development.

Draft SSDI has included the five (5) sectors in its scope of work, namely 1) transport and roads, 2) energy, 3) water and sanitation, 4) housing, and 5) health/social infrastructure. The water and sanitation sector has been described with 28 priority programmes, one of which is "Water Resources Development and Management Plans and Interventions". IDMP would produce one of the basic inputs towards the materialization of Water Resources Development and Management Master Plans under SSDI. This, namely water resources potential assessment, to be carried out in the course of the IDMP formulation, will be a basis for water resources development and utilisation.

1.6.3 Water Policy

The Water Policy was issued in November 2007 during the interim period of Comprehensive Peace Agreement (CPA). The Water Policy sets its overall goal as "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 in Southern Sudan". The purpose and scope of the Water Policy is stipulated as "to provide a framework for optimal allocation of available water resources in Southern Sudan on an equitable and sustainable basis. The Policy remarks that "it is important to note that policy should be dynamic and continuously evolving" and therefore, periodically re-assessed to meet the future changing needs.

The Policy addresses specific issues in three (3) sub-areas, namely Water Resources Management (WRM), Rural Water Supply and Sanitation (RWSS) and Urban Water Supply and Sanitation (UWSS). Nevertheless, irrigation is not categorized as a single topic.

As for the irrigation sector, the Policy recognizes it as "irrigation will form an important component of future strategies for achieving food security and agriculture-based economic growth" (page 3) and "agriculture is expected to be the single biggest user of water in South Sudan in the future, and as demand for irrigation water grows there is need to establish policies and strategies to promote efficient and responsible water use and mitigate potential conflicts between competing water users" (page 3). The Policy also suggests cost recovery through fees and levies charged to water users for specific services such as delivery of irrigation water, operation of dams/reservoirs (page 13).

1.6.4 Water, Sanitation and Hygiene (WASH) Sector Strategic Framework

The Water Sanitation & Hygiene (WASH) Sector Strategic Framework was formulated in August 2011 with the purpose of operationalizing the Water Policy of 2007 and ensuring its implementation through effective and technically sound strategic approaches, improved capacity and involvement of all stakeholders.

The vision of WASH strategic framework is addressed as "Sustainable harnessing and accountable management of water resources that respond to water related public-health needs, livelihoods and development aspirations of the people of South Sudan in an equitable manner". The Scope of WASH includes a time frame of up to 2015 and the strategic areas have been identified based on the Water Policy, namely water resources management, urban water supply and sanitation (& hygiene), and rural water supply and sanitation (& hygiene). Besides, WASH describes the overall governance and development strategy.

In relation to irrigation, the WASH Strategic Framework noted the requirement for a separate policy and regulatory establishment for irrigation development. This is due to the fact that "MWRI's mandate is to allocate and deliver bulk water to irrigated agricultural schemes; but at the on-farm level, it is the responsibility of the Ministry of Agriculture and Forestry (MAF) to distribute and manage that water among farmers on their plots and in crop fields. MWRI realizes that the shared responsibility between the two Ministries calls for a separate policy and regulatory framework for irrigated agriculture and other productive uses, to be adopted/enacted, so as to fully realize the potential of this subsector".

It is evident that IDMP policy and regulatory framework will be based on both the Water Policy and the WASH Strategic Framework, which are the principal documents under which irrigation has been mentioned as part of water resources management; but not addressed separately. The two documents emphasized the necessity of Integrated Water Resources Management (IWRM) with the anticipation of agriculture sector to be the biggest water users in the future.

1.6.5 Draft Water Bill

In an overarching manner, firstly the Draft Bill/Act stipulates establishment of the Water Council, stipulated in the Chapter 2 of Preliminary. The Water Council covers both water resources management and water supply and sanitation; and it will have a chair and will include members from the related ministries and institutions, including managing directors of the Water Resources Management Authority (WRMA) and the Safe Water Supply and Sanitation Services Regulator (SWSR); and the private sector and civil society. The Water Council works as the principal multi-stakeholder advisory body.

Under the Water Council, Water Resources Management Authority (WRMA) is established to regulate the management, development and use of water resources. WRMA is a corporate body headed by a managing director answerable to the board of directors. The Basin Water Board in each basin shall be established to be responsible for its defined/delineated basin area. Under the Basin Water Board, catchment/sub catchment committees shall be established. The committees will be responsible for planning and resolving conflicts within their hydrological boundaries. Water Users Association may be formed as a group of users of water as recognized by and represented to the WRMA. Facilitation of the establishment of irrigation boards has also been mentioned under powers of the Minister.

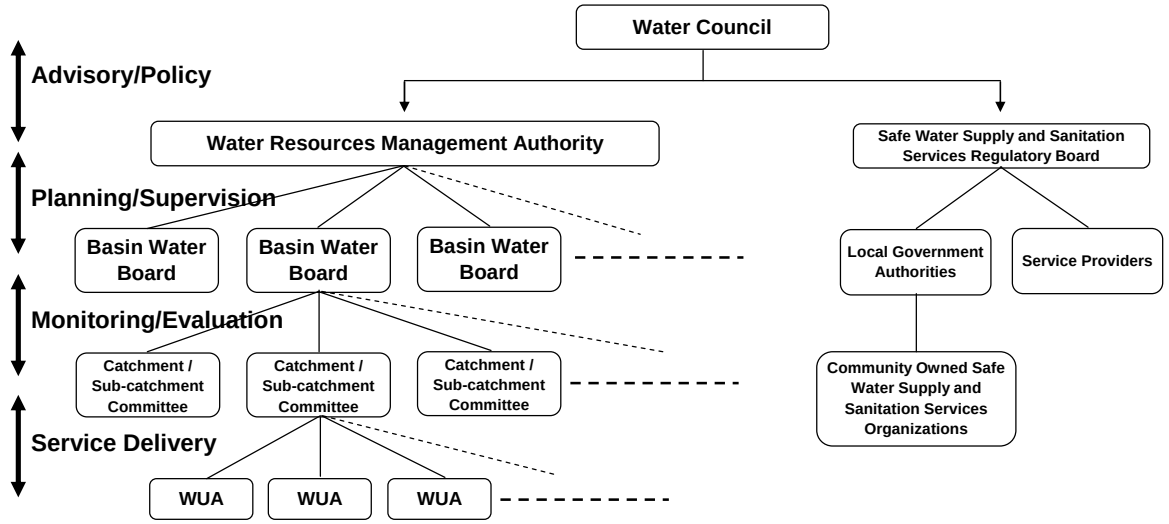


Figure 1.6.2 Proposed Structure of Water Resources Management in the Draft Water Bill Institutional Framework

The draft Water Bill stipulates that a permit shall be required for any use of water from a water source (except for use of water without the employment of works, spring of the landowner, storage of water

from a reservoir which does not constitute a watercourse), the drainage of any swamp or other land, the disposing of any waste into any water source/body of water and any purpose to be carried out in or in relation to a water resource.

As significant as the permit provision, the draft Act stipulates to formulate guidelines and a pricing strategy for the settings charges to be levied by the Basin Water Board in respect of: 1) Water abstraction; 2) Effluent discharge; 3) Payment for environmental services, 4) Granting of permits required under this Act; and 5) Any other matter for which the Basin Water Board considers charges shall be made pursuant to this Act.

1.6.6 Agriculture Sector Policy Framework (ASPF) 2012-2017

Agriculture Sector Policy Framework (2012-2017) with its setting vision of "Food security for all the people of the Republic of South Sudan, enjoying improved quality of life and environment", has addressed some key issues, for example acceleration of food and agricultural production through commercial smallholder and large scale agriculture, using mechanized and irrigation technology. The document sets policy guidelines, one of which states to promote sustainable irrigation infrastructure and flood management system to contribute to improved agricultural productivity and food security enhancement.

The guideline further describes its implementation strategy as: 1) collaborate with then MWRI in developing a National Irrigation and Drainage Policy and Strategy (NIDPS) to ensure IWRM, 2) build institutional and human capacity in irrigation and drainage development, 3) support and promote private sector participation, 4) support and collaborate with the then MWRI in implementing the Water Policy and implementing various water resource development activities and 5) promote water harvesting technique in arid and semi-arid areas for boosting irrigation agriculture

1.6.7 Environmental Policy

South Sudan National Environmental Policy was published and enacted in 2012, which covers a wide range of environmental problems notably; soil degradation due to wide spread deforestation with consequential loss of biodiversity and wildlife habitat, pollution of rivers and the environment due to improper oil drilling activities in the wetlands, over exploitation of fish stocks, conflict over diminishing grazing lands and water points for livestock, prevalence of water-borne diseases due to poor sanitation.

The goal aims "to ensure the protection, conservation and sustainable use of the natural resources without compromising the tenets of inter-generational equity" according to the section 1.6. Also the policy indicates guidance under each specific sector. Some of them may guide useful ideas to the irrigation development, so that it shall be reflected in the planning. Based on the "Environmental Policy", the following strategies are recommended to be put in the irrigation master plan:

1) Wisely use wetlands as well as rivers and lakes for irrigation development in consideration with environmental protection.
2) Balance use and impartially share water resources among agriculture, fishery, livestock and industry.

1.6.8 Land Policy

Both surface and subsurface water is an integral part of land, which is generally termed as one of the land-based natural resources of the country. Thus, the land policy of a country must be formulated by taking into account the water resources. In RSS, the Land Policy (draft), 2013, has been adopted by the council of ministers recently and is now awaiting adoption by the legislature. The land policy has given, reasonably, due consideration to the water sector in its policy statements.

At foremost, the Land Policy has the clearly stated goal of strengthening the land tenure security for all citizens, which implies that such security will also be applicable to the water resources as it is an integral part of the land, especially while talking about the agricultural farming and animal husbandry. Furthermore, the guiding land policy principles mentioned about the equitable access to land and statutory recognition of community land right and institution. Such principles are more relevant for the overall socioeconomic development in rural areas where most of the family practices subsistence agriculture and cattle rearing. The secure land tenure/ownership is also having its obligation to use land and natural resources sustainably and with due care by formulating appropriate policy in conjunction with other government policies for agriculture, forestry, water use and environment.

Although facilitation for the use of water for irrigated agriculture has not been mentioned explicitly, the policy (statement 13) encourages private/commercial investment in land for agriculture. Under the policy statement 15, it has been pointed out that National and State authorities, with their some jurisdictions, have alienated the community land used in common including grazing and water supply from local community for public use or sale or lease to private investor. To resolve such issues, policy envisages that communities should have legal right, through local government (County and Payam) to have lease agreements with private investors.

1.7 Institutional Settings in relation to Irrigation Subsector

1.7.1 National, State and Local Governments

On 23rd July 2013, the GRSS implemented the reduction and restructuring of the Ministries of the National Government. In this exercise, the Ministry of Water Resources and Irrigation (MWRI) was merged with the Ministry of Dams and Electricity, and hence became the Ministry of Electricity, Dams, Irrigation and Water Resources (MEDIWR). MAFCRD was also merged with other ministries at that time but again became back to the one as it is after the unrest during 2014, giving back the birth of the Ministry of Livestock and Fisheries Industry (MLFI).

There are ministries in charge of agricultural development and water resources management at the State government level. For water resources management, mainly working for safe water and sanitation at present, the responsibility falls in the ministry whose name varied such as physical infrastructure, housing and public utilities ministries as well as Water. State Ministry of Agriculture in each State also has a vital role for promoting irrigated agriculture. In the Eastern Equatorial State, the department in charge of irrigation is distinguished under the State Ministry of Agriculture. The county also generally has the departments of water and agriculture.

Part of the water budget support for the State ministries in charge of the water sector is allocated from the National Ministry, namely MEDIWR through the National Ministry of Finance and Economic Planning (MoFEP) through the State Ministries of Finance. The budget transferred to the State Ministry from the then MWRI in 2012 is around 10% of its total budget. MWRI established buildings for the State Directorates of Water and Sanitation; and apart from operating costs and salary support transfers, for the fiscal year 2013, according to the plan for the then MWRI, the transfer of capital to Counties is also included for the fiscal year 2013, only to carter for setup or establishment of county water and sanitation office. That capital transfer shares 50% of the transfer to States.

The allocation principle for the states and county budget transfers is based on equal allocations. Table below lists the ministries and departments in charge of water sector as well as agriculture.

Table 1.7.1 Departments and Ministries in Charge of Water and Agriculture Sectors in the State

State	MEDIWR line Ministry	MAFCRD line Ministry
Upper Nile	Department of Water Resources Management and Irrigation State Ministry of Physical Infrastructure and Rural Development	Mechanization and investment unit State Ministry of agriculture and Forestry
Jonglei	Department of Water Resources Management and Irrigation State Ministry of Physical infrastructure	Department of Mechanization State Ministry of Agri. and Forestry
Unity	Department of Water and Sanitation State Ministry of Physical Infrastructure, Urban Development and Natural Resources	Directorate of Agriculture and Extension Services State Ministry of Agriculture and Forestry
Warrap	Directorate of Urban Water, Water Resources Management and Irrigation State Ministry of Physical Infrastructure	Agriculture Mechanization Unit State Ministry of Agriculture and Forestry
NBG	Department of Water Resources Management and Irrigation State Ministry of Water and Rural development	Department of Agriculture and Extension State Ministry of Agriculture and Forestry
WBG	State Ministry of Irrigation and Water	Directorate of Agriculture State Minitry of Agriculture and Forestry
Lakes	Department of Water Resources Management and Irrigation State Ministry of Physical Infrastructure	Directorate of Mechanization State Ministry of Agriculture and Forestry
WE	Department of Water resources State Ministry of Physical Infrastructure and Public Utilities	Department of Agriculture Mechanization State Ministry of Agriculture and Forestry
CE	Directorate of Water Resources Management and Irrigation State Ministry of Physical Infrastructure	Department of Mechanization State Ministry of Agriculture and Forestry
EE	State Ministry of Housing and Public Utilities	Department of Mechanization, Crop Production and Irrigation State Ministry of Agriculture

1.7.2 Training, Research and Education Institutes/Institutions

The institutes for higher education and research for irrigation development, i.e. civil engineering and agricultural science are found at the universities/colleges in South Sudan. There are five (5) public universities in South Sudan and there are some private universities or colleges recently established in the country. Among them University of Juba is the only one which has the course of civil engineering, under the College of Engineering and Architecture. In relation to the irrigation development, at the College of Engineering and Architecture, the departments of Civil Engineering and Agricultural Engineering offer the studies of 1) Water resources, 2) Agriculture construction, 3) Properties of agricultural materials, and 4) Irrigation & hydraulics engineering. It was reported that the output of agricultural engineers will be declining from 21 to 17, 14 and 7 over the next four years from 2013.

MEDIWR in collaboration with MAFCRD are establishing capacity building for skills and knowledge in Water, Sanitation and Hygiene (WASH) at Amadi Rural Development Institute. This project is supported by the Dutch Government NUFFIC programmes through The Netherlands Initiative for Capacity in Higher Education (NICHE). The first enrolment of trainees/students in a technician certificate courses (including irrigation) is expected by the end of 2015, aiming at graduating water management/development and sanitation technicians.

1.7.3 Regional Institutions involving South Sudan

There are regional institutions, which have been organized among the countries in eastern Africa or along the Nile in relation to water sector. The major ones are: the Nile Basin Initiative (NBI), and its subsidiary action programmes; the New Partnership for Africa's Development (NEPAD); and the Intergovernmental Authority on Development (IGAD). It is expected that these institutions would contribute to technical corporations and funding resources for irrigation development under the partnership of the member countries.

(1) NBI and its Subsidiary Action Programmes

NBI was established in 1999 among the riparian countries of the Nile with their goal being to promote trans-boundary water cooperation in the region. RSS used to be an observer of NBI from 2006 to 2011 and RSS became the official member of NBI on 5th July 2012. Each country has a focal point. In case of RSS, the Department of the Water Resources Management of MEDIWR takes this role. NBI serves as the institution and platform of multilateral cooperation, e.g. through NBI Secretariat (Nile-SEC), Nile Equatorial Lakes Subsidiary Action Programme (NELSAP) and Eastern Nile Subsidiary Action Programme (ENSAP). There is also a fund called Nile Basin Trust Fund (NBTF) managed by the World Bank.

Other activities related to water sector of South Sudan are NBI-RHMS (River Hydrological Monitoring System) to monitor and assess the water and related natural resources of the Nile Basin and provide knowledge base to the member countries; NELSAP-RATP (Regional Agriculture Trade and Productivity Project) to carry out an integrated approach to irrigation and drainage development; NELSAP-MSIOA (Multi-sector Investment Opportunity Analysis) to prioritize and sequence potential investments in water resources management and also to develop planning model; ENSAP-RHMS (River Hydrological Monitoring System) to provide knowledge base on water and related natural resources in the eastern Nile region, etc.

IDMP implementation can be benefitted from these activities by means of funding, technical assistance and sharing information for water resource assessment.

(2) NEPAD

NEPAD has identified agriculture as central to achieving poverty alleviation, food and nutrition security and attaining the Millennium Development Goals (MDGs) (CAADP Pillar I Framework, 2009)[xviii]. Then the Comprehensive Africa Agriculture Development Programme (CAADP) was endorsed in 2003 as a common framework for simulating and guiding national, regional and continental initiatives on enhanced agriculture productivity. Under CAADP, four (4) continent-wide pillars for investment and action have been identified. These are: 1) sustainable land and water management, 2) improving market access, 3) increasing food supply and reducing hunger, and 4) improving agricultural research and systems to disseminate appropriate new technologies.

CAMP is formulated in line with the framework of CAADP, i.e. an investment plan to be formulated under CAMP will be positioned as the investment plan within the framework of CAADP. IDMP, as a support plan to CAMP, also need to take into consideration the framework of CAADP. Especially, IDMP should pay due attention to the Pillar 1; Sustainable Land and Water Management, which include Agricultural Water Development as one of the four key elements. Following the framework of Pillar 1 would promote partnership and support provision from Development Partners.

(3) IGAD

The IGAD region consists of eight countries, namely Uganda, Kenya, Djibouti, Ethiopia, Eritrea, Somalia, Sudan and South Sudan; and its technical secretariat is based in Djibouti. The IGAD establishment originated during the droughts of the 1980s; hence environmental sustainability and building of resilience are its core activities. In the region, agriculture is a predominant activity supported by land of differing capacity and utilizing both manual and mechanical means of production. The size of potentially arable land can be increased through irrigation. However, at the moment, less than 1% of the cultivable area in the region is irrigated, and at the moment there is no collective plan but every country is planning by its own effort to increase the area under irrigation.

Under such circumstance, IGAD has been trying to cooperate for regional water resource management and set its policy and legal framework under the programme titled IGAD-INWRMP (Inland Water Resources Management Programme). Under this programme, IGAD-HYCOS (Hydrological Cycle Observation System) has also been designed to develop and strengthen the hydrological information services of the member countries. The programme will contribute to constructing an information base for water resources management in South Sudan and this would help strengthen the planning of irrigation development based on more accurate hydrological information.

1.7.4 Development Partners (DPs)

The development partners have been cooperating with the line ministries of GRSS along with the aid coordination structure, which is one of the implementation strategies of South Sudan Development Plan (SSDP) 2011-2013. Though the mechanism may have modification in accordance with the restructuring of the Ministries and entering into the implementation of South Sudan Development Initiative (SSDI), the development partners will be following the four (4) development pillars and the budget sector working groups (WGs) in each pillar defined in the SSDP. These pillars are Governance Pillar WG, Economic Development Pillar WG, Human and Social Development Pillar WG and Conflict Prevention and Security Pillar WG.

The then MWRI belongs to the Infrastructure Budget Sector Working Group under the Economic Development Pillar WG. Under this Pillar WG, there is also Natural Resources Sector Working Group, to which CAMP related ministries belong; hence this Pillar WG is also closely related to IDMP. The MAFCRD and EU is co-chairing the NRS-WG, and JICA and EU is co-chairing the agriculture related donor group under NRS since 2013.

On the water issues related to cooperation with DPs, the Netherlands had been preparing the programme called Water Security for Peace and Economic Development in two (2) states, namely Lakes and Eastern Equatoria. The programme aims at introducing a concept of integrated water resources management in the Naam river watershed in the Lakes State and in the Kinyeti river watershed in the Eastern Equatoria State. The programme activities have started since January 2015 and are scheduled to be completed in 2020. This programme will give a model of water for productive use to implementation of IDMP in the future.

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CHAPTER 2 IRRIGATION DEVELOPMENT POTENTIAL ASSESSMENT

This process is done on the basis of geographical and demographic features; general natural conditions; rainfall; hydrology; prevailing livelihood systems; existing and planned water/land uses/utilizations; and related on-going envisaged commercial and industrial activities. This chapter shows current potentiality of water resources and location of priority areas in South Sudan compared to the other Nile Basin neighbouring countries, as well as African countries in the future.

2.1 Overall Methodology

Shortage of fundamental data such as periodical and encompassing data on rainfall, river discharges, evapotranspiration, vegetation, soil, etc. is an issue in the RSS due to the effect of the recurrent and prolonged civil war for about 40 years. Under this circumstance, IDMP-TT conducted an irrigation development potential assessment with the available data of rainfall and river discharges, etc. which were supplemented by remote sensing (R/S) and GIS technology, etc.

The assessment was conducted in two (2) stages, i.e. stage-1: rapid (low resolution) assessment on land productivity, water resource and socio-economic potentials nation-wide for the definition of high potential areas; and stage-2: detailed (high resolution) assessment of potential for irrigation planning at selected areas based on high precision satellite data, etc. for verifying priority areas and project sites. The criteria and flow of irrigation potential assessment are shown in Table 2.1.1 and Figure 2.1.1 respectively.

Table 2.1.1 Criteria for Assessing the Irrigation Development Potential

Assessment	Layer
Land Productivity Potential with prospects for gravity irrigation	Land cover, Slope, Temperature, Wetness, Soil, River Accessibility, Grazing area, Water bodies, etc.
Water Resources Potential	Rainfall, River discharge, Groundwater, Water use, etc.
Socio-economic Potential	Road accessibility, Population density, Protected area, Oil & gas concessions, Accessibility to market/capital advantage, etc.

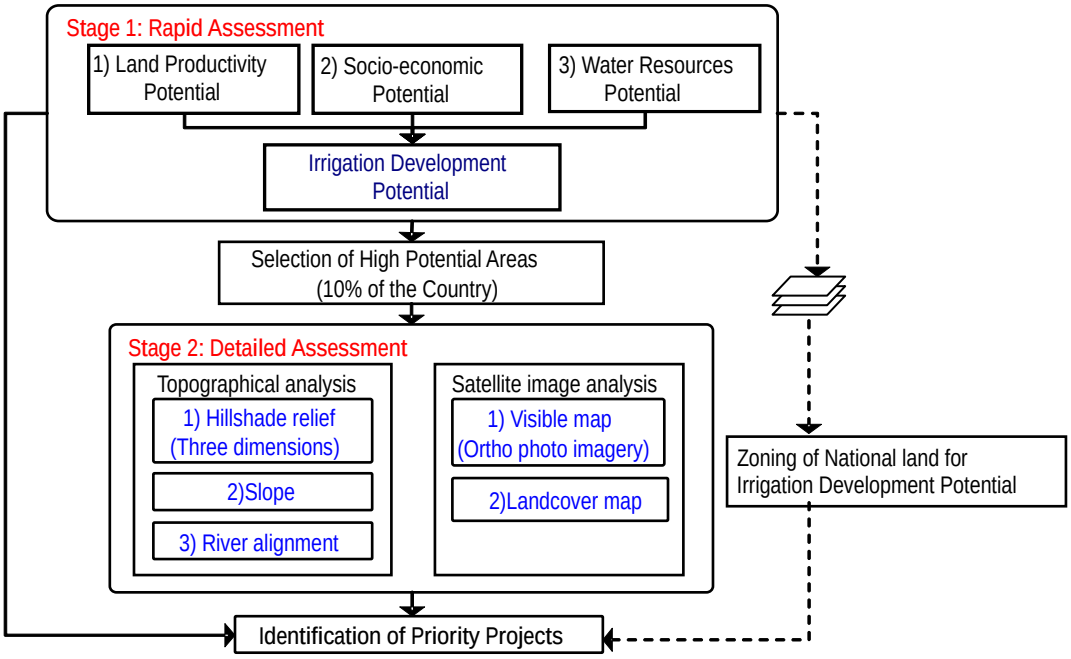


Figure 2.1.1 Flow Chart of Irrigation Development Potential Assessment

Stage 1: Rapid assessment of irrigation development potential (nation-wide): after collecting and sorting the above data, assessments for nation-wide land productivity and socio-economic potentials were conducted through overlay, using GIS technology. Thirteen (13) layers, where matters to be assessed through weighing of each layer, were selected. The assessment was decided on the assumption of eventually available data and through discussion among TT members. Then the high potential areas were agreed to be 10% of the country area, for identifying the short-term projects as well as priority projects.

Stage 2: Detailed assessment for the selected irrigation high potential areas: Stage 2 work of the detailed assessment at the selected high potential areas is positioned as part of the implementation plan formulation for priority projects. After this assessment, priority projects were identified through discussions among TTs, using a set of criteria.

2.2 Stage 1: Rapid Assessment of Irrigation Development Potential

The approach adopted in data collection and analysis; in addition to the factors that influenced the process are narrated, discussed and culminated in results upon which irrigation potentiality is based.

2.2.1 Layers Applied and Procedures for Land Productivity and Scio-economic Assessments

Strategic and analytical approach of assessment can be summarized as: 1) to collect nation-wide data for land productivity, 2) to examine, fix and analyse the data, 3) to employ the most accurate, detailed and latest data, 4) to rescale a spatial resolution of 90 meters, 5) to evaluate each data (layer) in terms of land productivity and irrigation potential, and give scores between values of 1 (low suitability) to 10 (high suitability), 6) to evaluate the importance of each layer, and give them the weighted score, and 7) to overlay all layers to get a rapid review of nation-wide land productivity potential. The data source of each layer for rapid land productivity potential assessment is summarized in Table 2.2.1 and Figure 2.2.1.

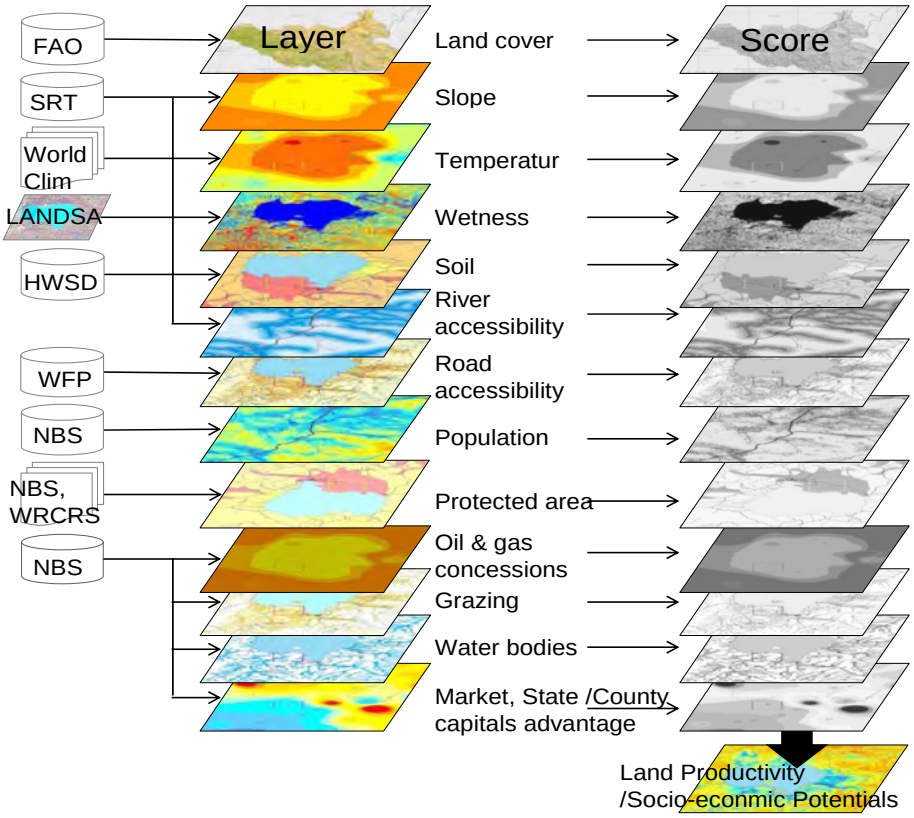


Figure 2.2.1 Creation of Land Productivity/Socio-economic Potential Maps

Table 2.2.1 Layers for Land Productivity and Socio-economic Potential Assessments

	Layer		Source	Remarks
Land productivity	01	Land cover	Land cover atlas – SIFSIA produced by FAO	Issued in 2011
	02	Slope	SRTM-DEM produced by USGS	Spatial resolution: 90m
	03	Temperature	WorldClim-Global Climate Data	Spatial resolution: 1km
	04	Wetness	LANDSAT produced by USGS	Spatial resolution: 30m
	05	Soil	Digital Atlas produced by NBS, Harmonized World Soil Database (HWSD)	Map scale: 1/2,000,000, Spatial resolution: 1km, Issued in 2009
	06	River accessibility	SRTM-DEM produced by USGS	Spatial resolution: 90m
	07	Grazing	Digital Atlas produced by NBS, MARF	Updated in 2010/11
	08	Water bodies	Digital Atlas produced by NBS, FAO	Updated in 2004
Socio-economic	01	Road accessibility	Transport overview map of assessed and un-assessed roads produced by WFP	Updated in May, 2013
	02	Population density	Population data produced by NBS	Updated in 2013
	03	Protected area	Digital Atlas produced by NBS, International Resource Group, Digitized by CRMA/Wildlife Research Centre Remote Sensing Authority	Map scale: 1/1,200,000, Updated in 2007
	04	Oil & gas concessions	Digital Atlas produced by NBS, ECOS	Updated in 2007
	05	County capital advantage	Digital Atlas produced by NBS	Location confirmed from the topographic map

2.2.2 Land Productivity Potential Assessment

Ten (10) layers in total out of thirteen (13) were used for the assessment of the Land Productivity potential. IDMP-TT discussed and categorized them into two groups, i.e. Step-1 and Step-2 in the viewpoint of impact to land and crop productivity with weighting rate 5:3 for the two (2) each steps, as shown in Table 2.2.2.

1) Step-1: Direct impact comparatively high to the land and crop productivity, and
2) Step-2: Direct impact comparatively low to the land and crop productivity.

Table 2.2.2 Weighting for Each Layer

	Group of Step-1 Weighting : 5	**Group of Step-2 Weighting : 3**	**Step-3 (Socio-economic Potential)**
Layers	1.Temperature for Non-rice	6. Land cover	Refer to "Socio-economic Potential Assessment"
	2.Temperature for Rice	7. Wetness	
	3.Slope	8. River accessibility	
	4.Soil for Non-rice	9. Grazing area	
	5.Soil for Rice	10.Water bodies	

Factors that give impact to socio-economic features such as road accessibility, population, market, etc., are categorized under Step-3 based on the discussions among TT Members. Procedure of assessment in Figure 2.2.2 shows that potentials of 1) Land Productivity and 2) Socio-economic were combined after the evaluation of Step-1 and Step-2 as Step-5.

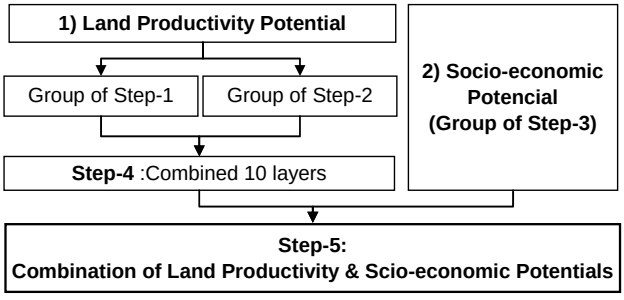


Figure 2.2.2 Procedure of Step 1 to 5 Evaluation

Step-4 combined Step-1 and Step-2 without adding Step-3 for socio-economic evaluation, which is the actual result of the Land Productivity Potential. Figure 2.2.3 indicates by light red with dotted dark red are the high potential area for the land productivity.

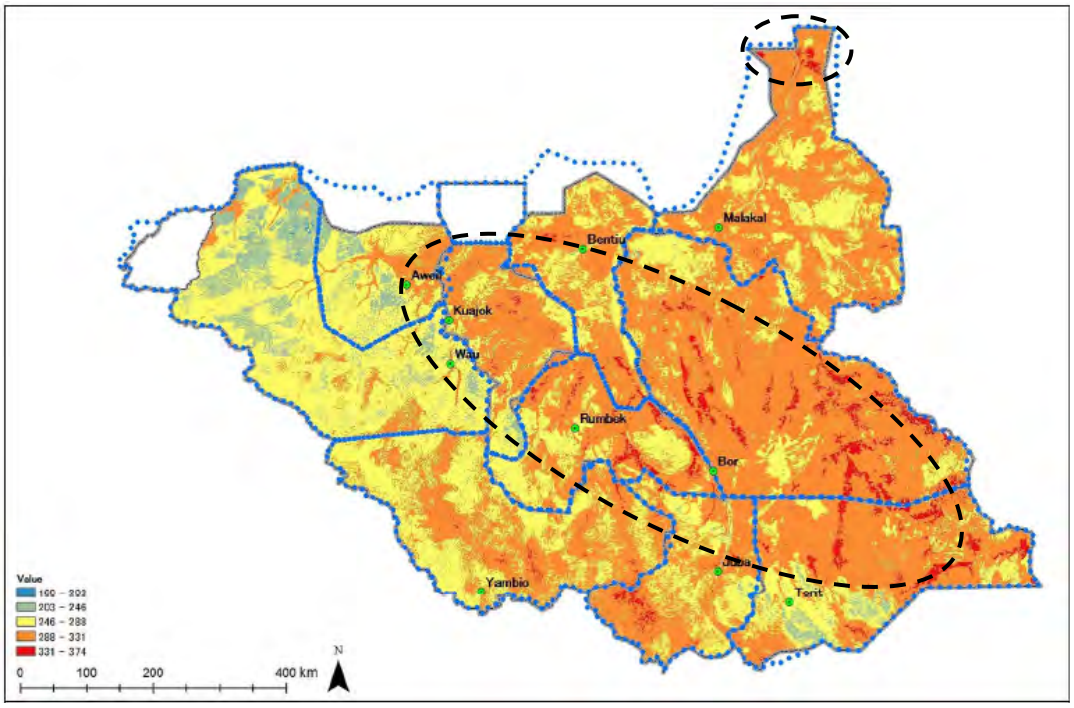


Figure 2.2.3 Step-4 Assessment: Land Productivity Potential Map

2.2.3 Socio-economic Potential Assessment

Figure 2.2.4 shows potential map of Step-3 group overlaid by "1) Road accessibility", "2) Population density", "3) Protected area", "4) Oil & gas concessions" and "5) County Capital Advantage (CCA)". The level of potential indicates high in red, medium in yellow and low in blue colours with dark to light. The map makes national parks in blank (white colour inside of the national land) with a "0" score where development is strictly prohibited in the future. Most of the lower potential areas described by blue and/or light yellow are located within game reserves and Ramsar convention area.

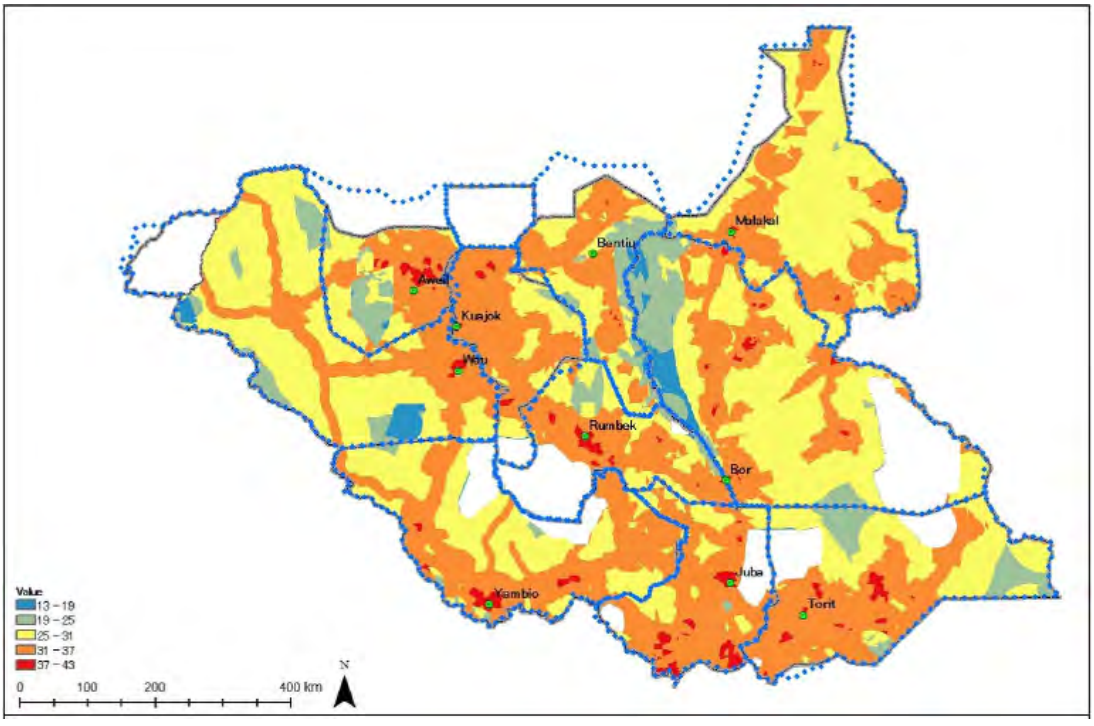


Figure 2.2.4 Step-3 Assessment: Socio-economic Potential Map

2.2.4 Combination of Land Productivity and Socio-economic Potentials

The Land Productivity Potential Map (i.e. Step-4) is overlaid with Step-3 group as Step-5 shown in Figure 2.2.5. It gives clearer identification of the high potential areas marked by a dotted black circle in comparison with the map of Step-4. The map shows that high potential areas mostly cover cities and most major towns.

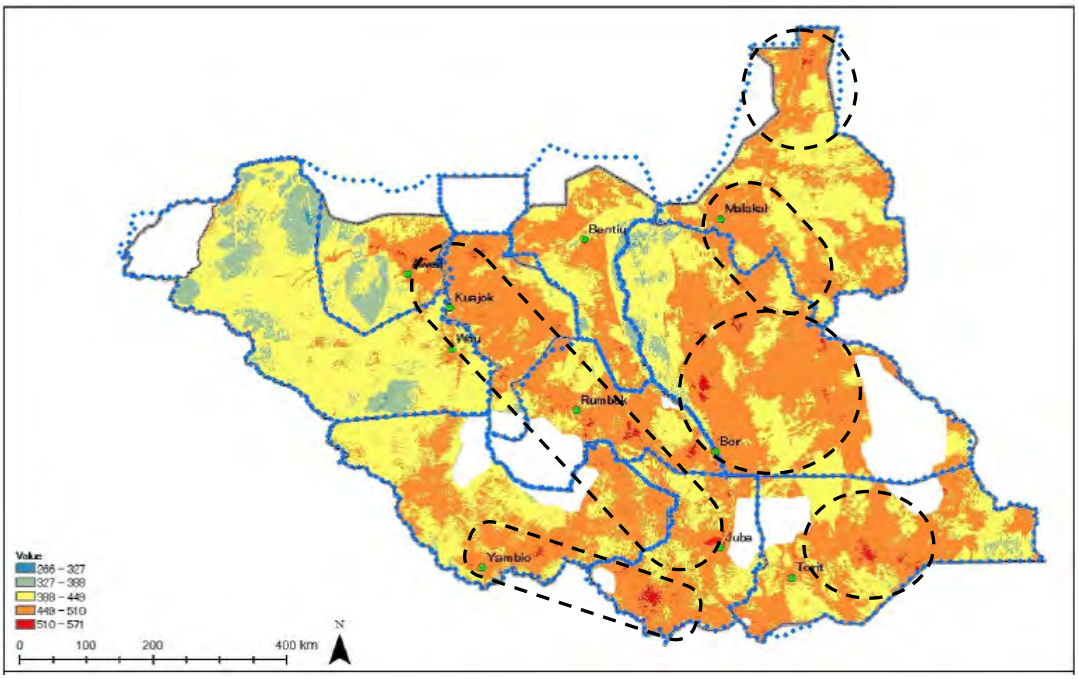


Figure 2.2.5 Step-5 Assessment: Land Productivity with overlaying of Socio-economic Potential

Furthermore, with the purpose of focusing on higher potential areas, the potential map of Step-5 was adjusted visually that higher potential areas showing a dark red colour for 15% of the country. High resolution areas for detailed assessment, then, were selected by contrasting with water resources potential assessment described in the following sections of this report.

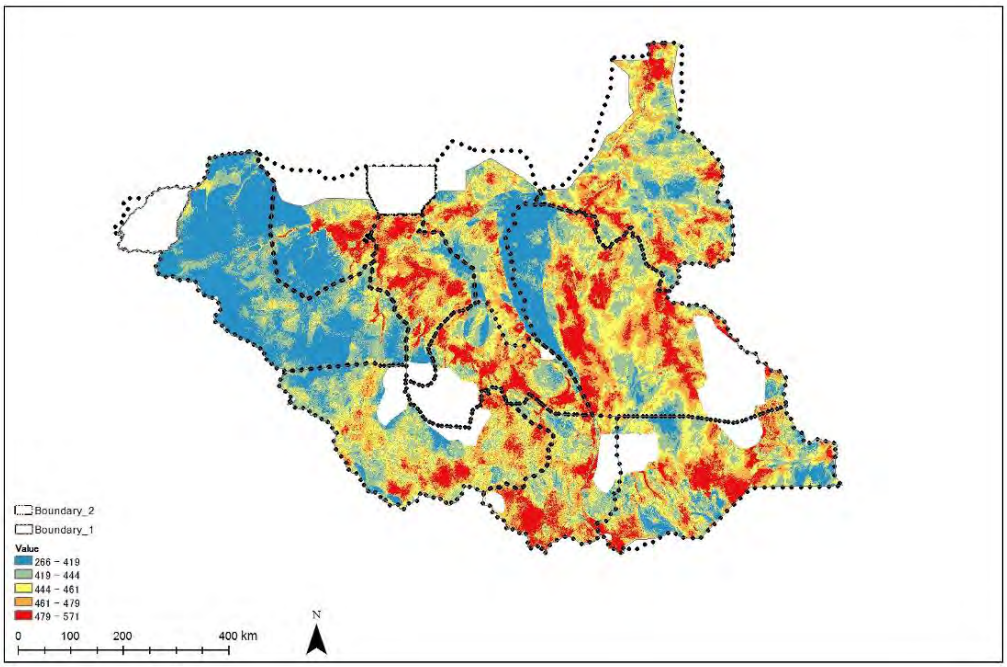


Figure 2.2.6 15% of National Land for High Potential Area (Land Productivity & Socio-economic Potentials)

2.3 Water Resources Potential Assessment

The Water Resource Potential Assessment consists of 1) Rainfall, 2) River discharge and 3) Groundwater analysis. The results of these assessments are summarized as follows:

2.3.1 Rainfall Analysis

Observed data collected from the several organizations were compiled for the rainfall analysis. Due to the civil war which occurred in Sudan in the 1980's, observation at most of the stations stopped in those periods. The stations having data for the last 30 years are only six (Malakal, Renk, Wau, Aweil, Raga and Juba).

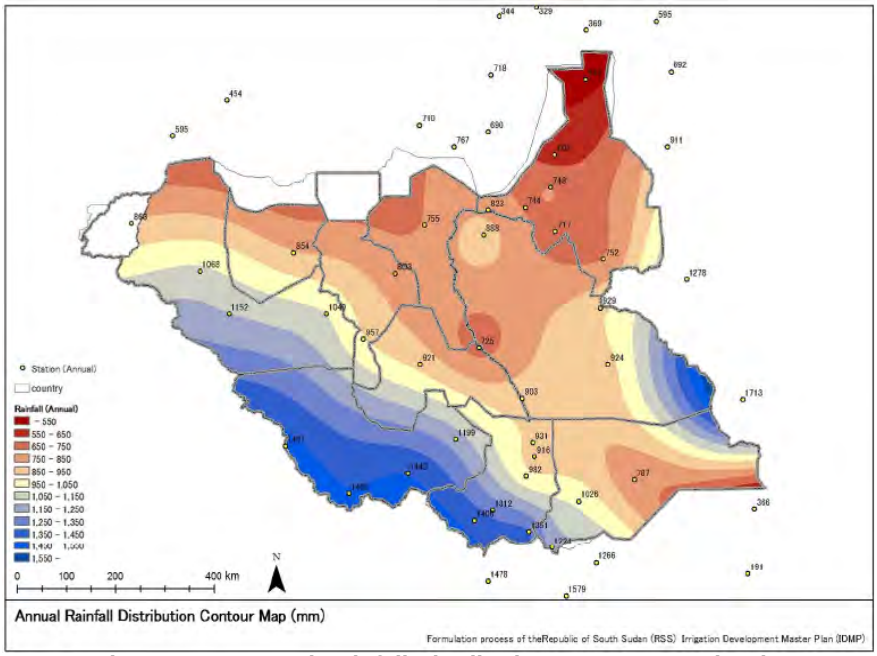


Figure 2.3.1 Annual Rainfall Distribution Contour Map (mm)

Basically stations with the conditions of "1) having old data only" and "2) having short period data only" were excluded from the target of analysis. Finally 34 stations were selected; and since data of stations outside of the country were also required for analysis, stations with the conditions of having long data and near the border of RSS were considered and finally 20 stations were selected.

Several trials have been made in order to estimate the data during the missing period of each station and finally the "Normal Ratio Method" was selected. According to the selected methodology, the average rainfall for the last 30 years at each observation station was estimated monthly and annually. Contours maps of annual rainfall amounts developed through this process as shown in Figure 2.3.1 above.

Trends in the country are found from the above contour map, namely i) annual rainfall decreases from south-west to north-east and to south-east; ii) the Sudd area does not follow this trend by showing a bit higher amount of rainfall in-between.

2.3.2 Runoff Analysis

The average of annual runoff Specific Yield (SY) amount for the last 30 years was calculated as the present surface water potential at each catchment area, using observed river discharge (Q) data. Due to the shortage of data for the same reason as in the case of rainfall, discharge station, which has more than 30 years data, is available at Malakal only. Basically the stations with the conditions of "1) location is clearly identified" and "2) area of catchment is not extremely small" were selected as analysis targets. In total 71 stations were selected out of 193.

The "Runoff Simulation Model" assessing the river discharge amount (Q) in time-series was considered as a measure to calculate the average Q for the last 30 years. However, the observed Q and rainfall data were limited and not enough to verify the results of simulation. Therefore the "Conceptual Mathematical Model" assessing the typical Q was selected as a measure.

To adopt the selected methodology, 1) river numbering tables (Tables 2.3.1 to 2.3.4), 2) river network diagrams (Figures 2.3.2 to 2.3.5) and 3) river and associated watershed delineation map (Figure 2.3.6) were developed; and the average amount of rainfall for the last 30 years of each catchment area was calculated by the Thiessen Polygon method. These tables and figures will be renewed and updated in the future according to the updated detailed river network map (shown as last page of this document), which has covered most of the main country's water courses and bodies on a low scale. More zooming-in mapping and delineation of rivers and associated watersheds will be carried out during implementation so as to reflect a complete water system for a given watershed or a project area on higher scales. This will be necessary for establishing a water resources monitoring plan, assessing availeable water resources, and preparing water budgets for specific catchments/areas.

Table 2.3.1 River Numbering Table (Bahr el-Ghazal Basin)

G: Bahr el-Ghazal basin

Primary tributary		2nd tributary		3rd tributary		4th tributary	
Code	Name of River	Code	Name of River	Code	Name of River	Code	Name of River
1	Bahr el-Ghazal	11	Jur	111	Geti		
				112	Busseri		
				113	Swue		
		12	Bahr el-Arab	121	Loll	1211	Pongo
						1212	Kuru
						1213	Sopo
						1214	Raga
						1215	Boro
		13	Tonj	131	Gel		
				132	Lesi		
				133	Ibba		
		14	Naam	141	Gulmar		
				142	Zoggo		
				143	Wonko		

: Flow of a watercourse that outfall into a lowland/marsh/swamp within plains without a clear exit or connection to another river or any water body

Table 2.3.2 River Numbering Table (Bahr el-Jebel Basin)

J: Bahr el-Jebel River Basin

Primary tributary		2nd tributary		3rd tributary	
Code	Name of River	Code	Name of River	Code	Name of River
1	Bahr el-Zeraf	11	Jurwell	111	Tem
		12	Magwong		
2	Atem				
3	Yei	31	Bostaki		
		32	Bibi		
		33	Tori		
4	Gel-Aliab	41	Anok		
		42	Awong		
		43	Tatan		
5	Gwar				
6	Ugurro				
7	Luri				
8	Kit	81	Lefuleur		
9	Kaya				
10	Aswa	10-1	Ateppi		
		10-2	Nyimur		
		10-3	Unyama		

Table 2.3.3 River Numbering Table (River Sobat Basin)

S: River Sobat Basin

Primary tributary		2nd tributary		3rd tributary		4th tributary		5th tributary	
Code	Name of River	Code	Name of River	Code	Name of River	Code	Name of River	Code	Name of River
1	Sobat	11	Fulus						
		12	Nyanding						
		13	Pibor	131	Baro				
				132	Makwai				
				133	Gilo				
				134	Geni				
				135	Akobo				
				136	Agwei	1361	Abana		
						1362	Kong kong		
				137	Kangen	1371	Lotilla	13711	Medikireit
								13712	Koss
						1372	Morech	13721	Lelazat
						1373	Kondech	13731	Singayta
								13732	Kidepo
						1374	Chabong		
						1375	Lotilet		
						1376	Kakua		
2	Atar								

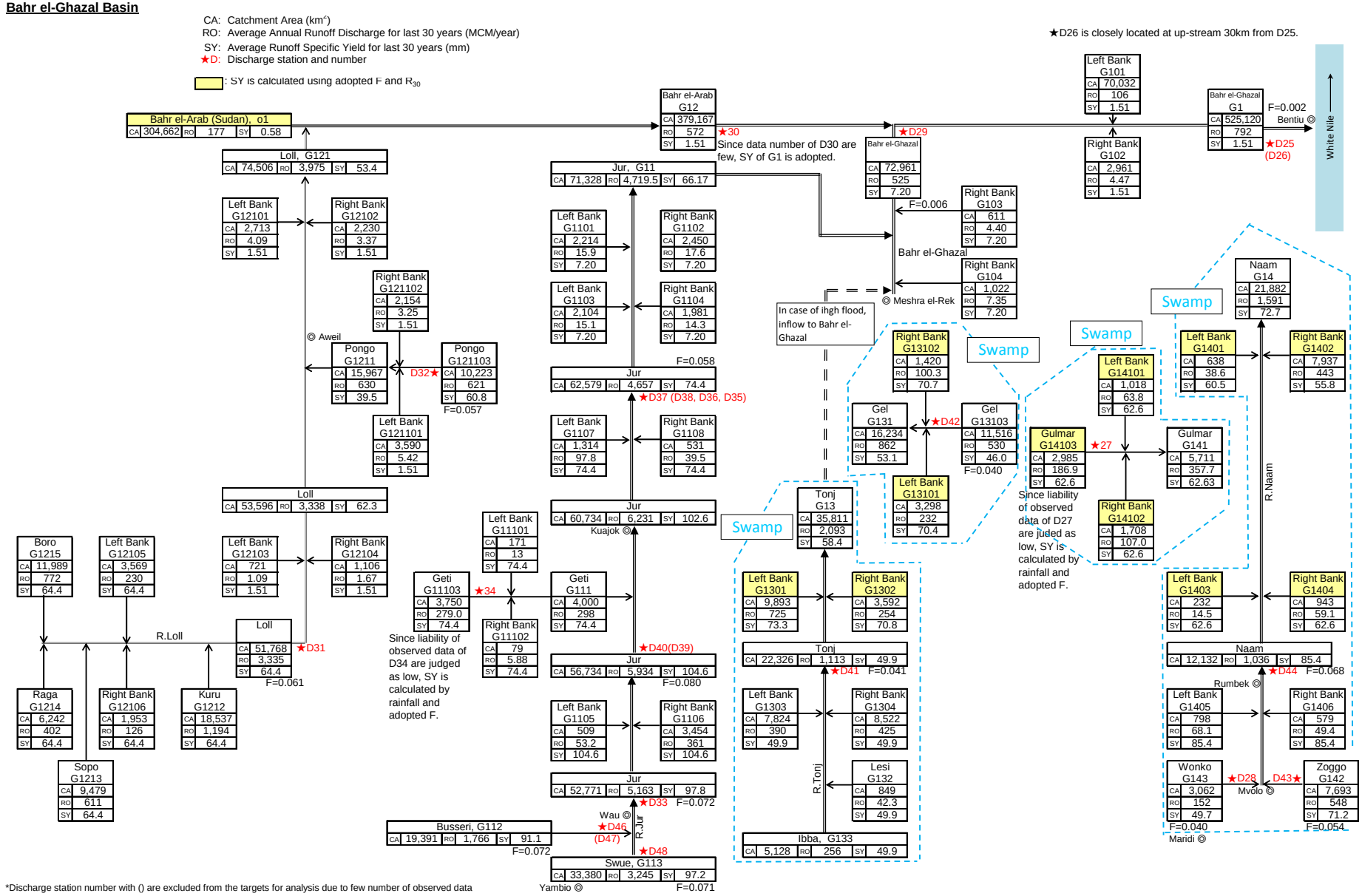
: Flow of a watercourse that outfall into a lowland/marsh/swamp within plains without a clear exit or connection to another river or any water body

Table 2.3.4 River Numbering Table (White Nile Basin)

W:White Nile River Basin

Primary tributary		2nd tributary		3rd tributary	
Code	Name of River	Code	Name of River	Code	Name of River
1	Adar	11	Tombao		
		12	Doga	121	Yabus
2	Birbari	21	Es Samaa		
		22	Chifayaca		
3	Doleib				

Bahr el-Ghazal Basin



*Discharge station number with () are excluded from the targets for analysis due to few number of observed data

Figure 2.3.2 River Network Diagram (Bahr el-Ghazal Basin)

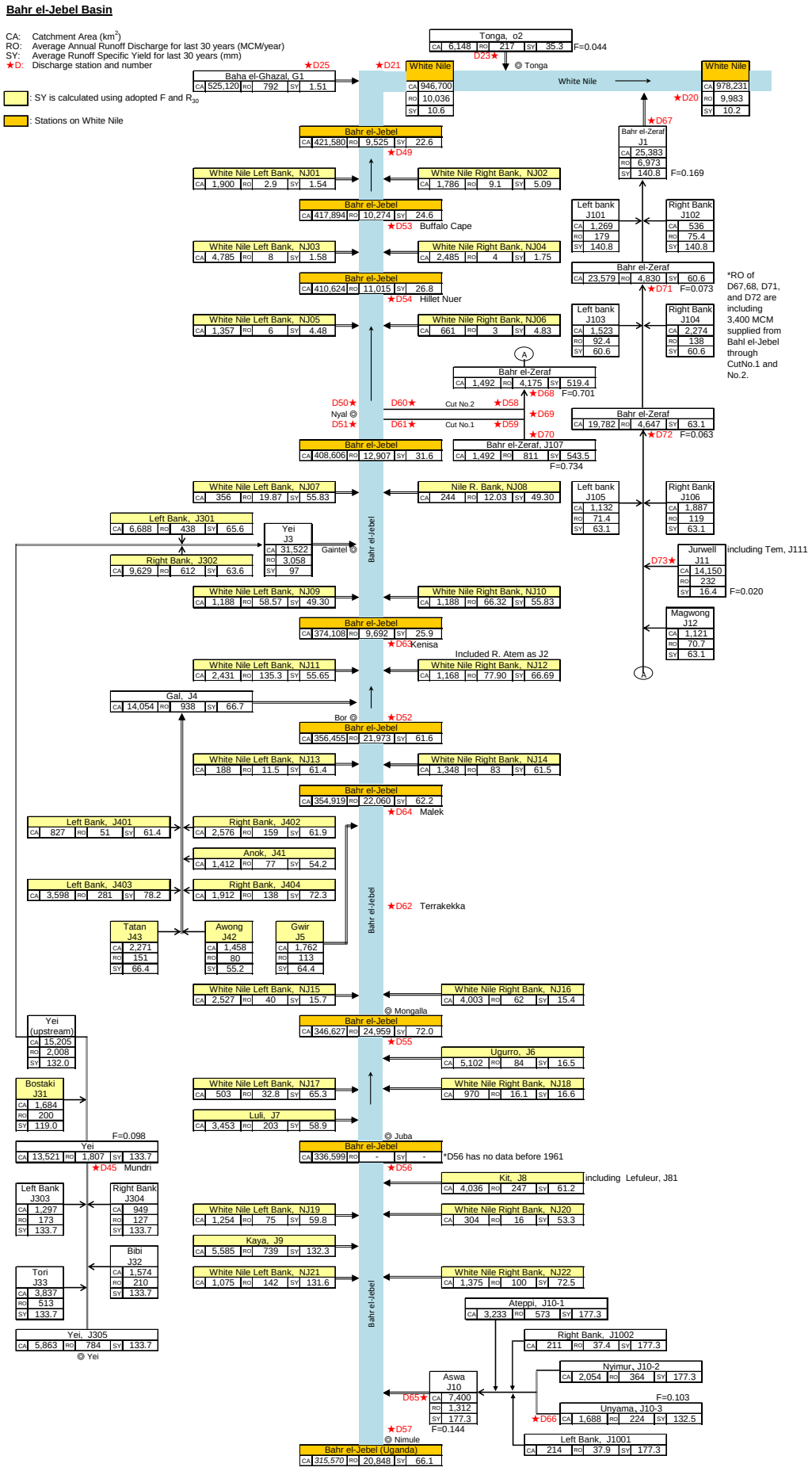


Figure 2.3.3 River Network Diagram (Bahr el-Jebel Basin)

River Sobat Basin

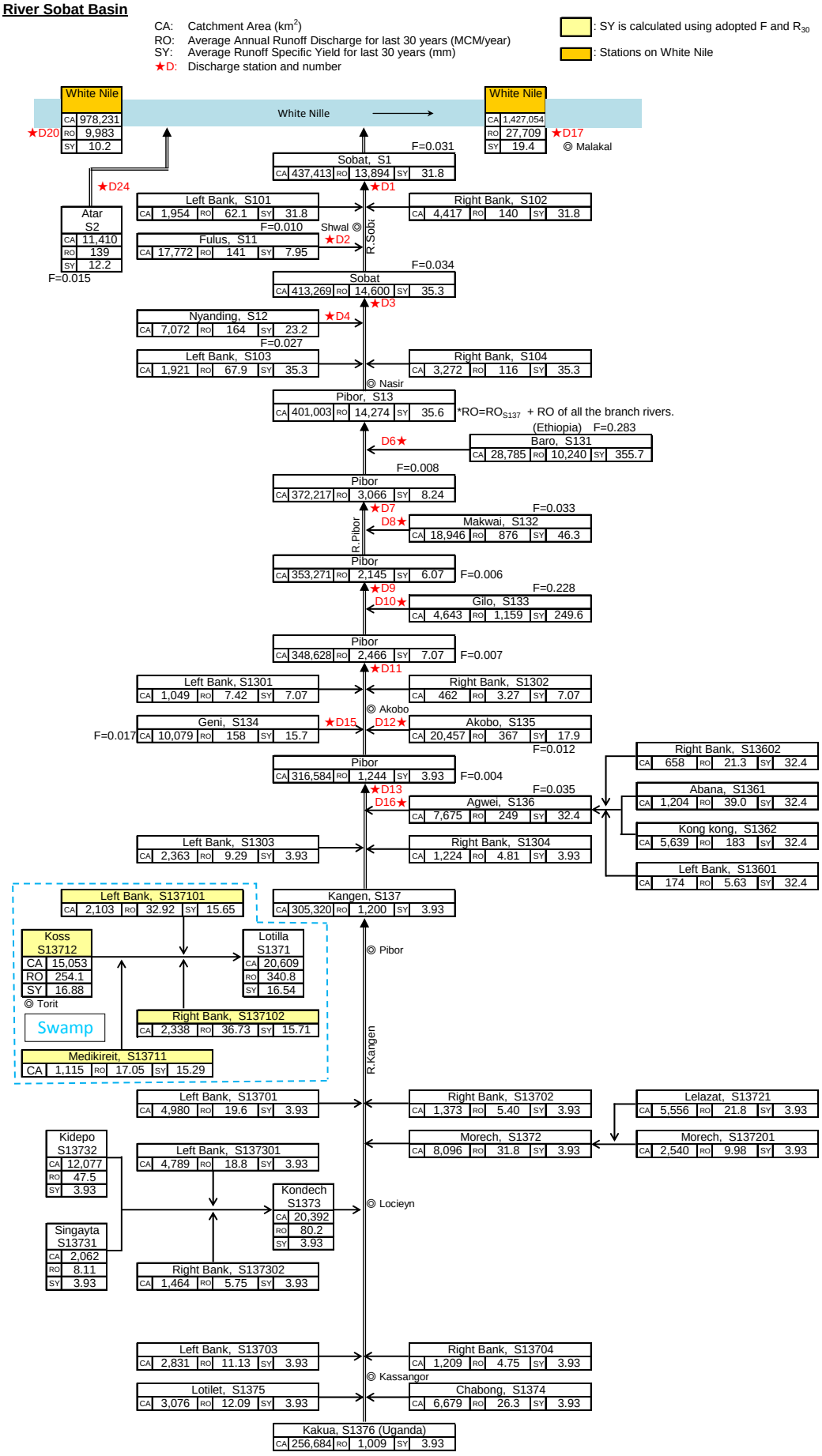


Figure 2.3.4 River Network Diagram (River Sobat Basin)

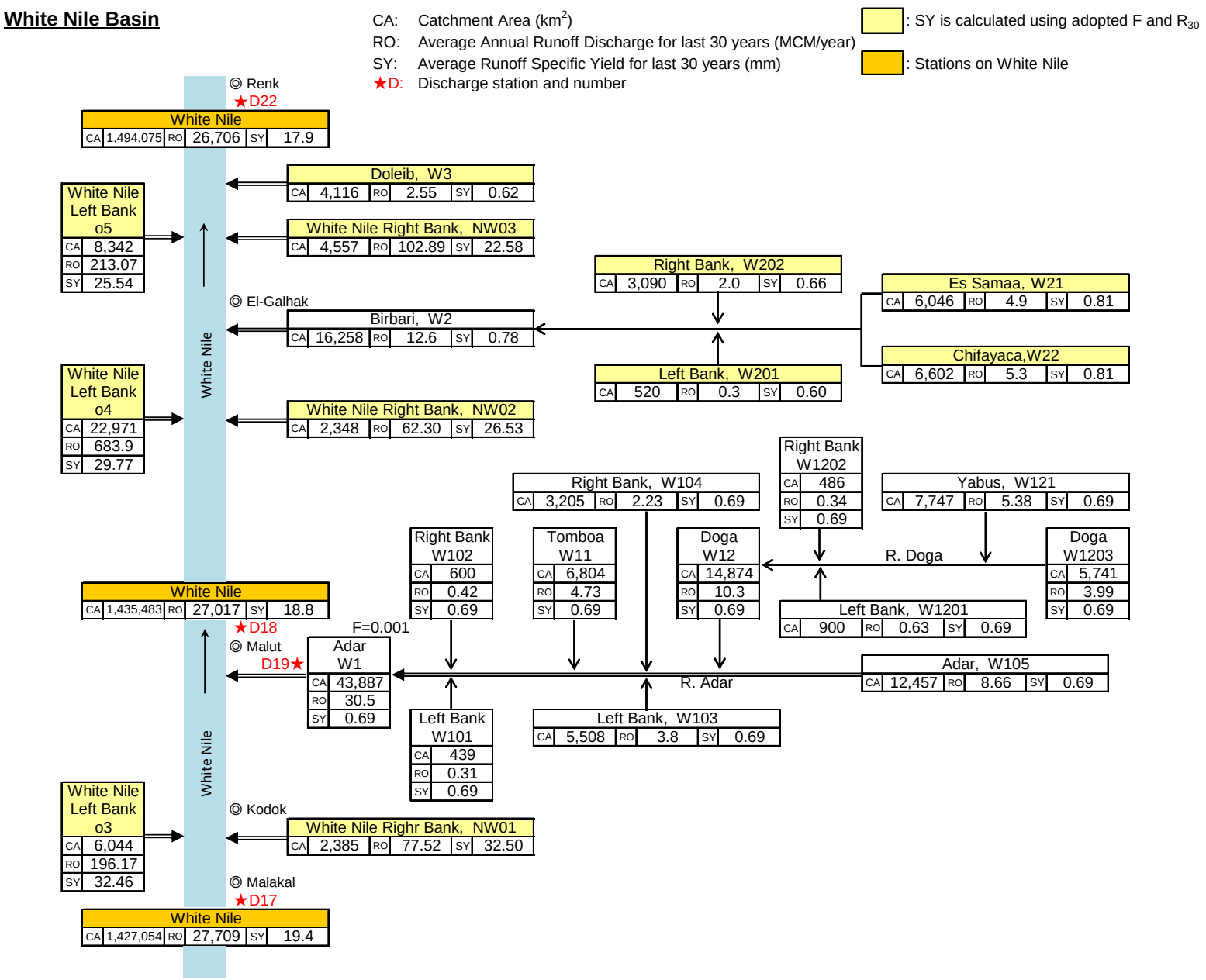


Figure 2.3.5 River Network Diagram (White Nile Basin)

Based on river basin diagrams and delineation maps, average annual SY for the last 30 years at each observation station were estimated and the SY map produced, with each catchment area coloured according to its calculated SY (Figure 2.3.6) .

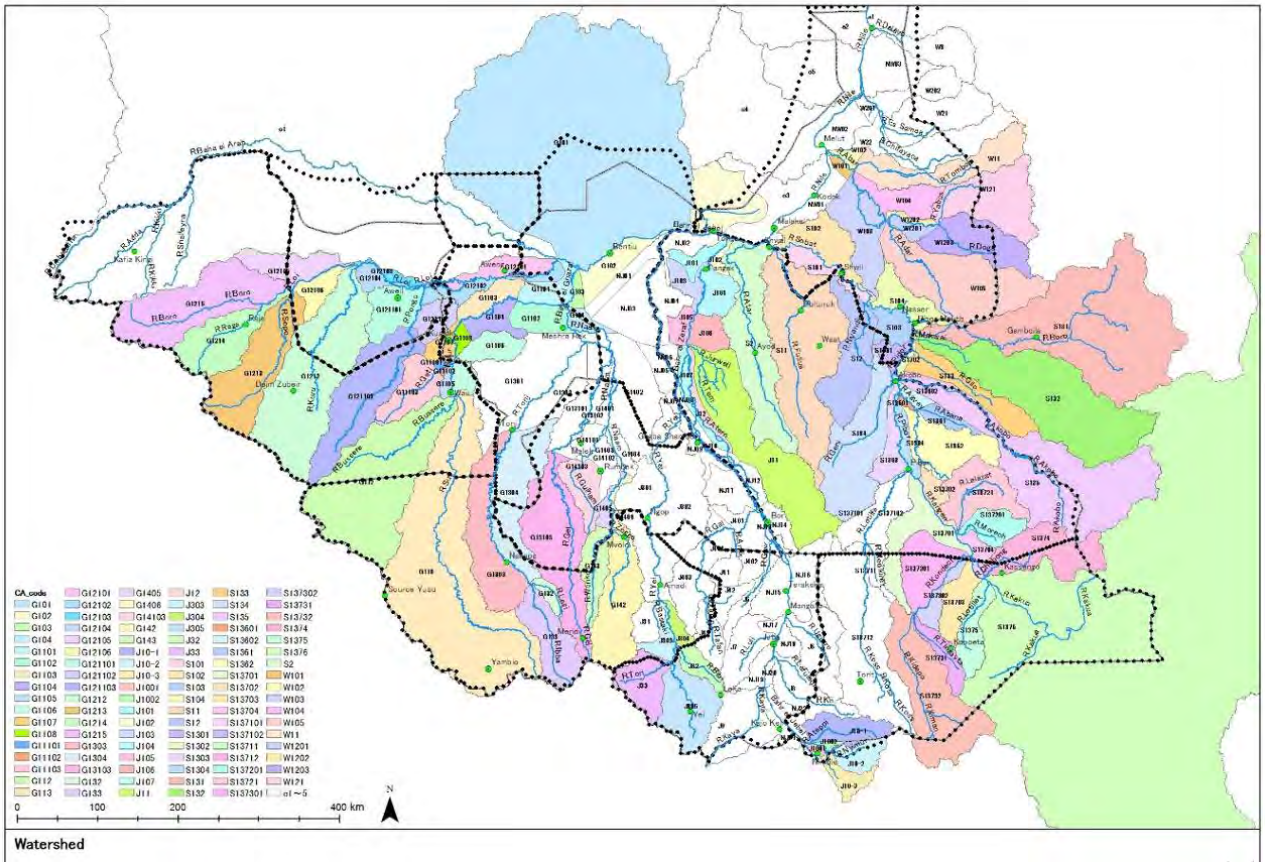


Figure 2.3.6 River and Associated Watershed Delineation Map

2.3.3 Assessment of Surface Water Potential

Average Qs for the last 30 years at each river discharge observation station, along main rivers were calculated and a map comprised of the SY and Q was created as a surface water potential map (Figure 2.3.7). Since the Q of the White Nile changed drastically during 1961-64 due to heavy rains in Equatorial Lakes Region (e.g. in Uganda) and its effects still continue at present (perhaps also due to increased releases out of Lake Victoria for hyropower generation in Uganda), Qs were calculated using data before 1961.

In Figure 2.3.7, the result of analysis indicates that: 1) the SY of Bahr el-Ghazal basin is higher than the other river basins, and especially the catchment areas of Swe and Busseri have high SYs; 2) the SY of the catchment areas located near the border with Uganda are high, too; 3) A huge volume of discharge of Bahr el-Jebel decreases between Bor and Kenisa, which might be occurring not only due to branching and spilling of the flow into a number of overflow channels and lowlands, but also because it suggests that the recharging of groundwater might be taking place within this river reach; and 4) the River Sobat is mostly supplied from the Ethiopian southwestern and South Sudan southeastern highlands.

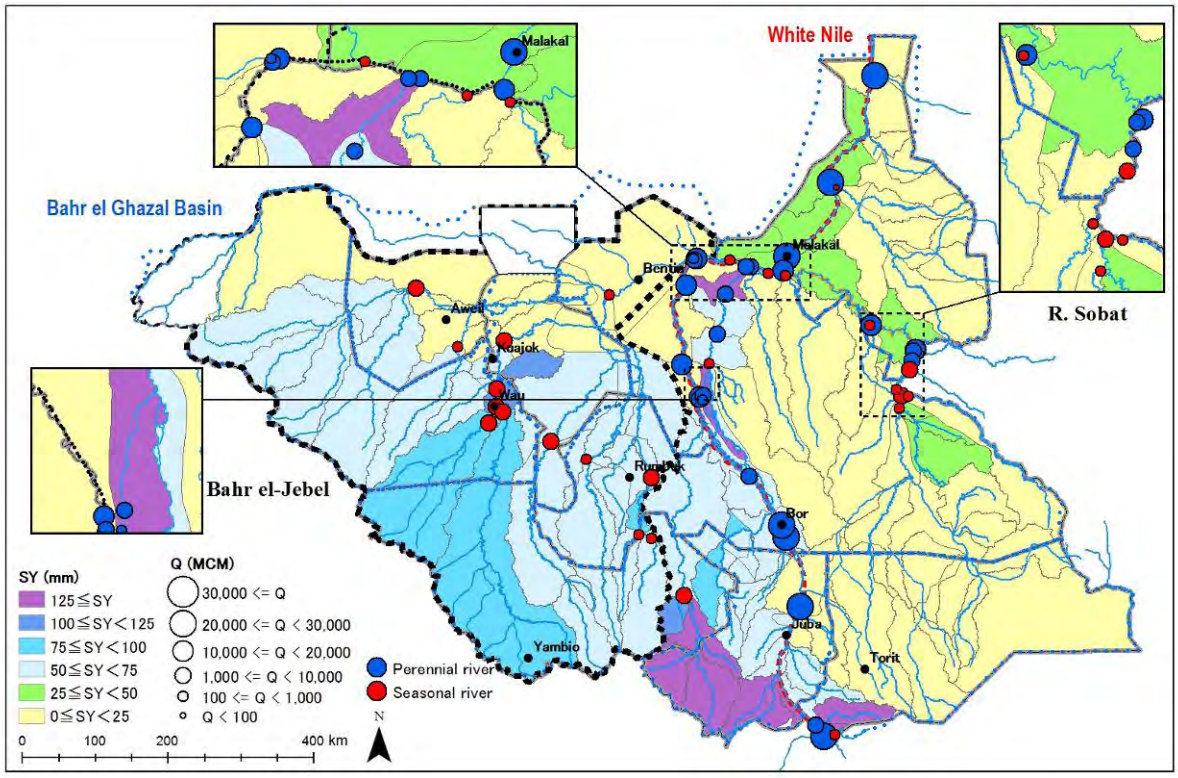


Figure 2.3.7 Surface Water Potential Map (SY + Q map)

2.3.4 River Discharge Analysis

The actual average Qs for the last 30 years at key river discharge observation stations were calculated and shown on a map below (Figure 2.3.8). Externally, it is evident that water resources development interventions upstream within Uganda and Southwest of Ethiopia can siginificantly affect the discharge volumes of Bahr el-Jebel and the River Sobat respectively. Furthermore, developments within the southwest of the Sudan and west of Ethiopia would have an insiginficant impact on the discharges of Bahr el-Ghazal and the White Nile in a respective manner.

At the national level, the total flow of the White Nile at Malakal is 27.7 BCM and 26.7 at Renk; hence the difference of 1 BCM could constitute the amount of surface water available for use within that White Nile reach in South Sudan without causing a drop in the outflow. This is in case the withdrawal would be at the expense of spills. In fact, reduction of flows over this river reach could be attributed to branching and spilling of a portion of the flow into a number of overflow channels and lowlands at the left bank.

In the same manner, the difference between Mangalla (25) and Bor (22), is 3 BCM, which is available for use uptream of the two stations below Nimule; the difference between Nasir (14.3) and Doleib Hill (13.9) is 0.4, which is available for use within that River Sobat reach upstream of Malakal; and even within the much seasonal river basin of Bahr el-Ghazal, there is about 10 BCM between the Tributaries of Bahr el-Ghazal and its mouth (0.8), which is available for use upstream of Lake No. Hence, within the country, plenty of water is available from rivers for irrigation. At any point, each river system is clearly having more water upstream. However, use of that water could constitute a concern downstream. Downstreams' Qs or wetlands status can be affected, since the discharges at given points are net (exclusive of transmission losses, i.e. infiltration and evaporation). Nevertheless, that given fact, could be offset if water is drawn from the waters that do not flow there during the dry season, or else, since most of irrigation will be on a supplementary basis, water would be mostly drawned during the wet season, a scenario that might lead to reduction in the size of wetlands and seasonally flooded areas.

In fact, a number of watercourses flow into lowlands/marshes/swamps within the plains without having clear exits or connections to other rivers or water bodies. But, with exception of some streams that flow towards Lake Turkana such as River Kibish, all rivers converge northward. They flow from the west, south and east; and exiting from the north through the White Nile, a drainage system and flow regime that depicts a dish like shape of the whole surface land of the country. Therefore, at the height of wet season water, which collects from these types of rivers into lowlands rises and flows more or less into a river or a water body downstream. This calls for proper analysis to be carried out prior to the implementation of major projects under the IDMP, so that informed decisions are made.

Also, some irrigation schemes in South Sudan would be implemented within the overall Nile and its sub-basins' planning, development and management; and a number of irrigated agricultural projects might use present international flows or enhanced river yields through catchments care.

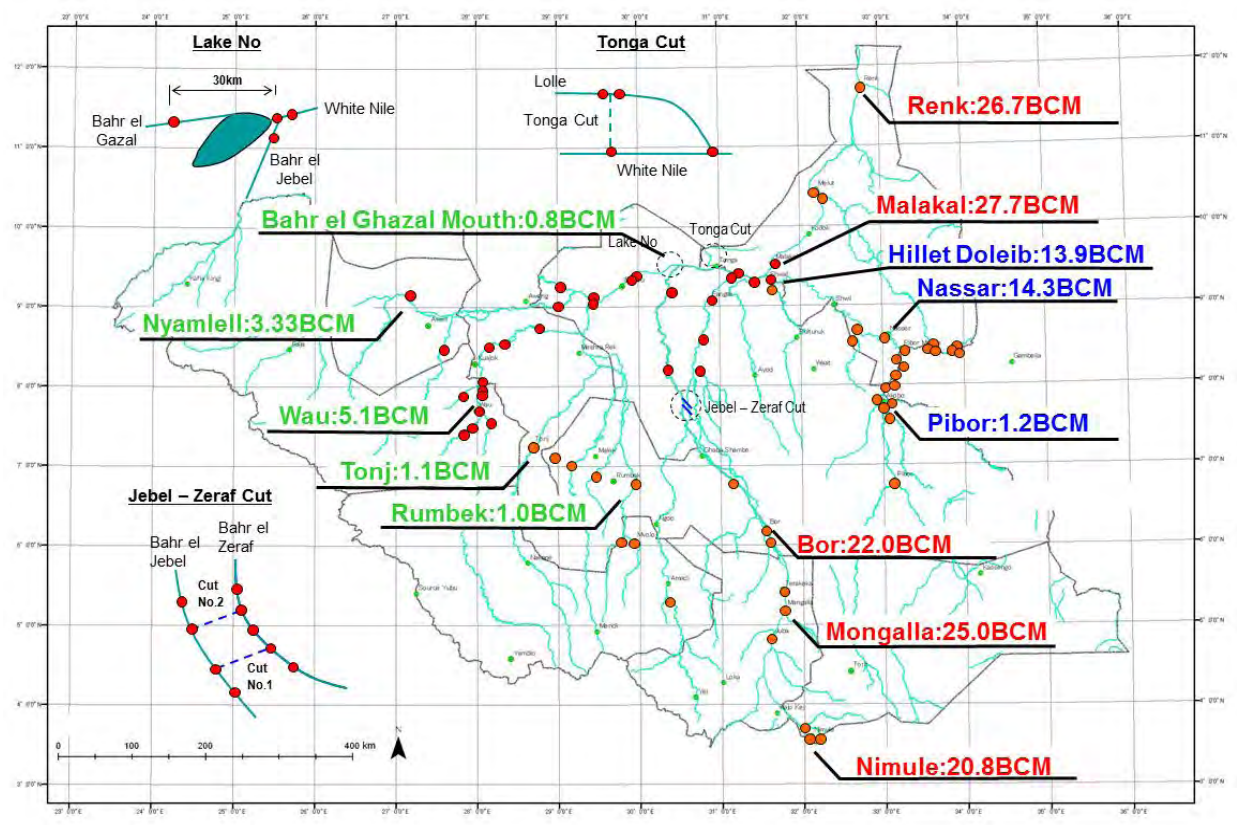


Figure 2.3.8: 30 years' actual average Qs at key river discharge observation stations

2.3.5 Groundwater Analysis

To estimate water storage volume, Sudd Basin is conceptually modelled by the Synthetic Storage Model. The total area of the Sudd Basin is as large as nearly 433,000 km^2. Because of the extensiveness of the basin, groundwater storage in the Sudd Basin also has a huge volume. In case, the depth of alluvial deposits is estimated as 50 m, and that of the Umm Ruwaba formation is around 350m, around $9.77x10^{13}$ m^3 is estimated as total volume of the aquifer, and $1.151x10^{13}$ m^3 as groundwater storage volume. Then, yields of groundwater are estimated to be a total of $7.35x10^{11}$ m^3. Since some of the important information/records for analysis are not described in the inventory, these estimations were carried out under assumptions on transmissibility, storability and radius of influence. Groundwater development potential is basically depending on the groundwater storage, and the storage depends on the depth of the aquifer.

The Isobathic contour map on the Sudd Basin is classified into three zones (at 150 m, 250 m and below), and each zone is given a potential ranking class (II to IV) depending on the depth. Nubian Sandstone is given the highest rank (V), because of its excellent aquifer property.

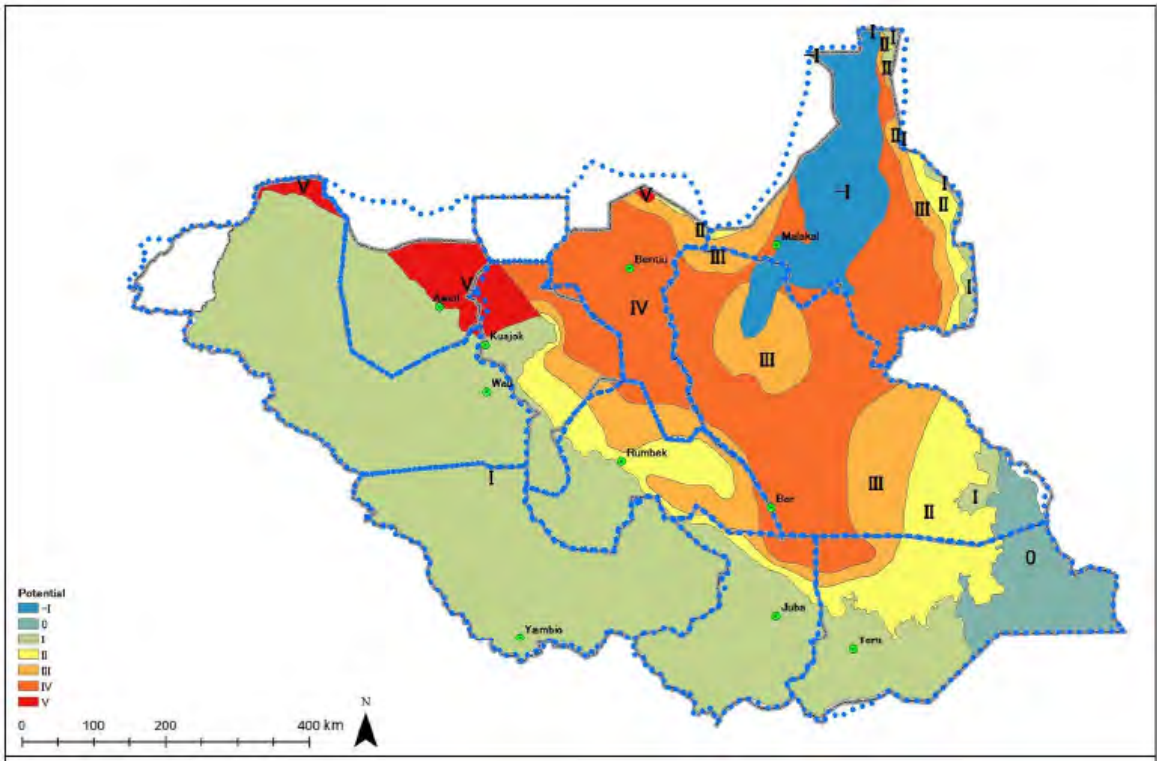


Figure 2.3.9 Groundwater Potential Map

The remaining wide area of the country underlain by the Basement Complex is given the lowest potential as “I” of which yield of groundwater is only enough for rural or urban water supply. And new volcanic intrusive rocks distributed along the southeastern edge of the basin is evaluated as no development potential (0). Then the brackish water body existing in the northern branch of the basin is given minus potential (-I) because of its high salinity level, which is not suitable in its natural condition for most purposes.

Based on the potential ranking and zoning, depending on the hydrogeology and depth of sediments, “Groundwater Development Potential Map” was developed as Figure 2.3.9.

2.4 Irrigation Development Potential Map

On the basis of results of assessments for 1) Land productivity, 2) Socio-economic and 3) Water resources potentials, three maps are overlayed in one in order to produce an "Irrigation development potential map.

2.4.1 Irrigation Development Potential with Surface Water

Given the current relative conditions of untapped available river water potential in RSS, surface water is considered as a main source for irrigation development. In consideration of that, the following irrigation development potential map has been created (Figure 2.4.1).

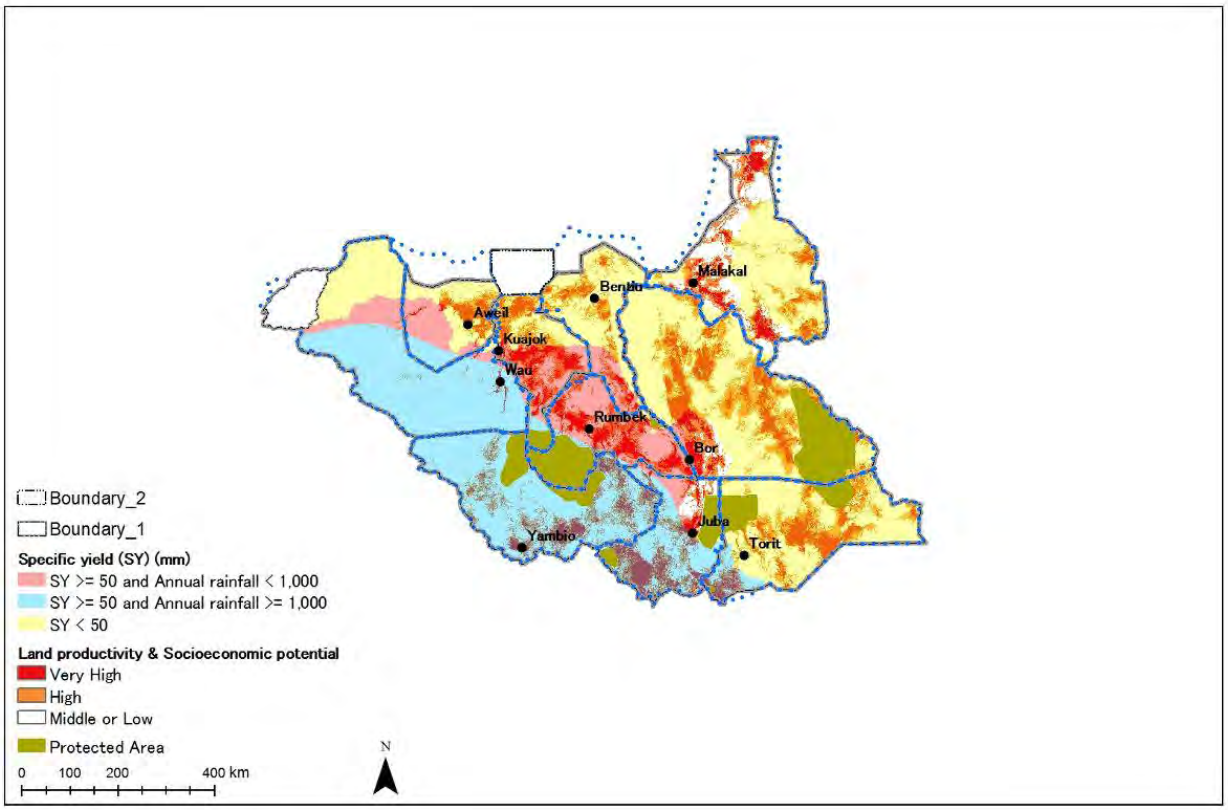


Figure 2.4.1: Irrigation Development Potenetail Map by land productivity + Socioeconomic + Surface water

In view of irrigation development, the potential areas are ranked as follows, based on the surface water potential as the SY with consideration of annual rainfall (more or less than 1,000 mm/year), which can be supplemeted to irrigate farms:

Area-1) Low/Middle potential in yellow: SY < 50 mm (less supply potential)
Area-2) High potential in blue: SY >= 50 mm with annual rainfall of >= 1,000 mm (less demand)
Area-3) Very high potential in red: SY >= 50 mm with annual rainfall < 1,000 mm (high demand)

Each area is coloured according to its ranking by overlaying Land productivity and Socio-economic potential maps where higher potentials of both coinciding are shown in dark red, while protected areas are shown in light grey and they are excluded due to restriction of land development. In addition, areas within catchments of the perennial rivers in which the water is available even during the dry season, are given higher potential even if their SY is low, except within/around the areas that are unsuitable or not permitted for irrigation development.

Following this procedure, about 11% (70,000-km^2/7 million ha) of country land has been identified as very high potential; and about 19% (120,000 km^2/12 million ha) as high potential irrigable area. Hence, a total potentiality of 30% (190,000 km^2/19 million ha), with consideration of surface water as major source for irrigation.

2.4.2 Irrigation Development Potential with Groundwater

Although costly, also utilisation of groundwater is recommended also as a supplemental source where appropriate. In consideration of that, the following irrigation development potential map has been created (Figure 2.4.2).

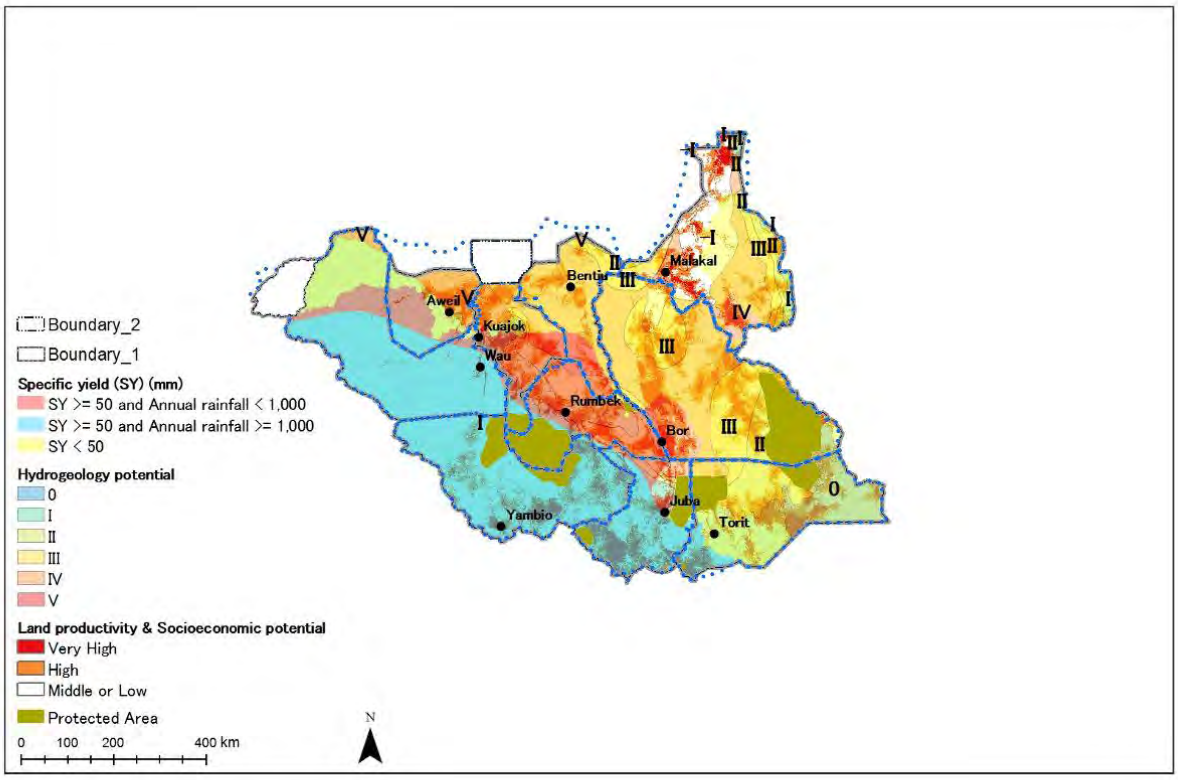


Figure 2.4.2 Irrigation Development Potential Map (with Groundwater Potential)

Groundwater can be the supplemental source at the areas near rivers or main source at areas far from rivers. Each area is coloured according to the ranking of groundwater potential with the overlaying of Land productivity and Socio-economic potential maps where higher potentials of both coinciding are shown in dark red, while protected areas are shown in light grey and they are excluded due to restriction of land development.

2.5 Detailed Assessment

2.5.1 Identification of High Potential Areas for the Detailed Assessment

High potentialility areas for the detailed assessment to be the target for priority areas and projects was narrowed at approximately 10% of national land and selected following procedures in line with the results of the rapid assessment, including water resources, land productivity and socio-economic potentials.

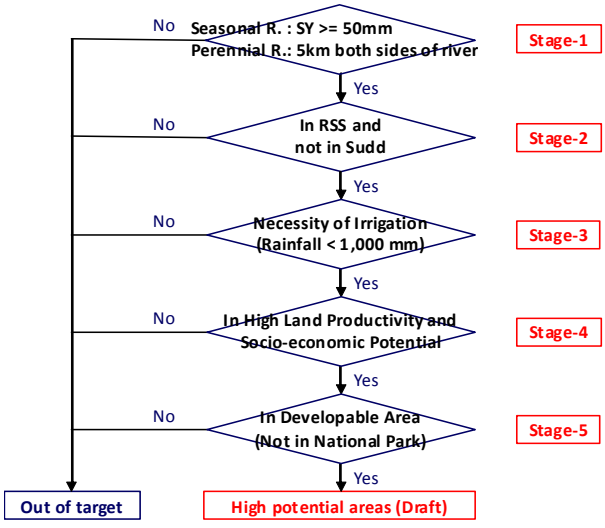


Figure 2.5.1 Flow chart for Identification of High Potential Areas

Stage-1: To select watersheds, which have equal or more than 50 mm of runoff specific yield (SY) for seasonal rivers, and an area within 5 km both sides of perennial rivers.

Stage-2: To exclude areas which are in the Sudd area.

Stage-3: To exclude the areas which have more than 1,000 mm annual rainfall in consideration of less irrigation necessity.

Stage-4: To exclude the areas which have low land productivity and socio-economic potentials.

Stage-5: To exclude the areas which are designated as national parks, game reserves and are protected.

Through the above procedure, 10.9% of national land has been identified as high potential areas for the detailed assessment as shown in Figure 2.5.2; the area colored in green along perenial rivers (White Nile and Sobat) and blue, dark blue and light blue are for seasonal rivers.

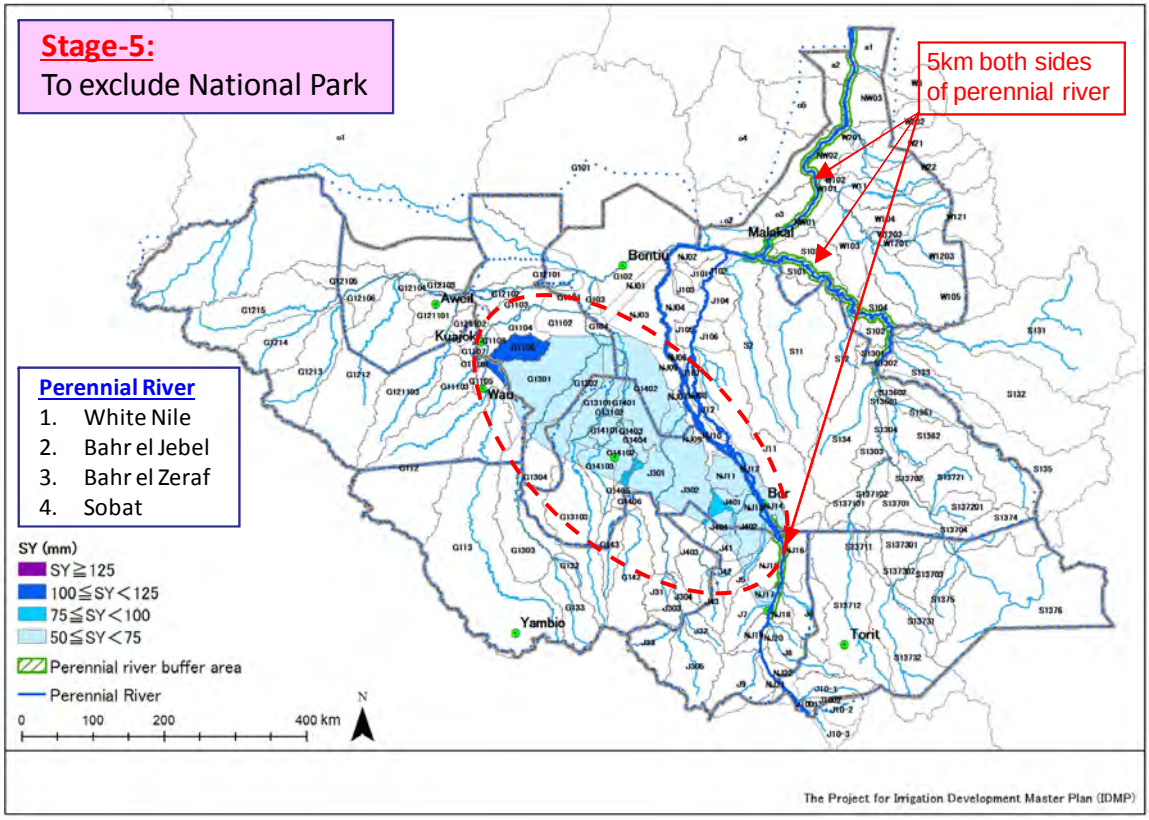


Figure 2.5.2 Stages 1-5: Identification of High Potential Areas (10.9% of the Country)

2.5.2 Selection of Target High Potenetial Areas for the Detailed Assessment

In addition to the above previous procedure and results, the below considerations were added to arrive at the final decision in selecting high potential areas for the detailed assessment:

1) Utilization of seasonal rivers as a source of irrigation is limited due to fluctuations of discharge volumes, especially in the dry seasons;

2) Areas within the watersheds along perennial rivers should therefore be given higher priority in comparison with ones along seasonal rivers as an irrigation water source;

3) Based on the above consideration, the first higher potential areas within watersheds along perennial rivers should be the ones covering higher land productivity and socio-economic potentials, but not in the Sudd area;

4) The second higher potential areas are the ones in watersheds along seasonal rivers and should also cover higher land productivity and socio-economic potentials, but not in swamps/marshes; and

5) The total of selected high potential areas for the detailed assessment should be within 10% of national land.On the basis of the above additional considerations, target high potential areas for the detailed assessment were finally selected through following stages:

Stage-6: To prioritise high potential areas within watersheds along perennial rivers;

Stage-7: To exclude: i) Areas within the Sudd and its surroundings and ii) areas more than 30 km from perennial rivers;

Stage-8: To exclude swamps/marshes from the high potential areas within watersheds along seasonal rivers;

Stage-9: To exclude the areas located within low land productivity and low socio-economic potentials along both prennial and seasonal rivers; and

Stage-10: To exclude the areas where there are no river discharge observation stations by taking into consideration future irrigation development.

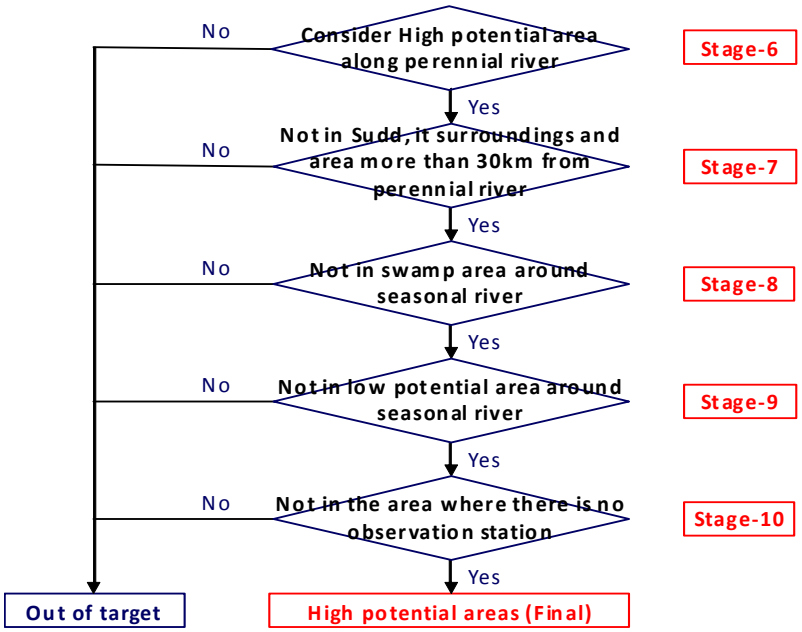


Figure 2.5.3 Flow chart for Selection of High Potential Areas

Through the above stages, 10% of national land is selected as high potential areas for the detailed assessment as shown in Figure 2.5.4.

2.5.3 Detailed Assessment for the High Irrigation Development Potential Areas

Detailed assessment for planning irrigation development in high potential areas, approximately 10% of national land, has been conducted to verify priority project sites.

(1) Topographical analysis

Topography data is important to understand slope, river alignment, catchment scale, etc. for deciding what types of irrigation facility should be constructed. Global-level elevation data of ASTER G-DEM (about 30m spatial resolution) distributed free of charge by NASA and J-space systems have been used for topographical analysis of hillshade relief, slope and river alignment.

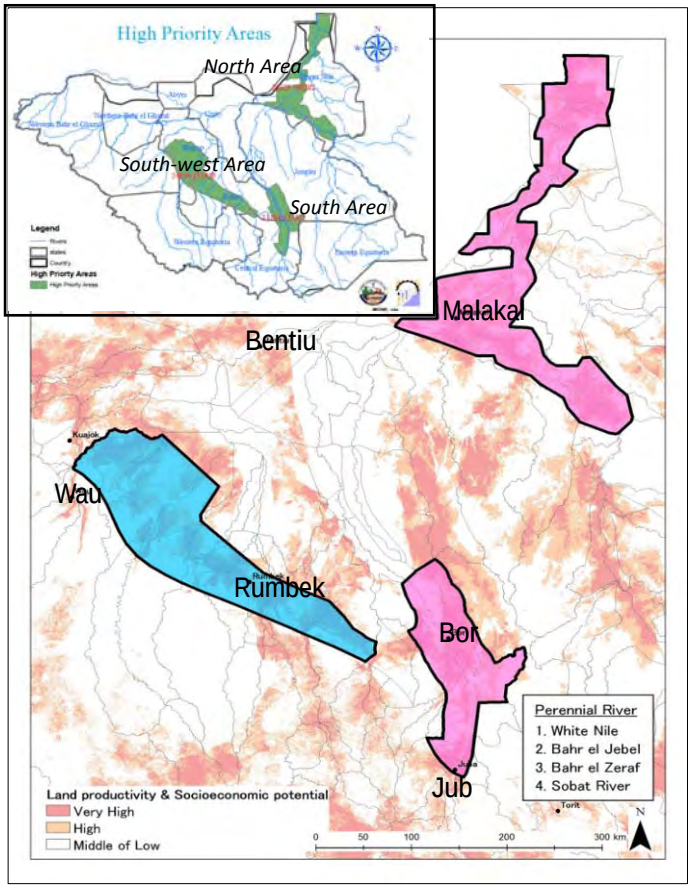


Figure 2.5.4 Selected High Potential Areas

Hillshade enables intuitive capture of landform features, so peaks look like peaks and valleys look like valleys. The hillshade relief analyzed from ASTER G-DEM shows that flat landscapes spread to the greatest extent of the detailed assessment area though a hill located at about 30 km north of Juba and slight depressions along the river can be found. The results of the analysis indicate landform in the target area is very flat compared with the DEM resolution.

Therefore the analysed hillshade relief is not so useful for detailed assessment because fine landform changes cannot be detected. Slope was also analyzed from ASTER G-DEM, however it does not show a particular feature for the same reason as hillshade relief.

River alignment is important information for deciding location and types of irrigation facility. When studying the analyzed river alignment by comparison with RapidEye imagery (about 6.5m spatial resolution), we found that the analyzed river data had low accuracy relative to the river data produced by NBS, which traced river alignment as shown by RapidEye imagery very well. Therefore the NBS river data should be used for detailed assessment.

(2) Satellite image analysis

Satellite imagery is an efficient tool to capture information of an extensive land situation in a short period of time while facing a shortage of fundamental data such as land form, land cover, land use, facilities, etc. or having difficulty in collecting such data.

To evaluate the possibility of introducing irrigation facilities, new satellite data with high resolution were procured in order to create land cover data from satellite data. Data from RapidEye (6.5 m spatial resolution) and ALOS/AVNIR-2 (10 m spatial resolution) were used for the extent of the high potential areas. RapidEye images were collected for the whole extent of the target area, dating mainly during the dry-season (November to April) from 2010-2013. ALOS/AVNIR-2 images did not cover the whole extent of the target area, so they were collected for some extent of the area, dating mainly during the rainy season (May to October) from 2009 to 2010 for filling in land cover information from RapidEye data.

Table 2.5.1 Landcover/Land Use Classification

Class		Definitions / Notes
1	Irrigated crop land	Mainly only in Renk
2	Rainfed crop land	Existing cultivated land
3	Orchard (planted fruit tree)	Planted fruit
4	Forest (closed canopy)	Density: >60-70%
5	Forest (open canopy)	Density: between 60-70% and 10-20%
6	Woodland (Savanna)	Grassland with tree, Density: <10-20%
7	Grassland (Pastoral land)	Grassland without tree or very sparse tree
8	Settlements	Both urban and rural areas
9	Bare rocks/desert	Lands with non or few vegetation and not under cultivation
10	Perennial wetlands/open water body	Lands under water throughout the year (cannot be accessed by land)
11	Seasonal wetlands	Lands is under water in wet season (can be accessed by land in dry season)

Enhancing satellite imagery like a photograph eases in visual interpretation process to capture the field situation especially at the beginning of a field survey. RapidEye has sensors of Blue, Green and Red spectral bands which can provide True Colour image, a picture image like a photograph. For the aim of this process, ortho photo imagery was created from the RapidEye imagery.

The ortho photo imagery shows various detailed land conditions, such as the extent of the flood area along the rivers, river channels in the past or in the rainy season, tree canopy size and density, the extent of open burning, irrigated crop land in the past, etc. Although ortho photo imagery enables acquiring much information, it is a bit difficult to tell what covers land surfaces instantly since the 190 RapidEye images were taken on different dates with differing atmospheric conditions and land conditions, which vary with the seasons. The landcover map, which is powerful for attaining what covers land surfaces instantly, was created. Land cover data is highly important information for assessing land potential.

The first step of creating landcover map is to decide on how to categorize the land cover into suitable mappable classes to be used on a minimum scale of 1:50,000. Landcover class was decided by referring to FAO landcover class used in rapid assessment and interview with experts in the University of Juba. Land cover has been categorized into eleven (11) in Table 2.5.1. But eventually three of these classes, orchard (planted fruit tree), bare rocks/desert, seasonal wetlands, have not been extracted as the result of interpreting the imagery.

The methodology implemented for the creation of the landcover map is based on supervised classification, which uses the spectral signatures obtained from training samples to classify an image, and also map digitizing by interpreting the imagery. Land cover atlas produced by FAO was used as a reference during the interpretation process. This information is very useful particularly for crop land.

The created landcover map is shown in Figure 2.5.5. Irrigated crop land looks like a box-shaped pattern and is consolidated. Its patch with a large distribution is only located in Renk. Rainfed crop land looks like a mottle pattern, but without clear farm land partition. It is located in a large size in the southwest priority area and seems to have expanded rapidly in comparison with the land cover atlas.

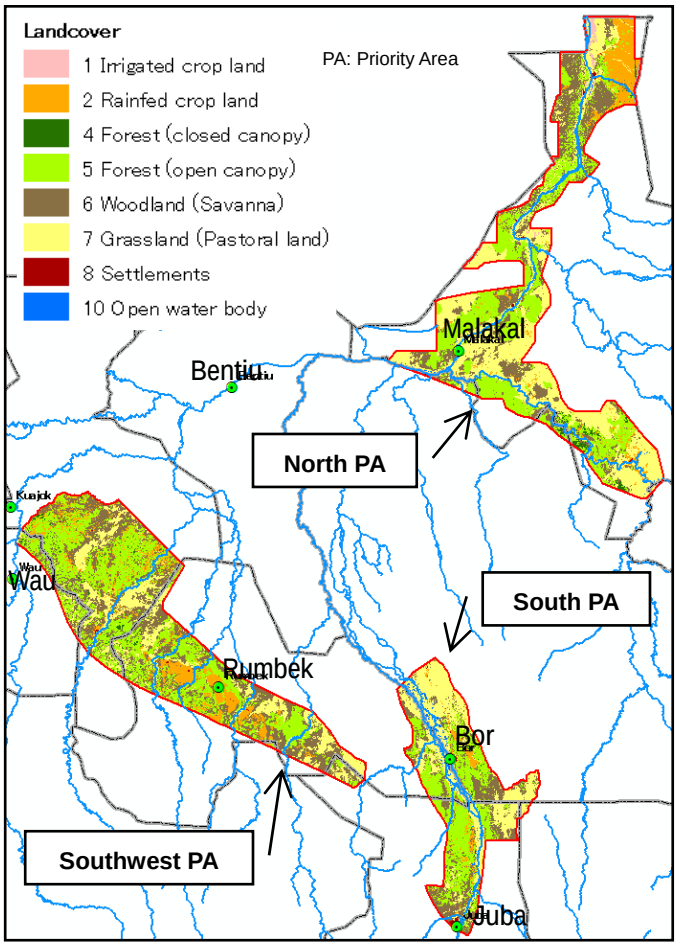


Figure 2.5.5 Created Map of Landcover for the Selected High Potential Areas

Forest (closed canopy) does not have a large area in the target area. Forest (open canopy), Woodland (Savanna) and Grassland (Pastoral land) have large areas. Forest and Woodland have a tree crown pattern with different density while grassland has a matted texture without trees or very sparse trees. It is located near the riverside and in open burning land. Settlements often have a minutia of harsh texture in a light colour. It does not have a large area, but seems to have expanded. Perennial wetlands or open water bodies looks dark in colour.

2.6 Deduced Result

Irrespective of terrain, soil type, source of water and weather conditions, e.g. amount and distribution of rainfall; and farm size, e.g. small, medium or large, due to the following reasons, among others, irrigation should be introduced and practiced using different models and techniques:

- Because, climate and seasonal changes are unpreventable, whether in short, medium or long-term;
- Ensuring food and nutrition security through selection of specific crops for growing in certain seasons; and
- It allows for diversification and scaling up of crop production, to stimulate agribusinesses and agroindustries.

CHAPTER 3 ISSUES FOR IRRIGATION DEVELOPMENT AND MANAGEMENT

3.1 Policy and Institutional Issues

IDMP is formulated on the basis of the existing and planned policy as well as strategic, institutional and legal frameworks in addition to experiences in relation to the overall water sector and the irrigation subsector.

3.1.1 Future Irrigation Planning Policy for the IDMP

The MWRI policy document clearly highlighted the need for a separate policy and regulatory framework for Irrigation. This may indicate the fact that although irrigation is not categorized as a single topic, a number of descriptions and statements related to irrigation were contained within the policy. This point is made clear in the WASH Strategic Framework document, which mentions, "MWRI's mandate is to allocate and deliver bulk water to irrigated agricultural schemes. From that point onwards, it is the responsibility of the Ministry of Agriculture and Forestry (current MAFCRD) to distribute and manage that water among farmers on the farms. MWRI realizes that the shared responsibility between the two Ministries calls for a separate policy and regulatory framework for irrigated agriculture and other productive uses, to be adopted/enacted so as to fully realize the potential of this subsector."

In the Water Policy, the word irrigation is defined as "The harnessing of water using pumps and specially constructed water control gates, to supply water to an area of land through canals and pipes to grow crops. Further, based on the overall on-farm water management, irrigation includes draining & evacuating of excess water from fields, so as to control water in the crop root zone, therefore drainage is synonymous with irrigation." In this definition, on-farm water management is mentioned together with drainage, implying that irrigation is from the intake of water source up to farms and off-taking it away through drains; hence the agricultural ministry is called for understanding and initiating cooperative actions.

The IDMP to be formulated as a preceding initiative will be a guiding document for future formulation of a clear and detail policy and regulatory framework for irrigation development. IDMP is therefore mandated to provide a strategic framework for irrigated agriculture and other productive uses of water resources, which would be the basis for formalizing the policy and regulatory framework of the irrigation subsector. To be the guiding document for the future policy and regulatory framework formulation, IDMP should consider inclusion of the roles of the institutions, namely MEDIWR and MAFCRD, in targeting irrigation schemes development with the definition of small-scale to large-scale irrigation development, new scheme development or rehabilitation of existing schemes, mode of management institution (public, private, or joint), functions of water users association, etc.

As irrigated agriculture is a sub-sector of the agricultural sector, for instance, discussions at the Workshop on Agriculture for Sustainable Food Security and Economic Growth in South Sudan held by RSS (28th November 2012) could provide some points to be considered in irrigation development, which includes the need for the building capacity of small-holder farmers; the need to create a conducive environment for the private sector to invest in irrigated agriculture by way of securing land and water rights; and the need for both large-scale and small-scale agricultural development.

The situation analysis carried out by IDMP-TT revealed details of these points, such as positioning of irrigated agriculture as a major component of agriculture extension, aligning the irrigation investment with the concept of Water Bill and Land Policy, e.g. requirement of permit for water abstraction and consideration of community interest in the area, and delineating the roles and responsibilities of farmers and governments for managing small to large-scale irrigation schemes development and management, etc. Detailing these points would also help formalize the future policy institutional framework.

The following section further discusses some critical points related to policy and institutional issues.

3.1.2 Roles and Responsibilities of Institutions Involved

GRSS has been developing a governance system since the civil war. Thus in some cases, roles and responsibilities for irrigation development has not been clarified among the line ministries from national to state and local governments. The demarcation of roles and responsibilities between MEDIWR and MAFCRD is indicated in the WASH Strategic Framework, but also it is necessary to clarify and demarcate the roles and responsibilities among all institutions at national, state, and local levels as well as for farmer organizations.

As an example, the primary responsibility or ownership of the Aweil Irrigation Rice Scheme that was revitalized after the CPA with the assistance of EU by GIZ IS and handed over to the RSS in 2012 was given to MAFCRD of the national government. On the other hand, the State Ministry of Agriculture and Forestry is also taking a vital role to run the scheme management. It seems the demarcation of roles between National and State Ministries remains vague. By the same token, roles and responsibilities between the government and the private sector have not been clarified at the field level.

As for small-scale irrigation, that would be the autonomous activity of the farmers themselves, and who to support and in what way to these small-scale irrigation initiatives should also be a discussion point. County level could be the one to directly support the community, however, the current capacity of the county is not enough to undertake the work at the moment. Clearly defined roles and responsibilities of each institution/level of the government/administration should be the issues, which the policy, institutional and regulatory should address, so that appropriate allocation of resources could be furnished.

3.1.3 Water Resources Policy/Strategic/Legal Framework & Implications for Irrigation

The three (3) documents, namely Water Policy, WASH Strategic Framework and the Draft Water Bill are formulated consistently by classifying the water sector into two (2) major categories, namely Water Resources Management and Water Supply and Sanitation. The contents of the three (3) documents are shown in the figure below. Although irrigation development is not specifically categorized in these documents, it is mentioned as part of water resources management; and it would be the pre-conditions of the irrigation development to comply with provisions therein.

Although it is still a draft, the Draft Water Bill provides legal framework for water resources management, by legalizing the establishment of the Water Resources Management Authority (WRMA), and under it the Basin Water Boards and Catchment/Sub-catchment Committees. Provision of water users association is also given in the draft Act and is governed by the administrative structure of WRMA. Facilitation of the establishment of irrigation boards has also been mentioned under powers of the Minister.

Establishment and operation of irrigation scheme, either small-scale by the community or large-scale by public or private sector, has to follow the provision of the draft Act. When planning the institutional setting of the irrigation development, the following items, for example, should be taken into consideration for the case of irrigation scheme development, especially on the relationship between irrigation scheme management and the water users association.

A guideline for irrigation development to follow the strategic framework and comply with the policy and Act would be required to address the following:

- Is irrigation scheme (management) defined as a water users association? In that case its relationship with the WRMA or with the Basin Water Boards and Catchment/Sub-catchment Committees must be outlined, in other words, does the establishment of irrigation schemes have

to go along hydrological boundaries? Is scheme management a Government e.g. a parastatal or a public corporation such as irrigation board; or should it be registered as a water users association, e.g. a private entity?

- Permit licensing: who has to get the license/permit of water use in case of National/State/County Irrigation Scheme? Is it the Scheme management, namely the Government? Or the water user association to be established in the command area of the irrigation scheme? And who should be paid for the permit/water?

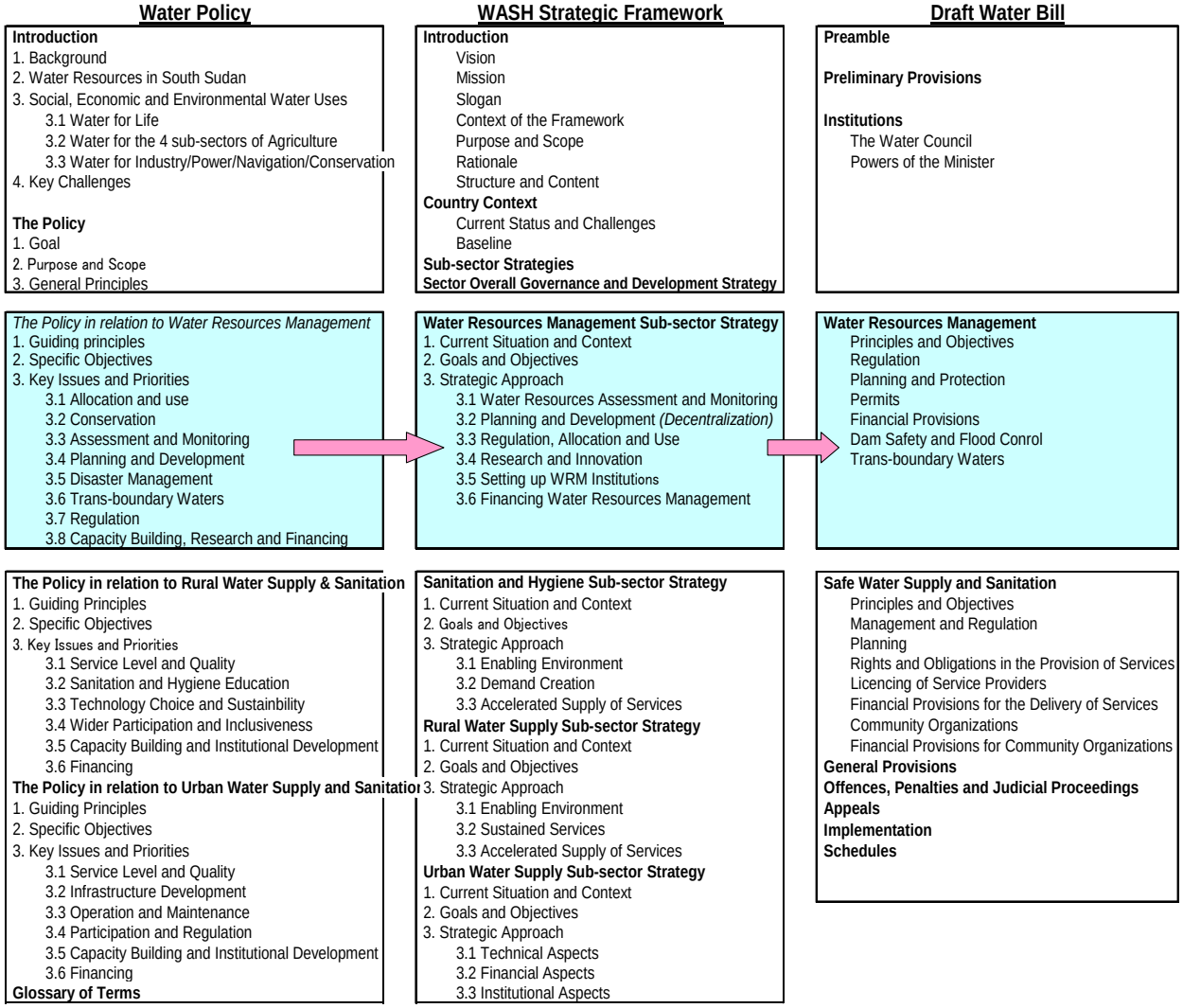


Figure 3.1.1 Contents of Water Policy, WASH Strategic Framework and Draft Water Bill

3.1.4 Land Policy for Agricultural and Irrigation Investment

Regarding how the land is going to be allocated for agriculture, the main factors can be listed as: (i) extent of potential agricultural land; (ii) current area under agriculture land use & status of food sufficiency; (iii) total population & population density; and (iv) government policy for agriculture sector in the country.

Concerning availability of land for irrigation development, all the land area currently under agricultural use can be considered as immediately available land; and most of it is either under rain-fed agriculture or under different related productive uses such as grazing and natural vegetation. While developing irrigation for a given area, some portion of the land of that area is consumed in the irrigation facilities and the rest becomes the irrigated land. Thus the ownership issues need to be examined.

(1) Land Administration and Investment Promotion

Recently there have been several favourable developments, which are directly or indirectly intended to promote investment in the agriculture sector. The most important development can be considered as government commitment of resolving land issues. Most of the legal framework on land use and land administration, i.e. Land Act 2009, Local Government Act 2009 and Land policy (draft), 2013, has been completed, and soon there will be a well-defined land tenure system to govern and manage the land that meets the international standards without jeopardising local customary practices.

Another important development is the promulgation of the Investment Promotion Act 2011, which shows that the government is committed to making an investment friendly environment both for public and private sectors. There is clear provision of investment certificate, which can be obtained in accordance with Article 22, section 3e, f and g. The article elaborates the land based investment terms and conditions for the agriculture and forestry sectors. The conditions are (i) increase in foreign exchange either through import substitution or export, and (ii) production and utilization of domestic raw materials and adoption of value addition in the processing of local resources.

Furthermore, Section A of the 1st Schedule in the Investment Promotion Act 2011 has prioritised agriculture -- crop, livestock and fishery based production as well as agro-industries -- and while doing so, as mentioned in Section C, due consideration should be given for environmental protection, such as preservation of the top soil, surface and subterranean water as well as river bank flora and fauna and ecosystem biodiversity.

The 2nd Schedule "Benefits and Incentives, Section 3" defines access to the land, which is 30 and 60 years lease for agriculture and forestry based investment respectively with the provision of extension with the mutual consent by the parties for foreign investors.

(2) Land Right and Land Acquisition

There were some incidences of land grabbing in the past (Deng, 2011).[i] However, the above recently developed legal framework gives clear guidelines for rectifying the past mistakes and streamlining the land based investment. The Land Act 2009, Section 14, with the subject to the provision of Section 16, stipulates terms and condition for land acquisition. Individual or collective foreign entities can acquire land or interest on land under leasehold (not freehold) for a specified period of time, which is further elaborated in the Investment Promotion Act 2009, as discussed earlier. Considerable progress has been made to define the land rights, but it needs to be enforced and streamlined.

(3) Institutional Weakness

It has been expected that the issue of land grabbing would be sorted out in accordance with the law. However, there are several institutional weaknesses, which is obvious, as being a newly born country where establishments are still fragile. The most demanding is both statutory and customary land administrations that are weak, i.e. due to lack of resources/know-how, manifested in issuance of duplicate title, loss of records, etc. At the moment, most of the government decisions and day-to-day work is conducted on an ad-hoc basis. There is room for personal judgment, which is disproportionately very high. There is a problem of accountability and transparency and provision of charges and punishment.

3.2 Human Resources

IDMP-TT carried out a Capacity Needs Assessment (CNA) for targeting the officials related to irrigation development at the national, state and county levels. The main issues identified through the CNA survey are shown in Table 3.2.1.

3.2.1 Human Resources & associated Challenges in relation to Irrigation Development

The following challenges for human resources development for present and future irrigation development have been identified through the CNA survey:

1) There have not been any new irrigation development projects implemented, since the independence. Therefore, only limited information and data related to irrigation developments have been accumulated. Moreover, these limited information and data have been owned by individual engineers and have become implicit knowledge, without any sharing systems being installed in governmental institutions.

2) State government officials have limited knowledge of irrigation development. Although they have irrigation units, in some cases, they do not appoint/retain officers suitable/designated for irrigation development/management, because the majority of the officers do not have basic/enough knowledge of irrigation development.

3) Considering the current competencies of county officers, they cannot perform roles of main implementers for irrigation development in the short term.

4) Generally, RSS famers are not familiar with innovative irrigated agriculture; and thus, they do not have enough knowledge of profits (e.g. increasing production yield, stabilization of production, income generation); in addition, they do not keep farm records to help calculate their profit.

5) The current working environment of MEDIWR's Water Sector has seriously affected the effectiveness of their service delivery. Moreover, trained governmental engineers cannot make the maximum use of their enhanced capacities without the productive working environment, including adequate working/storage space and functional unified information transfer/communication systems through the utilization of information and communications technology (ICT).

Table 3.2.1 Main Issues associated with Human Resources for Irrigation Development

Issue	Contents
Limited working experiences of irrigation development	➢ Only 8% of the state government engineers are conducting irrigation development[1]. ➢ The county engineers do not have any experiences of irrigation development. ➢ Only 3% of the state agricultural mechanization officers are conducting technical support of irrigated agriculture for famers[2]. ➢ The county officers do not have any experiences of irrigation project.
Limited training opportunities for officers	➢ The national governmental engineers (MEDIER, MAFCRD) have had the irrigation training opportunities provided by the DPs. However, these training programmes have been done mainly on an ad-hoc basis. ➢ The state engineers have received the limited training opportunities; in fact, only 10 engineers participated in irrigation development training[3]. ➢ Only 2 officers of the state agricultural mechanization institutions have participated in training on irrigated agriculture[4]. ➢ The county officers do not have any experiences of irrigation training.

3.2.2 Remedial Measures for Building Human Resources Capacity

1) MEDIWR and MAFCRD need to establish information/data accumulation and sharing systems. Additionally, since raw/historical information and data of foreign countries cannot always be applied for irrigation development in RSS, some necessary information/data collection and analysis functions are to be fulfilled by MEDIWR and MAFCRD for verifying/updating the applicability.

[1] Table 1.4.9 Annex 4: Human Resource Development
[2] Table 1.4.23 Annex 4: Human Resource Development
[3] Table 1.4.11 Annex 4: Human Resource Development
[4] Table 1.4.25 Annex 4: Human Resource Development

2) MEDIWR and MAFCRD need to provide some opportunities of formal advanced education for HR enhancement in relation to meteorology, hydrology and other related specific, technical fields. This is because analysis of these given basic subjects required advanced competencies in other specific technical fields such as statistics, mathematics and computer abilities to be considered as a prerequisite. In addition, MEDIWR and MAFCRD need to consider recruiting competent human resources in these fields.

3) Competencies of civil/mechanical/survey/agricultural engineers would be enhanced through actual project implementation activities. Therefore, implementation of the priority projects also need to be designed as on-the-job training opportunities, which should be clearly mentioned in the agreements and/or the technical specifications of the engineering services by consulting/engineering firms, construction firms, equipment providers and manufacturers.

4) Technical capacity development for the state/county government/administration staff needs to be considered as a medium-term challenge; and in the short term, it will be indirectly tackled through involvement in national irrigation projects that will be implemented in their states. Training for the officers needs to be conducted in a systematic manner, starting from fundamental knowledge of irrigation development.

5) In case county-level irrigation development will be implemented in short and medium terms, MEDIWR and MAFCRD need to provide complete assistance for all the county offices' activities.

6) MEDIWR and MAFCRD need to coordinate and work together in identifying and providing appropriate training to their staff and to employ competent new graduates in the field of irrigation and agriculture to improve the performance of the current workforce in the states and counties.

7) The training recording system that was established by MEDIWR in 2014 needs to be applied for related governmental institutions that will be assigned for future irrigation development.

8) Localization/Adaptation research of engineering fields (e.g. construction materials, facility design) and extension services of innovative agriculture under irrigation for famers need to be conducted for future irrigation development project implementation. Besides, achievements of research and tests need to be stored in a sharable database to be utilized for capacity enhancement of all stakeholders.

9) General capacities of agricultural extension workers will be enhanced in the CAMP projects. On the other hand, MEDWIR and MAFCRD need to provide the extension workers training opportunities related to innovative agricultural practices under irrigation and establishment/enhancement of the water users' associations through the IDMP. The training opportunities should be planned and provided through the CAMP and IDMP implementation mechanism.

10) MEDIWR and MAFCRD need to disseminate general information on innovative irrigated agriculture nationwide through a strengthening research system that generates innovative agricultural technological packages. Besides, both ministries need to provide opportunities of irrigated agriculture demonstration through priority projects' farms/schemes for famers nationwide, especially those who will participate in new irrigation schemes.

11) MEDIWR needs to provide training opportunities to enhance operation and maintenance of irrigation facilities and equipment that will be autonomously managed by famers, whereas MAFCRD need to provide training opportunities to enhance famer's competencies for innovative agricultural practices.

12) For the success of national irrigation development, the Government of South Sudan including

MEDWIR needs to improve the ministry's water sector buildings together with the installation of necessary equipment and functional unified information transfer/communication systems, in addition to implementation of human resource capacity development.

3.3 Irrigation Development Potential Assessment

Based on geographical and demographic features; natural conditions; existing livelihood systems socio-economics; and the hydrology among other parameters, IDMP TT carried out assessments to identify potentially irrigable lands across the country.

3.3.1 Lack of Information, its Mitigation and Future Measures

In the course of irrigation potential assessment, particularly for water resources assessment, IDMP-TT faced the lack of required data albeit some significant historical data on water resources were made available. This is mainly due to civil unrest and most of the measurement stations for rainfall and river discharge stopped their function in the 1980s.

For rainfall data, only six (6) stations in the country have had data for the last 30 years. As for river discharge data, books such as “The Nile Basin” containing quite a number of river discharge data from the year 1900 made it possible to analyse the data of 71 stations throughout the country, but the available data period greatly varies by station. The situation has given IDMP-TT a challenge of developing mitigation measures to fill the gap by estimating the area, where the data are missing. Nevertheless under such circumstances, IDMP-TT has come up with sound output of the potential assessment with the currently available information.

Meanwhile, it has become clear that certain points of rivers or other locations should be equipped with measurement stations so that the renewal and improvement of the irrigation potential assessment will become easy in the future. In this future point of view, it is indicated that IDMP should consider including a program of hydrometric schemes. The irrigation potential assessment output by IDMP will be the foundation for such future program.

3.3.2 Data Storage

It has also been recognized that the useful and important information are not well stored in the Ministry. These are scattered around the subsequent offices in Juba and other cities, too. Also there are quite significant historical data found in the Ministry and in the Aweil Irrigation Rice Scheme. These old data were not digitized/digitalised, but instead were just kept on a bookshelf. It is required to develop an information management system, which enables data storing and maintenance with easy retrievals and digitization/digitalisation of historical data as well. Some of the historical data have been digitized/digitalised by IDMP-TT in the course of water resources potential assessment. Other users can utilize these digitized/digitalised data as well.

3.4 Issues for Irrigation Systems Establishment

IDMP TT carried out an extensive stakeholders mapping; analysed existing irrigation management systems within the country and in the region; and reviewed related study reports across the world, upon which production and operation of the envisaged irrigation schemes will be based.

3.4.1 Involvement of Various Stakeholders

In case of AIRS and NUNIS, it became clear that there was considerable networking of different institutions surrounding the Scheme. The driving force underlying these institutional interactions was the pursuit of mutually beneficial interests. Three (3) examples will illustrate this:

- The Farmers Union at Aweil interacted with the local Chamber of Commerce, Aweil Farmers' Cooperative, AIRS, National farmers' Union, then MAFCRD at national and State Ministry of Agriculture and Forestry as well as FAO.
- AIRS reported its engagement with the National MAFCRD, State MAF, Aweil Farmers' Cooperative, Private sector (individual and companies), Traditional local authorities and World Food Programme.
- In NUNIS the collaboration also used to be extended to the private sector, where private companies have some investments in the irrigated agriculture.

In formulating the master plan, irrigation development must be placed within a wider context of many institutions and stakeholders whose support or lack of it can influence the outcome of irrigation development.

3.4.2 Participatory Irrigation Management (Irrigation Management Transfer)

It would be necessary to transfer most of the roles in an irrigation scheme to the farmer, in order to overstretch the capacity of the government administration and ensure expansion/sustainability of the irrigation schemes. Looking at the current situation of AIRS, the shortage of the skilled staff has been raised as a major challenge of the Scheme Management office run by the MAFCRD or State MAF. Currently the operation and management of irrigation facilities are under the responsibility of the Scheme except for the inlets and outlets of the field/plot. In expanding the irrigated area in the future, the workloads of operating the facilities up to field/plot level will soon exceed the Scheme's staff capacity.

Irrigation Management Transfer (IMT) enables reduction of the O&M cost of the Scheme; hence the public expenditure will be curbed instead of swelling. As for the farmers' side, they will have more room to exercise their discretion. It is also expected that bringing the operation authority close to the field level will increase the efficiency of water use and management. Farmers could seek to reduce production cost as their part of share increases as well. Establishing public (National or State or County) irrigation schemes nation-wide requires that a significant share of roles and responsibilities should be given to farmers in the schemes. For such an institutional set up, establishing Water Users' Associations (WUAs), i.e. by scheme farmers will be necessary.

In the case of the Aweil Irrigation Rice Scheme, in both 2012 and 2013, the Scheme had budgetary constraints, which reduced the management's capacity to meet its responsibilities of ploughing, input supply and de-silting canals. It is farmers and their cooperative association who came to the assistance of Management by contributing their paddy rice or their labour. On the basis of the farmers' intervention, it can be concluded that the sharecropping model was not working as originally intended since farmers were taking up management responsibilities.

In drawing out the master plan, there will be need for exploring alternative models that broaden the areas of farmer participation, including the financial issue. In particular, future irrigation schemes are likely to recognize the potential and ambitions of farmers and their farmers' organizations, by transferring a wider range of roles and responsibilities to the farmers (tertiary canal water management, land preparation, input procurement, marketing, etc). The Scheme management can then focus on:

- Operation and maintenance of main irrigation infrastructure (intake, main and secondary canals down to tertiary canal off-take)
- Research on irrigated crop production, and development and multiplication of high quality seeds
- Provision of technical advisory services to the farming community (irrigation methods, on-farm water management, crop cultural practices)

- Research on and dissemination of market information to farmers

In return for providing the above services, Scheme management can then be entitled to charge Operation and Maintenance (O&M) fees, which beneficiary farmers will pay.

3.4.3 Research and Extension Systems

"The South Sudan Rapid Water Sector Needs Assessment and a Way Forward" (Fernando and Garvey, 2013)[ii] points out the importance of research and an extension system to be put in place for promoting irrigated agriculture, based on the fact that most of the farmlands in South Sudan are rain-fed and most of the farmers are not very familiar with irrigation. Though there are farmers using portable pumps or even buckets to lift water from lakes, rivers, streams, swamps and marshes, it should be considered that they are still very few and not at a level of required innovation in the context of the national situation. As the report points out, the research and extension system for irrigation development and management have not been established yet and it would also be said that the promotion of irrigated agriculture could be accelerated with the research and extension system to be in place.

3.4.4 Financial Arrangements (Beneficiary Cost Sharing)

Irrigation is necessarily a costly undertaking, as it needs initial investment, O&M and replacement costs. Hence in preparing the master plan, the cost issue will be an important consideration in prioritizing identified projects and models. GRSS will not have all the resources needed and therefore, capacity and institutional building, technical assistance and financial support are expected from regional institutions/initiatives and the development/implementing partners. Also financial inputs and other kinds of contributions from the beneficiaries of irrigation projects should be taken into account.

It is worthwhile to explore how the cost can be shared with prospective beneficiaries. Discussions with farmer organizations in AIRS indicated the prospects for cost sharing arrangement between the public institutions and farmer beneficiaries. At the time of Aweil site visit, the two farmer organizations (Farmers' Union and Cooperative Society) gave the impression that they were capable of discussing with an implementing agency how to share development cost so long as they are guaranteed irrigation water supply, supported with quality inputs and assured of the market for produce. For instance, both organizations had ambitious future plans, which among other things included procurement of tractor, quality seed and fertilizers.

3.5 Planning Feasible Irrigation Development Interventions

There are several issues to consider for planning feasible and operative irrigation development projects. The situation analysis including the field visits of existing irrigation schemes in South Sudan as well as the literature study hereunder indicates the major issues to be related to the feasible irrigation planning.

3.5.1 Sources of Water

When planning and designing the irrigation scheme, economic aspects, i.e. cost-benefit efficiency should be carefully taken into consideration. Especially the reliability of source of water is fundamental for irrigation development. Whether the water source is a perennial or seasonal river, a reservoir or groundwater, or supplementary rain, it would influence planning a feasible irrigation project, e.g. the size of command area, cropping calendar, selection of crops, design of infrastructure, etc.

In the case of AIRS, available water sources for an existing irrigation scheme were not stabilized throughout the year. Especially in the dry season, the availability of water remarkably reduces irrigation due to the decrease in the water level of the source river. The Loll River, the water source of irrigation, is a seasonal river, which flows full from the middle of July, and it can then start to spill into the scheme

site or not at all, but it retains low flows up to January. Hence the irrigated agriculture can be practiced only once annually. Currently, rice seeds are sown directly on the field in June and rainwater is used from the germination to the seedling stage. Irrigation starts afterwards, especially during budding and milking; but water should be out of the fields when harvesting is due.

These unreliable conditions of an extensive farming method may be one of the reasons for a currently very low yield level. With only one unreliable irrigation period per year and basic farming practice, it would be difficult to expect high return from the farm's field. This low yield level and one crop by unreliable irrigation per year would make the cost-benefit efficiency low.

Indeed, no controlled abstraction from the Loll River was put in place, but floodwater was still harnessed in quantities and over the durations that could support rice crop production in an otherwise semi-arid and dry sub-humid environment. This was a significant achievement. AIRS has demonstrated that where similar river and land conditions exist, engineering interventions may create potential for medium–large-scale irrigation projects.

3.5.2 Rehabilitation of Existing Irrigation Schemes

On the basis of available information (documentary, key informants and field observation of AIRS and NUNS), the conditions of the existing irrigation infrastructure are extremely poor either as a result of vandalism and lack of repairs during the war period or sheer neglect and lack of incentives afterwards. In NUNIS, pumps frequently break down while the availability of spare parts is unreliable. In AIRS, there are only a few functional water control structures. Hence, during the wet season (June to November), the Loll River overspills its banks, resulting in floodwater entering rice fields through many points along the Scheme's perimeter, thus destroying the farm/field embankments and the crop.

In both schemes, production is constrained either by the poor conditions of infrastructure or by insufficiency or unavailability of irrigation water, as well as the institutional and management issues. There is therefore, a need for considerable investment in infrastructure for the rehabilitation and proper reestablishment of the existing irrigation schemes.

3.5.3 Spare-parts Consideration

Through the field visits of the existing irrigation schemes, it was ascertained that there is significant need for spare parts procurement to maintain the efficient operation of the irrigated agriculture in the schemes. In NUNIS, most of which were established in the 1950's, the model of the pumps is so old that it is doubted whether spare parts of such old models still exist. Therefore, there is a need to establish this fact before major decisions are taken to rehabilitate the existing pumps.

For medium to large-scale irrigation schemes, heavy machinery is required at the time of project implementation as well as during operation and maintenance of the irrigation system. In AIRS, there is a large mix of broken-down tractors, trucks and earth-moving machinery. Apart from budgetary constraints, spare parts are not readily available because the idle machinery consists of many brands and specifications.

In planning implementation of future irrigation scheme projects, an important consideration is the need to minimize idle time of project machinery and equipment. This objective can be realized, in part, by reducing the number of brands as well as by giving preference to suppliers with reliable backup of locally available spare parts.

3.5.4 Irrigation Scheme Financial Viability

The current financial arrangement of the rice production between the Rice Scheme and farmers in the

Aweil Irrigation Rice Scheme is based on a Sharecropping system, which is to share the harvest between the Scheme and farmers according to their share of the production cost. Farmers and the Scheme are to renew contracts every year and the ratio of the share is revised, e.g. the shares between the Scheme and farmers in 2009/10 were 40% and 60% respectively, while the shares in 2012/13 were stipulated in the contract as 48% for the Scheme and 52% for farmers.

However, this system does not always give enough incentive to farmers to produce more, since the payment to the Scheme from their income is considered very high. The harvest is a gross income from the farming activity and as a result of tenancy the farmer has to give 48% of share to the Scheme. As the public entity, the Scheme does not have to get profit. To give more incentive to farmers to be innovative in rice farming to increase and sustain the production, it is recommended that the Scheme apply a “Cost Recovery System” instead of a “Sharecropping System”. In this case, farmers are to pay to the Scheme constant a tenant fee and the costs of inputs and services; then any surplus the farmers produce will fall into their hands. In this arrangement, farmers would have more incentive than with the current arrangement and thus increased production and productivity can be expected.

In this case, of course, the options to include depreciation of the facilities, when the Scheme calculates the tenant fee must be considered. The salary of staff and some administrative charges to be revenue for the Government could be incorporated into the production cost as O&M to be recovered. Also considering the capacity of the Scheme, the O&M responsibility of the Scheme should be transferred to the farmers. Transferring the responsibilities to farmers would: 1) reduce the cost borne by the Scheme; 2) have a lower cost recovery base of the Scheme; and would give farmers more incentive to make an effort in reducing the production cost. This will help in expanding the irrigated area of the Scheme by motivating more farmers through such a process of empowerment and ownership creation.

3.5.5 Infrastructure for Enabling Marketing

The outputs or effects of irrigated agriculture cannot be realized only by providing irrigation structures. The value of increased crop production under irrigation cannot be realized without selling to markets. Therefore, the irrigation planning, e.g. selection of location, selection of target crops, needs of ancillary facilities, etc., must be associated with other infrastructure aspects, namely feeder roads and access roads to markets, storage facilities, agro-processing facilities, etc.

Aweil produces an agricultural commodity (paddy) with a fairly long post-harvest shelf life. However, bad roads to potential market destinations and lack of processing facilities have posed a major marketing challenge both to the scheme management and farmers. The lesson to learn for irrigation master planning is that access to markets must be a key consideration in specifying the location as well as the type of crop to be irrigated.

In addition, lessons learnt from Aweil show that if a similar rice project is going to be planned (based on small-scale farmers), several small to medium size milling machines, operated by private individuals or companies, would be preferred as opposed to a single large rice mill. With several small-scale mills, the breakdown of one will leave others available for milling services. In any case, any planned large-scale irrigation development must give sufficient attention to an appropriate processing facility.

3.5.6 High Potential for Smallholder Irrigation Scheme Development

There is a considerable number of small-scale irrigation activities located along the White Nile and its tributaries. These are based on lifting of water either manually using a bucket or by harnessing a portable petrol pump. To illustrate the significance of small-scale irrigation, as mentioned above, some 177 pump-sets were bought through the Agricultural Bank of South Sudan (ABSS) in 2011.

Some literatures have shown that small-scale irrigation has been practiced in South Sudan for a long period of time; with the exception of AIRS and NUNIS, large-scale irrigation would be new in most areas of South Sudan. Therefore, knowledge and skills on large-scale irrigation is either lacking or limited in South Sudan. The word irrigation is perceived differently in the South Sudan context, especially, given absence of a clear policy/institutional framework. This leads people to have their own ways of defining the word irrigation.

For example, the State Minister of Physical Infrastructure and Public Utilities in WES said, “I have never heard of any irrigation in South Sudan other than what used to be practiced in Upper Nile”. His statement is not unfamiliar with many South Sudanese on the understanding of irrigation. This may be a result of some South Sudanese being exposed or not to; for example large irrigated agricultural schemes in the then United Sudan. The idea here is that irrigation is associated only with large-scale irrigated schemes where crops are grown and involves large irrigation facilities.

Small-scale irrigation practices during the dry season, using water jerry cans, treadle pumps and sometimes-motorized pumps to grow vegetables are overshadowed by the above understanding of irrigation. And these small-scale growers using irrigated agriculture are often not talked about or even recognized that they exist until you pay a field visit to the farms.

There is insufficient official recognition of the potential contribution of small-scale irrigation. Hence, apart from the South Sudan Agricultural Bank, which has provided credit for purchasing irrigation pumps, neither MEDIWR nor MAFCRD has so far given tangible technical backup to individual small-scale irrigation initiatives. For this reason, there is a need of clear policy on irrigation, which stipulates and designates roles and responsibilities in irrigation practices, including these small-scale ones. For example, who should be responsible for small-scale irrigation? Should this responsibility be defined by the scale of irrigation, or volume of water used or equipment/machinery used, or irrigation techniques, or types of crops, or depending on who is the initiator?

Example of Practice of Smallholder Irrigation (assisted by JICA Technical Cooperation in Malawi and Zambia)

3.6 Lessons Learned from Irrigation Practices in Other Countries

IDMP TT conducted visits and tours; and collected relevant information and documentation out of which the following experiences and recommendations are drawn.

3.6.1 Literature Study

Since there are few cases of irrigation schemes in South Sudan, it is worth referring to the lessons learned from other countries' irrigation practices, i.e. factors that led to success and failure. The World Bank Report “Costs and Performance of Irrigation Projects: A Comparison of Sub-Saharan Africa and other Developing Regions (Inocencio, et al. 2007)”[iii], based on study and data analysis of 31 projects in six (6) developing regions of the world, including 19 Sub-Saharan African countries, revealed some worthy lessons.

The study analysed the cost (including hardware and software components) of the projects and calculated the average unit cost (on ha basis). The study then found out that the unit cost of the successful projects was up to USD 5,700 for new construction and USD 3,500 for rehabilitation in the year 2000 prices, while the unit cost of failed projects counted for around four (4) times the successful ones. The study concluded that high project cost is a significant risk of failure for irrigation projects.

Also based on the successful practices introduced in the CAADP report Pillar I Framework (CAADP, 2009)[iv] and the review of other literature including the Gezira Scheme in Sudan, Office du Niger, and ten (10) other cases of Sub-Saharan countries (Annex 1), it could be summarized that the best performing irrigation projects of recent years tend to have the following characteristics:

- Market-driven investments by individual small-scale farmers with low-cost technology
- Small-scale community managed irrigation schemes
- Large-scale irrigation with transparent, accountable, efficient and financially self-sustaining institutions (e.g. Office du Niger).

3.6.2 Knowledge from the Study Visits

IDMP-TT carried out study visits in Tanzania and Ethiopia in December 2013. The systems and practices of irrigation development in those countries gave the TT insights on formulating the IDMP as well as the strategic framework for irrigated agriculture. The following are the lessons learned from those study tours.

(1) Institutional set-up (Case of Tanzania)

In Tanzania, the country has been divided into seven (7) zones for irrigation development. The central government, namely, the Ministry of Agriculture and Food Security operates the irrigation development and administration through the seven (7) Irrigation Zone Offices. A Zone Office covers a group of local governments and is independent from the local governments.

The Irrigation Act under discussion in the Tanzanian Government challenges this Zone set-up as being not cost effective and it proposes new structures under the National Irrigation Commission. The Commission will be self-autonomous, answerable to a Board of Directors and it will have powers to seek for funding being internal or external. In addition, the Irrigation Act proposes the set-up of Regional offices as opposed to Zone offices, which will be much nearer to the Local Government Authorities (LGAs) and a department of Irrigation at the LGA level.

Although such re-structuring is under discussion in Tanzania, it seems that the Zone Office is working well. The office has developed packages of works for irrigation development and O&M. The work descriptions of the staff in the Zone Office are clear and most significantly the knowledge on irrigation development has been well accumulated in the Zone Office.

It may be instructive that the irrigation administration does not have to be necessarily demarcated by the administrative boundaries. It could be an idea to establish such Zone-office and Zone-wise irrigation administration structure in seeking the efficiency and effectiveness of the irrigation development and administration.

For the case of the Zone Office in Tanzania, these zones are demarcated based on administrative boundaries, unlike the hydrological boundaries exercised by the Ministry of Water. As in South Sudan, an irrigation administration structure could be designed in harmony with the water resources management administration to be developed in accordance with the draft Water Bill or in accordance with identified irrigation development potential zones under the IDMP framework.

(2) Proposed System from the Community (Case of Tanzania)

In Tanzania, a proposed system has been applied in developing irrigation schemes. A community who wishes to develop an irrigation scheme will prepare a proposal for it and apply it to the Zone Office. The Zone Office will evaluate the application and carry out a feasibility study as well as determine the assistance required. The Zone Office helps the community in all the procedures, beginning from the application to planning, designing, implementation and O&M in cooperation with local government.

Since it is a proposal by the communities, it tends to be small-scale. As the data of Table 3.6.1 shows, 94% of the irrigation type in Tanzania is smallholder and small commercial irrigation as of 2002. IDMP-TT visited three (3) irrigation schemes during the study visit and all the schemes have been managed by the community farmers themselves with the technical assistance of the government officers. The scheme is designed in a way that the community can manage it themselves.

Table 3.6.1 Types of Irrigation Systems in Tanzania (as of 2002)

Type	Area (ha)	Share
Estates, Out-growers, Medium to large commercial farms	2,400	0.6%
Parastatal/Government farms	19,700	5.2%
Smallholder, Small commercial farms	359,000	94.2%
Total area under irrigation	381,000	100.0%

Source: International Commission on Irrigation and Drainage (ICID), 2002[v]

The system of proposal and application from the community may give high sustainability with technical/engineering assistance from the experts. For adopting this proposal system, it is required to establish a justification system of irrigation scheme development, including community-led, government-led and private sector investment in South Sudan.

3.6.3 Learning from the Seminars

For future practices of irrigation promotion and capacity building in RSS, JICA consultants organized a number of seminars, drawing experiences from other countries across the world, including Philippines, Egypt, Japan, Kenya, Iraq and Zambia. During the seminars, irrigation history; and enhancement of its planning, technical design and management improvement cases such as participatory irrigation management were presented and discussed. This contributed to preparation of preliminary guidelines and determination of public institutions & farmers roles, e.g. ways of private sector involvement.

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iii. Inocencio, A. Kikuchi M. et al. 2007, *Costs and Performance of Irrigation Projects: A Comparison of Sub-Saharan Africa and Other Developing Regions*, Vol. 109, Research Report, Colombo: International Water Management Institute (IWMI).
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v. International Commission on Irrigation and Drainage (ICID), 2002, *Tanzania* (http://www.icid.org/v_tanzania.pdf).

Policies, Strategies, Laws and Plans of GRSS

1. The then Government of Southern Sudan (GoSS), 2009, Local Government Act.
2. The Government of the Southern Sudan (GoSS), 2009, Investment Promotion Act.

CHAPTER 4 ZONING FOR IRRIGATION DEVELOPMENT & IRRIGATION MODELS

While the topography of national land in RSS mainly consists of plains and mountainous areas and meteorological/hydrological conditions emanated from the topography, this Chapter aims to suggest an applicable irrigation methodology to each zone determined, through its characteristics. In the process of IDMP formulation, proposed irrigation schemes have been identified in consultation with the state governments through the States Focal Points (SFPs). Those schemes are categorized by zones in Chapter 6 according to their locations, and most of them, however, are placed on a long-term timeframe for implementation due to the necessity of required more information for activities such as the detailed assessment at the pre-F/S study level.

4.1 Zoning for Irrigation Development Potential

(1) Information used

The following information available in RSS and/or created by IDMP-TT is used for the zoning for irrigation development:

1) Topographical information with Digital Elevation Model (DEM):
2) Rainfall contour map (prepared by IDMP-TT):
3) Groundwater potential map (prepared by IDMP-TT): and
4) Livelihoods zone map (adopted from Annual Needs and Livelihoods Assessment 2009/2010).

(2) Topographical features of RSS - relation between elevation and terrain slope

Three (3) longitudinal sections from mountainous to Sudd areas were made by using DEM data as shown in Figure 5.1.1 for alignment and shown in Figure 5.1.2 to 5.1.4 for each section, namely:

- Section 1:
  Deim Zubeir (WBGS) – Aweil (NBGS) – Tonga (UNS) – Malakal (UNS), indicated in black,
- Section 2:
  Source Yubo (Sirsibo) (WBGS) – Wau (WBGS) – Tonga (UNS) – Malakal (UNS), indicated line in red, and
- Section 3:
  Nimule (CES) – Juba (CES) – Terekeka (CES) - Ghaba Shambe (LS) – Fangak (JS) - Malakal (UNS), indicated line in blue.

The above longitudinal sections verified by the relation between elevation and terrain slope. As a result of verification, RSS is classified into four (4) areas in consideration of topographical features as shown in Table 4.1.1.

Table 4.1.1 Characteristics by Zone

Zone	Characteristics
1. Mountainous	Elevation is more than 600 m, comparatively steep terrain with slope 1/500 to 1/1,500.
2. Intermittent	Elevation from 400 to 600 m, terrain with slope 1/2,000 to 1/5,000.
3. Plains	Elevation around 400 m, very gentle terrain with slope 1/5,000.
4. Wetlands and River Corridors	Elevation (less than the plains around it) and terrain slope less than 1/5,000.

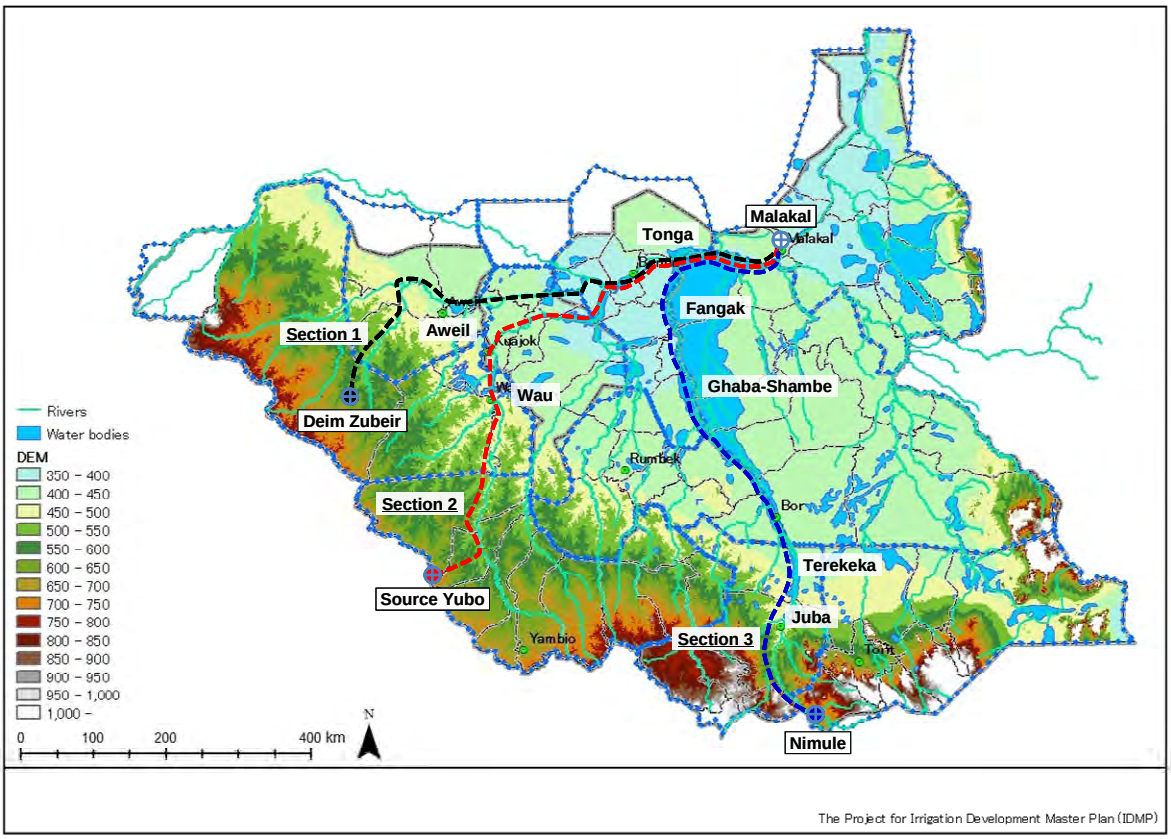


Figure 4.1.1 Alignment of Longitudinal Sections

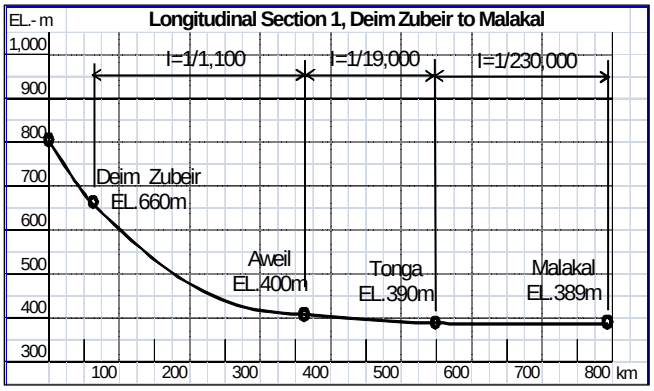


Figure 4.1.2 Longitudinal Section 1
(Deim Zubeir – Malakal Line)

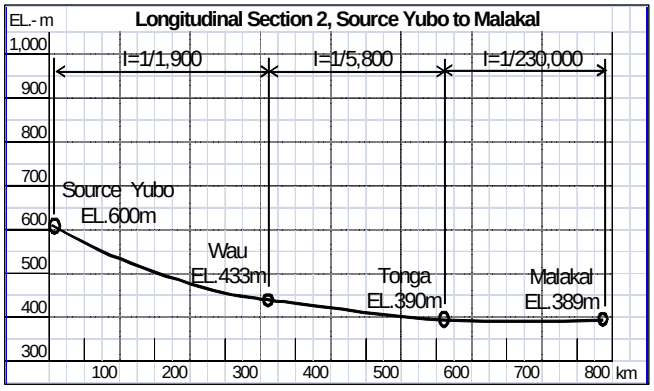


Figure 4.1.3 Longitudinal Section 2
(Source Yubo (Sirsibo) – Malakal Line)

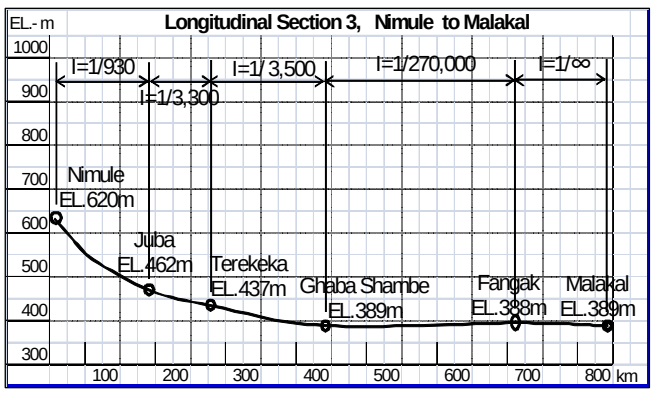


Figure 4.1.4 Longitudinal Section 3
(Nimule – Malakal Line)

4.2 Outline of Irrigation Potential Zones

Based on elevation, terrain slope, applicable irrigation development mode/model and potential irrigable lands, RSS is divided into four (4) zones as shown in Figure 4.2.1 below. The characteristics of each zone can be summarized as shown in Table 4.2.1

Table 4.2.1 Characteristics and Suitable Irrigation Modes by Zone

Zone	Elevation	Terrain Slope	Irrigation Modes/Models				Soil Type	Land Cover
			Types	Techniques/ Methods	Sources of Water	Scale		
Mountainous	More than EL.600m	1/500 – 1/1,500	Dominated by pressurised irrigation	Furrow, Terracing	springs, aquifers and reservoirs	Micro/ Small	LP, LX	TCO, SCO
Intermittent	EL.400 – 600m	1/2,000 – 1/5,000	Mix of gravity and pressurised irrigation	Basin, Furrow	rainfall, rivers, lakes, reservoirs and groundwater	Micro/ Small/ Medium	LX, RG	TCO, SCO, HCO
Plains	Around EL.400m	1/5,000	Dominated by gravity irrigation	Basin, Furrow	lakes, rivers and reservoirs	Micro/ Small/ Medium/ Large	VR, FL	SCO, HCO
Wetlands and River Corridors	Less than elevation of the plains around it	Less than 1/5,000	mixed of gravity and pressurised irrigation	Basin	soil moisture, rivers and lakes	Micro / Small	VR, FL	SCO, HCO

Note 1) Soil Type: LP; Leptosols, LX; Luvisols, RG; Regosols, VR; Vertisols, FL: Fluvisols
2) Landcover: TCO; Forest, SCO; Woodland, HCO; Grassland

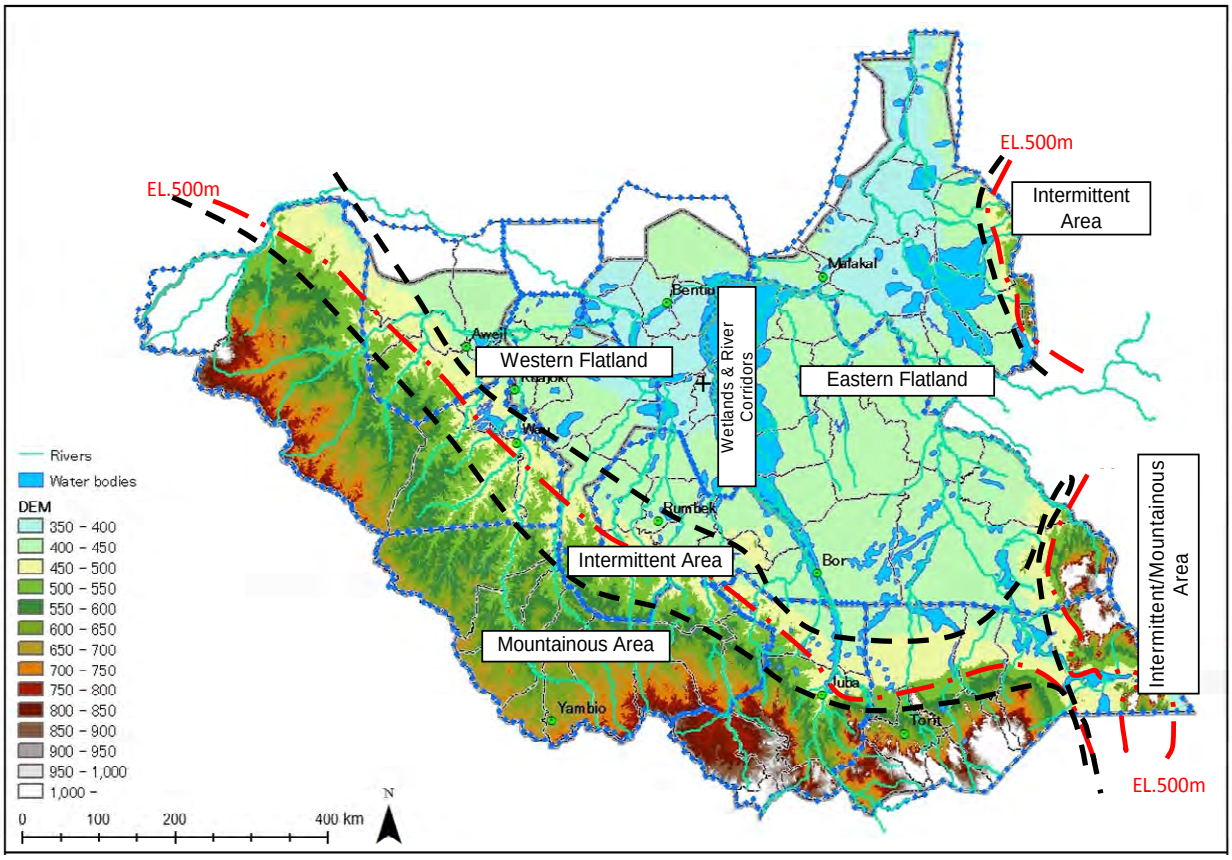


Figure 4.2.1 Zoning Map for Irrigation Development

The wetlands and river corridors zone are delineated separately from the plains zone due to the distinct characteristics of using residual soil moisture after wetlands, rivers and lakes recede; in addition to direct withdrawal from the rivers and lakes. Therefore, there is a need to delineate wetlands and river corridors zones, where micro/small-scale irrigated farming can be practised, similar to the mountainous zone.

4.3 Identification of Irrigation Models by Zone

Types of irrigation include pressurised (sprinkler, drip, etc.) and gravity (open channels, etc.), while irrigation techniques include basins, furrows, terracing, etc.

Criteria for zoning by irrigation models:

(1) Topography

a. Mountainous Area
   : Dominated by pressurised irrigation, sourcing water from springs, aquifers and reservoirs)
b. Intermittent Area
   : Mix of gravity and pressurised irrigation, sourcing water from rainfall, rivers, lakes, reservoirs and groundwater.
c. Plains
   : Dominated by gravity irrigation, sourcing water from lakes, rivers and reservoirs
d. Wetlands and River Corridors
   : Mix of gravity and pressurised irrigation, sourcing water from, rivers and lakes; in addition to residual soil moisture use.

(2) Sources of water

a. Rainfall (Precipitation);
b. Residual Soil Moisture (after receding of floods);
c. Rivers/Lakes/Reservoirs;
d. Aquifers (Groundwater); and
e. Springs.

These criteria followed water occurrence cycle, e.g. rainfall/precipitation, infiltration, runoff or land surface drainage, flow (in streams and rivers) and storage (lakes, wetlands and aquifers).

Irrigation models will be used during the design of the irrigation systems for priority projects e.g. an irrigation model will act as a tool to help in determining the amount of water from each water sources to be used at certain schemes/farms. This will inform a decision to plant certain types of crops in a certain season. This would also depend on type of soil, land surface slope (terrain). This exercise will be aided by information from topographic, soil and geological surveys/analyses. The results would be determination of irrigable field sizes, farm/scheme sizes, etc.

4.4 Irrigation Potential Zones as Analogous of Livelihood Zones

Irrigation potential zones are derived from the same geographical features and associated natural conditions that divided the country into distinct agro-ecological zones, which in turn translated into specific livelihood zones, which is explained in Chapter 1 (on Pages 1-2 & 1-3).

Analogically, the four (4) irrigation potential zones correspond to the seven (7) livelihood zones as follows:

i) Mountainous area irrigation potential zone is equivalent to the greenbelt plus hills and mountains;

ii) Intermittent area irrigation potential zone is similar to ironstone plateau together with eastern semiarid;

iii) Plains irrigation potential zone is the same with western and eastern floodplains combined; and

iv) Wetlands and river corridors irrigation potential zone corresponds to Bahr el-Jebel, White Nile and Sobat River Corridors.

South Sudanese have led their lives in accordance with the conditions of each livelihood zone, and the zoning for irrigation development will help adopting of appropriate types of irrigation and water control techniques. As an analogy, this will help adapting and transforming the existing livelihoods to a better condition of living through improved ways of harnessing and managing water resources for crop and timber production; animal husbandry (including establishment of irrigated rangelands); and fish farming.

CHAPTER 5 THE IDMP STRATEGIC FRAMEWORK

5.1 Formulation Methodology

IDMP formulation process is based on the analysis of the Issues for Irrigation Development (Chapter 3); Irrigation Development Potential Assessment (Chapter 2); Irrigation Development Prospects in South Sudan (Chapter 1); rationale (as captured in the introduction); and the analyses of the existing Policy, Institutional, Legal and Strategic Framework (Annex 1).

5.1.1 Alignment with the Present Policy & Institutional Framework

IDMP strategic framework is formulated based on the results of the situation analysis to set the direction of the envisaged master plan and its action plan or implementation mechanism. The strategic framework for irrigated agriculture and other productive uses of water will therefore be formulated in consistence with the provisions of the overall Water, Sanitation and Hygiene (WASH)/Water Sector Strategic Framework; the Water Resources Management subsector policy and strategy; Draft Water Bill; the policies, strategies, laws and plans of the related institutions/sectors/subsectors at all levels; national initiatives; and regional frameworks.

In addition, the contents will reflect experiences in relation to the overall water sector and the irrigation subsector planning, development and management nationally; and across the region and the globe.

In line with that and specifically linked to the CAMP, the following steps of the IDMP framework will be the current situation and context; objectives and strategic goals; strategic approaches; programmes and projects; and delineation of roles and responsibilities; and the implementation mechanism.

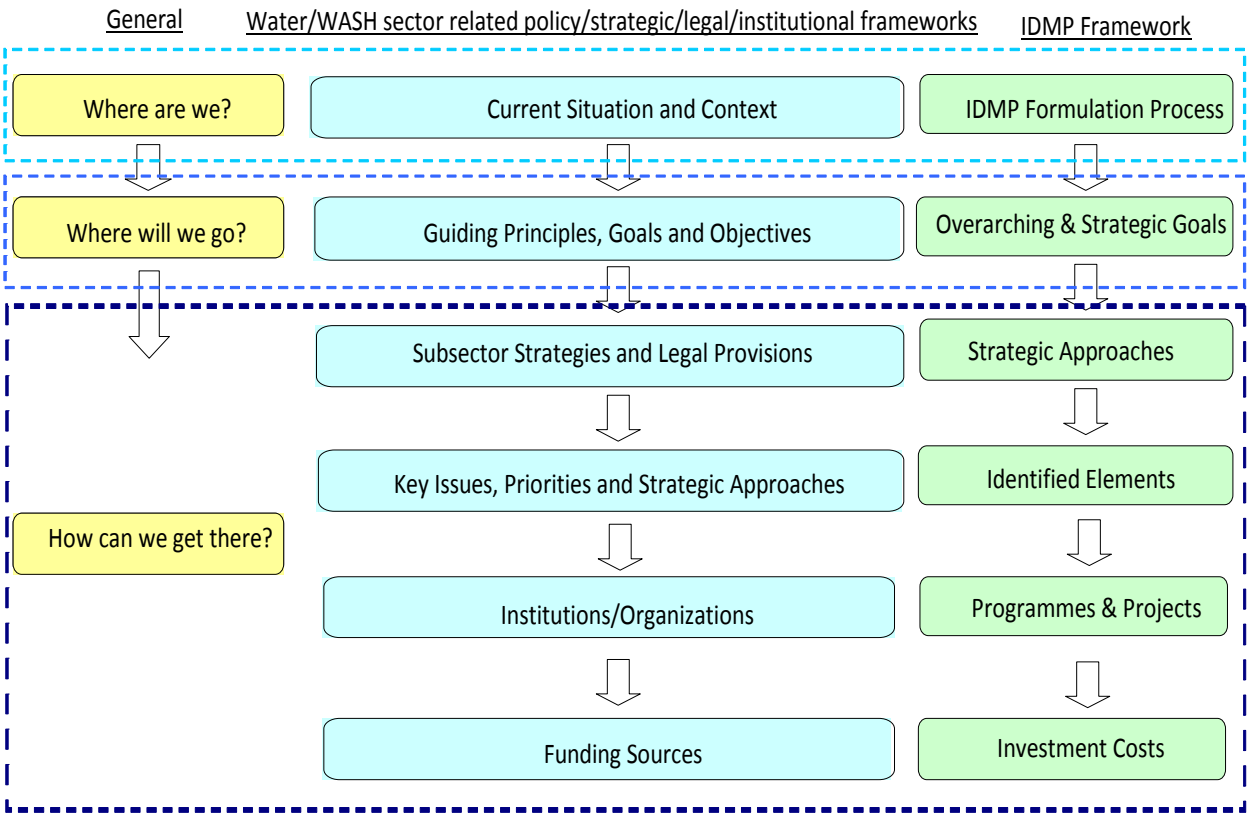


Figure 5.1.1 IDMP Framework Logical Flow

5.1.2 Formulation Steps

(1) Current Situation and Context

The results of the situation analysis are summarized as a starting point to formulate the strategy for irrigated agriculture and other productive uses of water.

The situation analysis in relation to the irrigation sub-sector in South Sudan and elsewhere has been captured in Annex 1 and further analysed and presented in Chapter 1 (Irrigation Development Prospects in South Sudan) & Chapter 3 (Issues for Irrigation Development).

As the first step, the current situation has been organized into categories, challenges and opportunities to easily translate the current situations into the strategic approaches.

(2) Setting of Goals

The overall and strategic goals of the irrigation development are defined in phases with given timeframes, based on the current situation and context.

The goals are set in line with the RSS vision; national socio-economic development plans and projections for the country; and in consistence with the CAMP planning horizons, forecasts and targets.

(3) Strategic Approaches

Considering the current situation and context of the entire water sector in general and of the irrigation subsector in particular; a country's developmental vision and socio-economic projections; and CAMP targets, the strategies are formulated to reach the strategic goals.

Strategic approaches describe the directions, baselines and interventions for irrigation development and management.

(4) IDMP Elements

The situation analysis and context results; and the associated challenges and opportunities are streamlined into three (3) packages known as IDMP elements, to elaborate on the stated strategic approaches.

(5) Programmes

To address the existing challenges and make use of the available opportunities in a strategic manner, IDMP framework is structured in a programmatic approach as a main strategy to realise the envisaged irrigation development outcomes.

The programmes are formulated and clustered under the elements, with a set of means and tools to implement them. Each programme consists of an objective, outputs, components and activities. The programmes are described in Chapter 6; and the detailed Programmes' Profiles is given in Annex 6.

5.2 Goals

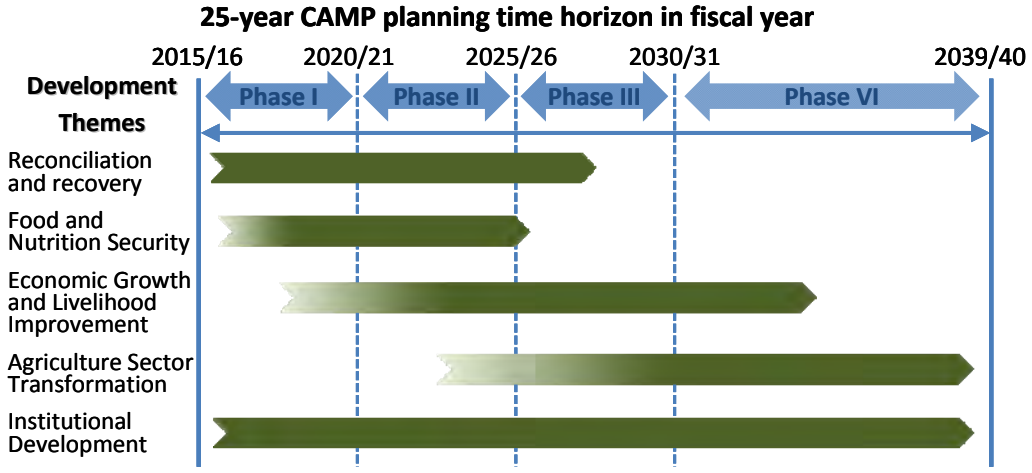
From the water sector point of view, IDMP sets its overarching goal as "to achieve sustainable irrigated agriculture and the other productive uses, thereby improve food security and resilience; reduce poverty; and contribute to economic growth and development".

5.2.1 Setting of Strategic Goals

IDMP strategic goals are set and defined in consistence with CAMP development themes. The CAMP strategic goals are proposed for 2040 as the target year, which corresponds to the South Sudan's "Vision 2040". In line with this national vision, CAMP has defined and aligned four (4) development themes, namely "reconstruction and recovery", "food and nutrition security", "economic growth and livelihood improvement" and "agriculture sector transformation".

These themes represent the expected stages of agricultural development respectively; in short, medium and long-term time horizons in a concurrent, overlapping, interlinking manner (CAMP, 2015)[i].

In line with CAMP development themes and time horizons, IDMP set and defined its strategic goals in three phases as "(1) to promote irrigated agriculture and other productive uses"; "(2) to expand irrigated areas and improve productivity"; and "(3) to ensure efficient and sustainable irrigation management" in the short-term; medium-term; and long-term respectively.



Project objective time horizon	
Short-term	Projects with quick win objectives (less than 5 years)
Medium-term	Projects with medium-term objectives (5 to 10 years)
Long-term	Projects with long-term objectives (more than 10 years)

Figure 5.2.1 Development Themes, Planning Horizon & Programmes'/Projects' Objectives
(Adopted from CAMP TT)

(1) National Goal: South Sudan Vision 2040

By 2040, South Sudan will be educated and informed; prosperous, productive and innovative; compassionate and tolerant; free, just and peaceful; democratic and accountable; safe, secure and healthy; united and proud.

Table 5.2.1 IDMP Goals

(2) IDMP Overarching Goal	To achieve sustainable irrigated agriculture and the other productive uses, thereby improving food security and resilience; reducing poverty; and contributing to economic growth and sustainable development		
(3) IDMP Strategic Goals	Short-term (2015/16-2021/22)	Medium-term (2022/23-2027/28)	Long-term (2028/29-2039/40)
	To promote irrigated agriculture & the other productive uses	To expand irrigated areas and improve productivity	To Ensure efficient and sustainable irrigation management

MEDIWR is mandated to allocate and deliver bulk water to irrigated agricultural schemes and also to the production projects' areas, at which water is required. In this regard and as captured in the IDMP overall goal, i.e. provision of water for the other productive uses; namely livestock, forestry and fisheries is included in the scope of IDMP. However, the amount of water for irrigation development is much larger than other uses and therefore; the target and measureable indicator of IDMP are discussed as below, mainly on the basis of irrigated areas or the number of irrigation schemes' sites to be developed.

5.2.2 Strategic Targets

In order to set measurable indicators to evaluate the achievement of short, medium and long term strategic goals, the target development number of irrigation schemes is projected based on the population and cereals production forecast. In order to maintain the consistency with CAMP process, the basis of the projection was taken from the 25-year cereals production forecast of CAMP report. Table 5.2.2 shows the projections and setting of the targets in consistent with the CAMP forecast of population projections; and demands for cereals and their net production.

It is assumed target ratios of cereals production to projected production (ton) by irrigation, are 10% for short term (by 2021), 20% for medium term (by 2027) and 40% for long term (by 2040). Accordingly, on the basis of above, target ratios of irrigation area to projected farmland areas are estimated 4% for short term, 8% for medium term and 18% for long term. The number of schemes and the average size of small, medium and large-scale irrigation schemes are all provisional and hence the table can be revised and updated with the new set of schemes development projection.

Table 5.2.2 Cereals Production Projections and Irrigation Development Targets

S/#	Year	Unit	Yield (Net)	2015	By 2021	By 2027	By 2040	Remarks
1.	Population forecast (CAMP)			11,022,000	12,411,889	13,977,803	18,081,778	
2.	Cereals demand: CAMP forecast	ton		1,201,398	1,352,896	1,523,580	1,970,914	
3.	Projection of (Net) production by CAMP process	ton		800,000	1,268,510	1,879,681	3,113,457	
4.	**Target ratio of cereals production (ton) by irrigation**			**5%**	**10%**	**20%**	**40%**	
5.	Assumed farmland to fulfil production by CAMP forecast	ha		773,333	1,183,943	1,629,057	2,283,202	
6.	Required farmland to fulfil production **by rain-fed**	ha	1-t/ha (Net)	760,000	1,141,659	1,503,745	1,868,074	
7.	Required farmland to fulfil production difference **by irrigation**	ha	3-t/ha (Net)	13,333	42,284	125,312	415,128	Cumulative
8.	**Target ratio of irrigation area to projected farmland**			**2%**	**4%**	**8%**	**18%**	Cumulative
9.	Percentage to country potential land (190,000 km^2)			0.07%	0.22%	0.66%	2.19%	Cumulative
10.	Percentage to national land (640,000 km^2)			0.02%	0.07%	0.20%	0.65%	Cumulative
11.	Projected farmland to come under irrigation development/production in each time horizon	ha	3-t/ha (Net)	-	42,284	83,028	289,816	Periodic Increment
12.	Target number of irrigation schemes to be developed by time horizon			Time period	2015-2021	2022-2027	2028-2040	
				Small-scale	S: 338	S: 476	S: 1,261	Periodic Increment
				Medium-scale	M: 25	M: 100	M: 456	
				Large-scale	L: 3	L: 14	L: 66	

With the assumed cereals yield of 3-t/ha on average under irrigation (Page-23, 3.2 Key Policy Choices and Objectives, ASPF, 2012-2017). In row 7 of Table 5.2.2 above, target areas for irrigation are the per cents of projected production in row 3 divided by this assumed yield.

Also, in the table, production difference is calculated by subtracting the current net cereals production from the projected production by 2040, which is equal to the assumed area to come under rain-fed with an assumed average yield of 1-t/ha. Then the required irrigated area to produce the difference to fulfil the projected production is calculated with the same assumed average yield of cereals with irrigation (3-t/ha). With these assumptions, it is estimated that developing 415,128 ha of irrigated agriculture would support achieving the projected cereals production by 2040. This size is just 0.65% of the national land (2.19% of the totally assessed irrigation potential of the country).

This leaves great opportunities for irrigated rangelands; fish farming; afforestation; agro-industries and agribusiness based crops production; and the other sectors and stakeholders. The following are provisional irrigated agriculture projections for demonstrating the targets assumed to fulfil the forecast of CAMP process (Table 5.2.3 below).

Table 5.2.3 Target Types of Schemes percentage by Assumption

Type of Scheme	Ave. Size (ha)	Planning Horizons									Remarks
		By 2021			By 2027			By 2040			
		%age	Area (ha)	no	%age	Area (ha)	no	%age	Area (ha)	no	
Small-scale	100	80%	33,827	338	65%	81,453	814	50%	207,564	2,075	Cumulative
Medium-scale	250	15%	6,343	25	25%	31,328	125	35%	145,295	581	Cumulative
Large-scale	750	5%	2,114	3	10%	12,531	17	15%	62,269	83	Cumulative
Total		100%	42,284	366	100%	125,312	957	100%	415,128	2,740	Cumulative

Source: IDMP-TT

In terms of control, coordination and support, the IDMP target is considered as the responsibility of MEDIWR's water sector; hence the number of irrigation schemes to be developed has been suggested as an indicator for irrigation development achievement.

It was discussed whether the irrigated area should be the indicator, but it was anticipated that the expansion of the irrigated areas using the established irrigation infrastructure would more or less depend on: Farmers, communities and private sector; in addition to other governmental institutions responsible for extension, trade, industry and investment at all levels; and development partners concerned with poverty reduction and economic growth.

The role of each and every one among these organisations would constitute an external factor to MEDIWR's water sector.

5.3 Current Situation and Context of Irrigation Subsector

The current situation and context of irrigation subsector in RSS has been studied since the onset of the IDMP formulation process.

It began with the analyses of the existing policy, institutional, legal and strategic framework; inventory of the plans in place, on-going activities, projects, programmes and the lead players in relation to the irrigation sub-sector (Annex 1). Then the capturing of the general features and natural conditions of the country; and carrying out the irrigation development potential assessment as described in Chapters 1 and 2 respectively followed. After that the issues for irrigation development were considered, analysed, discussed and streamlined in Chapter 3.

Table 5.3.1 summarizes the results of the situation analyses, categorised into four categories with associated challenges and available opportunities as (1) policy and institutions; (2) natural resources and their utilization; (3) human resources; and (4) information base.

Table 5.3.1 Summary of the Current Situation in Irrigation Subsector

Category	Challenges	Opportunities
Policy and Institutional Framework	• Absence of irrigation policy • Unclear demarcation of responsibilities and roles among institutions • No specific guidelines for policy adoption (land policy, environmental policy, water policy) • No clear demarcation of responsibility for the existing schemes (e.g. Aweil Irrigation Rice Scheme) • O&M system in Aweil scheme is dependent on the government.	• Water Resources Management framework is in progress • Recognition of joint responsibility of MEDIWR and MAFCRD
Natural resources and their utilization	• Erratic rainfall • Flood and drought occurs (control of water is required) • Less investment in irrigation (collapsed irrigation schemes left without comprehensive operation, maintenance and rehabilitation)	• Abundant irrigation development potential has been identified from the several points of view: water resources, land productivity and socio-economic potentials.
Human resources	• Limited number of capable human resources for irrigation • Limited HRD institutions (training & research centres, universities, etc.) • Limited capacity of farmers for irrigated agriculture	• Irrigation and Agriculture administrative structures in place
Information base	• Limited number of hydro-meteorological measurement stations • Absence of nationwide water resources planning, monitoring and assessment system	• Long history and experience of hydro-meteorological measurement in certain locations across the country • The first nationwide hydro-meteorological information mapping has been made with available data through IDMP formulation process

5.4 Strategic Approaches

Upon analyses of the current situation and context, the above rather simpler summary helped in identifying the strategic approaches. They are identified for each category, with the aspects of how to tackle the challenges; and at the same time on how to utilize the opportunities. Figure 5.4.1 illustrates the dimension of the above categories.

5.4.1 Policy/Institutions

As summarized in the above Table 5.3.1, the challenges associated with policy and institutional issues are the absence of irrigation policy; and no specific guidelines for irrigation development in land policy, environmental policy as well as water policy. However, the policy framework of water resources management subsector has been formulated under Water Policy, WASH Strategic Framework and draft Water Bill.

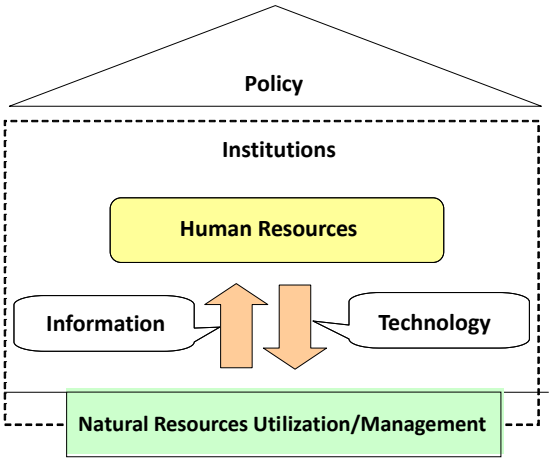


Figure 5.4.1 Dimensions of the Strategic Approaches

In these documents, the integrated water resources management by watershed (hydrological boundaries) has been consistently considered as a basis for the water/WASH sector policy, strategy and the draft regulatory and institutional framework.

Although there is no specific irrigation policy and strategy, the water policy, strategy and the envisaged institutions/regulations/laws indicate the direction for irrigation development and management. Then what is required in the case of irrigation investment would be to develop guidelines to be followed in compliance with the existing water/WASH sector frameworks.

As for the institutional aspects, the WASH Strategic Framework clearly states the joint responsibility of MEDIWR and MAFCRD in relation to irrigation development and management. But this demarcation has not been well established on the ground; and the delineation of roles and responsibilities between the Central and State Governments is still unclear as well. When you look at Aweil Irrigation Rice Scheme (AIRS), which is the only currently partially operating public irrigation scheme in RSS, O&M system is also a particular set-up, just at the scheme level.

Considering these issues, it would call for the necessity of developing a guideline for irrigation development and management, which would consist of: Land acquisition, planning, designing, procedures for environmental and social considerations and implementation; in addition to determination and delineation of roles and responsibilities of institutions, O&M set-up, water resources management, etc.

Here an approach for “formulating a guideline for irrigation development and management in accordance with the national water resources management frameworks” is suggested. The guideline formulation could help in filling the gap of no specific irrigation policy within the water sector.

Challenges	Opportunities
• Absence of irrigation policy • Unclear demarcation of responsibilities and roles among institutions • No specific guidelines for policy adoption (under land policy, environmental policy, water policy) • No clear demarcation of responsibility for the existing scheme (AIRS) • O&M system in Aweil scheme is dependent on government	• Water Resources Management framework is in progress • Recognition of joint responsibility of MEDIWR and MAFCRD

Approach
Formulating a guideline for irrigation development and management in accordance with the on-going national water resources management framework.

Figure 5.4.2 Strategic Approach: Policy/Institutions

Such a guideline would guide investing in irrigated agriculture and other productive uses of water during initial stages; and eventually help in formulating a dedicated policy pertaining to irrigation development and management as well. After the formulation of the policy, the guideline should be updated, so that it is harmonized with the policy.

5.4.2 Natural Resources and their Utilization/Management

In this category, the IDMP TT intensively worked out the irrigation development potential assessment from the natural resources point of view, namely land productivity, rainfall, surface water and groundwater. Some socio-economic aspects were also incorporated in this assessment. As a result the potentiality has been confirmed abundant and it should be utilized for irrigation development.

There is always a risk with erratic and sometimes disastrous climate instability, and therefore controlling water e.g. by infrastructure development is required, while at the same time these structures result in stable water provision for irrigation development. Therefore, an approach of "controlling water and exploiting the irrigation development potential" is stated.

Challenges	Opportunities
• Erratic rainfall • Flood and drought occurs (control of water is required) • Less investment in irrigation (collapsed irrigation schemes left without comprehensive rehabilitation)	• Abundant irrigation development potential has been identified from the several points of view: water resources availability, land productivity, and socio-economic aspects.

Approach
Exploiting the potential for irrigation development through participation and cooperation among stakeholders (governments, farmers, communities, DPs and the private sector) at the critical stages of planning, decision-making, resources mobilisation, execution, operation and maintenance.

Figure 5.4.3 Strategic Approach: Natural Resources and their Utilization and Management

5.4.3 Human Resources

As a result of the Capacity Needs Assessment (CNA), limited human resources in capacity and numbers, including government staff and farmers have been identified. But the administrative structure for irrigation and agriculture development is in place. To tackle these challenges and to utilize the opportunity, the approaches in human resources are stated as "developing capacity of existing staff/professionals/technicians/farmers" and "establishing training/education/research institutions to supply generations of knowledgeable and skilful human resources".

Challenges	Opportunities
• Limited number of capable human resources for irrigation • Limited HRD institutions (training & research centres, universities, etc.) • Limited capacity of farmers for irrigated agriculture	• Irrigation and Agriculture administrative structures in place

Approach
• Developing capacity of existing staff/professionals/technicians/farmers • Establishing training/education/research institutions to supply generations of knowledgeable and skilful human resources

Figure 5.4.4 Strategic Approach: Human Resources

5.4.4 Information Base

In order to identify the potential irrigation development areas, the assessment of water resources potential to calculate available water volume at the target areas is crucial. Required measurements and information for water resources assessment is rainfall, river discharge, water level (in a river/lake) and groundwater storage.

Apart from rainfall, additionally meteorological information such as temperature, humidity, wind speed, sunshine hours, etc., is essential to calculate irrigation water requirement at the target areas.By balancing available water and irrigation water requirement, identification of irrigable area and design of irrigation facilities can be carried out.

One of the biggest challenges in situation analysis was the data availability of such information in the country. Although there is so valuable historical hydro-meteorological (hydromet) information since more than 100 years ago, the data is insignificant and incomplete. Some periods have been missing due to the civil war and most of the measurement stations have not been rehabilitated yet after the CPA. It forced the IDMP-TTs to exert a lot of efforts in estimating the water resources potential in the areas without raw data.

It has been, therefore, considered crucial to establish the hydromet measurement stations to collect, analyse, monitor and evaluate hydromet data and information. The water resources potential assessment carried out by the IDMP-TT is the basis of starting-up; and there is a need to periodically update the hydromet information base to elaborate and update the assessment of the irrigation development potential in the future. Hence the fourth approach is stated as “establishing of nationwide hydromet information monitoring and evaluation (M&E) system by increasing actual measurement stations”.

Challenges	Opportunities
• Limited number of hydromet measurement stations • Absence of nationwide hydromet information M&E system	• Long history and experience of hydromet information measurement at certain points in the country • The first nationwide hydromet information mapping has been made with available data

Approach
Establishing of nationwide hydromet information M&E system by increasing actual measurement stations.

Figure 5.4.5 Strategic Approach: Information Base

5.5 IDMP Elements

IDMP TT unpackaged and repackaged the four categories that resulted from the situation analysis and context; the associated challenges and opportunities; and the stated approaches into IDMP elements, namely:

(1) **Policy, Legal and Regulatory Framework**, to deal in an elaborated manner with the policy part of the first category, expanding on the basis of the stated approach;

(2) **Institutions and Capacity Development**, to tackle institutional and human resources aspects; and

(3) **Irrigation facilities development and management**, to combine information base and natural resources utilization and management.

5.6 Programmes

To address existing challenges and make use of available opportunities, in a strategic manner, IDMP adopted a programmatic approach. Nine (9) programmes, with their identified components, projects[1] and activities have been prepared under the elements, in order to translate the strategic approaches into the actual action plans. Figure 5.6.1 summarizes the strategic approaches and corresponding programmes.

The formulated nine (9) programmes, are; "Irrigation Development Guidelines Formulation Programme (IDGFP)", "National Irrigation Scheme Development Programme (NISDP)", State Irrigation Scheme Development Programme (SISDP)", "County Irrigation Scheme Development Programme (CISDP)", "Community Irrigation Farms Development Programme (CIFDP)", Private Sector Irrigation Investment Promotion Programme (PSIIPP)", "Human Resource and Institutional Development for Irrigation Programme (HRDIP)", "Irrigated Agriculture Extension Programme (IAEP)", and "Information Network System Establishment Programme (INSEP)".

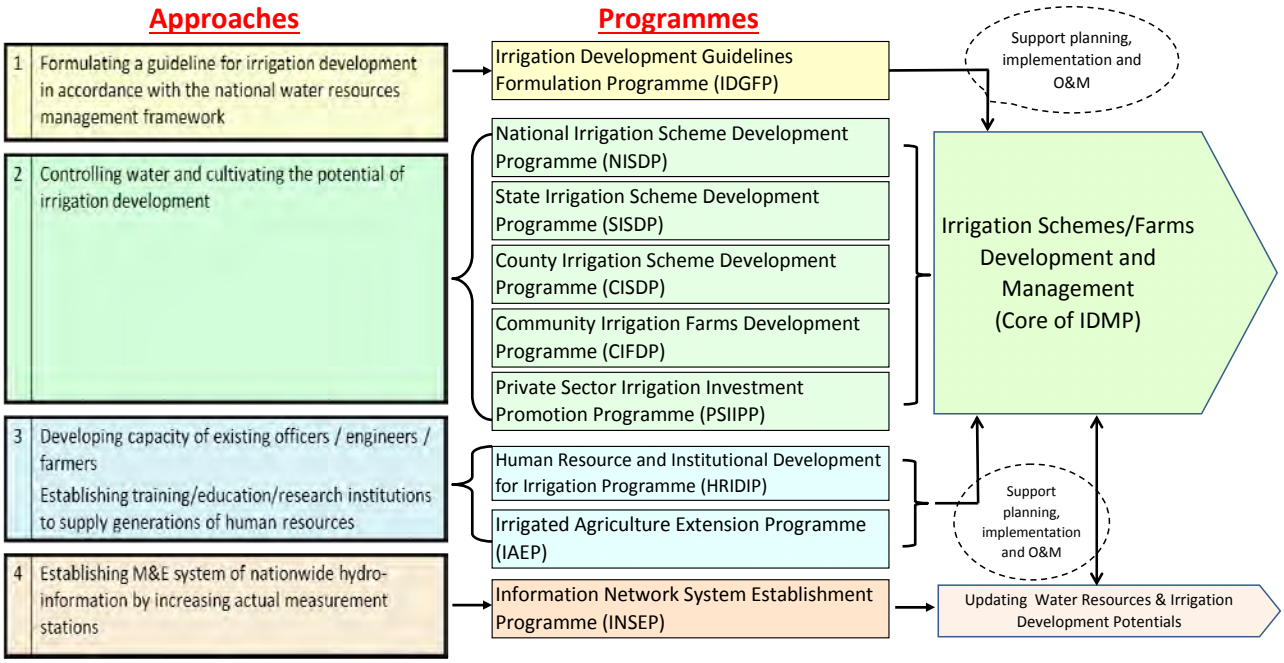


Figure 5.6.1 Strategic Approaches, Corresponding Programmes and their Synergies

Expanding irrigation area is literally the way to achieve the strategic goals of IDMP and therefore the programmes to develop irrigation schemes and farms, namely NISDP, SISDP, CISDP, CIFDP and PSIIPP are the core of the nine (9) programmes. Then the other four (4) programmes are defined as supportive programmes, to support planning; implementation; and operation and maintenance of the schemes/farms. These programmes are meant to make synergy effects in implementing simultaneously. Irrigation schemes/farms development will be carried out according to the irrigation development guidelines.

Human Resource and Institutional Development i.e. capacity development of human resources (training of staff/professionals/technicians/farmers) along with establishment of training/education/research institutions; and Irrigated Agriculture Extension i.e. hands on operation and maintenance, will be aligned to schemes/farms development. The Information Network System Establishment will provide information for planning the schemes/farms and for updating water resources and irrigation development potentials.

[1] Projects are adopted from the CAMP sub-sectors' lists, in addition to submission by states, counties and communities; and the regional joint programmes and projects.

5.7 Organisations Involved and Delineation of Responsibilities

Participation by stakeholders at the critical stages of planning, decision-making, resources mobilisation, execution, monitoring and evaluation is necessary to ensure realisation of the projected outcomes. Promotion of wider stakeholder involvement builds mutual trust between various players; therefore, a crucial step for the start of buying-in is cultivating ownership; and ensuring successful and sustainable implementation. Different types of participants and their roles, including through consultation, approval process; supervision; coordination; reporting; and different means of contributions are demonstrated in the matrix below.

Table 5.7.1 Organisations Involved and Delineation of Responsibilities

Code	Type of programme/ project	Roles and Responsible Organizations				
		National Government/DPs	State Government /DPs	County or LG/DPs	Community/DPs	Private Sector
01	National programme/project (Nationally planned and nationally implemented)	・Planning ・Financing ・Implementation ・M&E	・Coordination ・M&E	・Coordination ・M&E	・Contribution ・Coordination ・M&E	
02	National-State programme/project (Jointly planned and implemented by national and state governments)	・Planning ・Financing ・Implementation ・M&E	・Planning ・Financing ・Implementation ・M&E	・Coordination ・M&E	・Contribution ・Coordination ・M&E	
03	State programme/project (Planned and implemented by state government)	・Technical support ・Coordination ・M&E	・Planning ・Financing ・Implementation ・M&E	・Coordination ・M&E	・Contribution ・Coordination ・M&E	
04	State-County programme/project (Jointly planned and implemented by state and local government)	・Technical support ・Coordination ・M&E	・Planning ・Financing ・Implementation ・M&E	・Coordination ・M&E	・Contribution ・Coordination ・M&E	
06	County-Community programme/project (Jointly planned & implemented by local government & community)	・Technical support ・Coordination ・M&E	・Technical support ・Coordination ・M&E	・Planning ・Financing ・Implementation ・M&E	・Initiative ・Identification ・Planning ・Financing ・Implementation ・M&E	
07	Community programme/project (Planned and implemented by community)	・Technical support ・Coordination ・M&E	・Technical support ・Coordination ・M&E	・Technical support ・Coordination ・M&E	・Initiative ・Identification ・Financing ・Implementation ・M&E	
08	Private sector project (Initiated and implemented by private sector)	・Coordination ・Facilitation ・Supervision ・M&E	・Coordination ・Facilitation ・Supervision ・M&E	・Coordination ・Facilitation ・Supervision ・M&E	・Coordination ・Contribution ・M&E	・Planning ・Financing ・Implementation ・M&E

5.8 Linkage between IDMP and CAMP

In line with CAMP, IDMP will continuously provide information on hydrometeorology, topography, land use and other engineering aspects pertaining to water control and delivery infrastructure at some farming, aquaculture, forestry and livestock projects'/schemes' sites.

The information network system establishment programme will ensure standardized nation-wide monitoring and forecasting of water resources occurrence and other related data. This will continuously inform water users and managers, in taking informed decisions, e.g. in relation to early warning systems in case of droughts, floods and other climate variability scenarios.

Thus supporting agricultural production and productivity is an ultimate goal in the assessment and management of water resources in South Sudan, without jeopardising the needs of the other sectors.

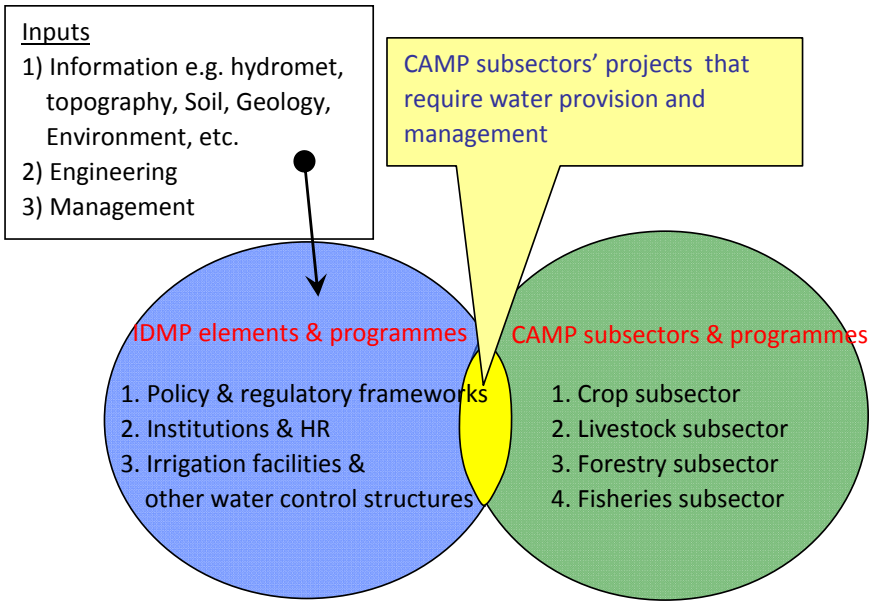


Figure 5.8.1 Linkage between IDMP and CAMP

References

i. Comprehensive Agriculture Master Plan (CAMP), 2015, *CAMP Final Report*, May 2015.

CHAPTER 6 PROGRAMMES

6.1 Overview

To address existing challenges and make use of available opportunities in a strategic manner, IDMP adopted a programmatic approach. Nine (9) programmes, with their identified components, projects[1] and activities have been prepared under the elements in order to translate the strategic approaches into the actual action plans.

6.1.1 Outline of the Programmes

As described in Chapter 5 (the IDMP Strategic Framework), nine (9) programmes have been identified to achieve the strategic goals of irrigated agriculture and other productive uses of water without jeopardising needs of the other sectors across the country at all levels. The following tables summarise the outline of each programme for which details are shown in the Programmes' Profiles (Annex 6).

Among the nine (9) programmes, in relation to physical establishment, the programmes pertaining to "Irrigation Scheme/Farm Development Programmes" are defined as "five (5) with different ownerships, namely: national irrigation scheme; state irrigation scheme; county irrigation scheme; community irrigation farms; and private sector irrigation investment promotion. The other four (4) programmes as "Soft Component Programmes", namely: "irrigation development guidelines formulation, irrigated agriculture extension, human resources and institutional development and information network system establishment" to enhance and promote development and management of the irrigated agriculture and other productive uses schemes/farms efficiently and effectively.

Table 6.1.1 Outline of the Programmes: Irrigation Scheme/Farm Development Programmes

Programme	ID	Outline
National Irrigation Scheme Development Programme (NISDP)	02	To establish Irrigation Schemes by the National Government as the main owner and operator of irrigation facilities. The Programme covers the irrigation potential areas all over the country.
State Irrigation Scheme Development Programme (SISDP)	03	To establish Irrigation Schemes by the State Governments as main owners and operators of irrigation facilities. SISDP will deal with water delivery and control systems for small to medium scale farming. SISDP covers the irrigation potential areas in all the states and the administrative areas, excluding the areas cutting across their boundaries.
County Irrigation Scheme Development Programme (CISDP)	04	To establish Irrigation Schemes by the County (LG) as the main owner and operator of irrigation facilities. The Programme covers the irrigation potential areas in all the counties, excluding the areas cutting across their boundaries.
Community Irrigation Farms Development Programme (CIFDP)	05	To establish smallholder Irrigation Schemes by the communities as main owners and operators of irrigation facilities. The programme will focus on facilitation and capacity development of communities, to be able to establish small-scale irrigation farms using available and accessible resources. Specifically, the Programme is to provide technical assistance to the community farmers on how to plan irrigation farm development and management and on O&M requirements i.e. on how to perform and carry out good land and water control practices for crops production.
Private Sector Irrigation Investment Promotion Programme (PSIIPP)	06	To formulate a system for providing an enabling environment for private sector investment in irrigated agriculture and other productive uses of water, while complying with relevant policies, laws, regulations and standards. The guiding documents and associated procedures will be periodically reviewed in the course of promoting business enterprises in irrigation development.

Note: ID corresponds to the Programme Profiles

[1] Projects are adopted from the CAMP sub-sectors' lists, in addition to submission by states, counties and communities as well as the regional joint programmes and projects.

Table 6.1.2 Outline of the Programmes: Soft Component Programmes

Soft Component Programme	ID	Outline
Irrigation Development Guidelines Formulation Programme (IDGFP)	01	To develop guidelines for irrigation development and management of irrigation schemes at all levels. Preliminary guidelines will be developed within the master plan and will be updated afterwards.
Human Resource and Institutional Development for Irrigation Programme (HRIDIP)	07	To capacitate human resources (staff/professionals/technicians/farmers) and to establish training/education/research/management/governance institutions, to provide training opportunities and to establish a human resource and institutional development (HRID) monitoring and feedback system. The training can be divided mainly into two categories: on-the-job and off-the-job training. Opportunities of advanced formal education will also be provided for specified technical officers. HRID monitoring and a feedback system will be established for ensuring HRIDIP to be accomplished as expected for ensuring effectiveness and efficiency.
Irrigated Agriculture Extension Programme (IAEP)	08	To develop extension programme for irrigated agriculture and disseminate innovative farming methods to farmers with regards to irrigation, drainage and other water control/conservation measures. Particularly, this programme focuses on the capacity development of farmers for "on-farm water management". Stable water supply and control will enable diversification of crops and improve productivities through good land and water management practices. Therefore, the programme also covers dissemination of innovative farming methods of various crops.
Information Network System Establishment Programme (INSEP)	09	To establish an information network system and measurement facilities by the National Government for hydro-meteorological and land use monitoring, among others. Hydromet information/data measuring stations will be installed at appropriate locations within some river basins/watersheds. A centralized system to collect, analyse and manage data from all the stations will be established to support planning/design, O&M and decision-making.

Note: ID corresponds to the Programme Profiles

6.1.2 Implementing Institutions and their Respective Roles

Among the above nine (9) programmes, two (2), namely: Irrigation Development Guidelines and the Information Network System will be solely implemented under MEDIWR. The other seven (7) i.e. irrigation schemes/farms development, human resource aspects, institutions and extension/outreach services will be carried out in close collaboration with MAFCRD, MLFI, MTRB and MTII (Figure 6.1.1).

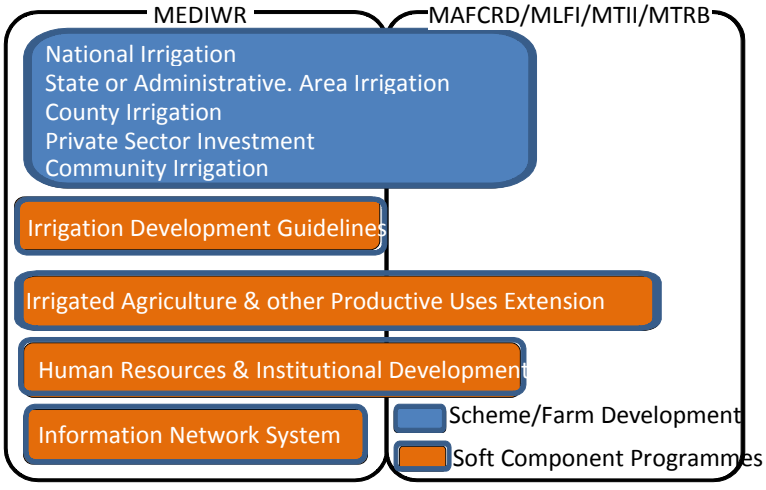


Figure 6.1.1 Division of Responsibilities & Collaborating Implementers

Besides the five (5) GRSS executing ministries, the other stakeholders (government institutions, development partners, other organisations and communities) at all levels will participate at the critical stages of planning, approval process, resources mobilisation, monitoring, evaluation, etc. The figure does not show inclusive division of responsibility and areas of collaborative efforts and joint actions in relation to implementation of the programmes, as collaborations with the other stakeholders on implementation are anticipated. The institutions captured there in, are the ones for which explicit separate budgeting is required, in such a way that there is budget line for a specific programme, project or an activity.

This will make it simpler and clearer, to trace line of responsibility, in accounting for or allocating/contributing resources; and in performing duties. For instance, as portrayed in section 5.8 (relation between IDMP and CAMP) of Chapter 5 (the framework), if the scheme/project development programme is prioritized and designed according to the water use, which can be related to livestock subsector projects in CAMP. In this case, the collaboration and apportionment of roles and responsibilities between MEDIWR and MLFI is required for the implementation accordingly, right from the beginning and after the national budget preparation; and with the concerned stakeholders, as well, from the start of planning and resources mobilisation.

It was first assumed that among the scheme/project development programmes, the national, state and county irrigation schemes will be mainly under the responsibility of MEDIWR & MAFCRD; and the private sector irrigation investment promotion will additionally involve MTII. Regarding the community irrigation farms development programme, the main activity of this programme will be technical assistance by MAFCRD & MEDIWR on planning, design, implementation and setting up of an O&M system; in addition to providing extension and outreach services to the farmers/communities periodically or routinely.

Furthermore, as integration between the CAMP subsectors at the scheme/farm level has been emphasised during the stakeholders' consultation and technical committee meetings, MLFI will take part where appropriate, as well as MTRB on the feeder roads, linking schemes/farms to main roads and markets. Among the soft component programmes, the irrigation development guidelines formulation programme and the information network system establishment programme will be undertaken by MEDIWR, in consultation with the other stakeholders including MoE, MGCSW, MAFCRD, MLFI, DPs, Private sector, etc., so as to incorporate the concerns and needs of all the involved organisations into the guidelines.

As for human resource and institutional development for the irrigation programme; and irrigated agriculture extension programme, to a greater extent both will be implemented jointly by MEDIWR and MAFCRD and with involvement of MLFI as well where appropriate. The programme includes the capacity development of irrigation (water control) technicians, agricultural extension workers, irrigation and agricultural engineers, agronomists and farmers in addition to establishment of irrigation schemes management boards, water harvesting and storage facilities management committees and water users' associations. The CAMP/IDMP implementation coordination mechanism will ensure such different types of collaborations and joint ventures during preparation of the annual work plan and budget (AWPB) of the ministries concerned.

6.1.3 Classification of Irrigation Schemes/Farms

The programmes include construction of physical infrastructure for irrigation, i.e. national, state, county, community and private sector investment irrigation schemes'/farms' systems. Irrigation projects under these programmes should be differentiated by size, mode of investment, and definition of ownership as well as the ability and extent of responsibility for a stakeholder to make the investment; and to carry out other related interventions and to perform associated duties in irrigation development and management, as efficiently and effectively as possible.

Table 6.1.3 summarises the classification of the programmes and projects in addition to the assignment of roles and responsibilities among organisations and stakeholders involved.

Table 6.1.3 Classification of the Programmes and Projects

Programme	Scheme/ Farm Size	Definition	Responsible Organization for Land Allocation	Ownership	Technical Assistance	Capital Investment i.e. funding source for implementation	O&M (Short-term)/a	Supervision of Scheme/Farm Management (Short-medium term)/b
National Irrigation Scheme Development Programme (NISDP)	500 ha or more	Large scale	National/ Community	Land property acquired by National Government	National/ DPs	National/Private Sector (Bank)/ International Development Bank/DPs (grant)	National/IB/ WUA	National
State Irrigation Scheme Development Programme (SISDP)	Up to about 500 ha	Medium scale	State/ Community	Land property acquired by State Government	National/ DPs/	State/ National/ Private Sector (Bank)/ International Development Bank/DPs (grant)	National/ State/IB/ WUA	State/ National
County Irrigation Scheme Development Programme (CISDP)	Up to about 200 ha	Small scale	County/ Community	Land property acquired by Local Government	National/ State/DPs	County/State/ National/ Private Sector (Bank)/DPs (grant)/ NGOs	National/ County/IB WUA	County/ State/ National
Community Irrigation Farms Development Programme (CIFDP)	Up to about 200 ha	Small scale	Community	Land property acquired by Community group	National/ State/ County/ DPs/ NGOs	Community/County/State/National/ Private Sector (Bank)/DPs (grant)/ NGOs	National/ State/ County/ Community/ IB/WUA	Community/ County/State/ National
Private Sector Investment Promotion in Irrigation Development Programme (PSIPIDP)	Undefined	Undefined	National/ State/County/ Community	Land property acquired by Private Sector Organization	Private Consultants/ Government Facilitation	Private Sector, Government Support and Community Contribution	Private Sector WUA, IB, BW & C/SC	Private Sector

Note:
a/ Operation and maintenance of irrigation schemes/farms could transfers to Irrigation Boards (IBs), Waters Users' Associations (WUAs), Farmers, in medium to long-term, depending on their capabilities.

b/ Supervision of scheme/farm management could transfers to states' governments, local governments and community development committees in the long-term, depending on their capabilities.

As demonstrated above, the scale of the irrigation schemes/farms is also defined to categorise the programme, i.e. large-scale or upper medium irrigation schemes would be developed by the national government; whereas state and county governments would deal with lower medium to small-scale schemes/farms. Depending on the objective, in some strategic areas, the national government will deal with the schemes/farms no matter how big or small is the size. Capital investment is another criterion of classification, e.g. the main investor for the national, state and county irrigation schemes/farms should be the national, state and local governments respectively. Community/smallholder irrigation farms should basically be established through community investment.

The government (national/state/county), development partners and implementing partners (e.g. NGOs) are to give technical assistance, so that the communities can develop irrigation farms (including horticulture and timber production) in addition to aquaculture and animal husbandry projects according to their capacities. The scale can be small, so that it is manageable and sustainable by the community.

The ownership of an irrigation schemes/farms should correspond to the respective programme government level at which the land property is acquired, although the land itself may be on leasehold basis from the communities as owners or from the government as a custodian. The ownership or a leasehold agreement of the land will be the basis for compensation obligation resulting from the establishment of an irrigation scheme/farm and the related operations/activities.

In the short-term, operation and maintenance (O&M) in the national, state and county irrigation schemes/farms are considered a joint management responsibility between water users association (WUA), i.e. farmer beneficiaries; subsector governance organisations such as irrigation boards; and the government at respective levels of each category of the programme. Usually, the government side and an irrigation board would be responsible for the O&M of head-works (pumping stations, barrages, weirs, settling basins, etc.); and conveyances (main and secondary canals). The WUA would be responsible for water control gates and distribution canals; and on-farm water management among individual farmers.

In the medium- and long-terms, the degree of the government side and the irrigation boards' responsibility at each level could gradually reduce and more could be shifted to WUAs as their capacity develops. As for community irrigation farms, the farmer beneficiaries in the community would be solely responsible for O&M. However, to safeguard the overarching and strategic goals and objectives of the IDMP, in all cases, the government at a given level will continue with the supervision of schemes/farms management in the short, medium and long-term, based on appropriate competences.

6.1.4 Implementation Process

According to the irrigation development potential, the irrigation schemes/farms area will be identified and the planning, design and investment will be facilitated.

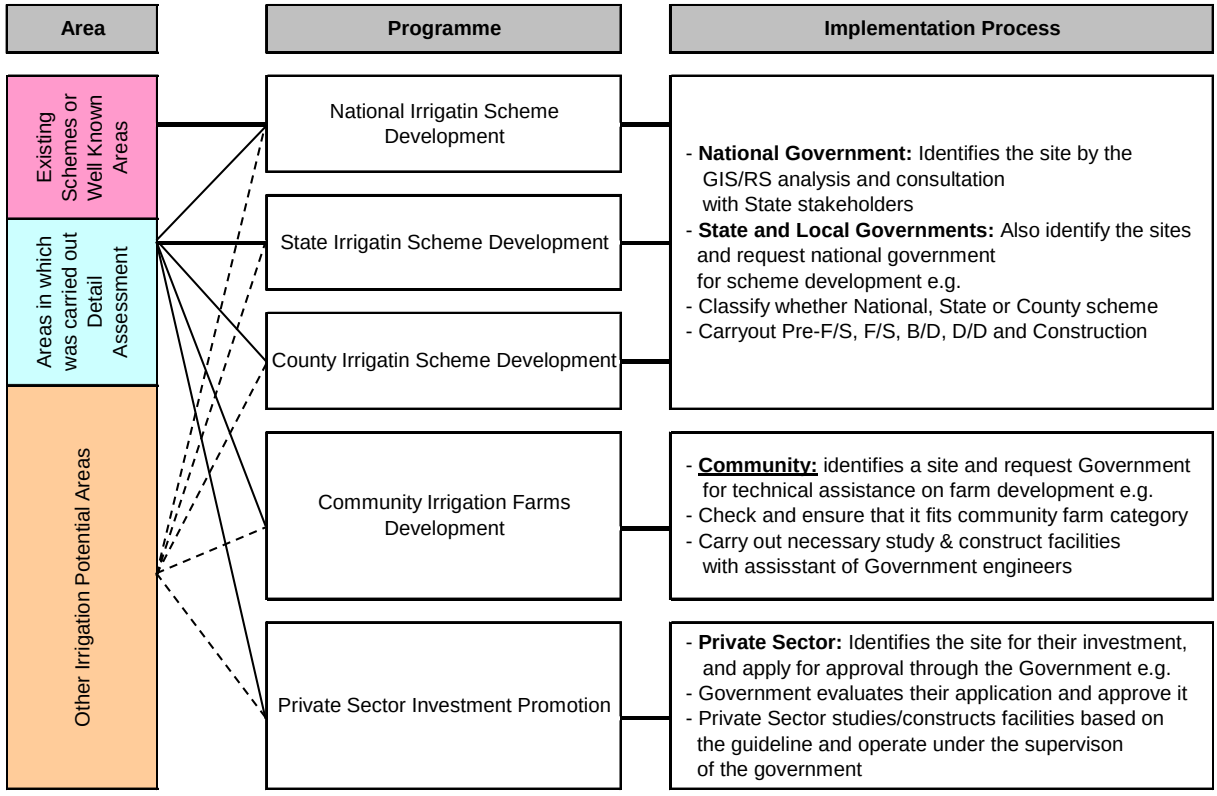


Figure 6.1.2 Implementation Process of the Programmes

The process of identification of an irrigation development area and the decision of investment and implementation would differ by the category of the programme. The national government, namely MEDIWR would help in the identification of irrigation scheme areas except for the community irrigation farms and the private sector investment areas. For this purpose, results of irrigation development potential assessment under IDMP will be used; and based on the schemes'/farms' classification criteria, it will be decided which level of the government should be the main player.

The IDMP documents should be accessible to all government institutions at all levels as well as the communities and private sector, so that the states and counties can also come up with requests for schemes development using the IDMP document.

The community can also find out possible sites for irrigation farms and request for technical assistance from the government. The government side should be equipped with the capacity of irrigation promotion and outreach services, which will be developed through the Human Resource and Institutional Development for Irrigation Programme (HRIDIP) and extended through the Irrigated Agriculture Extension Programme (IAEP). The Irrigation Development Guidelines Formulation Programme (IDGFP) should clearly define the difference between programmes and their implementation process accordingly.

(1) Implementation Matrix by Programmes' Activities

The strategic programmes will be implemented stage-by-stage in short, medium and long-term. Also the volume of implementation will be adequate enough, so as to achieve the strategic goals. Table 6.1.4 below summarises implementation of the programmes by time horizon.

Table 6.1.4 Programmes Implementation Matrix by Time Horizon

S/#	Programme	Short-term (2015/16-2021/22)	Medium-term (2022/23-2027/28)	Long-term (2028/29-2039/40)
1	Irrigation Development Guideline Formulation Programme (IDGFP)	• Guideline formulation based on the preliminary ones formulated during IDMP	• Revision of guideline	• Revision of guideline
2	National Irrigation Scheme Development Programme (NISDP)	• Implementation of priority area • F/S for schemes in priority watershed • High resolution analysis in other watershed	• Implementation of priority schemes • F/S for schemes in priority watershed • High resolution analysis in other watershed	• Implementation of priority schemes • F/S for schemes in the watershed with high resolution analysis done
3	State Irrigation Scheme Development Programme (SISDP)			
4	County Irrigation Scheme Development Programme (CISDP)			
5	Community Irrigation Farms Development Programme (CIFDP)	• Pilot (Model) project Implementation	• Expansion of implementation	• Expansion of implementation
6	Private Sector Irrigation Investment Promotion Programme (PSIIPP)	• System and guideline formulation • Promotion of private sector investment	• Revision of system • Promotion of private sector investment	• Revision of system • Promotion of private sector investment
7	Human Resource and Institutional Development for Irrigation Programme (HRIDIP)	• Training programme • Training centre establishment	• Training programme • Monitoring and feedback	• Training programme • Monitoring and feedback
8	Irrigated Agriculture Extension Programme (IAEP)	• Pilot (model) project in relation to CIFDP • Extension to the irrigation farms/schemes	• Extension to the irrigation farms/schemes	• Extension to the irrigation farms/schemes
9	Information Network System Establishment Programme (INSEP)	• Planning & designing the measuring, M&E system • Strengthening function of the centre	• Establishment of measuring stations • Establishing the information network and M&E system	• Renewal of water resources potential assessment

For the short term, guidelines for irrigation development and capacity development, etc. will be developed and pilot implementation will start. Then the expansion of the activities will follow for the medium and long-terms. Irrigation schemes/farms development will start with the feasibility study (F/S) of the priority project areas. After the F/S, necessary steps, including basic and detail designs will follow to make actual implementation of physical works possible. In the meantime, the high resolution analysis for irrigation development potential analysis is proposed to continue, to identify the potential schemes/farms development areas. The implementation will subsequently be expected for the medium and long-terms.

Irrigation development guidelines will be reviewed and updated based on the actual experiences with irrigation projects and after promulgation of laws and regulations related to water, land use, environment, etc. Figure 6.1.3 below illustrates the programmes from the viewpoint of the implementation process, i.e. how irrigation schemes/farms would be categorised and put into the time horizon. An area to be put into irrigation scheme/farm development will be allotted a timeframe along the IDMP time horizon based on the degree of information a given area. As the figure shows, firstly IDMP carried out the rapid irrigation potential assessment, covering all the land of South Sudan.

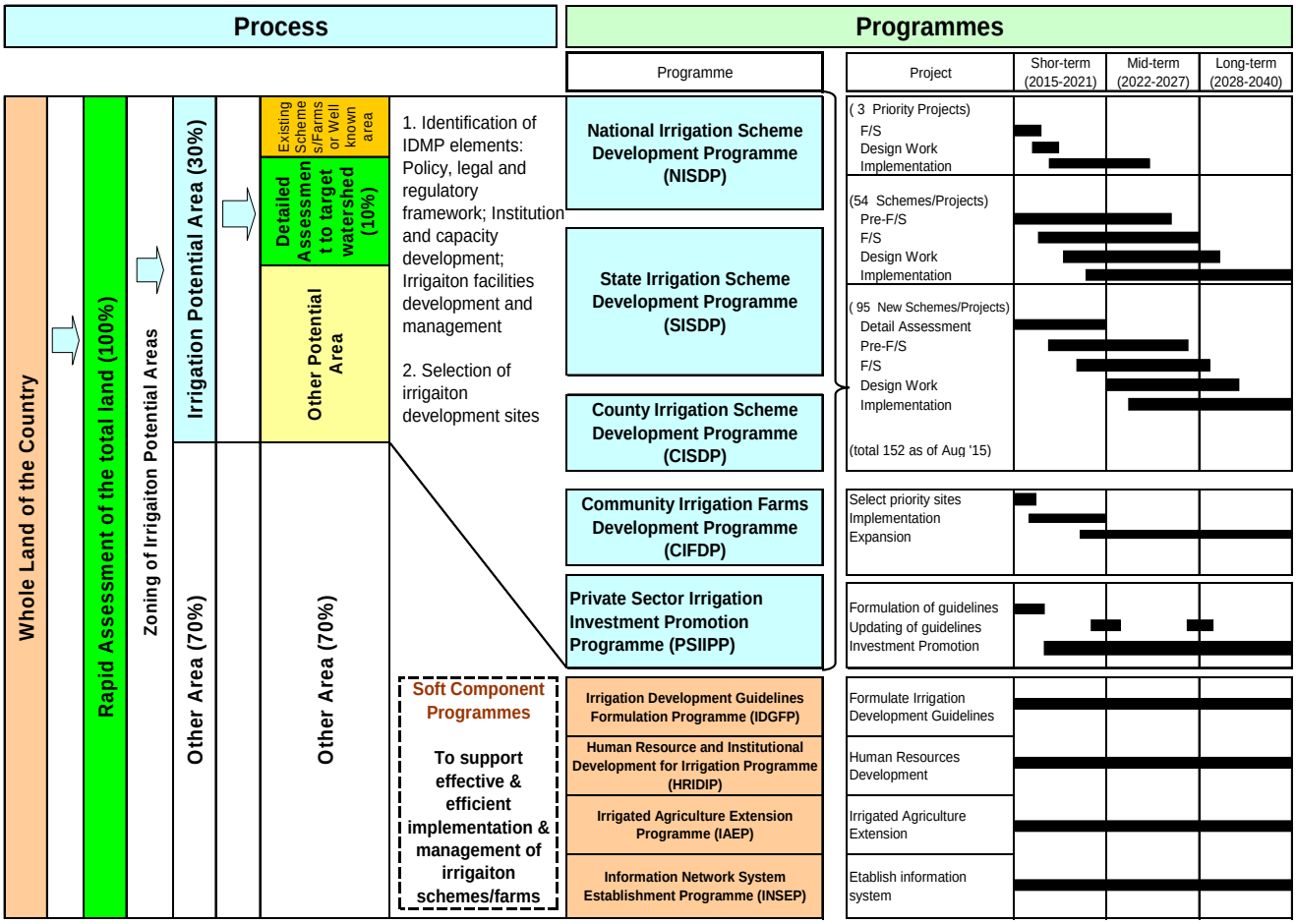
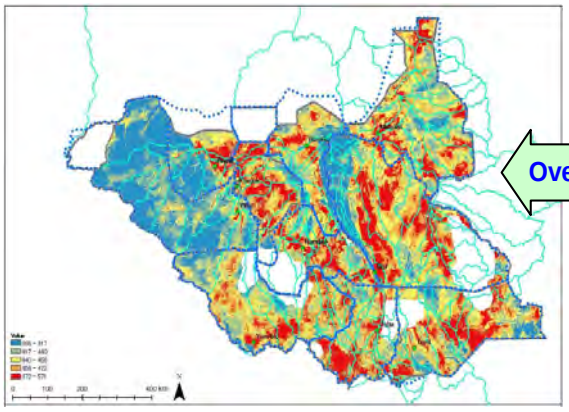


Figure 6.1.3 Implementation Horizon according to the Degree of Information Available

During the IDMP formulation process, 1) High potential areas (10% of national land) was identified through 2) land productivity, social-economic & 3) surface water resources potential assessments.

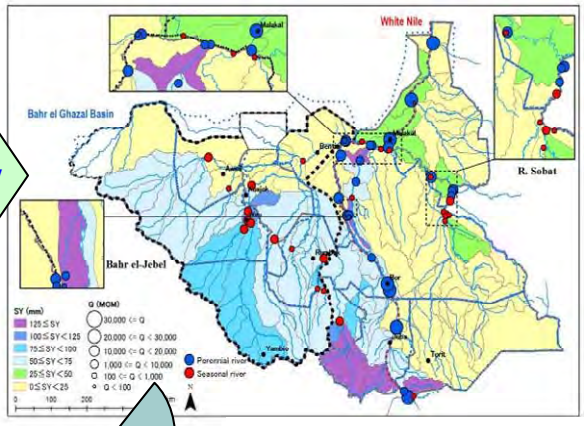
Then, 4) priority projects were selected by considering well-known potential areas such as; Aweil (AIRS), Renk (NUNIS), Wau, Rejaf East, Lafon, Kapoeta and so on even under JICA security regulation.

During the implementation of IDMP, 5) irrigation schemes proposed in consultation with state governments will be prioritized by following selection criteria shown in Chapter 2 of this document (Main report) and irrigation development guideline 3 (Annex 5) in IDMP formulation process. The guidelines and criteria will be updated periodically according to RSS natural and socio-economic conditions. Those irrigation schemes should be categorized with topographical characteristics of each scheme location and their irrigation modes will be decided by using 6) the Zoning Map for Irrigation Development.



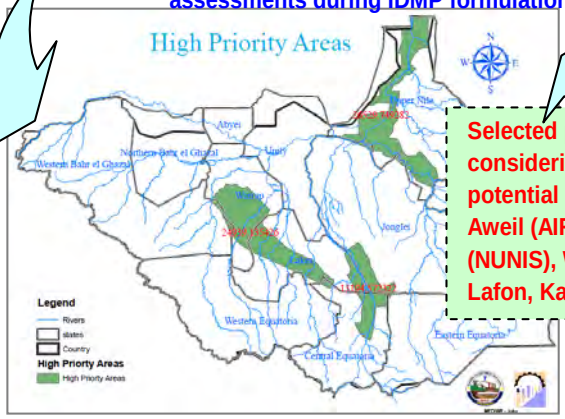
2) Land Productivity+Socio-economic Potential Map

Overlay



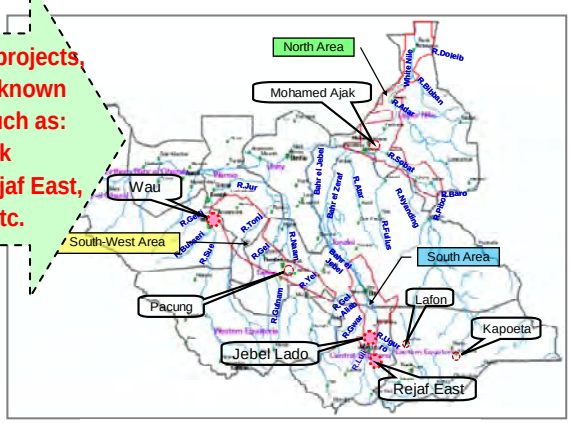
3) Surface Water Potential Map

High potential area was determined through land productivity, socio-economic & water resources assessments during IDMP formulation.



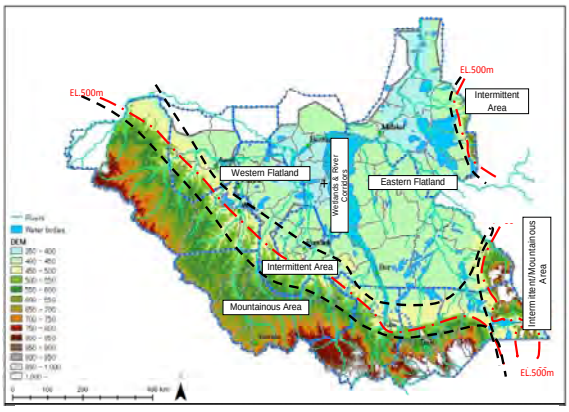
1) High Potential Area (10% of the Country)

Selected priority projects, considering well-known potential areas such as: Aweil (AIRS), Renk (NUNIS), Wau, Rejaf East, Lafon, Kapoeta, etc.



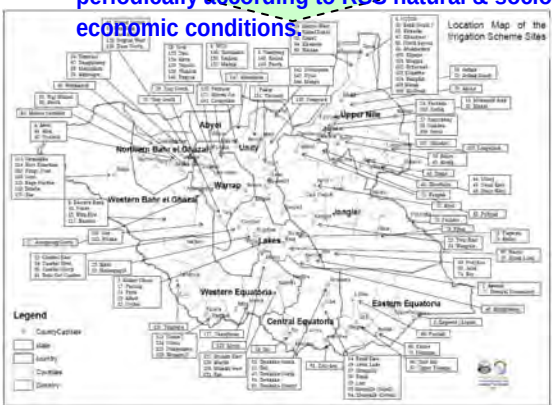
4) Selected Priority Projects' Areas (Wau, Jebel Lado & Rejaf East)

To be prioritized irrigation schemes by using Chapter 2 of Main report , irrigation development guideline 3 (Annex 5) & by following selection criteria prepared during IDMP formulation process. The guidelines & criteria will be updated periodically according to RSS natural & socio-economic conditions.



6) Zoning Map for Irrigation Development

To be categorized according to topographical characteristics of each scheme location and their irrigation models/modes will be decided by using the Zoning Map.



5) Irrigation Schemes proposed in Consultation with State Governments (152 Schemes as of August 2015)

Figure 6.1.4 IDMP Formulation, Identification, Selection, Prioritisation & Categorization Process for Implementation

(2) Implementation Horizon by Projects' Activities

Eventually the lands of South Sudan have been categorised into 1) priority projects' areas (pre-F/S areas), 2) detailed assessment areas (high resolution analysis areas) + existing schemes/farms and the well-known potential areas, and 3) irrigation potential areas (rapid assessment areas) from the irrigation development point of view. In this IDMP document, pre-F/S documents of the priority projects' areas are included. Then the next step (F/S: Feasibility Study, B/D: Basic Design & D/D: Detail Design) can start from the beginning of the short-term and the implementation is expected to start from the onset of the medium term.

In the detailed assessment, existing and well-known areas, the areas for irrigation schemes/farms development have been identified and therefore, pre-F/S will be the next step. The first implementation from this category of land is expected in the course of the medium term. Then for other irrigation potential areas, depending on the accessibility to the sites, detailed assessment could firstly be carried out and the identification of the schemes and subsequent studies would be followed.

The Community Irrigation Farms Development Programme (CIFDP), as it would be on a small-scale and investment will be by or through communities; it can start with pilots in the short term, followed by nationwide dissemination and putting in place technical assistance for capacity building and management supervision. The IAEP can also be implemented with the commencement of CIFDP implementation to offer outreach services to farms/farmers along with the development of community irrigation farms and the irrigation schemes associated with the various levels of government. The other soft component programmes will also continue in line with the development of physical irrigation development from short to long term.

(3) Synergy Effects of the Programmes Implementation

In order to efficiently and effectively implement the programmes, prioritization and synergy effects among the programmes in cooperation with CAMP projects are taken into consideration. The following are proposed as the priority components of the programmes in the short-term:

1. It is proposed to conduct feasibility study, basic design & detail design, and implementation of the priority projects, the pre-feasibility studies of which have been completed, as the National Irrigation Scheme Development Programme (NISDP). The priority sites are Jebel Lado, Rejaf East and Wau.

2. Formulation of Irrigation Development Guidelines (IDGFP): preliminary guidelines have been prepared during the IDMP formulation, and these guidelines should be improved and updated to full-scale along with the promulgation of the draft Water Bill and other related laws and regulations. Feedback from the practice of the priority project implementation and pilot projects below shall be continuously incorporated into the updating and formalization process of the guidelines.

3. Detailed assessment (high resolution analysis) of the irrigation potential area: IDMP completed 10% of the whole country's land for detailed irrigation development potential assessment. In the meantime of proceeding with the implementation of priority projects, high resolution analysis can be carried out under the National Irrigation Scheme Development Programme (NISDP).

4. In close collaboration between MEDIWR, MAFCRD, MLFI, MTRB and MTII, the five (5) GRSS executing ministries, pilot implementation of the Community Irrigation Farms Development Programme (CIFDP) together with the Irrigated Agriculture Extension Programme (IAEP) will be adopted into practice under the coordination of the CAMP/IDMP implementation mechanism. Identification of community smallholder irrigation farms (including horticulture and trees

plantation); and aquaculture and livestock husbandry projects would be carried out with the help of agriculture, forestry, fisheries and livestock extension officers, together with water engineers as well as developing small-scale irrigation farms, fish farming and animal husbandry. Extension and outreach activities for irrigated agriculture and other productive uses will be practiced. In the course of piloting activities, extension and outreach service delivery manuals will be developed for disseminating and replicating the pilots. The other stakeholders (government institutions; and development and implementing partners) at all levels will participate at the critical stages of the projects, especially during planning, resources mobilisation and implementation.

5. **Strengthening the functioning of the information base:** During the IDMP process, hydromet measuring and data collection stations, including weather and sedimentation data have been installed at the priority project sites. These hydromet stations will be incorporated into the nationwide Information Network System Establishment Programme (INSEP). The functioning of the existing WASH/Water Information Management System (WIMS) centre in Juba should be strengthened by practicing data collection and analysis using these new stations and existing measuring stations. Data and results should be accumulated and stored (database building), to enable production/issuance of relevant information materials from the database.

After the implementation of the prioritized activities, it is expected to have more information than the onset of the IDMP implementation for prioritizing development of irrigation schemes/farms for the mid- and long-term periods. The information includes the outputs of the detailed assessment; updated hydromet and high resolution data/information; and also the progress of CAMP projects implementation. These can help in prioritizing the areas for developing irrigation schemes/farms, i.e. detailed assessment and updated hydromet high resolution information can give more knowledge and tools for identifying the potential irrigation locations.

For instance, areas in which CAMP projects are implemented should be given high priority to provide adequate and necessary information. The activities in the short-term will provide information to effectively and efficiently develop the irrigation schemes/farms. The implementation of the priority projects and the pilot projects of community irrigation, together with irrigated agriculture extension should give enormous lessons from the actual practices, which will improve the planning and implementation for mid- and long-term developments.

The formulation of full-scale irrigation development guidelines will also facilitate the efficient implementation resulting in optimum resources allocation. All the nine (9) programmes will be implemented strategically in consideration of the synergetic effects of the activities. Among the strategies will be by combination as well as concurrent execution, inclusion of the finding of linkages with the implementation of projects identified under CAMP. Irrigation schemes/farms should be developed in a prioritised manner. One of the criteria for prioritization will be the implementation areas of CAMP projects, which require provision and management of water. The irrigation schemes development programmes and community irrigation farms development programme consist of the projects related to CAMP. The areas in which CAMP projects are implemented will be given priority in order to provide the facilities for water control and supply, so that the synergy effects between CAMP and IDMP interventions can be realized.

Irrigation development guidelines will be disseminated immediately after the adoption of the IDMP by the GRSS and during the actual implementation of the irrigation schemes on the ground. The guidelines will contribute to more effective, efficient and impartial implementation of the programmes/projects. Human resources and institutional development will strengthen the implementation capacity of the government, which will accelerate the expansion and multiplication of the projects. Increasing the

number of implemented projects will also accelerate the human resources development and institutional building by providing opportunities for on-the-job training; and by triggering organisational needs.

The information network system establishment will help in revising the irrigation development potential assessment. The water resources potential and prioritisation of the proposed irrigation scheme sites should periodically be revised with the updated hydromet data/information and high resolution maps. Accumulation of long term data and information will enable more accurate water resources, land use/productivity and socio-economic analyses. Thus contributing to more accurate targeting as well as to the planning & designing of water resources harnessing and supply infrastructure. Periodical revision of the water resources in South Sudan with constantly accumulated data and information can also contribute to the consideration of the climate change concerns in regard to water resources development and management. Figure 6.1.5 below illustrates the synergy effects among the programmes.

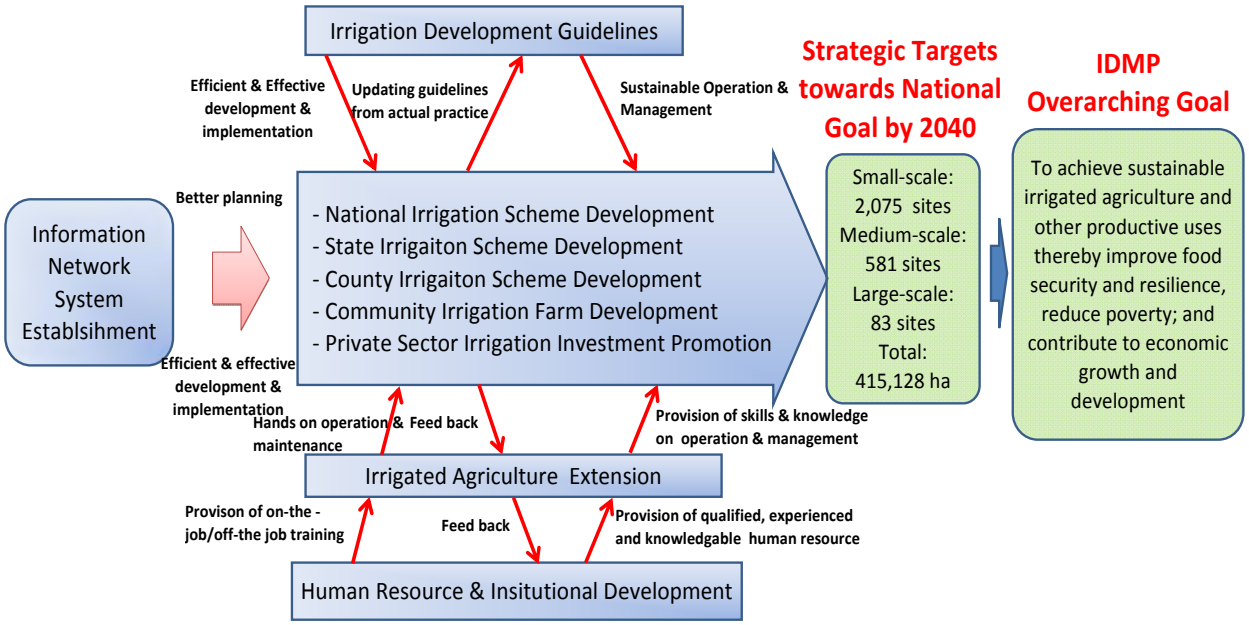


Figure 6.1.5 Synergy Effects of the Programmes Implementation

6.1.5 Major Outputs and Programmes' Costs

Major outputs of the programmes and the costs are estimated mainly based on the results of the priority projects implementation plan described in Chapter 8. Tables 6.1.5 and 6.1.6 summarise the major outputs and costs respectively. The output of the irrigation schemes development is the number of sites. Total targets are 83 large-scale and 581 medium-scale schemes. Average sizes are 750 ha for the large-scale scheme and 250 ha for the medium-scale scheme. Hence the total irrigation development area by medium and large-scale schemes is estimated at 207,500 ha. The cost for these schemes development is an investment cost including intake structures, pumps, canals, land consolidation, etc. O&M cost is not included. The total investment cost up to 2040 for medium- and large-scale schemes is estimated at USD 4.98 billion.

As for the community irrigation farms development, the total target is set at 2,075 sites with average size per site of 100 ha. The cost includes the investment cost and technical assistance. The total cost for the whole period is estimated at USD 4.8 million.

It is noteworthy that based on lessons learned from irrigation developments and current capacity, RSS opted to start with modest sizes in each category of schemes/farms and will gradually expand to reach the international standards.

The major outputs of the other programmes (IDGFP, PSIIPP, HRIDIP, IAEP and INSEP) are developing guidelines, the systems of operation, monitoring & evaluation, and installation of measurement equipment, etc. The total cost for these programmes consisting of equipment and technical assistance is estimated at USD 35.5 million excluding the topographical map development, which alone costs USD 54.55 million. The total cost of the programmes would be USD 5.08 billion including the topographical map development. This amount is within USD 5,222 million of the funding availability, estimated at Section 6.1.6, coming below.

Table 6.1.5 Major Outputs of IDMP

Programme	Short-term (2015/16-2020/21)	Mid-term (2021/22-2027/28)	Long-term (2028/29-2039/40)	Total
Irrigation Development Guidelines Formulation Programme (IDGFP)	Guidelines development	Monitoring & periodical update	Monitoring & periodical update	
National Irrigation Scheme Development Programme (NISDP) State Irrigation Scheme Development Programme (SISDP) County Irrigation Scheme Development Programme (CISDP)	Developing irrigation schemes: 28 sites 3 Large-scale 25 Medium-scale, (8,457 ha)	Developing irrigation schemes: 114 sites 14 Large-scale 100 Medium-scale, (35,402 ha)	Developing irrigation schemes: 522 sites 66 Large-scale 456 Medium-scale, (163,705 ha)	Large: 83 sites Medium: 581 sites (207,564 ha)
Community Irrigation Farms Development Programme (CIFDP)	Pilot project Site establishment 338 sites: 33,827 ha Training Guideline	Site establishment 476 sites: 47,626 ha	Site establishment 1,261 sites: 126,111 ha	2,075 sites 207,564 ha
Private Sector Irrigation Investment Promotion Programme (PSIIPP)	System & Guideline development	Execution of system	Execution of system	
Human Resource and Institutional Development for Irrigation Programme (HRIDIP)	ITC development and operation HRID Monitoring & feedback system establishment and operation	ITC operation and maintenance HRID Monitoring & Feedback system operation and maintenance	ITC operation and maintenance HRID Monitoring & Feedback system operation and maintenance	
Irrigated Agriculture Extension Programme (IAEP)	Pilot project Training / Guideline Extension to irrigation schemes/farms	Extension to irrigation schemes/farms TOT	Extension to irrigation schemes/farms TOT	
Information Network System Establishment Programme (INSEP)	1. Installation of hydromet observation equipment 2. Establishment of hydromet observation system 3. Development of Nationwide high resolution maps (4. Development of Nationwide topographical map)	1. Installation of hydromet observation equipment 2. Improvement of hydromet observation system	1. Installation of hydromet observation equipment	

Table 6.1.6 IDMP Programmes' Costs (000 USD)

Programme	Short-term (2015/16-2020/21)	Mid-term (2021/22-2027/28)	Long-term (2028/29-2039/40)	Total
Irrigation Development Guidelines Formulation Programme (IDGFP)	1,418	7	62	1,487
National Irrigation Scheme Development Programme (NISDP)	202,962	849,660	3,928,910	4,981,532
State Irrigation Scheme Development Programme (SISDP)				
County Irrigation Scheme Development Programme (CISDP)				
Community Irrigation Farms Development Programme (CIFDP)	2,714	585	1,487	4,786
Private Sector Irrigation Investment Promotion Programme (PSIIPP)	722	7	62	791
Human Resource and Institutional Development for Irrigation Programme (HRIDIP)	7,265	2,817	3,426	13,508
Irrigated Agriculture Extension Programme (IAEP)	2,051	137	299	2,487
Information Network System Establishment Programme (INSEP)	8,318	3,360	5,537	17,215
(Topographical map development)	(54,550)			(54,550)
Total	280,000	856,573	3,939,783	5,076,356

(Unit: 000 USD)

6.1.6 Funding Availability Forecast

This section discusses the funding availability based on a public policy scenario as demonstrated in CAMP, in predicting the funds that might be available from the government and development partners in the future.

This approach shows that the selected public policy will determine the associated opportunities for implementation of the IDMP. Prediction of the funding availability was conducted through the following four steps:

1) Confirmation of the government's budget for the water resources and irrigation in 2012/13
2) Estimation of the government's budget for the water resources and irrigation in 2015/16
3) Estimation of the development partner's contribution for the water resources and irrigation in 2015/16
4) Estimation of the total budget for the water resources and irrigation from 2016/17 to 2039/40

(1) Confirmation of the Government's Budget for Water Resources and Irrigation (WR&I)

As the basic unit of the government's budget for IDMP, we applied the approved budget of the then Ministry of Water Resources and Irrigation in 2012/13.

Table 6.1.7 Capital Expenditure of then Ministry of Water Resources & Irrigation (2012/13)

Items	SSP
Use of Goods and Services	5,947,046
Capital Expenditure	27,000,000
Transfers Operating	1,016,550
Total	33,963,596

Source: Approved Budget 2012/13 of the Government of RSS

The basic unit does not include recurrent expenditures, such as salaries; only development expenditures, which allow the government and its employees to carry out activities to develop South Sudan, are included. The next table shows the basic unit was about 34 million SSP.

(2) Estimation of the government's budget in 2015/16

The second step is the estimation of the basic unit in 2015/16. We will project the available fund for IDMP in accordance with the prediction of CAMP; however, the prediction starts from 2015/16, and the latest approved budget is the one of 2012/13, which was presented in the previous Table 6.1.7.

Therefore, the development budget in 2012/13 would be expanded, using the incremental ratio of the GDP between 2012 and 2015, in the below Table 6.1.8 on the assumption that a budget is increased in proportion to a rate of GDP.

Table 6.1.8 Budget Estimation of the Water Resources and Irrigation in 2015/16

Year	GDP Mill. SSP	Fiscal Year	Development budget for water Resources & Irrigation (SSP)
2012	15,232	2012/13	33,963,596
2015	30,577	2015/16	68,266,828
2015/2012	2.01	2015/2012	2.01

Source: IDMP-TT

Those values of the GDP are indicated in the Table 6.1.8: Predicted GDP by crop, livestock subsectors, in the CAMP Annex I: CAMP Investment Plan, May 2015. About 34 million SSP of the development budget in 2012 was expanded to about 68 million SSP.

(3) Estimation of DP's contribution for water resources and irrigation

The third step is the estimation of the donor's budget for the water resources and irrigation.

It would be estimated, using the expenditure ratio of infrastructure between the government and the donors, on the assumption that the donors would provide fund for investment in water resources and irrigation as well in the same way as for the entire infrastructure sector.

Table 6.1.9 Budget Estimation of the Donors for Water Resources and Irrigation in 2015/16

Item	Fiscal Year	RSS SSP	Donor SSP	Total SSP
Expenditure on infrastructure	2012/13	160,216,284	824,589,136	984,805,420
		1.00	5.15	6.15
Budget for WR&I	2015/16	68,266,828	351,574,164	419,840,992

Source: IDMP-TT

The donors' expenditure on infrastructure is indicated in the Approved Budget in 2012/13. About 352 million SSP of the donors' budget for water resources and irrigation was estimated and the total fund became roughly 420 million SSP.

(4) Estimation of the Available Funds from 2016/17 to 2039/40

The last step is the estimation of the total funds for the water resources and irrigation from 2016/17 until 2039/40. The IDMP available funds would be estimated in accordance with the peace dividend scenario of CAMP, which is the most affluent scenario.

Results of the calculation are shown in the table above. From 2015/16 to 2039/40, USD 5,222 million would be available for funding IDMP implementation.

Table 6.1.10 Predicted Funds Available to IDMP under Normal Circumstances

Phase	Fiscal year	Peace Divident Scenario			
		CAMP		IDMP	
		Mill. SSP	2015=1.00	Mill. SSP	Mill. USD
		a	b=a/a(2015)	c=b*c(2015)	d=c/2.95
I	2015/16	377	1.00	420	142
	2016/17	388	1.03	432	147
	2017/18	396	1.05	441	150
	2018/19	404	1.07	450	153
	2019/20	411	1.09	458	155
II	2020/21	419	1.11	467	158
	2021/22	427	1.13	476	161
	2022/23	434	1.15	484	164
	2023/24	442	1.17	492	167
	2024/25	451	1.20	502	170
III	2025/26	460	1.22	512	174
	2026/27	470	1.25	524	177
	2027/28	481	1.28	536	182
	2028/29	494	1.31	550	187
	2029/30	510	1.35	568	193
IV	2030/31	531	1.41	592	201
	2031/32	558	1.48	622	211
	2032/33	593	1.57	661	224
	2033/34	630	1.67	702	238
	2034/35	679	1.80	756	256
	2035/36	731	1.94	814	276
	2036/37	790	2.10	880	298
	2037/38	859	2.28	957	324
	2038/39	916	2.43	1,020	346
	2039/40	977	2.59	1,088	369
Total		13,826	36.67	15,405	**5,222**

Source: IDMP-TT

6.1.7 Outcomes and Impacts of the Programmes

The following Tables 6.1.11 & 6.1.12 summarises the expected outcomes and impacts of the programmes implementation. Irrigation schemes/farms development programmes which will generate outcomes such as mitigation of seasonal and climate variability, productivity enhancement, production increase and creation of job opportunities will lead to impacts such achieving food and nutrition security, enabled agribusinesses and agro-industries and economic growth.

The soft component programmes will create an enabling environment and capacity for efficiently and effectively developing and managing schemes/farms in a sustainable manner and that will safeguard against financial and economic losses.

Table 6.1.11 Outcomes and Impacts of the Programme: Irrigation Scheme Development Programmes

Programme	Outcomes	Impacts
2. NISDP	• Improved land and crop productivity. • Increased income across the country • Reduction of risks and vulnerability of crops production to seasonal and climate variability. • Increase in jobs and enabled entrepreneurs/enterprises.	• Emergence of national agricultural production supported agro-industry and agribusiness. • Improved food and nutrition security nationwide. • Realized contribution by irrigated agriculture to national Gross Domestic Product (GDP). • Realised resilience against seasonal and climate variability
3. SISDP 4. CISDP 5. CSIDP	• Improved land and crop productivity. • Transformation from subsistence farming to surplus production. • Increased income among populations and state governments. • Reduction of risks and vulnerability of crops production to seasonal and climate variability. • Increased in jobs and enabled entrepreneurs/enterprises.	• Improved food and nutrition security. • Reduction in levels of poverty among farmers and populations at state level. • Realized contribution by states to national Gross Domestic Product (GDP). • Realised resilience against seasonal and climate variability at state level.
6. PSIIPP	• Increased number of private or foreign investors exploiting potential irrigable agricultural land. • Increased number of entrepreneurs and enterprises in irrigated agriculture.	• Increased contribution of private sector investment in irrigation to the national GDP (growth domestic products).

Table 6.1.12 Outcomes and Impacts of the Programme: Soft Component Programmes

Programme	Outcomes	Impacts
1. IDGFP	Innovative, effective, efficient and sustainable development and management of Irrigation schemes,	Saving transaction cost comparing with and without the guidelines
7. HRIDIP	• Effective, efficient and sustainable management of the Irrigated schemes • Improved agricultural productivity through water management for crops	• Expansion of the irrigated areas • Job creation
8. IAEP	• Extending the irrigated area by efficient use of water in crop production • Improved agricultural productivity through water management for crops • Job creation • Income generation through increased crops production	• Effective, efficient and sustainable management of the Irrigation schemes • Mitigating water conflict among farms' water users by enlightening and training farmers on on-farm water management
9. INSEP	• Avail information on water resources, to inform water users and managers in taking informed decisions • Avail information for early warning in case of disaster (e.g. drought and flood forecasting) • Avail information, to informed climate change adaptation programmes/projects/activities • More accurate water resources assessment results • Avail information to protect the social and economic infrastructures • Available information to be used in IDMP review	• More efficient use of water resources • Safeguarding against financial and economic losses • Implementation of projects with value for money (cost effective)

6.2 Implementation Aspects of the Individual Programmes

6.2.1 Preliminary Irrigation Development Guidelines

During the IDMP formulation process, preliminary irrigation development and management guidelines have been prepared. These guidelines will be periodically revised and updated in order to make use of the outputs and lessons from actual practices, field experiences and latest information, as the implementation progresses; and in order to align with the upcoming legislations, laws, institutions and regulations. The full text is found in Annex 5.

In the short term, the preliminary guidelines will be updated with the latest information and lessons to be learnt from actual irrigation practice, which is expected to take place through the other programmes, especially the core ones involving physical infrastructure and equipment. Table 6.2.1 below, shows the implementation plan of the programme; and its detailed cost estimate is in Annex 7.

Table 6.2.1 Implementation Plan (IDGFP)

	Common Activity for each Project	1st yr	2nd yr	3rd yr	4th yr	5th yr	after
1	Information Collection						
2	Consultation workshops						
3	Study visits						
4	Development of guidelines						
5	Dissemination workshops						
6	Operation and Monitoring,Periodical Updating guidelines						

6.2.2 National/State/County Irrigation Schemes Development Programmes

These programmes consist of components and projects, hence under each irrigation scheme development programme, there are development projects pertaining to identified irrigation schemes. The name of an irrigation scheme will be used as a project name. The irrigation development schemes have been identified through the irrigation development potential assessment (detail assessment), proposals from the relevant state ministries, and consideration of existing and well-known irrigation potential areas.

Table 6.2.2 shows the number of schemes identified based on these assessment, proposals and considerations. The details are described below and a list of the irrigation schemes is attached in Table 6.2.8 (see Page 6-23 to 6-25).

Table 6.2.2 Projects Identified and Projects to be Identified

Irrigation Scheme Development Project	No. of Site	National	State	County
Priority Projects (Jebel Lado, Rejaf East and Wau)	3	O		
Irrigation schemes identified as existing & well-known potential areas	12	O	O	O
Irrigation schemes identified through detail assessment	42	O	O	O
Other irrigation schemes proposed from States	95	O	O	O

There are also on-going related initiatives in the water sector with the assistance of development partners (see Table 6.2.3 below). These types of water related developmental activities take the form of programmes; and under the IDMP irrigation schemes development programmes, they will be considered as components from which specific projects related to crops, forestry, livestock and fisheries will be derived.

Table 6.2.3 On-going Projects Initiated by the Regional Organisation and Development Partners

Output	National	State	County
NELSAP-MSIOA and ENSAP-MSIOA of NBI	O		
Baro-Akobo/Pibor-Sobat multipurpose water resources study project under ENSAP	O	O	O
Water for productive uses in Eastern Equatoria State with the support of The Netherlands		O	
Water for productive uses in Lakes State with the support of The Netherlands		O	
Nyimur multipurpose water resources management and development project of NELSAP on Aswa in Magwi County, Eastern Eqatoria State	O	O	O

The linkage with CAMP projects will be one of the criteria to prioritize the implementation of the irrigation schemes. The role of irrigation development is to provide and manage water for agricultural development. Therefore, an irrigation scheme development should be prioritized and implemented in relation to the implementation of the related projects of CAMP. Table 6.2.4 summarizes the irrigation scheme development projects from the viewpoint of the linkage with CAMP projects.

For instance, CAMP Project ID01.05 is titled as “Subsistence farmer rice production project”. The project from IDMP to link with this CAMP project is defined as “Provision and establishment of irrigation facilities and systems for rice production in lowlands/plains”. This title will be the sub-title of the irrigation scheme development project, e.g. “Wau Rice Scheme Development Project – provision and establishment of irrigation facilities and systems for rice production in lowlands/plains”.

Table 6.2.4 Projects in Relation to CAMP Proposed Projects

Project from the viewpoint of linkage with CAMP	CAMP Project ID	National	State	County
Provision and establishment of irrigation facilities and systems in collaboration with private sector and communities for rice production in lowlands/plains. Identified locations include:Aweil rice scheme; Wau Rice scheme; Adior Agot Rice scheme; Pagarou Rice scheme	ID01.05	O	O	O
Provision and establishment of irrigation facilities and systems in collaboration with the private sector for oilseed crops production (G/nuts, sunflower, sesame) in semi-arid areas e.g. Renk	ID01.21	O		
Provision and establishment of small scale irrigation facilities and systems for horticulture farming (vegetables and fruits production) in rural areas	ID01.06		O	O
Provision and establishment of small scale irrigation facilities and systems for peri-urban horticulture farming (vegetables and fruits production)	ID01.20		O	O
Provision and establishment of small scale irrigation facilities and systems for maize crop in wet land and river corridors, after recede of floods (drawdown or recession irrigation)	ID01.04			O
Provision, operation and maintenance of dipping and watering facility for livestock at international boarder points. Identified locations include: Nimule, Kaya; Nadapal; War-awar; Wunthou; Jikou;Nasir; Akobo, etc.	ID02.08	O		
Provision, operation and maintenance of livestock watering points along cattle migratory routes within the rangelands. Identified locations are in Jongolei; Eastern Equatoria, Warrap and Lakes states	ID01.14 ID02.08	O	O	O
Provision, operation and maintenance of irrigation facilities and systems for fruit trees productions in cities and major towns	ID01.22	O		
Provision of flood control and drainage infrastructure for sorghum farms	ID01.03	O	O	O

Project from the viewpoint of linkage with CAMP	CAMP Project ID	National	State	County
Provision, operation and maintenance of water for small-scale aquaculture (fishpond) for communities who have no access to natural fishing opportunities. Identified locations are Yei, Morobo, Kajo-keji in Central Equatoria; Nzara, Ezo, Yambio in Werstern Equatoria; Wau in Western Bahr el-Ghazal and Eastern Equatoria has been earmarked for fish ponds but locations are yet to be identified (Lafon, Kapoeta and Parajok)	ID04.07	O	O	O
Restoration of vegetation at water catchments through water and soil conservation constructions (check dams, terraces and etc.), to arrest erosion and prevent siltation in water facilities including reservoirs, canals, etc. Identified areas include Eastern Equatoria water harvesting sites, etc	ID03.03	O	O	O
Provision, operation and maintenance of water facilities for tree nurseries	ID03.02	O		
Provision, operation and maintenance of water and irrigation/dipping facilities for livestock at demonstration farms e.g MarialBai integrated Farm at Wau; and Malakal Dairy Farm, and Central Equatoria Dairy Farm and Central Equatoria Poultry Farm); Kapoeta Sheep ranch	ID02.22	O		
Provision, operation and maintenance of dipping and watering facilities at livestock auction centres at Juba, Wau and Malakal	ID02.16	O		
Provision, operation and maintenance of safe water supply facilities at feed mills, e.g Yei; Renk; Aweil; Wau; Yambio	ID02.13	O		
Provision, operation and maintenance of safe water supply facilities at feed testing and analysis laboratories	ID02.06	O		

(1) Identification of Irrigation Schemes Development Areas

Irrigation scheme development areas have been identified in the irrigation development potential assessment by the IDMP-TT and also in a proposal from the States. As explained in Section 6.2.2, Table 6.2.8 at the end of this section shows the list of the identified and proposed irrigation scheme areas from the high resolution analysis as well as the proposal from the States. The irrigation potential areas well known historically or from other studies were also added to the list. There are 152 areas listed in the Table, but the degree of information differs among them.

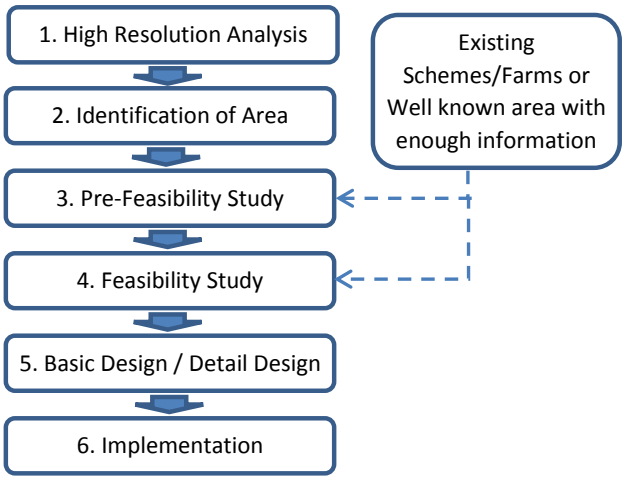


Figure 6.2.1 Step of Implementation

For reaching the actual implementation of the scheme development, the steps are assumed as 1) high resolution analysis, 2) identification of area, 3) pre-feasibility study, 4) feasibility study, 5) basic design/detail design, and 6) implementation. Hence, it is proposed to conduct high resolution analysis or any other means to other areas and identify more irrigation scheme development areas in the future.

The high resolution analysis and pre-feasibility study can be skipped in the areas already known as high irrigation potential areas and the areas with easily accessible information. The prioritization of the scheme development will basically follow the degree of information in each site. As explained below, the first three (3) priority projects' schemes have been identified. For other schemes, implementation steps in short, medium and long-terms have been specified in Table 6.2.7.

The priority of individual schemes will be planned and set in each annual work plan and budget; and M&E and periodical mid-term evaluations will be carried out as described in Chapter 7.

(2) Selection of Priority Project Areas

In the course of IDMP formulation, three (3) priority projects' areas have been identified, based on the maps developed through the high resolution analysis and the pre-feasibility study has been carried out in these priority projects' areas as presented in Chapter 8. These areas are the first targets for the implementation. Hereunder explains how these priority projects areas were selected. Areas including the category of "Irrigated crop land" or "Rainfed crop land" on the high resolution land cover maps were selected as candidates for priority project areas.

However, from the viewpoint of water availability, areas located far from the rivers or other water sources, e.g. which are more than 10 km, were excluded from the candidate areas, even if such areas included "Irrigated crop land" or "Rainfed crop land".

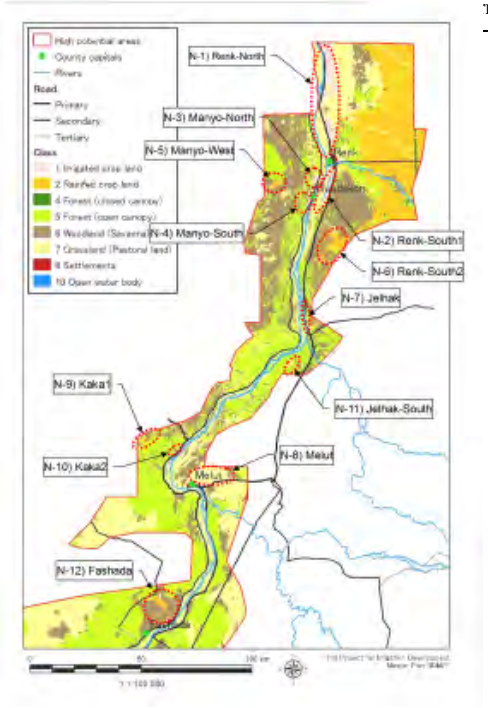
The selected candidate areas were prioritized with scoring criteria. The criteria was developed based on water resources, land productivity and socio-economic, same as the rapid assessment process. In addition to these criteria, existing government plans were also considered as one of the criteria for the selection. Scores of each criterion were ranked from 0 to 5 as shown in Table 6.2.5, below.

Finally 48 areas (North: 25 areas, South: 11 areas and South-West: 12 areas) were selected as candidates for priority project areas as shown Figures 6.2.2 to 6.2.4; and Table 6.2.6.

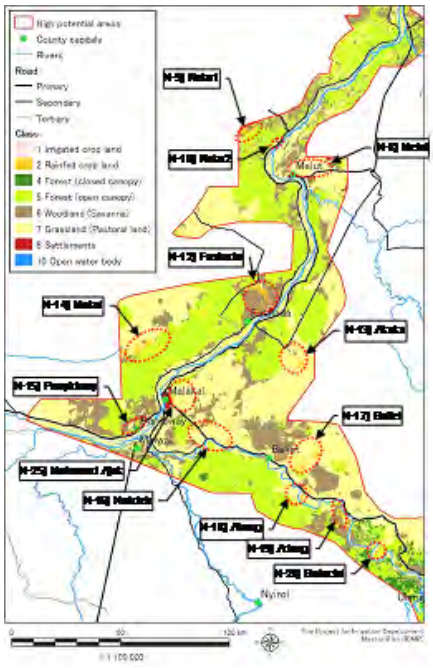
Table 6.2.5 Criteria for Selection

Items				Score
1. Technical (Water Resouce and Land Productivity)	(1) Water Availability	Perennial river		5
		Seasonal River*1	Jur	4
			Yei	3
			Naam, Tonj	2
			Gel	1
			Gulmam	0
	(2) Main Land Cover*2	Irrigated Crop Land		5
		Consolidated Rainfed Crop Land		4
		Fragmented Rainfed Crop		3
		Grass Land & Woodland		1
		Others		0
	(3) Irrigable size	More than 50 Feddan		5
		Less than 50 Feddan		0
2. Socio Economic	(1) Physical accessibility	Road	0 - 10 km	4
			More than 10 km	2
		County Capital*3	0 - 5 km	2
			5 - 10 km	4
			More than 10 km	3
		Water point	0 - 10 km	4
			More than 10 km	2
	(2) Schemes with national Impact (Food security, income generation etc)	High		5
		Moderate		3
		Low		2
	(3) Conflict records over land use	Yes		0
		No		4
3. Government Plan	(1) Proposed/Agreed schemes by RSS Gov (National, State, County)	Yes		4
		No		0
	(2) Previously proposed schemes by Sudan MP, IGAD, NBI etc	Yes		2
		No		0

*1: Score is settled based on annual discharge volume
*2: As for Rainfed Crop Land, Consolidated and Fragmented is judged based on the Land Cover Map.
*3: Since there has possibility to be occupied by residential area in future and become difficult to be farm lands, score of 0- 5km is lower than 5 - 10km .

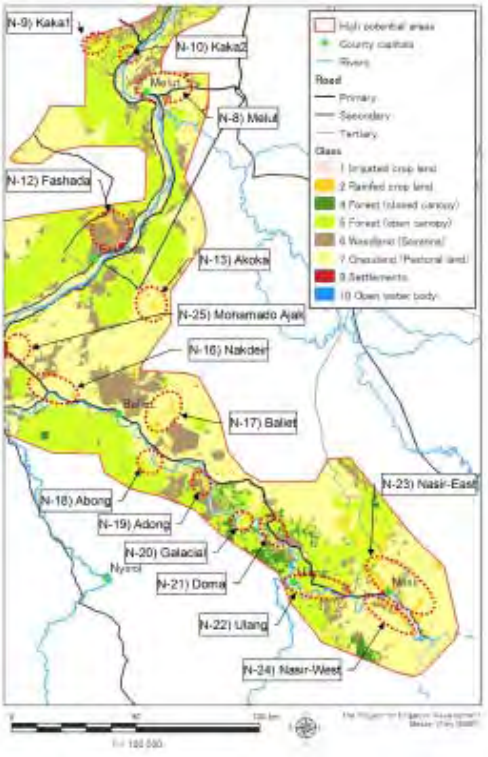


(North Priority Area-1)

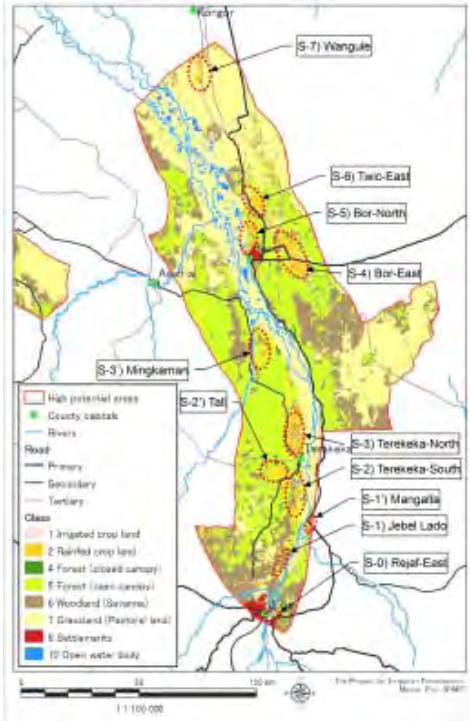


(North Priority Area-2)

Figure 6.2.2 Candidates for Priority Project Areas (1/3)



(North Priority Area-3)



(South Priority Area)

Figure 6.2.3 Candidates for Priority Project Areas (2/3)

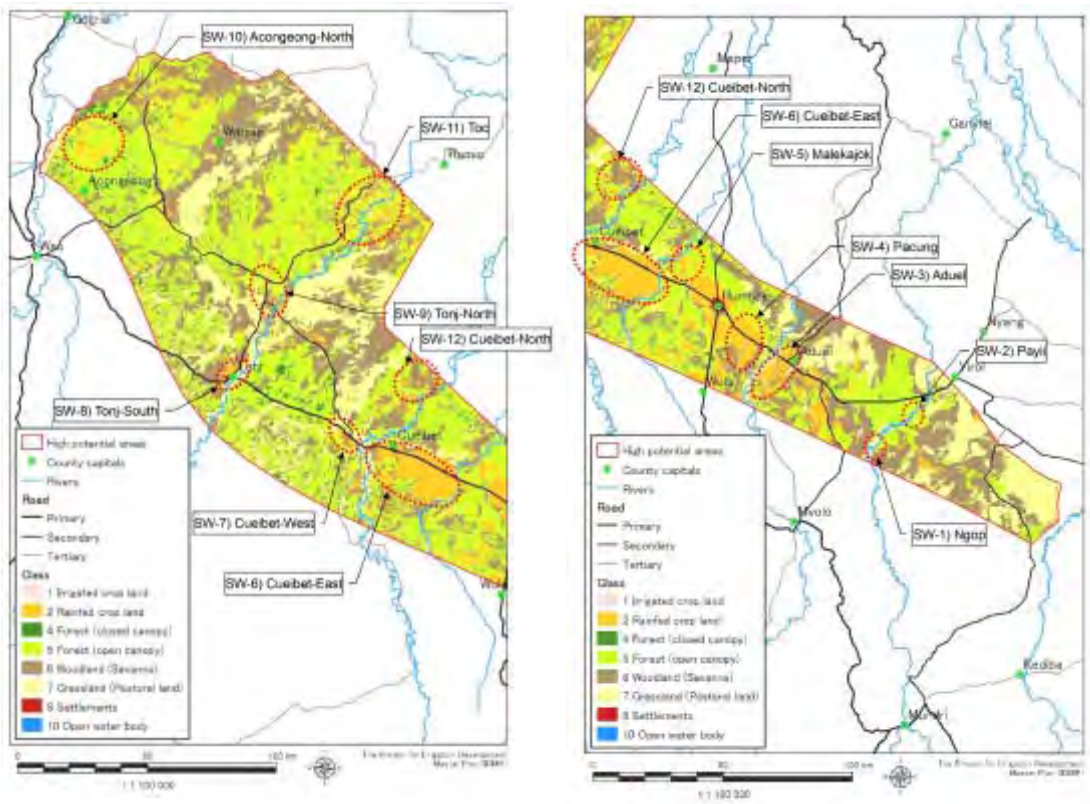


Figure 6.2.4 Candidates for Priority Project Areas (3/3)

Table 6.2.6 Candidates for Priority Project Areas

North Priority Area

No.	Name	State	Command Area (sq.km)	Command Area (ha)	Water Source
N-1	Renk-North	UNS	260	26,000	R.Nile, R.Doleib
N-2	Renk-South1	UNS	40	4,000	R.Nile, R.Doleib
N-3	Manyo-North	UNS	30	3,000	R.Nile
N-4	Manyo-South	UNS	30	3,000	R.Nile
N-5	Manyo-West	UNS	40	4,000	R.Nile
N-6	Renk-South2	UNS	110	11,000	R.Nile
N-7	Jelhak	UNS	20	2,000	R.Nile, R.Bibban
N-8	Melut	UNS	90	9,000	R.Nile, R.Adar
N-9	Kaka1	UNS	40	4,000	R.Nile
N-10	Kaka2	UNS	10	1,000	R.Nile
N-11	Jelhak-South	UNS	50	5,000	R.Nile, R.Bibban
N-12	Fashada	UNS	100	10,000	R.Nile
N-13	Akoka	UNS	70	7,000	R.Nile
N-14	Makal	UNS	120	12,000	R.Nile
N-15	Panyidway	UNS	30	3,000	R.Nile
N-16	Nakdeir	UNS	110	11,000	R.Sobat
N-17	Baliet	UNS	90	9,000	R.Sobat
N-18	Abong	UNS	30	3,000	R.Sobat
N-19	Adong	JS, UNS	40	4,000	R.Sobat
N-20	Galacial	JS, UNS	30	3,000	R.Sobat
N-21	Doma	UNS	50	5,000	R.Sobat
N-22	Ulang	UNS	100	10,000	R.Sobat, R.Nyanding
N-23	Nasir-East	UNS	190	19,000	R.Sobat
N-24	Nasir-West	UNS	80	8,000	R.Sobat
N-25	Mohamed Ajak	UNS	70	7,000	R.Nile
Total			1,830	183,000	

Notes: UNS: Upper Nile State, JS: Jonglei State

South Priority Area

No.	Name	State	Command Area (sq.km)	Command Area (ha)	Water Source
S-0	Rejaf-East	CES	10	1,000	R.Nile
S-1	Jebel Lado	CES	20	2,000	R.Nile
S-1'	Mangalla	CES	10	1,000	R.Nile
S-2	Terekeka-South	CES	70	7,000	R.Nile, Oxbow Lake
S-2'	Tali	CES	40	4,000	R.Nile
S-3	Terekeka-North	CES	60	6,000	R.Nile, Oxbow Lake
S-3'	Mingkaman	LS, CES	60	6,000	R.Nile, R.Gwar
S-4	Bor-East	JS	90	9,000	R.Nile
S-5	Bor-North	JS	40	4,000	R.Nile
S-6	Twic-East	JS	50	5,000	R.Nile
S-7	Wangule	JS	60	6,000	R.Nile
Total			510	51,000	

Notes: CES: Central Equatoria State, JS: Jonglei State, LS: Lakes State

South-West Priority Area

No.	Name	State	Command Area (sq.km)	Command Area (ha)	Water Source
SW-1	Ngop	LS	40	4,000	R.Yei
SW-2	Payii	LS	40	4,000	R.Yei
SW-3	Aduel	LS	120	12,000	R.Naam
SW-4	Pacung	LS	120	12,000	R.Naam
SW-5	Malekajok	LS	70	7,000	R.Gulnam
SW-6	Cueibet-East	LS	330	33,000	R.Gulnam, R.Gel
SW-7	Cueibet-West	LS	60	6,000	R.Gel
SW-8	Tonj-South	WS	50	5,000	R.Tonj
SW-9	Tonj-North	WS	120	12,000	R.Tonj
SW-10	Acongeong-North	WBGS, WS	190	19,000	R.Jur
SW-11	Toc	WS	270	27,000	R.Tonj
SW-12	Cueibet-North	LS	110	11,000	R.Gel
Total			1,520	152,000	

Notes: LS: Lakes State, WS: Warrap State, WBGS: Western Bahr el Ghazal State

The criteria of each candidate area were scored and areas were prioritized based on the total score. Prioritization was carried out by priority area, namely North, South and South-West, and an area with the highest score in each priority area was selected as the priority project area.

The result of the scoring and categorizing is shown in Table 6.2.7 below.

Table 6.2.7 Scoring and Categorization of Candidate Areas

North Priority Area

No.	Name of Area	Total Score	Priority	Category
N-1*	Renk-North	40	1	S
N-2*	Renk-South1	40	1	S
N-3*	Manyo-North	40	1	S
N-4*	Manyo-South	40	1	S
N-5	Manyo-West	28	23	M
N-6	Renk-South2	32	8	M
N-7	Jelhak	37	7	S
N-8*	Melut	40	1	S
N-9	Kaka1	27	25	M
N-10	Kaka2	31	14	M
N-11	Jelhak-South	31	14	M
N-12	Fashada	30	21	M
N-13	Akoka	30	21	M
N-14	Makal	28	23	M
N-15	Panyidway	32	8	M
N-16	Nakdeir	32	8	M
N-17	Baliet	32	8	M
N-18	Abong	32	8	M
N-19	Adong	31	14	M
N-20	Galacial	32	8	M
N-21	Doma	31	14	M
N-22	Ulang	31	14	M
N-23	Nasir-East	31	14	M
N-24	Nasir-West	31	14	M
N-25	Mohamed Ajak	39	6	P

South Priority Area

No.	Name of Area	Total Score	Priority	Category
S-0	Rejaf-East	38	2	S
S-1	Jebel Lado	39	1	P
S-1'	Mangalla	37	3	L
S-2	Terekeka-South	32	6	S
S-2'	Tali	33	5	S
S-3	Terekeka-North	31	7	M
S-3'	Mingkaman	31	7	M
S-4	Bor-East	31	7	M
S-5	Bor-North	31	7	M
S-6	Twic-East	36	4	S
S-7	Wangule	30	11	M

South-West Priority Area

No.	Name of Area	Total Score	Priority	Category
SW-1	Ngop	28	4	S
SW-2	Payii	29	2	S
SW-3	Aduel	28	4	S
SW-4	Pacung	31	1	P
SW-5	Malekajok	27	8	M
SW-6	Cueibet-East	27	8	M
SW-7	Cueibet-West	27	8	M
SW-8	Tonj-South	27	8	M
SW-9	Tonj-North	28	4	S
SW-10	Aconjeong-North	29	2	S
SW-11	Toc	28	4	S
SW-12	Cueibet-North	25	12	M

Category

P: Priority Projects (implementation term is short)
S: Short Term Projects (2015-2020)
M: Medium Term Projects (2015-2027)
L: Long Term Projects (2015-2040)

At the same time, each area was roughly organized into one of three categories according to its implementation timing; short, medium and long term projects.

There is also, a need to further develop and update the criteria for categorizing the schemes into short; medium; and long term based, on factors other than timing.

In the North Priority Area, priority projects' areas are the target of the field surveys (topographic, geological, soil, river discharge) and socio-economic surveys, to collect the necessary information for the pre-feasibility study.

Areas like N-1: Renk-North, N-2: Renk-South1, N-3: Manyo-North, N-4: Manyo South and N-8: Melut, are under the Northern Upper Nile Irrigation Schemes; and there are enough surveys' documented, which have already been conducted before.

These areas were therefore, eliminated from the target of the priority projects' areas; and as a result, even though it ranks sixth, N-25: Mohamed Ajak has been selected as the priority project area due to its secondary highest score in the North Priority Area.

In the South Priority Area, sugarcane is considered as the target crop of Mangalla area. Since sugarcane is considered as a commercial crop and thus contributes less to the achieving of the strategic government goal for IDMP: "improvement of food security and reduction of poverty", development priority of this area is considered as low and this area was placed in the category of long-term projects. Nevertheless, if resources would be available, especially from the private sector, its development could still be realised in short to medium term.

Priority project areas are selected from the viewpoint of "areas with high irrigation potential (water resource, land productivity and socio-economic potential)." This viewpoint includes the necessity of irrigation development and the irrigation schemes to be constructed in such areas would have bigger effects of irrigation in increasing crop production and productivity.

Then the priority projects' areas were not selected from the mountainous area because there is enough rainfall (more than 1,000mm/year) and necessity of irrigation (effective irrigation) is low, or the areas of irrigable lands are small, so the investment effects of irrigation facility is considered low. However, there are many areas having high land productivity and socio-economical potential in the mountainous areas.

Another issue of the selection was security. Initially selected priority projects' areas were Mohamed Ajak (N-25) in the North Priority Area, Jebel Lado (S-1) in South Priority Area, and Pacung (SW-4) in the South-West Priority Area. Due to the current security situation, it was not possible to carry out the pre-feasibility study in Mohamed Ajak and Pacong in early 2015.

Therefore, alternative priority areas have been selected from the other potential areas, to comply with security assurances. The selected alternative areas are Rejaf East and Wau rice scheme. Although Wau rice scheme is outside the high resolution area, the area has been well-known as having high irrigation potential for rice cultivation in South Sudan.

Finally the three (3) sites of Wau, Jebel Lado and Rejaf East have been selected as priority projects' sites, for carrying out the pre-feasibility study under the IDMP formulation. The results of the pre-feasibility study are shown in Chapter 8 and Annex 9.

Table 6.2.8 List of Proposed Irrigation Schemes (1/3)

No.	Scheme / Farm	Category	Zone	Location (State / County)		Ownership			Size (ha)	Source of Water	Planning Horizon		
						National	State	County			Short-term	Mid-term	Long-term
1	Kapoeta / Lapon Irrigation Scheme Development Project	Existing or Well-known	Intermittent	EES	Kapoeta					R. Kenetti	F/S, B/D, D/D, Const.		
2	Awerial (Pap)	Existing or Well-known	Intermittent	LS	Awerial					Rainfall /Moisture	F/S, B/D, D/D, Const.		
3	Maker-Nhom	Existing or Well-known	Intermittent	LS	Rumbek East				25	Well	F/S, B/D, D/D, Const.		
4	Aweil Irrigation Rice Scheme Rehabilitation Project	Existing or Well-known	Plains	NBGS	Aweil	O				R. Lol	F/S, B/D, D/D, Const.		
5	Northern Upper Nile Irrigation Schemes Rehabilitation Project	Existing or Well-known	Plains	UNS		O				R. Nile	F/S, B/D, D/D, Const.		
6	WUN women society	Existing or Well-known	Plains	US	Mayom				42	Branch of Bah-Rl-Gazal	F/S, B/D, D/D, Const.		
7	Pakur Project Farmer	Existing or Well-known	Plains	US	Koch				6	Ground Water	F/S, B/D, D/D, Const.		
8	Yoanyang Farmers	Existing or Well-known	Plains	US	Bentiu				6	Branch of R.Nile	F/S, B/D, D/D, Const.		
9	Eastern Bank	Existing or Well-known	Plains	WBGS	Wau					R.Jur	F/S, B/D, D/D, Const.		
10	Natab Farmers	Existing or Well-known	Plains	WBGS	Wau					R.Jur	F/S, B/D, D/D, Const.		
11	Mayen Gumel (Greenhouse)	Existing or Well-known	Plains	WS	Malwal					Ground Water	F/S, B/D, D/D, Const.		
12	Pan Rook (Greenhouse)	Existing or Well-known	Plains	WS	Akot					Ground Water	F/S, B/D, D/D, Const.		
13	Kuec Ariik Rice Scheme	Existing or Well-known	Plains	WS	Akot					R. Tharkuong	F/S, B/D, D/D, Const.		
14	Rejaf-East Irrigation Scheme Development Project (Pre-F/S d	Existing or Well-known	Intermittent	CES	Juba	O			1,000	R. Nile	F/S, B/D, D/D, Const.		
15	Wau Rice Scheme Development Project (Pre-F/S done)	Existing or Well-known	Intermittent	WBGS	Wau	O				R. Jur	F/S, B/D, D/D, Const.		
16	Jabel Lado Irrigation Scheme Development Project (Pre-F/S d	Detail Assessment	Intermittent	CES	Juba	O			2,000	R. Nile	F/S, B/D, D/D, Const.		
17	Pacung Irrigation Scheme Development Project	Detail Assessment	Intermittent	LS	Rumbek East				12,000	R. Naam	Pre-F/S, F/S, B/D, D/D, Const.		
18	Mohamed Ajak Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Makal				7,000	R. Nile	Pre-F/S, F/S, B/D, D/D, Const.		
19	Jelhak Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Mult				2,000	R. Nile, R. Bibban	Pre-F/S, F/S, B/D, D/D, Const.		
20	Terekeka-South Irrigation Scheme Development Project	Detail Assessment	Intermittent	CES	Terekeka				7,000	R. Nile, Oxbow Lake	Pre-F/S, F/S, B/D, D/D, Const.		
21	Tali Irrigation Scheme Development Project	Detail Assessment	Intermittent	CES	Terekeka				4,000	R. Nile	Pre-F/S, F/S, B/D, D/D, Const.		
22	Twic-East Irrigation Scheme Development Project	Detail Assessment	Plains	JS	Maar				5,000	R. Nile	Pre-F/S, F/S, B/D, D/D, Const.		
23	Maar Irrigation Scheme Development Project	Detail Assessment	Intermittent	LS	Maar				4,000	R. Yei	Pre-F/S, F/S, B/D, D/D, Const.		
24	Payii Irrigation Scheme Development Project	Detail Assessment	Intermittent	LS	Yirol				4,000	R. Yei	Pre-F/S, F/S, B/D, D/D, Const.		
25	Aduel Irrigation Scheme Development Project	Detail Assessment	Intermittent	LS	Karic				12,000	R. Naam	Pre-F/S, F/S, B/D, D/D, Const.		
26	Tonj-North Irrigation Scheme Development Project	Detail Assessment	Plains	WS	Tonj				12,000	R. Tonj	Pre-F/S, F/S, B/D, D/D, Const.		
27	Acongeong-North Irrigation Scheme Development Project	Detail Assessment	Plains	WBGS/WS					19,000	R. Jur	Pre-F/S, F/S, B/D, D/D, Const.		
28	Toch Irrigation Scheme Development Project	Detail Assessment	Plains	WS	Aweng				27,000	R. Jur	Pre-F/S, F/S, B/D, D/D, Const.		
29	Manyo-West Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Manyo				4,000	R. Nile		Pre-F/S, F/S, B/D, D/D, Const.	
30	Renk-South 2 Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Renk				11,000	R. Nile		Pre-F/S, F/S, B/D, D/D, Const.	
31	Kaka1 Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Manyo				4,000	R. Nile		Pre-F/S, F/S, B/D, D/D, Const.	
32	Kaka2 Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Manyo				1,000	R. Nile		Pre-F/S, F/S, B/D, D/D, Const.	
33	Jelhak-South Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Mult				5,000	R. Nile, R. Bibban		Pre-F/S, F/S, B/D, D/D, Const.	
34	Fashada Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Fashada				10,000	R. Nile		Pre-F/S, F/S, B/D, D/D, Const.	
35	Akoka Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Akoka				7,000	R. Nile		Pre-F/S, F/S, B/D, D/D, Const.	
36	Makal Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Makal				12,000	R. Nile		Pre-F/S, F/S, B/D, D/D, Const.	
37	Panyidway Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Panyikang				3,000	R. Nile		Pre-F/S, F/S, B/D, D/D, Const.	
38	Nakdeir Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Panyikang				11,000	R. Sobat		Pre-F/S, F/S, B/D, D/D, Const.	
39	Baliet Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Baliet				9,000	R. Sobat		Pre-F/S, F/S, B/D, D/D, Const.	
40	Abong Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Baliet				3,000	R. Sobat		Pre-F/S, F/S, B/D, D/D, Const.	
41	Khorfulus Irrigation Scheme Development Project	Detail Assessment	Plains	JS	Feji				4,000	R. Sobat		Pre-F/S, F/S, B/D, D/D, Const.	
42	Pultruk Irrigation Scheme Development Project	Detail Assessment	Plains	JS, UNIS	Khorfulus				3,000	R. Sobat		Pre-F/S, F/S, B/D, D/D, Const.	
43	Doma Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Olang				5,000	R. Sobat		Pre-F/S, F/S, B/D, D/D, Const.	
44	Ulang Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Nasir				10,000	R. Sobat, R. Nyanding		Pre-F/S, F/S, B/D, D/D, Const.	
45	Nasir-East Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Nasir				19,000	R. Sobat		Pre-F/S, F/S, B/D, D/D, Const.	
46	Nasir-West Irrigation Scheme Development Project	Detail Assessment	Plains	UNS	Nasir				8,000	R. Sobat		Pre-F/S, F/S, B/D, D/D, Const.	
47	Terekeka-North Irrigation Scheme Development Project	Detail Assessment	Intermittent	CES	Terekeka				6,000	R. Nile, Oxbow Lake		Pre-F/S, F/S, B/D, D/D, Const.	
48	Mingkaman Irrigation Scheme Development Project	Detail Assessment	Plains	LS, CES					6,000	R. Nile, R. Gwar		Pre-F/S, F/S, B/D, D/D, Const.	
49	Penykou Irrigation Scheme Development Project	Detail Assessment	Plains	JS	Penykou				9,000	R. Nile		Pre-F/S, F/S, B/D, D/D, Const.	
50	Jalle Irrigation Scheme Development Project	Detail Assessment	Plains	JS	Athoc Jalle				4,000	R. Nile		Pre-F/S, F/S, B/D, D/D, Const.	

Table 6.2.8 List of Proposed Irrigation Schemes (2/3)

No.	Scheme / Farm	Category	Zone	Location (State / County)		Ownership			Size (ha)	Source of Water	Planning Horizon		
						National	State	County			Short-term	Mid-term	Long-term
51	Wangule Irrigation Scheme Development Project	Detail Assessment	Plains	JS	Kongor				6,000	R. Nile		Pre-F/S, F/S, B/D, D/D, Const.	
52	Malengagok Irrigation Scheme Development Project	Detail Assessment	Intermittent	LS	Rumbek				7,000	R. Gulnam		Pre-F/S, F/S, B/D, D/D, Const.	
53	Cueibel-East Irrigation Scheme Development Project	Detail Assessment	Intermittent	LS	Abiriu				33,000	R. Gulnam, R. Gei		Pre-F/S, F/S, B/D, D/D, Const.	
54	Cueibel-West Irrigation Scheme Development Project	Detail Assessment	Intermittent	LS	Malou-Pec				6,000	R. Gei		Pre-F/S, F/S, B/D, D/D, Const.	
55	Tonj-South Irrigation Scheme Development Project	Detail Assessment	Intermittent	WS	Tonj				5,000	R. Tonj		Pre-F/S, F/S, B/D, D/D, Const.	
56	Cueibel-North Irrigation Scheme Development Project	Detail Assessment	Plains	LS	Pantoich				11,000	R. Gei		Pre-F/S, F/S, B/D, D/D, Const.	
57	Mangalla Irrigation Scheme Development Project	Detail Assessment	Intermittent	CES	Juba				1,000	R. Nile			Pre-F/S, F/S, B/D, D/D, Const.
58	Yei	Other Potential Area	Mountainous	CES	Yei					R. Yei	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
59	Terekeka	Other Potential Area	Intermittent	CES	Terekeka					R. Bahr el-Jebel	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
60	Rejaf	Other Potential Area	Intermittent	CES	Juba					R. Bahr el-Jebel	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
61	Kajo-keji	Other Potential Area	Mountainous	CES	Kajokeji					R. Kajokeji	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
62	Luri	Other Potential Area	Intermittent	CES	Juba					R. Luri	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
63	Mongalla (Small scale rice scheme)	Other Potential Area	Intermittent	CES	Juba					R. Bahr el-Jebel	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
64	Mongalla (Cotton Scheme)	Other Potential Area	Intermittent	CES	Juba					R. Bahr el-Jebel	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
65	Terekeka County (Small scale rice scheme)	Other Potential Area	Intermittent	CES	Terekeka					R. Bahr el-Jebel	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
66	Torit Bur	Other Potential Area	Mountainous	EES	Torit					R. Kenetti	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
67	Upper Talanga	Other Potential Area	Mountainous	EES	Magwi					Reservoirs (Water harvesting)	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
68	Katire	Other Potential Area	Mountainous	EES	Ikwoto				50	R. Kwate	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
69	Pachidi	Other Potential Area	Mountainous	EES	Lopa Lafon				84	R. Kwate	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
70	Naduma	Other Potential Area	Mountainous	EES	Ikwoto				3	R. Naduma	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
71	Akobo	Other Potential Area	Plains	JS	Akobo					R. Akobo, residual moisure and GW	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
72	Fangak	Other Potential Area	Plains	JS	Fangak					R. Nile or R. Bahr el-Zeraf	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
73	Ayod	Other Potential Area	Plains	JS	Ayod				210	R. Bahr el-Zeraf	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
74	Bor	Other Potential Area	Plains	JS	Bor					R. Bahr el-Jebel	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
75	Pashala	Other Potential Area	Plains	JS	Pochala				210	R. Akobo, residual moisure and GW	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
76	Pibor	Other Potential Area	Plains	JS	Pibor					R. Pibor, residual moisure and GW	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
77	Hweiral Community Farm/Awerial	Other Potential Area	Plains	LS	Awerial				42	River	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
78	Pagarau	Other Potential Area	Plains	LS	Yirol East					R.r Yei	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
79	Beilet	Other Potential Area	Plains	LS	Yirol East (Bei in Malek payam)					R. Bahr el-Jebel and residual moisture	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
80	Hanyi	Other Potential Area	Plains	LS	Yirol West				63	Swamp	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
81	Bahl-Gel-Cuiebet-County	Other Potential Area	Plains	LS	Cuiebet				42	Rainfed	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
82	Nyibor	Other Potential Area	Plains	LS	Rumbek East				42	Lake	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
83	Aluak-Luak	Other Potential Area	Plains	LS	Yirol West				21	R. Nam	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
84	Tonychol (Aweil East)	Other Potential Area	Plains	NBGS	Aweil					R. Lol	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
85	Wqr Malual	Other Potential Area	Plains	NBGS	Aweil North					Branch of R. Lol	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
86	Abuth	Other Potential Area	Plains	NBGS	Aweil North					Branch of R. Lol	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
87	Dangajuong	Other Potential Area	Plains	NBGS	Aweil East					R. Nayon	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
88	Mualalkon	Other Potential Area	Plains	NBGS	Malualkon					R. Lol	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
89	Adioragot	Other Potential Area	Plains	NBGS	Malualkon					R. Akuem	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
90	Wathmyok	Other Potential Area	Plains	NBGS	Aweil South					R. Kueng	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
91	Alok	Other Potential Area	Plains	NBGS	Aweil Center					R. Kueng	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
92	Nyalath	Other Potential Area	Plains	NBGS	Aweil Center					R. Kumo	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
93	Mabior-yanthdit	Other Potential Area	Plains	NBGS	Aweil West					Branch of R. Lol	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
94	Elremela	Other Potential Area	Plains	UNS	Manyo				294	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
95	Halaka	Other Potential Area	Plains	UNS	Manyo				273	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
96	Eltaashi	Other Potential Area	Plains	UNS	Renk				336	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
97	Khurajaez	Other Potential Area	Plains	UNS	Renk				252	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
98	North payour	Other Potential Area	Plains	UNS	Renk				945	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
99	Abukhathra	Other Potential Area	Plains	UNS	Renk				3,780	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
100	Elgeger	Other Potential Area	Plains	UNS	Renk				1,260	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.

Table 6.2.8 List of Proposed Irrigation Schemes (3/3)

No.	Scheme / Farm	Category	Zone	Location (State / County)		Ownership			Size (ha)	Source of Water	Planning Horizon		
						National	State	County			Short-term	Mid-term	Long-term
101	Maggra	Other Potential Area	Plains	UNS	Renk				651	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
102	Brhatajab	Other Potential Area	Plains	UNS	Renk				7,598	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
103	Elthebba	Other Potential Area	Plains	UNS	Renk				756	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
104	Bangdid	Other Potential Area	Plains	UNS	Renk				441	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
105	Majak	Other Potential Area	Plains	UNS	Renk				294	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
106	Mulbouk	Other Potential Area	Plains	UNS	Renk				945	R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
107	Malakal	Other Potential Area	Plains	UNS	Malakal					R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
108	Kodok	Other Potential Area	Plains	UNS	Fashoda					R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
109	Sobat	Other Potential Area	Plains	UNS	Panyikang, Ulang, Nasir					R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
110	Longochok	Other Potential Area	Plains	UNS	Longochok					R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
111	Sue	Other Potential Area	Intermittent	WBGS	River Jur					R. Nile	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
112	Firaka	Other Potential Area	Intermittent	WBGS	River Jur				84	Rainfall	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
113	Sirmolaka	Other Potential Area	Intermittent	WBGS	Raga				63	Rainfall	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
114	Boro Elmedina	Other Potential Area	Intermittent	WBGS	Raga				126	Rainfall, Bor river	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
115	Pongo Nuer	Other Potential Area	Intermittent	WBGS	Raga					R. Pongo	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
116	Sopo	Other Potential Area	Intermittent	WBGS	Raga					R. Sopo	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
117	Bussari Scheme	Other Potential Area	Intermittent	WBGS	Wau				19	Groundwater	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
118	Raga Garden	Other Potential Area	Intermittent	WBGS	Raga				13	R. Raga	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
119	Deleba	Other Potential Area	Intermittent	WBGS	Raga				42	Rainfall	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
120	Eur	Other Potential Area	Intermittent	WBGS	Raga				63	Rainfall	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
121	Nzara Irrigation scheme	Other Potential Area	Mountainous	WES	Yambio					River	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
122	Mundri East	Other Potential Area	Mountainous	WES	Mundri					Streams	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
123	Mvolo scheme	Other Potential Area	Mountainous	WES	Mvolo					R. Yei	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
124	Nzara scheme	Other Potential Area	Mountainous	WES	Yambio					R. Sue	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
125	Nakpangau	Other Potential Area	Mountainous	WES	Yambio					Nakpangau Reservoir	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
126	Woman Development Group Scheme	Other Potential Area	Mountainous	WES	Yambio				0	R. Nayure	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
127	Naangbimo Irrigation Scheme	Other Potential Area	Mountainous	WES	Maridi				1	R. Uze	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
128	Maridi	Other Potential Area	Mountainous	WES	Mundri				2	R. Maridi	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
129	Mundri-west	Other Potential Area	Mountainous	WES	Mundri				5	R. Maridi	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
130	Tambura	Other Potential Area	Mountainous	WES	Tambura				2	R. Yubu	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
131	Sue	Other Potential Area	Mountainous	WES	River Jur				210	R. Sue	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
132	Gogrial East (Pathuon)	Other Potential Area	Plains	WS	Gogrial					R. Jur	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
133	Twic (Toch Akol Aher Rice)	Other Potential Area	Plains	WS	Aweng					R. Lol	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
134	Gogrial West - Akon (Rice)	Other Potential Area	Plains	WS	Akon					R.Bamnhom	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
135	Gogrial West - Gogrial (Maluil Ajak)	Other Potential Area	Plains	WS	Gogrial					R. Jur	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
136	Kuac North (Rice)	Other Potential Area	Plains	WS	Gogrial					R. Jur	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
137	Gogrial Eest - Mayen Jur	Other Potential Area	Plains	WS	Gogrial					R. Jur	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
138	Twic - Turalel	Other Potential Area	Plains	WS	Twic					R. Lol	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
139	Twic - Wunrok	Other Potential Area	Plains	WS	Twic					R. Lol	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
140	Twic - Panyok	Other Potential Area	Plains	WS	Twic					Swamp	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
141	Gogrial East (Luonyaker)	Other Potential Area	Plains	WS	Gogrial					R. Lol	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
142	Dolangana Irrgation Scheme	Other Potential Area	Plains	US	Raingnhom					Ground Water	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
143	Nyiel Irrigation Scheme	Other Potential Area	Plains	US	Narir					Ground Water	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
144	Manga Irrigation Scheme	Other Potential Area	Plains	US	Narir					Branch of R. Nile, Ground Water	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
145	Congcord Irrigation Scheme	Other Potential Area	Plains	US	Narir					Branch of R. Nile, Ground Water	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
146	Kaijak Irrgation Scheme	Other Potential Area	Plains	US	Bentiu					Ground Water	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
147	Abiemnom Irrgation Scheme	Other Potential Area	Plains	US	Abiemnom					Ground Water	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
148	Tuorlmalu Irrgation Scheme	Other Potential Area	Plains	US	Mayom					Ground Water	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
149	Puoch Irrgation Scheme	Other Potential Area	Plains	US	Bentiu					Ground Water	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
150	Kaikang Irrigation Scheme	Other Potential Area	Plains	US	Mayom					Ground Water	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
151	Thonuor Irrigation Scheme	Other Potential Area	Plains	US	Koch					Ground Water	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.
152	Maduk Irrgation Scheme	Other Potential Area	Plains	US	Mayom					Ground Water	Detail Assessment	Pre-F/S, F/S, B/D	F/S, B/D, D/D, Const.

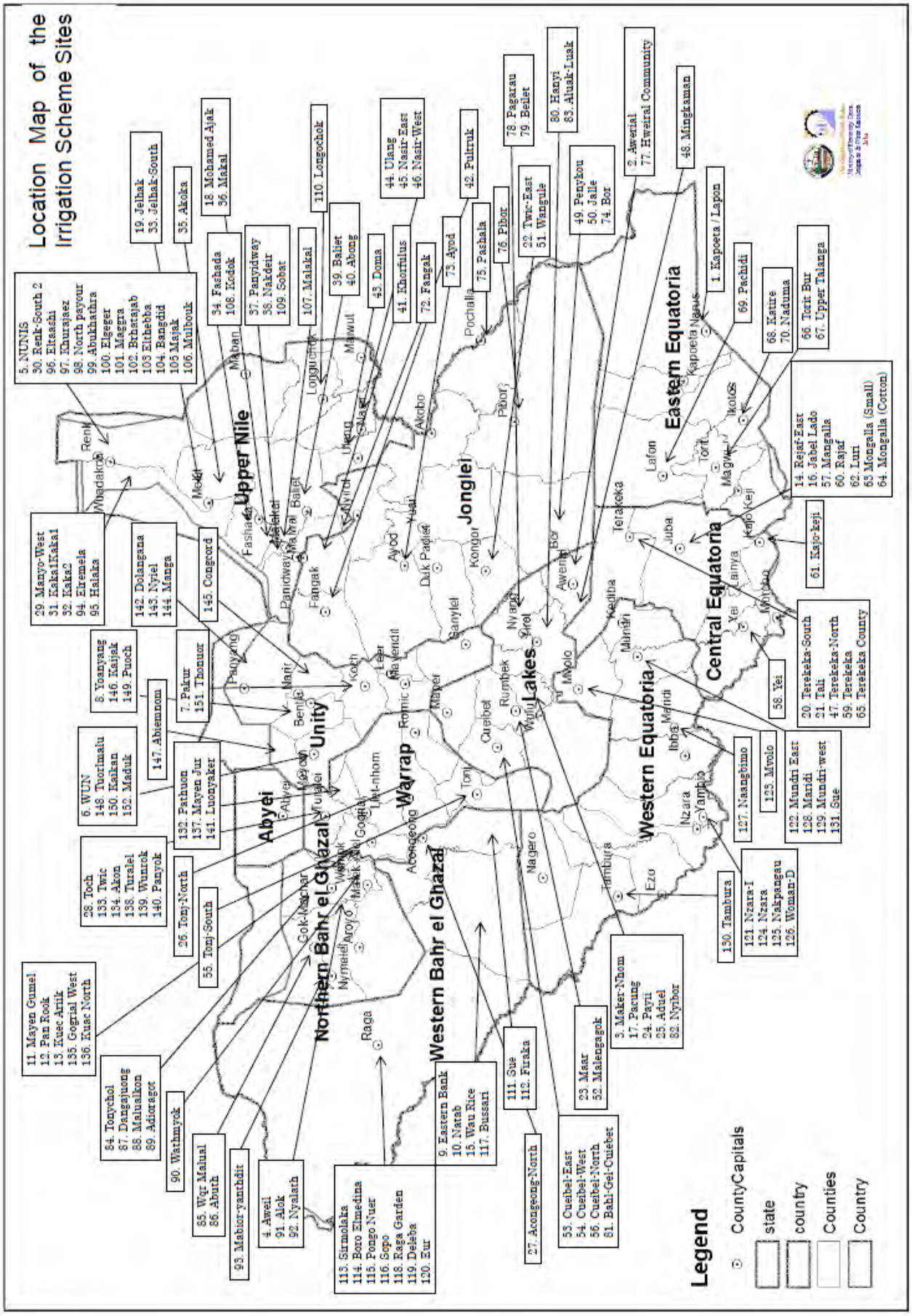


Figure 6.2.5 Location of Proposed Irrigation Schemes

6.2.3 Community Irrigation Farms Development Programme

The Community Irrigation Farms Development Programme is designed to establish smallholder Irrigation Schemes by the communities as main owners and operators of irrigation facilities. The Programme covers the irrigation potential areas across the country. To a large extent, the programme will focus on capacity development of communities, to be able to establish small-scale irrigation farms using available and accessible resources. Specifically, the Programme is to provide technical assistance to the community farmers on how to carry out good land and water management practices for crops production. This will include use of soil and water conservation methods/technique; and management of water storage, control and conveyance facilities. The Programme includes short-term, medium-term and long term time frames.

(1) Components under the Programme

The Programme is composed of (1) the pilot project and (2) the extension of the pilot. In this programme, the approach would be different from the National/State/County Irrigation Schemes Development since the ownership of the facilities will be the community and they will be fully responsible for O&M. The government side is to basically provide technical assistance to the community.

The basic concept is the investment and management by the community on its own, which means to seek low cost investment and likely sustainability. Also the major occasion will be utilizing permanent streams during the beginning or end of the dry season to supplement the crop growth period in combination with rainfall.

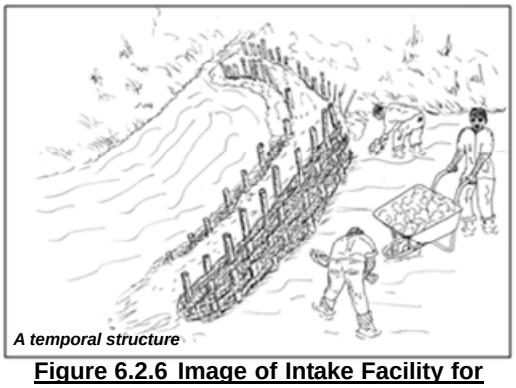


Figure 6.2.6 Image of Intake Facility for Community Schemes (1/2)

This low cost investment can be realized in a way by utilizing the locally available materials such as wood, soils, stones, etc. In this case, the irrigation structure can be a temporal one, which can work in perennial streams during the dry season when there is no risk of flood. "This kind of technology has been applied by certain communities in South Sudan: the study reported the example in a community in Eastern Equatoria State as follows":

> A more ambitious engineering scheme is carried out by the Lango section of the Latuka. ..... At the end of March the Lango build a dam of brushwood and earth which, in the early April spates, raises the level of the water sufficiently for it to spill over the banks on to the fertile strip. Lower down, a similar dam is built which …. diverts water into an irrigation ditch..... Both dams fail at high flood, but by then their purpose of enabling the crop of maize and millet to germinate and begin growth before the heavy rains has been achieved (Sudan Government, 1954).

As far as the technology is transferred to the community members, this kind of irrigation will greatly contribute to increasing the agricultural productivity. In case of using materials to purchase such as cement, a low cost design such as masonry instead of concrete will be sought. The community could tart with temporal structures and upgrade to the permanent structure according to the financial capacity of the community. In cash investments, the programme could provide a subsidy for the community but at minimum level, so that the government can spare the limited resources for as many communities as possible. The following are the steps of the implementation:

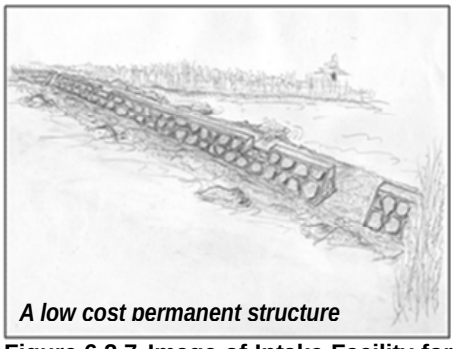


Figure 6.2.7 Image of Intake Facility for Community Schemes (2/2)

(2) Pilot Project

a) Identifying the areas for the community irrigation schemes and selecting the area for a pilot implementation;

b) Developing an irrigation model for community irrigation (small-scale) with locally available materials with facilities that can either be temporal (during dry season) by using trees, stone, mud, etc. or permanent by using concrete according to the availability of water resources and the capacity of the community. The community can start with temporary facilities and then update them to the permanent ones;

c) Technically assisting the community to apply an irrigation model in their locality.

(3) Extension of the Community Irrigation Farms

a) Organizing a site visit for other communities to lean from the pilot implementation;

b) Developing the guidelines for community irrigation development based on the pilot results

c) Preparing materials such as posters and leaflets and disseminating them through the local government offices;

d) Extending the implementation of community irrigation farm development.

(4) Linkage with CAMP Project

The community Irrigation Farms Development Programme also contributes to the implementation of the projects identified by CAMP by supplying water to the project activity. The following components are identified in relation to the CAMP Projects. In the areas where the following CAMP projects are implemented, the site identification of the community irrigation farms will be prioritized. Other initiatives (NELSAP) also includes the community irrigation aspect, therefore, it is also listed here as a related project to the IDMP:

1. Provision and establishment of small scale irrigation facilities and systems for horticulture farming (vegetables and fruits production) ***(CAMP Project ID01.06)***
2. Provision and establishment of small scale irrigation facilities and systems for peri-urban horticulture farming (vegetables and fruits production) ***(CAMP Project ID01.20)***
3. Provision and establishment of small scale irrigation facilities and systems for maize crops in wet lands and river corridors, after the receding of the floods (drawdown or recession irrigation) ***(CAMP Project ID01.04)***
4. Implementation, operation and maintenance of water for small-scale aquaculture for communities who have no access to natural fishing opportunities ***(CAMP Project ID04.07)***
5. Conservation and restoration of vegetation at water catchments, to arrest erosion and prevent siltation in water facilities, including reservoirs, canals, etc. ***(CAMP Project ID03.03)***
6. Provision and establishment of irrigation facilities and systems in collaboration with the private sector for rice production in lowlands/plains ***(CAMP Project ID01.05)***
7. Provision, operation and maintenance of livestock watering points along cattle migratory routes within the rangelands.***(CAMP Projects ID01.14 and 02.08)***
8. Some specific irrigation schemes/projects to be identified from high resolution assessment
9. Provision of flood control and drainage infrastructure for sorghum farms ***(CAMP Project ID01.03)***
10. Nyimur multipurpose water resources management and development project of NELSAP on Aswa, Parjok Payam, Magwi County, Eastern Equatoria State

(5) Implementation Plan

As mentioned above, the programme starts with a pilot project. After selecting the areas and/or communities, the pilot project will be implemented, and in the course of the implementation, training of trainers will be conducted and a guideline will be prepared. After the pilot, the full implementation in all the States will start and an attempt will be made to reach the communities in the counties with introduction of small-scale irrigation. Table 6.2.9 below, shows the implementation plan and the detailed programme cost is given in Annex 7.

Table 6.2.9 Implementation Plan (CIFDP)

	Common Activity for each Project	1st yr	2nd yr	3rd yr	4th yr	5th yr	after
1	Identification of pilot project sites						
2	Development of irrigation model						
3	Training of Extension Engineers						
4	Technical assistance to water users to apply the model						
5	Construction of the pilot scheme						
6	Development of guidelines						
7	Extension of the community irrigation (TOT+ extension activity)						

6.2.4 Private Sector Irrigation Investment Promotion Programme

To well cultivate the potential of irrigation in the country, various sources of capital could be utilized. Hence if the private sector wishes to invest in the irrigation sector for their enterprise, it should be promoted rather than prohibited. However, uncontrolled private sector investment would result in over exploitation of natural resources as well as land grabbing.

According to a survey (Deng, 2011)[i], it was reported that the land of 2.64 million ha had been designated for post-CPA foreign investments in agriculture by 2011. While the report looks at the positive points of the private investment as it can provide support to post-conflict reconstruction efforts, generate employment opportunities, increase food productivity, provide a source of revenue to the governments, and help to diversify the economy, it also warns of the risks of food insecurity, instability, and social unrest if the investments are to benefit small transnational elite at the expense of the rural poor, i.e. the use of arable land for food or bio-fuels for foreign populations.

In order not to harm the national and community interests in the rural areas by such uncontrolled private investments, establishing clear guidelines and regulations for private sector investment promotion based on the existing relevant laws is essential. Private Sector Investment Promotion in irrigation is therefore required with due consideration of the following:

- Utilization of potential irrigable agricultural land through private investment promotion
- Utilization of various sources of capital
- Enhancement of entrepreneurship and establishment of enterprises in irrigated agriculture
- Regulation of private sector investment, so as to control overexploitation and illegal use of natural resources, e.g. to prevent land grabbing
- Protection of national and community interests while accommodating foreign investment, e.g. formulation of guidelines and regulations based on the existing laws for private sector investment promotion is essential
- Safeguarding of community interest while accommodating private sector investment

(1) Outline of the Programme

The programme will ensure that a policy, laws, regulations, standards and guidelines are formulated for providing an enabling environment for private sector involvement in irrigated agriculture. The investment in irrigation by the private sector will be guided by this programme. MEDIWR will set up a system to promote irrigation investment with preparation of guiding documents and associated procedures for irrigation investment and they will be periodically reviewed in line with the progress of the business enterprise in irrigation.

(2) Components under the Programme

The components of the Programmes will consist of two (2) categories, which are; 1) establishing support and promotion system with regulations and/or guidelines under the compliance of the related laws, and 2) a promotion activity for private investment in irrigation. So far the Land Act 2009 and the Investment Promotion Act 2011 would be the related regulations for private sector investment, and the Draft Land Policy (2013) would also be the guiding document particularly for investment in agriculture.

The promotion system is subject to the national laws such as the Land Act 2009 and the Investment Promotion Act 2011 and therefore the cooperation with the relevant institutions such as the Land Commission, MAFCRD (CAMP), South Sudan Investment Authority (SSIA), Ministry of Physical Infrastructure or its equivalent ministries of the States, and the South Sudan Chamber of Commerce, Industry and Agriculture (SSCCIA).

The CAMP crop-subsector investment plan includes the Private Sector Investment Project (ID01.28). The support and promotion system for the private sector irrigation investment should be established in linkage with this project. SSIA facilitates the procedure for issuance of investment licenses and permits. Legal procedure should be clarified with SSIA and particularly the Land commission. SSCCIA could also be the entry point for the private sector to invest in South Sudan, e.g. they facilitate foreign investors by providing a recommendation letter through the embassies, facilitating duty exemptions, etc.

In establishing support and a promotion system of the private sector investment in irrigation, the following provisions of the Land Act (2009) should particularly be considered, i.e. the lease of land (99 years for long term), validity of the lease, accordance with land zoning and land use plan of State, compensation policy, and social and environmental preservation. Especially, the interest of the community in question has to be duly taken into consideration as Section 63 of Land Act 2009 says:

a) The activity to be carried out by the investor shall reflect an important interest for the community or people living in the locality.
b) It shall contribute economically and socially to the development of the local community.
c) The concerned Ministries in the Government of South Sudan and the State and the Investment Authority shall consult with the Community concerned about any decision related to the land that the investor intends to acquire and the view of the Community shall be duly taken into consideration.

The Draft Land Policy (2013) also describes as one of the principal policy problems, the acquisition of land without regard for the interests of existing landholders' rights or interests, which is known as "land-grabbing". In order to avoid such incidents or to prevent them from occurring, a guideline for private sector investment for irrigation will be prepared to accompany the effective implementation and M&E system under this programme.

The following are the major activities:

(1) Establishing a support and promotion system (short-term) in cooperation with the Land Commission, MAFCRD, SSIA, State ministries and SSCCIA

- Establishment of linkage and cooperation mechanism with the relevant organizations such as the Land Commission, MACRD, MPMI, SSCCIA and State ministries.
- Establishment of investment support and promotion system of irrigation development for domestic private investors or by Public-Private Partnership (PPP) in accordance with the laws of RSS, such as Land Act, Investment Act, Land Policy, etc.
- Establishment of investment support and promotion system of irrigation development for foreign investors or under the PPP in accordance with the laws of RSS
- Establishment of an incentive/attraction system for special types of investment intervention, e.g. Scarce Food Security, Labour Intensive, Cash Generating and Agro-industry Supporting Crops, for irrigation development by private, individual or smallholder groups
- Preparation of a guideline (which can be compiled with the ones prepared in the IDGFP) for irrigation investment by the private sector in conjunction with the investment policy and regulations including the form of application (especially containing clauses related to avoiding speculative investment of the private companies and the minimizing of negative impacts to the communities, such as displacement of a community's people).

(2) Promotion Activity of Private Investment (Mid and Long-term) in Cooperation with the above Institutions

- Identification of the areas to be allowed for private sector investment, public consultation with the communities or people living in the areas to clarify their interest and finalize the specific boundary of the land that can be leased for private sector investment.
- Area identification will be carried out by State Ministries and Local Governments (County and Payam), or the private sector can bring their proposals to the MEDIWR. The candidate areas will all be made known to the MEDIWR and the list of the candidate areas are to be maintained and updated by the Ministry.
- Periodical advertisement for private sector investment in the irrigation sector by MEDIWR
- Receipt of applications from the private sector and their evaluation. Evaluation should be carried out by the specially formed committee consisting of national, state, and local government officials.
- Evaluation of applicants for permitting the investment by the National Government or for the possibility of PPP investment
- Judgement of the proposal of applicants for the permission of the investment or adoption to PPP.
- Supervision of private sector investment by State and Local Government. Periodical monitoring will be conducted by the National Government.

(3) Implementation Plan

In the short term, a guideline for private sector investment and system will be developed with the latest information. Afterward, the programme will be put into practice. The guideline will be periodically updated in line with the enforcement of related laws and accumulation of field experiences. Table 6.2.10 below, shows the implementation plan and the detailed programme cost is in Annex 7.

Table 6.2.10 Implementation Plan (PSIIPP)

	Common Activity for each Project	1st yr	2nd yr	3rd yr	4th yr	5th yr	after
1	Information Collection	▬	▬	▬			
2	Consultation workhops		▲	▲			
3	Study visits		▲	▲			
4	Development of guidelines		▬	▬	▬		
5	Dissemination workshops				▲		
6	Operation and Monitoring,Periodical Updating guidelines					- - -	- - -

6.2.5 Human Resource and Institutional Development for Irrigation Programme

Qualified engineers and extension workers will be one of the essential factors for the success of future irrigation development. MEDIWR, MAFCRD and most of the other key stakeholders related to irrigation development have already allocated officers required for irrigation development.

However, based on the CNA survey[2] conducted by the IDMP Task Team, it can be clarified that the majority of stakeholders need to enhance their technical competencies in the fields of engineering and innovative agriculture for irrigation development because they have a limited opportunity of enhancement of their competencies.

Human Resource and Institutional Development for Irrigation Programme (HRIDIP) is therefore needed to tackle these challenges and to utilize opportunities in addressing human resource capacity development and related institutional building.

This will encompass the provision of appropriate skills, knowledge and tools/equipment for the different individual actors and institutions involved, including irrigation and drainage engineers/technicians, agronomists, governance personnel, farms, farmers Water Users Associations and other actors concerned.

(1) Outline of the Programme

HRIDIP consists of 1) provision of training opportunities and 2) establishment of a human resource and institutional development (HRID) monitoring and feedback system. The training for HRIDIP can be divided mainly into two categories: on-the-job and off-the-job trainings. Moreover, the opportunities of advanced formal education need to be provided for specified technical officers. Regarding an HRID monitoring and feedback system, it will be established for ensuring HRIDIP to be accomplished as expected as well as for improving the effectiveness and efficiency.

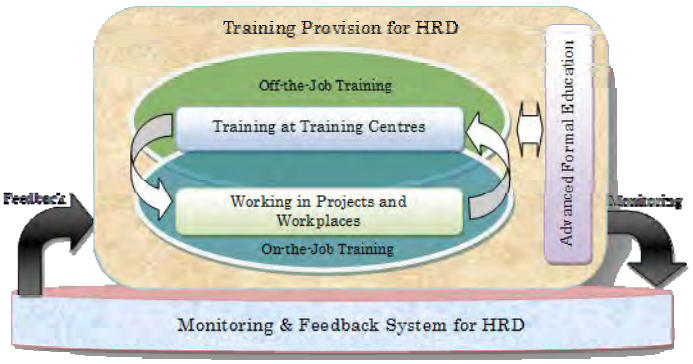


Figure 6.2.8 Outline of HRIDIP

(2) Components under the Programme

The components under this programme and the methodology and framework of the programme are described below:

[2] Section 1 Current Situation of Human Resource Capacities for Irrigation Development in ANNEX 4: Human Resource Development

1) Irrigation and Drainage Training Centre Project (IDTC)
2) HRID monitoring and Feedback system establishment project

(3) Preconditions of Planning for Components[3]

This HRIDIP has been formulated based on the current situations of the human resources, which are expected to be assigned in future irrigation development. The capacities of the human resources will be enhanced along with the IDMP implementation and through the routine work in their institutions. The life of the HRIDIP is no longer than ten (10) years.

Reviews and renewals of the HRIDIP need to be conducted every five (5) years. After ten (10) years of the implementation of the HRIDIP and the IDMP (at the time of the completion of short and middle terms of the IDMP), the capacities of MEDIWR, MAFCRD and other core stakeholders will be fostered enough for them to autonomously develop a new HRID programme.

HRID will be conducted by targeting engineers/administrators as trainees and their superiors as supervisors/trainers. The target trainees of HRIDIP will be engineers/administrators allocated from Grade 4 (deputy director) to Grade 9 (assistant inspector); and supervisors/trainers are expected to be the ones from Grade 3 (director) to 5 (assistant director).

(4) Irrigation and Drainage Training Centre Project[4]

a) The Expected Project Objective and Outputs

The expected objective for the irrigation and drainage training centre (IDTC) project is the "Promotion of innovative agriculture under irrigation through nation-wide human resource capacity development". This objective consists of the following outputs:

- Promoting innovative irrigated agriculture for RSS;
- Strengthening engineering capacities for governmental engineers/technicians (at the national, state and local levels);
- Strengthening technical capacities for extension workers (at the national, state and local levels);
- Strengthening organization capacities of Water Users Associations; and
- Strengthening famers' capacities (Supporting for irrigation scheme).

b) Necessary Inputs, Cost and Implementation Schedule

The project costs for conducting the aforementioned activities have been considered in terms of necessary facilities, equipment and human resource for the newly established IDTC, as well as other costs related to management and operation of the project. The cost items and their estimate amounts are shown in Table 6.2.11[5]. The expected duration of the project is 5 years.

Table 6.2.11 Inputs and Cost of IDTC

Items		1st Year			2nd Year			3nd Year			4th Year			5th Year			6th and After Year		
		Quantity	Unit	Total Price (US$)	Quantity	Unit	Total Price (US$)	Quantity	Unit	Total Price (US$)	Quantity	Unit	Total Price (US$)	Quantity	Unit	Total Price (US$)	Quantity	Unit	Total Price (US$)
1. ITC Construction	Specialist/consultants	17	M/M	350,000	12	M/M	245,000												
	Construction of ITC Buildings	1,200	m2	500,000	1,300	m2	420,000												
	Construction of Farms	30	ha	800,000	30	ha	650,000												
	Equipment				1	set	1,760,000												
2. HR/Training for Engineer	MEDIWR Officers	36	M/M		48	M/M		108	M/M		108	M/M		108	M/M		108	M/M	
3. HR/Training for Extension Workers	MAFCRD Officers	12	M/M		30	M/M		60	M/M		60	M/M		60	M/M		60	M/M	
4. O&M Staff								36	M/M	10,800	36	M/M	10,800	36	M/M	10,800	36	M/M	10,800
5. Supporting Specialist	Specialist/Consultants				3	M/M	60,000	28	M/M	560,000	20	M/M	400,000	9	M/M	180,000			
6. Operation Cost								1	set	76,400	1	set	76,400	1	set	76,400	1	set	76,400
Total (US$)				1,650,000			3,135,000			647,200			487,200			267,200			87,200

[3] Section 3.1 Concept of Human Resource Development for Irrigation Progurramme in ANNEX 4: Human Resource Development
[4] Section 4.1 Irrigation Training Center Project in ANNEX 4: Human Resource Development
[5] Detailed Cost Estimation are shown in Table4.1.3 in Section 4.1 of ANNEX 4: Human Resource Development.

The project is divided into two (2) phases: "Construction Phase" and "Operation Phase". In the construction phase, the IDTC buildings, facilities and equipment will be installed. In the operation phase, the ITC operation will be started. The time schedule of the project activities are shown in Table 6.2.12.

Table 6.2.12 Time Schedule of the IDTC Project Activities

Phase	Activities	1st Year	2nd Year	3rd Year	4th Year	After 4th Year
1.Construction	1-1 Design					
	1-2 Installation of Farms & Facilities					
	1-3 Construction of ITC Buildings					
	1-4 Installation of Equipment					
2.Operation	2-1 Research					
	2-2 Training					
	2-3 Publication					

(5) HRID Monitoring and Feedback System Establishment Project[6]

a) Target

MEDIWR has a training unit for the enhancement of competencies of officers to improve their service deliveries. The HRID Monitoring and Feedback System will be established and operated by the unit; and the officers working in the directorates of MEDWIR that belonged to the previous MWRI structure will be set as the target of the system.

b) The Expected Objective and Functions for the Monitoring and Feedback System (MFS)

The expected objective of the system is "Ensuring human resource capacity development through establishment of the HRID monitoring and feedback system". To achieve this objective, the following four (4) outputs should be produced for the establishment of the system.

- The HRID monitoring and feedback system designed
- Improvement of ICT facilities
- Installation of ICT equipment
- Operation of System

c) Necessary Inputs, Cost and Implementation Schedule

Estimated project cost is shown in the Table 6.2.13. MEDIWR Officers' salaries and allowances and other costs related to daily operation of the ministry are not included in the cost estimate. The duration of the project is three (3) years. In the system operation phase, the system operation will be started; the project activities and inputs will be monitored and improved.

Table 6.2.13 HRID's MFS Project Cost Estimate

Input Items	1st Year			2nd Year			3rd Year			Total Cost(US$)
	Volume	Unit-cost	Cost(US$)	Volume	Unit-cost	Cost(US$)	Volume	Unit-cost	Cost(US$)	
1. Specialist										
HRD Specialist1	7	25,000	175,000	3	25,000	75,000	4	25,000	100,000	350,000
HRD Specialist2	8	20,000	160,000	4	20,000	80,000	5	20,000	100,000	340,000
Architecture	4	20,000	80,000	-	20,000		-	20,000		80,000
ICT Specialist	3	20,000	60,000	-	20,000		-	20,000		60,000
Irrigation Engineer	1.5	20,000	30,000	1	20,000	20,000	1	20,000	20,000	70,000
River Engineer	1.5	20,000	30,000	1	20,000	20,000	1	20,000	20,000	70,000
Water Supply Engineer	1.5	20,000	30,000	1	20,000	20,000	1	20,000	20,000	70,000
Project Monitoring Specialist	1.5	20,000	30,000	1	20,000	20,000	1	20,000	20,000	70,000
2. facilities Constriction	set		140,000							
3. Equipment Procurement	set		85,000							
4. Other Operation Cost	set		12,000			12,000			12,000	36,000
Tota Cost (US$)			832,000			247,000			292,000	1,146,000

[6] Section 4.2 HRID Monitoring and Feedback System Establishment Project in Annex 4: Human Resource Development

The project is divided into two (2) phases: “Preparation Phase” and “System Operation Phase”. In the preparation phase, the system will be designed in terms of both structural and non-structural components, and facilities and equipment for establishing the system will be installed. In the system operation phase, the system operation will be started, monitored and improved. The time schedule of the project activities is shown in Table 6.2.14.

Table 6.2.14 Time Schedule of the HRID’s MFS Project Activities

Phase	Activities	1st Year	2nd Year	3rd Year	4th Year	After 4th Year
1.Preparation	1-1.System Design and Establishment					
	1-2.Orientation for Trainees and Supervisor					
	1-3.Construction of facilities					
	1-4.Installation of Equipment					
2.Operation	2-1.Priodical Monitoring by Target Officers					
	2-2.Evaluation of Annual Achievements					
	2-3.Feedback for Activities of Next Year					

6.2.6 Irrigated Agriculture Extension Programme

Since most of the farmers are practicing rain-fed farming in South Sudan, irrigated agriculture is not yet familiar to the farmers. Proper adoption of on-farm irrigation methods is especially critical for the efficient use of water to realize the maximum benefits from the irrigation. In line with the irrigation scheme development, the capacity development of farmers for irrigated agriculture is crucial. I order to provide extension services in the field of irrigated agriculture that contributes to improving the agricultural productivity and increasing the production, thereby contributing to the national objectives of improving food security, economic development, and job creation.

(1) Outline of the Programme

The programme is to develop an extension programme for irrigated agriculture and disseminate innovative farming methods to farmers with regards to irrigation and drainage. This programme particularly focuses on the capacity development of farmers for “on-farm irrigation”. As the shared responsibility mentioned in the WASH Strategic Framework, MEDIWR is responsible for allocating and delivering bulk water to irrigation schemes and MAFCRD is responsible for distributing and managing that water on farms. Therefore, the main responsible institution of this programme falls to MAFCRD.

The agriculture extension officers, irrigation technicians, irrigation agronomists, agricultural engineers and irrigation engineers especially in the State and local governments will train farmers in operating and maintaining irrigation facilities attached to the farmland and in managing on-farm irrigation systems/methods such as furrow, basin, border, sprinkler, drip, etc. The programme will ensure provision of knowledge on plant growth requirements as well as provision of skills in operation and maintenance of the irrigation facilities attached to the farm and application of on-farm irrigation techniques to farmers.

Stable water supply will enable diversification of crops and improve productivities through good land and water management practices. Therefore, the programme scope also includes the dissemination of the farming methods of various crops.

In implementing the programme, the capacity of the agriculture extension officers and extension system need to be strengthened. For these aspects, this programme needs to be implemented in cooperation with the Human Resources Development for Irrigation Programme (HRIDIP) as well as the CAMP related projects, namely “Strengthening of extension service delivery project (ID01.15)” and “Strengthening and

establishment of training institution infrastructure project (ID01.16)". The actual irrigation schemes and farms will be the venue of the interactions of these related programmes and projects.

This extension programme will be implemented in the short, medium, and long terms according to the IDMP planning phases and objective time horizons.

(2) Components under the Programme

The components under this programme are (1) Pilot project and (2) Extension of irrigated agriculture. The programme focuses on on-farm irrigation methods. While the irrigation scheme management will be conducted as a joint management of the government and farmers' organization, i.e. water users association, the on-farm irrigation will be applied by individual farmers on their farms. At the same time of irrigation scheme or farm development, the programme should be firstly piloted in the farm to train farmers on the farms by the initiative of MAFCRD and MEDIWR. Through the pilot project, methodologies of irrigated agriculture will be developed and guidelines for them will be prepared. Then as the irrigation schemes and farms increase, the extension will be carried out.

On-farm irrigation is mainly categorized into: 1) basin, 2) furrow and 3) border strip irrigations. The first two methods, namely basin irrigation and furrow irrigation would be the major application. Basin irrigation is the most common type of surface irrigation and this method is suited for any kinds of crops such as row crops, orchards, wheat, alfalfa, rice, etc., as long as water logging does not last for very long. The furrow irrigation is best suited to row crops such as maize, beans, onions, tomatoes, potatoes, etc. These kinds of irrigation methods would be the core of trainings and guideline development under this programme.

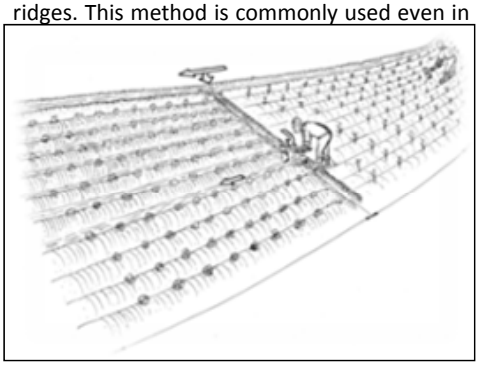
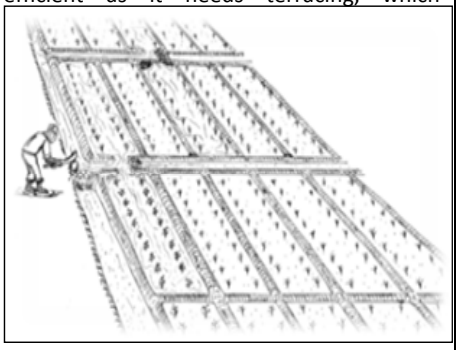
Furrow irrigation	Basin irrigation	Border strip irrigation
This method is to make furrows and ridges on the field. The water is led to the furrow that should be on a uniform longitudinal slope, and capillarity moves and lifts the water into the ridges. This method is commonly used even in 	This method is to make small basins in the field with the levelled land surrounded by raised earth dike. This is the most efficient irrigation method If th land is properly levelled. Applying slope land would be less efficient as it needs terracing, which 	This method is a combination of furrow and basin: the field is divided into long stripes separated by raised earth border. This method is hardly applied for small lands, so it does not suit smallholders' irrigation.

Figure 6.2.9 Type of On-farm Irrigation

(3) Pilot Project

a) Developing manuals for irrigated agriculture and farms drainage practices
b) Training of trainers for extension workers; irrigation technicians; and agricultural/irrigation engineers.
c) Identifying pilot sites (link with the Community Smallholder Irrigation Development Programme)
d) On-farm training to farmers and other beneficiaries/workers (WUAs) at each developed/rehabilitated irrigation scheme, on water management:

- At water facilities
- For water saving irrigation, and
- For water distribution systems.

(4) Extension of Irrigated Agriculture

a) Organizing site visit for other communities to learn from the pilot implementation
b) Developing guidelines for irrigated agriculture (on-farm irrigation) based on the pilot results
c) Prepare the dissemination materials such as posters and leaflets and disseminate through the local government offices
d) Training of trainers for operation and maintenance
e) Extending the implementation

(5) Implementation Plan

The programme basically follows the actual implementation of the irrigation scheme development from community irrigation to a national irrigation scheme. When the needs of on-farm irrigation application arise with the irrigation scheme/community irrigation farms development, the extension activity will be exercised on the farms. Identical with the community irrigation farms development programme (CIFDP), it should start as a pilot. In the course of the pilot implementation, training of trainers and development of a guideline are carried out. After the pilot, the full implementation of the schemes will start. Table 6.2.15 below, shows the implementation plan and the detailed programme cost is provided in Annex 7.

Table 6.2.15 Implementation Plan (IAEP)

	Common Activity for each Project	1st yr	2nd yr	3rd yr	4th yr	5th yr	after
1	Identification of pilot sites	▬					
2	Development of On-farm irrigation model	▬	▬				
3	Training of Extension Engineers	▬	▬				
4	Technical assistance to water users to apply the model	▬	▬	▬	▬		
5	Development of manuals			▬	▬		
6	Extension to the irrigation schemes/farms (TOT+ extension activity)				▬	▬	▬

6.2.7 Information Network System Establishment Programme

In the course of the irrigation development potential assessment, particularly for water resources assessment, the IDMP-TT faced the lack of required data albeit some significant historical data on water resources were available. It has become clear that certain points of rivers or other locations should be equipped with observation stations so that the renewal and improvement of the irrigation potential assessment will become possible in the future with higher accuracy. In this future point of view, it is indicated that IDMP should consider including a programme of a hydromet information observation system.

The importance to exchanging hydromet information of trans-boundary rivers and aquifers among the riparian countries increases in order to mitigate emergencies on a disaster level scale caused by recent climate change such as flood or draught. Also, the National Government is responsible for the allocation of water according to the availability across the country at all levels of government. However to deal with these trans-boundary issues, the number of observation stations are not enough. Due to this situation, the establishment of hydromet information observation system is important from the viewpoint of trans-boundary issues as well.

(1) Outline of the Programme

This programme is for observing and updating the nationwide water resources information for irrigation development, among others. The programme is to establish hydromet information system including the installation of observation facilities by the National Government. Information observation stations will be installed at appropriate locations and at a centralized system in order to manage data from all the stations that will be established i.e., automatic data recording on site, data transmission through mobile networks to a centralized system and data storing/arrangement/analysis by the system. A data dissemination structure will be included as well.

(2) Components under the Programme

a) Hydromet information observation system establishment

It is proposed that a Hydromet information observation system be established by installing observation and measurement stations along/across major tributaries of the River Nile in South Sudan, i.e. Bahr el-Jebel, Bahr el-Ghazal, River Sobat and the White Nile; and also to establish the same fo4 the rivers that are not connected to the Nile. The activities already initiated by the regional organizations are incorporated into the components of this programme, so that a comprehensive nationwide information network can be established.

Target items of hydromet information to be measured are river discharge, water level, sedimentation of river bed and water quality; in addition to weather data, which include precipitation, temperature, humidity, wind speed, wind direction, solar radiation, sunshine hours, evaporation and barometric pressure. Table 6.2.16 shows the components and the number of stations to be recommended to be established or rehabilitated. Tables 6.2.17 and 6.2.18 provide the detailed information about the recommended Hydrometric stations and Meteorological stations, and Figures 6.2.10 and 6.2.11 show their locations.

Table 6.2.16 River Basin Wise Components and Recommended Number of Stations

Component	Recommended Number of Stations				
	Hydrometric				Meteorological
	River discharge	Water level	Water quality	Sediment	Weather data
(A) Bahr el-Jebel Basin Hydromet Information System (HIS)	11	10	3	0	14
(B) Bahr el-Ghazal Basin Hydromet information system (HIS)	15	15	2	0	28
(C) River Sobat Basin Hydromet information system(HIS)	8	8	2	2	8
(D) White Nile Basin Hydromet information system (HIS)	7	7	2	0	9

Table 6.2.17 Recommended Stations (Hydrometric Stations)

1. Bahr-el- Jebel Basin

Term	S/N	Name	Present Status			Parameter				Equipment			Telemetry		Remarks
			Active	Inactive	New	WL	D	WQ	S	Rad	PS	SE	GPRS	Sat	
Short	1	Nimule													
	2	Mangalla													
	3	Juba													
	4	Yei at Yei													
Meddium	1	Aswa at Mouth													
	2	Kit 1													
	3	Mundri													
	4	Pagarau													
Long	1	Phom el Zeraf													
	2	Shambe													
	3	Yirol at Bridge													New Additional Station

2. Bahr-el- Ghazal Basin

Priority	S/N	Name	Present Status			Parameter				Equipment			Telemetry		Remarks
			Active	Inactive	New	WL	D	WQ	S	Rad	PS	SE	GPRS	Sat	
Short	1	Wau													
	2	Nyamlell													
	3	Tonj													
	4	Rumbek (Mvolo)													The right name is Mvolo.
Meddium	1	Pongo at Bridge													
	2	Sopo													
	3	Gel at new Bridge													
	4	Wunrok													New Additional Station
Long	1	Ibba at River Tonj													New Additional Station
	2	Maridi at River Gel													New Additional Station
	3	Awolnhom													
	4	Bentiu													
	5	Raga													
	6	Peth at river Lol													New additional station
	7	Naam at Bridge													New additional station

3. Sobat Basin

Priority	S/N	Name	Present Status			Parameter				Equipment			Telemetry		Remarks
			Active	Inactive	New	WL	D	WQ	S	Rad	PS	SE	GPRS	Sat	
Short	1	Akobo (D/S at mouth with Pibor)													
	2	Doleib Hill													
	3	Kenetti													
Meddium	1	Akobo Town													
	2	Pibor													
Long	1	Jikou													
	2	Nasir													
	3	Pibor post													

4. White Nile Basin

Priority	S/N	Name	Present Status			Parameter				Equipment			Telemetry		Remarks
			Active	Inactive	New	WL	D	WQ	S	Rad	PS	SE	GPRS	Sat	
Short	1	Malakal													
	2	Renk													
Meddium	1	Tonga (at D/S Khor Lolle mouth with White Nile)													
	2	Khor Adar (Malut)													
Long	1	Khor Fulus													New Additional Station
	2	Khor Atar													New Additional Station
	3	Khor Achiir (D/S at Mouth with white Nile)													New Additional Station

*Parameters: WL(Water Level), D(Discharge), WQ(Water Quality), S(Sediment)
*Equipment: Rad(Water Level Rader), PS(Pressure Sensor), SE(Shaft Encoder)
*Telemetry: GPRS(GSM/GPRS cellular telemetry). Sat(Satellite telemetry via EUMETSAT)

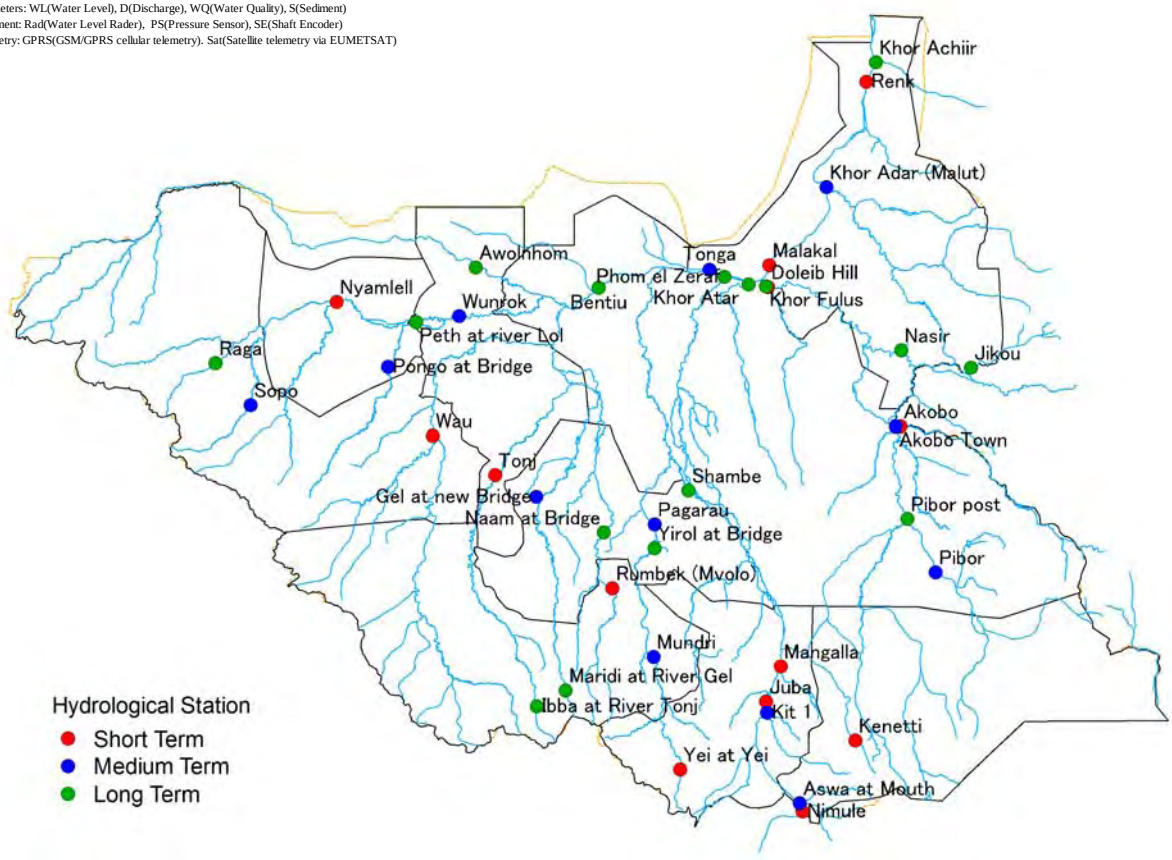


Figure 6.2.10 Location of Recommended Hydrometric Stations

Table 6.2.18 Recommended Stations (Meteorological Stations)

1. Bahr-el- Jebel Basin

Priority	S/N	Name	Present Status			Parameter		Equipment			Telemetry		Remarks
			Active	Inactive	New	Full Met	Rainfall	AWS	ARG	Manual	GPRS	Sat	
Short		Nimule											
	1	Juba											
	2	Torit											
	3	Yei											
	4	Bor											
	5	Mongalla											
	6	Lui (Mundri)											To be replace with Mundri
Meddium	1	Shambe											
	2	Fakwak (Old Fangak)											The right name of location is Old Fangak
	3	Nagi Shot											
	4	Iwatoka									NA		
Long	1	Fangak (Phom el Zaraf)									NA		To be replace with Fam al Zaraf
	2	Farajok									NA		
	3	Thar Nhom									NA		

2. Bahr-el- Ghazal Basin

Priority	S/N	Name	Present Status			Parameter		Equipment			Telemetry		Remarks
			Active	Inactive	New	Full Met	Rainfall	AWS	ARG	Manual	GPRS	Sat	
Short	1	Maridi											
	2	Yambio											
	3	Bentiu											
	4	Aweil											
	5	Rumbek											
	6	Abyei											
	7	Tonj											
	8	Gogreial											
	9	Deim Zubeir									NA		
	10	Kuajok											
	11	Raga											
	12	Wau											
Meddium	1	Meshrearreq											
	2	Na Andi (Nadiangere)											The right name of the location is Nadiangere.
	3	Tumbura											
	4	Biri									NA		
	5	Amadi									NA		
	6	Gunna									NA		
	7	Kambala									NA		
	8	Wer Ping									NA		
	9	Liyubu									NA		
	10	Mbia									NA		
	11	Mupoi									NA		
	12	Peili									NA		
Long	1	Umm Begago									NA		
	2	Raffili									NA		
	3	Pachua (Pariang)											The right name is Pariang.
	4	Na Andi											

3. Sobat Basin

Priority	S/N	Name	Present Status			Parameter		Equipment			Telemetry		Remarks
			Active	Inactive	New	Full Met	Rainfall	AWS	ARG	Manual	GPRS	Sat	
Short	1	Kapoeta											
	2	Nasir											
	3	Pibor post											
	4	Pibor											
Meddium	1	Boma											
	2	Faddoi (Waat)											To be replaced wht Waat
	3	Akobo											
Long	1	Daga Post									NA		
	2	Junguls									NA		

4. White Nile Basin

Priority	S/N	Name	Present Status			Parameter		Equipment			Telemetry		Remarks
			Active	Inactive	New	Full Met	Rainfall	AWS	ARG	Manual	GPRS	Sat	
Short	1	Kodok											
	2	Bunj											
	3	Malakal											
	4	Renk											
Meddium	1	Malut											
	2	Tonga											
Long	1	Ayod									NA		
	2	Yarkwaich									NA		
	3	Turaybah									NA		

*Parameters: Full Met(Precipitation, Wind, Temperature, Humidity, Barometric Pressure, Solar Radiation), Rainfall(Precipitation only)

*Equipment: AWS(Automatic Weather Station), ARG(Automatic Rain Gauge), Manual(Manual Rain Gauge)

*Telemetry: GPRS(GSM/GPRS cellular telemetry), Sat(Satellite telemetry via EUMETSAT), NA(No Telemery at Manual Rain Gauge)

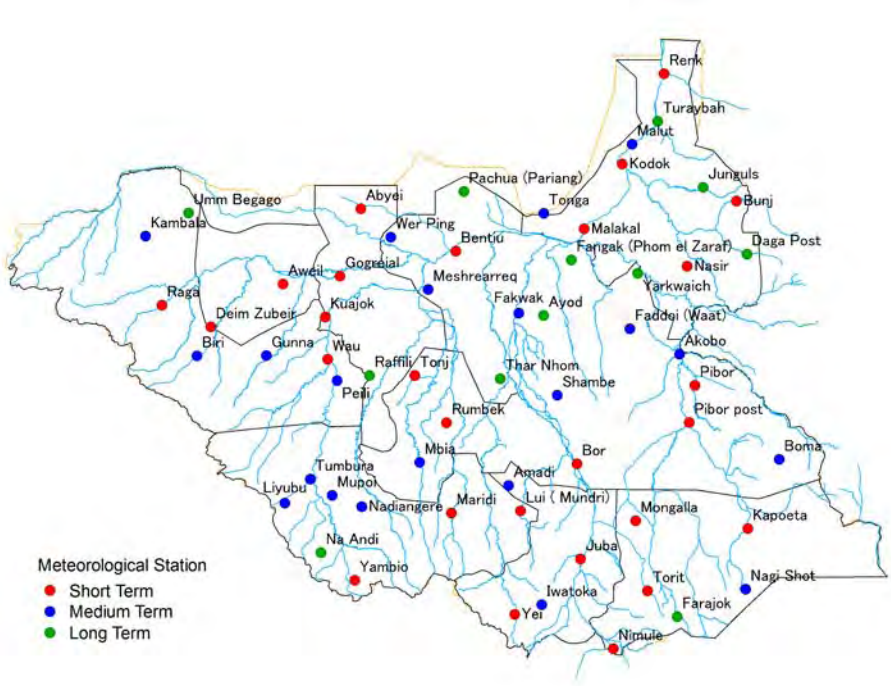


Figure 6.2.11 Location of Recommended Meteorological Stations

b) Ground water monitoring system establishment

Ground water can be one of the water sources for irrigation and the ground water potential map was created during the IDMP formulation process, however, its accuracy is not high due to the lack of available survey results and observed data. To grasp the available ground water volume with higher accuracy, an analysis of ground water is essential at first, especially for the clarification of the recharging structure. Even the available data are limited, so it can be said that a huge volume of ground water is recharged by not only rainfall but also river water. Therefore clarification of the recharging system is important in order to manage the river water as well.

Figure 6.2.12 Location of Monitoring Wells (Short-term Period)

The establishment of a ground water monitoring system will provide fundamental ground water data for the analysis. The items to be observed are ground water level (time series) and water quality. The results of the observation can contribute not only to irrigation but also to the other sectors especially drinking water. Figure 6.2.12 shows the location of monitoring wells for the short-term project. Based on the results of these wells, additional monitoring wells will be established during the mid and long-term periods.

Table 6.2.19 Outline of Groundwater Monitoring System

Component	Contents
(E) Groundwater monitoring system	- Establishment of monitoring wells - Monitor ground water level and quality

c) Information management system establishment

Observed data will be stored, arranged and analyzed to make them useful. This system will act as a main centralized system of these above systems. This system includes a dissemination function as well. This component includes the capacity development of the WIMS's staff.

Meanwhile, the Nile Basin Initiative (NBI) formulated a system called the "Nile Basin Decision Support System (NBDSS)" and promoted it to the riparian countries of the Nile. The NBDSS was formulated aiming to provide the necessary knowledge base and analytical tools to support the sharing of the Nile Basin water resources on an equitable, efficient and sustainable manner. The established centralized system of this programme will be improved to adapt to the NBDSS.

Table 6.2.20 Outline of Hydromet Information Management System

Component	Contents
(F) Regional Nile Basin Hydromet Services and a National Water Resources Monitoring System for South Sudan	- Establishment of data storing/arrangement/analysis system - Capacity development of WIMS's staff
(G) Nile Basin Decision Support System (NBDSS)	- System improvement for NBDSS

d) Nationwide maps development

At present in South Sudan, topographic maps with the scale of 1:500,000 are available. However, this scale is not enough for the planning of the irrigation project. With this scale, it is difficult to decide the command area and the location of the main facilities such as the pump station or dam and canal alignment. Additionally, detailed topographic maps will contribute to improving accuracy of water resources assessment because the detailed water delineation map can be created by these maps. Therefore, the creation of nationwide topographic maps with a scale 1:50,000 shall be proposed as one of the components of the programme.

At high resolution map has been developed for the 10% of the national land during the IDMP formulation process in order to identify the irrigation scheme development areas. The preparation of a high resolution map to cover the rest of the country should be undertaken under this programme. These nationwide high resolution maps together with nationwide topographic maps will contribute to the decision making for the irrigation project, especially to identify the target command area.

Table 6.2.21 Outline of Nationwide Topographic and High Resolution Maps Development

Component	Contents
(H) Nationwide topographic maps development	- Development of topographic maps with scale 1:50,000 - Covering area: whole the country
(I) Nationwide high resolution maps development	- Development of high resolution maps - Target area: 90% of national land (10% has been developed during IDMP)

e) Other related components

Table 6.2.22 summarizes the related components which have been initiated by the regional organisations and development partners. IGAD-HYCOS (hydrological cycle observation system) is explained in Chapter 2 to strengthen the hydrological information services of IGAD member countries. It is being designed to enhance the regional cooperation in collection, analysis, dissemination and exchange of hydrological and meteorological information for water resources assessment. Egypt has also provided a grant as bilateral cooperation for the rehabilitation of river discharge measuring stations.

Table 6.2.22 Outline of Other related Components by the Initiative of DPs

Component	Contents
(J) IGAD-HYCOS	- Provision of adequate infrastructure for hydrological observations and regional cooperation in information exchange - Upgrading 15 hydrometric stations within South Sudan
(K) Rehabilitation of river monitoring measurement network with support of Egyptian government	- Support provision for the rehabilitation of Malakal, Wau, Juba, Mongalla and Bor river discharge measurement station - Strengthen of water quality assessment and monitoring capacity

(3) Implementation Plan

The components shown above are mutually related to each other and cannot be implemented independently. Therefore, the sequence of the implementation of those components has to be taken into consideration. Table 6.2.23 below, shows the implementation plan considering the relation and sequence of each component; and the detailed costing is in Annex 7.

Table 6.2.23 Implementation Plan of Hydromet Information Observation System

Implementation Plan of Hydromet Information Observation System Establishment

Component				Short-Term 2015-2021	Medium-Term 2022-2027	Long-Term 2028-2040
(A)	Hydromet Information Observation System	Bahr el-Jebel Basin	- Installation of stations - Observation	Installation	Observation	
(B)		Bahr el-Ghazal Basin				
(C)		Sobat Basin				
(D)		White Nile Basin				
(E)	Groundwater monitoring system		- Installation of stations - Monitoring	Installation	Monitoring	
(F)	Hydromet information management system	Regional Nile Basin Hydromet Services and a National Water Resources Monitoring System	- Establishment - Operation	System Establishment	Operation	
(G)		Nile Basin Decision Support System (NBDSS)	- Establishment - Operation	System Establishment	Operation	
(H)	Nationwide maps	Topographic maps	- Creation of map with scale 1:50,000	Map Development		
(I)		High resolution maps	- Creation of maps (90% of National Land Area)	Map Development		
(J)	Others	IGAD-HYCOS	- Upgrading 15 hydrometric stations	Implementation plan is not sure.		
(K)		Rehabilitation of river monitoring measurement network with support of Egyptian government	- Rehabilitation of 5 stations	Implementation plan is not sure.		

References

i. Deng D. K., 2011, *the New Frontier: a baseline survey of large-scale land-based investment in Southern Sudan in 2011, Researched by GADET-Pentagon and the South Sudan Law Society,* Norwegian People's Aid, May 2011

CHAPTER 7 IMPLEMENTATION MECHANISM

IDMP will continuously provide information on hydrometeorology, topography, land use and other engineering aspects pertaining to water control and delivery infrastructure at some farming, aquaculture, forestry and livestock projects'/schemes' sites. As such both CAMP and IDMP will be implemented together under CAMP/IDMP Implementation Coordination Structure (ICS). Through this mechanism the government will oversee, using its systems and procedures, to ensure an efficient and effective achievement of the envisaged outcomes of the two master plans.

7.1 CAMP/IDMP Implementation Coordination Mechanism

The implementation mechanism to be used by the CAMP and IDMP implementing ministries/institutions, directorates, departments, units and organizations will allow adaptive management of CAMP/IDMP implementation process with an emphasis on results and performance monitoring in all aspects of operational, financial and human resource management.

Figure 7.1.1 shows a schematic representation of the CAMP/IDMP ICS, including national; state; and local levels legislature, executive and technocratic bodies that will have overall responsibility for CAMP/IDMP implementation coordination and facilitation. The CAMP/IDMP ICS defines levels of authority and functions given to each CAMP/IDMP related entities within a defined decision-making process of the overarching government establishment.

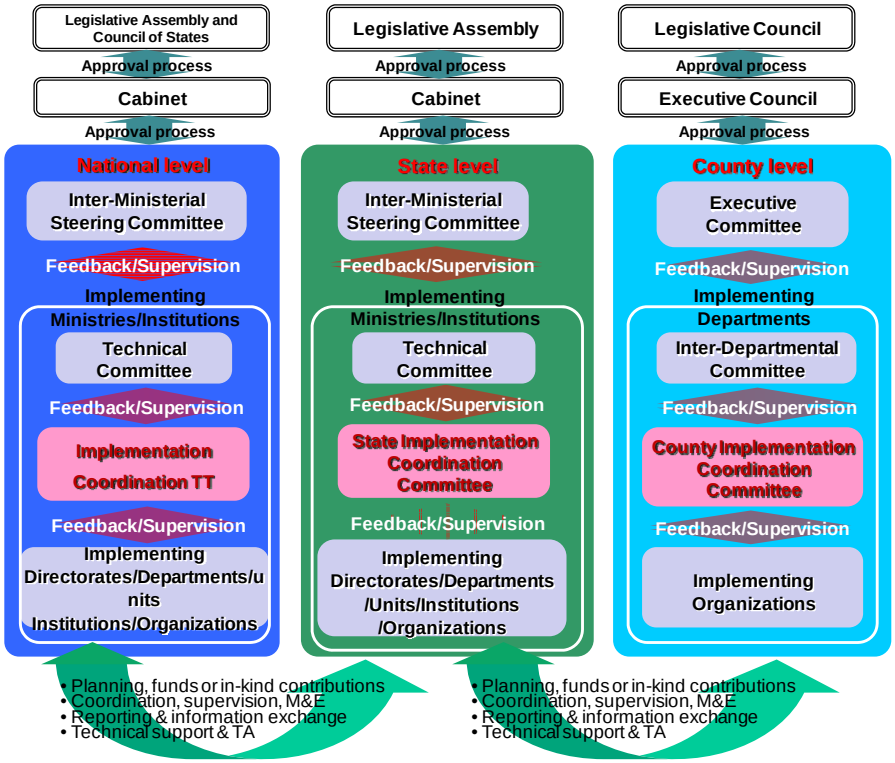


Figure 7.1.1 CAMP/IDMP Implementation Coordination Structure (adopted from CAMP-TT)

The CAMP/IDMP Implementation Coordination Task Team (ICTT) is responsible for the overall implementation coordination and facilitation at national level; and the state implementation coordination committees (SICCs) and county implementation coordination committees (CICCs) are responsible for the implementation coordination and facilitation at state and local level respectively. ICTT, SICCs and CICCs facilitate resource mobilisation of internal and external investment to

promote the implementation. They coordinate, monitor and share information on the implementation of CAMP & IDMP at respective levels and in an interface between levels. MEDIWR and the state/county line ministries, directorates, departments and units will assign personnel into ICTT, SICCs & CICCs, to facilitate the implementation of IDMP in conjunction with CAMP.

Concerning further discussion on CAMP/IDMP ISC, reference is made to the Inter-Ministerial Steering Committee Meeting held on 4th of August 2015, among representatives of the ministries in charge of the sectors related to CAMP and IDMP from national and state levels. The meeting discussed the final draft IDMP and the proposed CAMP/IDMP ICS at national, state and county levels, which was presented as shown below (Figures 7.1.2, 7.1.3 and 7.1.4 for national, state and county levels respectively). After discussion the participants agreed to the proposal as advisable compositions. ICTT, SICCs and CICCs will have similar compositions for similar functions.

The basic structure comprises of members from MAFCRD, MLFI, MEDIWR, MTII and MTRB at national level; and from their state/county line ministries, directorates, departments and units as implementing institutions; in addition to members from community organs, consultants and secretaries.

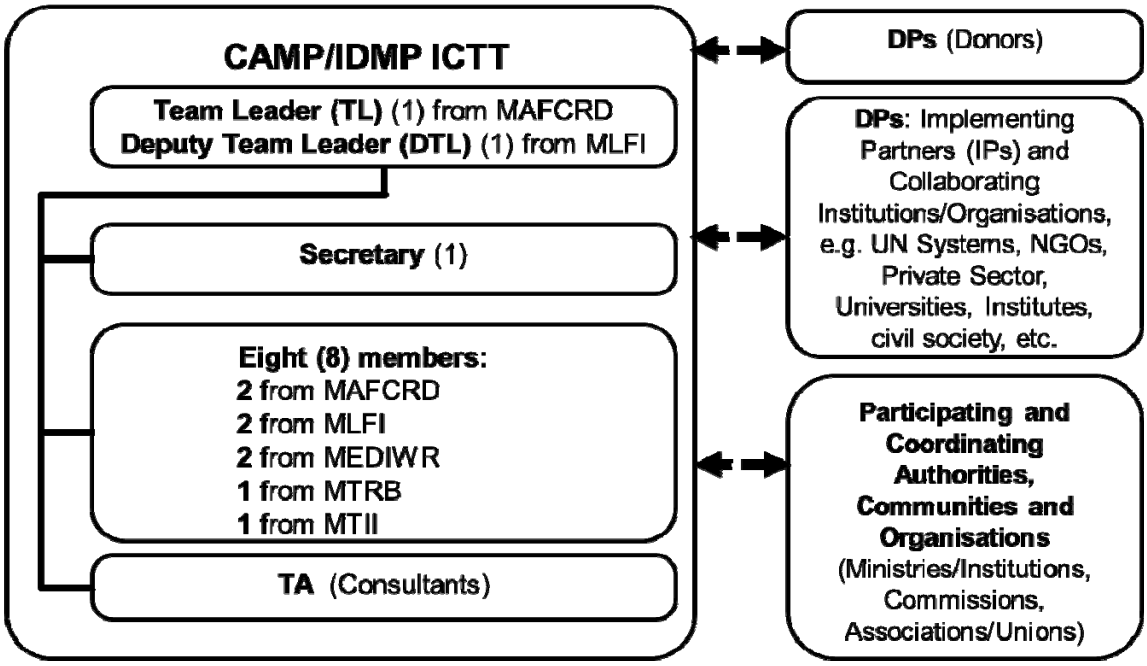


Figure 7.1.2 CAMP/IDMP Implementation Coordination Task Team (adopted from CAMP-TT)

Secretaries are expected to support basically administrative functions and the logistical tasks which include handling of communications and documentation. The Technical Assistants (TAs) or the consultants are to help in technical aspects of the ICTT, SICCs and CICCs, including preparation of annual work plan and budget (AWPB) and carrying out of M&E.

It is anticipated that development and implementing partners (donors, International Banks and NGOs, UN Systems, etc.), together with the government would support and finance recruitment of the secretaries and consultants; and DPs can directly provide technical assistants (TAs). ICTT, SICCs and CICCs, as a team, will establish a good relationship with DPs, participating and coordinating authorities and organisations, from whom they will get inputs.

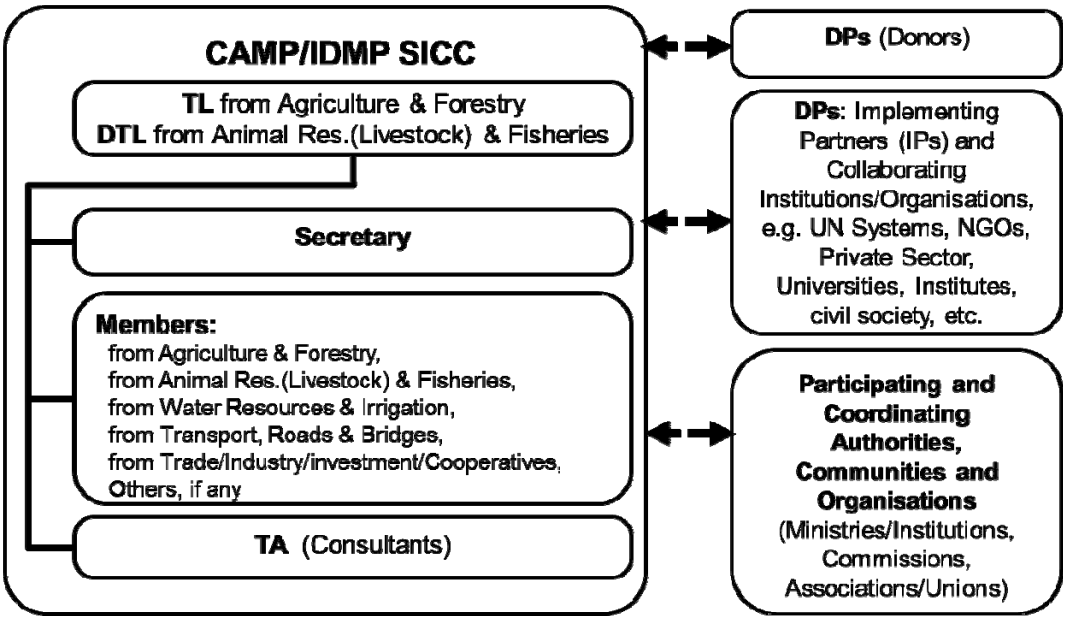


Figure 7.1.3 CAMP/IDMP State Implementation Coordination Committee (adopted from CAMP-TT)

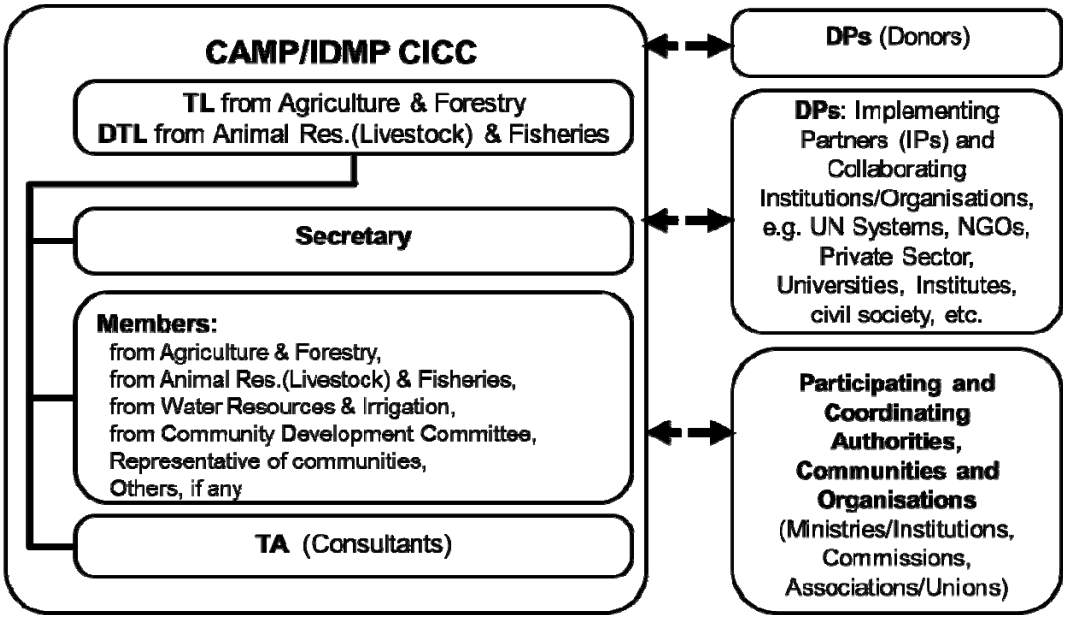


Figure 7.1.4 CAMP/IDMP County Implementation Coordination Committee (adopted from CAMP-TT)

At national level, ICTT was established in August 2015; and the SICCs and CICCs at state and county levels respectively will be gradually established according to the progress of programmes/projects implementation and actual situation in each state or county. The compositions presented here are flexible; and can be modified, based on the convenience or capacity of the government at respective levels.

7.2 IDMP Workflow under CAMP/IDMP Implementation Coordination Mechanism

CAMP/IDMP implementation coordination mechanism should be aligned with the government's Public Financial Management System (PFMS), to regulate the management of public and donor finances.

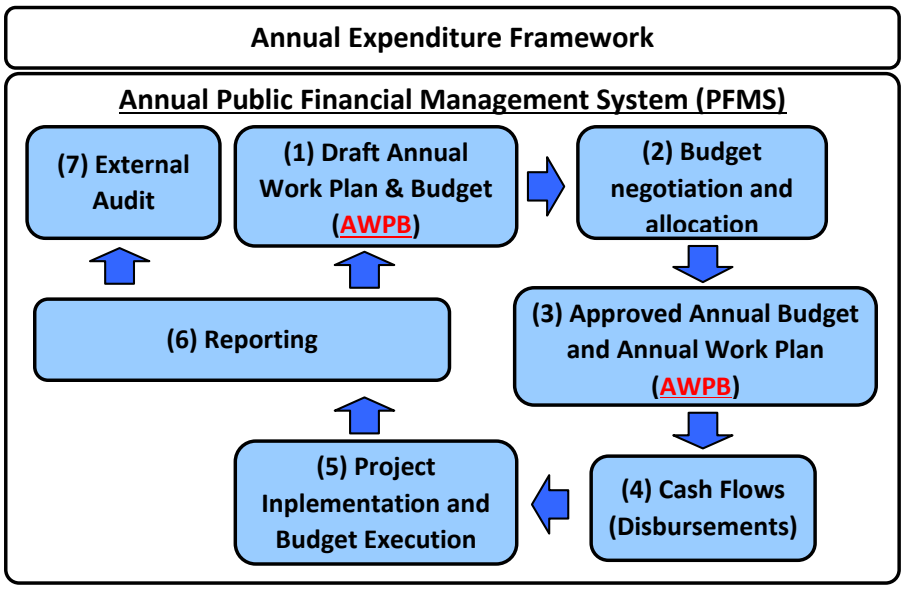


Figure 7.2.1 Public Financial Management System (PFMS): Adopted from CAMP-TT

This section describes the workflow of IDMP in its implementation under the CMAP/IDMP implementation mechanism.

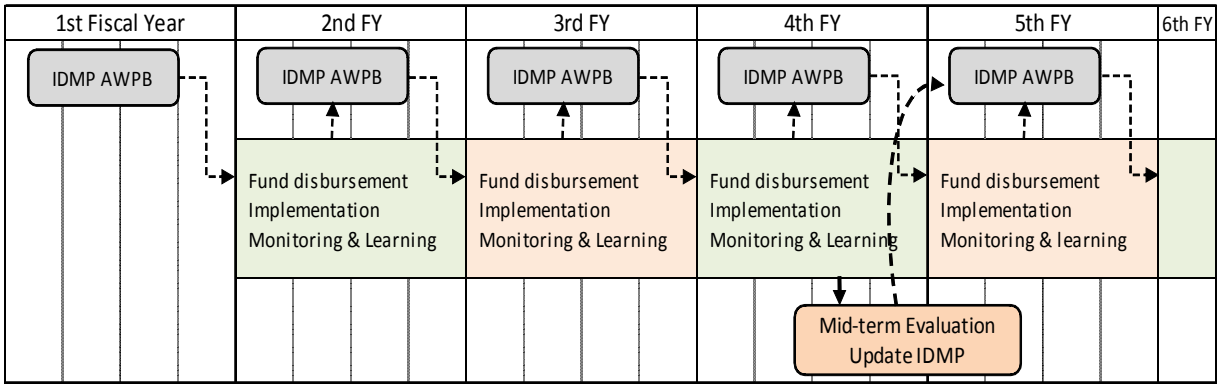


Figure 7.2.2 Proposed IDMP Basic Workflow

IDMP workflow should consist of Annual Work Plan and Budget (AWPB) and periodical update, preferably in 3-year period, taking into consideration the change of situations and progress of programmes implementation, which will make it possible to renew the priorities and to specify the details of the programmes' activities.

There are nine (9) programmes identified under IDMP, among which five (5) programmes are categorized as "Irrigation Schemes/Farms Development Programmes" with different ownership by scheme/farm, namely national irrigation schemes, state irrigation schemes, county irrigation schemes, community irrigation farms and private sector investment promotion.

The other four (4) programmes can be defined as “Soft Component Programmes” to enhance and promote these schemes/farms development efficiently and effectively. These programmes are irrigation development guidelines formulation, irrigated agriculture extension, human resource and institutional development and information network system establishment.

As described in Chapter 6, the nine (9) programmes are meant to make synergy effects with one another, to well promote irrigation development in South Sudan. To make them work as intended, the target and progress of each programme should be set and monitored. Then it is proposed to carry out mid-term evaluation in every three (3) years. As the soft component programmes make progress, it would enable to update the list of candidate irrigation scheme/farm sites and accelerate the implementation process.

7.3 IDMP Annual Work Plan and Budget

AWPB of IDMP should include all the nine (9) programmes every year. The number of the programmes, namely nine (9) ones, would be few enough to monitor the overall progress of IDMP implementation. As mentioned above, since the programmes are structured so as to create synergy effects with each other, AWPB should cover all the programmes every year to realize such synergies. AWPB should be made according to the AWPB structure shown in the CAMP report. In line with the contents of AWPB, the output and outcome setting for each programme is incorporated into the annual plan. Tables 7.3.1 & 7.3.2 below shows the annual target setting, output and outcome for monitoring and evaluation.

Table 7.3.1 AWPB Structure

Section	Elements
1. Overall project plan	Objectives, rationale, and project description
	Expected outcome
	Components and expected outputs
	Total budget including source of funds, cost items and allocation plan
	Responsible parties, time frame and other necessary information for M&E
2. Annual work plan and budget	Outcome and output review of previous year
	Planned annual activities assembled under relevant components
	Estimated budget including source of funds, expenditure items, unit costs, quantities, costs by line items, procurement method, and other information necessary for M&E for operational, financial and human resource management
	Timing and locations of activities and expenditure
3. Sub-tools	Quarterly and monthly plan, monitoring and evaluation plan, Risk assessment plan, Procurement plan, Gantt chart, Formats of monthly, quarterly and annual reports

Source: CAMP TT

Table 7.3.2 Output Setting of AWPB for Each IDMP Programme

Category	Programme	Annual Output	Budget	Responsible Dept.
Schemes/Farms development programme	NISDP SISDP CISDP PSIPP	High resolution analysis (area) Pre-F/S or F/S (names of sites) B/D and D/D (names of sites) Implementation (names of sites)		
	CIFDP	Identification of community/Area (number of sites) Implementation (number of community)		
Soft Component programme	IAEP	Identification of community/scheme/Area Implementation (number of community/site)		
	IDGFP	Topics to update		
	HRIDIP	Topics of training (number of items) Implementation (number of trainings/trainees) Number of institution established and built		
	INSEP	Installation of stations (number of stations) Data recording and update of water resources data		

Main responsible departments of the IDMP AWPB are those of MEDIWR and MAFCRD, MLFI, MTII and MTRB; but the degree of responsibility among the ministries differs according to the programmes, as discussed in Chapter 6 (section 6.1.2). It needs CAMP/IDMP implementation coordination mechanism to coordinate preparation of annual work plan and budget for the programmes, whose responsibility and inputs requires multiple ministries.

7.4 Mid-term Review and Updating of the IDMP

It is planned to carry out a mid-term evaluation in every after three (3) years implementation of the programmes and make decision whether to update the strategic programmes. The relevance of the period of the mid-term evaluation, namely three (3) year-interval will also be reviewed in the course of the IDMP implementation.

The most important aspect of updating IDMP would be the priority review of the schemes/farms development based on updated information, in order to re-allocate the limited resources. Each programme has the specific check-points for updating information and plan. To set the specific check-points facilitates the coherent evaluation, planning and implementation of IDMP. The following are the proposed procedures for mid-term evaluation and updating of IDMP:

1. Confirmation of the progress of implementation and change of situation by the check points
2. Update the water resources information.
3. Decision of updating the contents of the strategic programmes
4. Entry of candidate sites based on updated information
5. Scoring the candidate sites according to criteria
6. Update of the list of irrigation scheme sites with revised priority, and
7. Approval of Updated IDMP

1-1 Confirmation of progress and change of situation: Soft Component Programmes

Programme	Check Points
Irrigation Development Guideline Formulation Programme (IDGFP)	Enacted laws within the past 3 years Lessons from actual implementation
Human Resource and Institutional Development for Irrigation Programme (HRDIP)	Number of staff trained/engaged in practice Activated irrigation sites/areas New and types of institutions established
Information Network Establishment Programme (INEP)	Obtained recent data within the past 3 years Installed stations and obtained data
Irrigated Agriculture Extension (IAEP)	Activated irrigation sites/areas

2. Carrying out water resources assessment with updated information
3. Decision to updating of the contents of the strategic programmes

1-2 Confirmation of progress and change of situation: Schemes/farms Development Programmes

Programme	Check Points
National/State/County Irrigation Schemes Development Programmes Community Irrigation Farms Development Programme (CIFDP) Private Sector Investment in Irrigation Promotion Programme (PSIIPP)	• Progress of implementation • Requested scheme sites from State/County/Community/Private Sector within the past 3 years • Updated water resources potential data

4. Entry of candidate sites based on updated information

5. Scoring of the candidate sites according to criteria

6. Update of the list of irrigation scheme sites with revised priority,

7. Approval of Updated IDMP

Figure 7.4.1 Proposed Mid-term Evaluation Process

Basic data to be updated are mainly the river network diagrams (Chapter 2: Irrigation Development Potential Assessment, Section 2.3: Water Resources Potential Assessment) and the list of proposed irrigation schemes (Chapter 6: the Programmes, section 6.2.2: implementation aspects of schemes development programmes).

CHAPTER 8 IMPLEMENTATION PLANS FOR PRIORITY PROJECTS

This chapter highlights and summarizes the implementation plan for the priority projects. On the basis of Chapter 2 (Irrigation Development Potential Assessment) and Chapter 6 (Programmes), three (3) priority project sites, namely Wau, Jebel Lado and Rejaf East have been selected through GIS/RS (high resolution) analysis and other factors mentioned below under Section 8.1. The detailed plan is attached as Annex 9 and it includes field and socio-economic surveys analysis and results; and an initial environmental evaluation (IEE). The lessons learned from the formulation process and experiences elsewhere have been reflected in the preliminary irrigation development guidelines of this Master Plan.

8.1 Objectives for the Preparation of Priority Projects

This exercise was embarked on by the IDMP TT during the formulation process, to set basis for implementation of the master plan through conducting of prefeasibility studies for realization of irrigation projects.

In addition, it was also designed to strengthen the capacity of RSS-TT members through knowledge gaining on agricultural, economic, environmental and social planning aspects; and in providing skills on engineering methods and other related technical works pertaining to irrigation schemes.

Candidate areas for priority projects are shown in Figure 8.1.1, which are 1) Mohamed Ajak for the North Area, 2) Jebel Lado for the South Area and Pacung for the South-west Area as the 1st list within the 10% of high resolution areas. In addition, 4) Lafon and 5) Kapoeta were selected out side of 10% to represent mountainous zone.

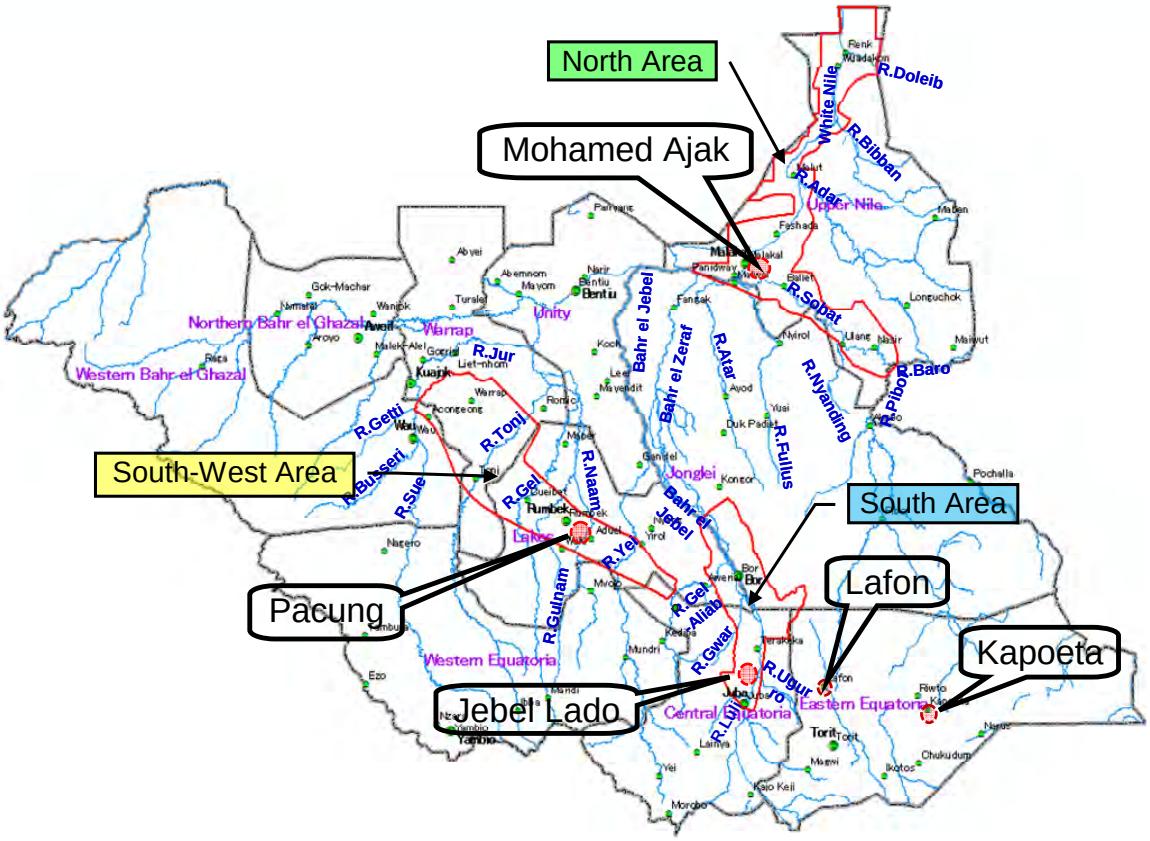


Figure 8.1.1 Identified and Prioritised Project Areas within the North, South and South-west High Potential

(1) Adopted criteria for the selection of priority projects

a) Areas within the 10% for high resolution satellite imagery assessment;

b) The current existing schemes;

c) Accessible areas;

d) Availability of a water source or possibility of controlling water;

e) Proposed/agreed schemes by national/state/county government/authority or communities;

f) Proposed irrigation development schemes in the old Sudan master plan, CAADP, NBI, IGAD, etc.;

g) Proposed areas should not have a record of conflict over land use; and

h) The scheme must be the one that can contribute to national goals, e.g. food and nutrition security and economy growth/development.

(2) Selection of the priority project areas

Due to the on-going conflict, security reasons, accessibility and irrigation potentiality; 1) Wau, 2) Jebel Lado and 3) Rejaf East were selected as priority projects for preparation, i.e. carrying out of Prefeasibility Study (Pre-F/S).

Wau and Rejaf East were not initially in the 1st list, but added due to the reasons above; and they also fall within high irrigation potential areas.

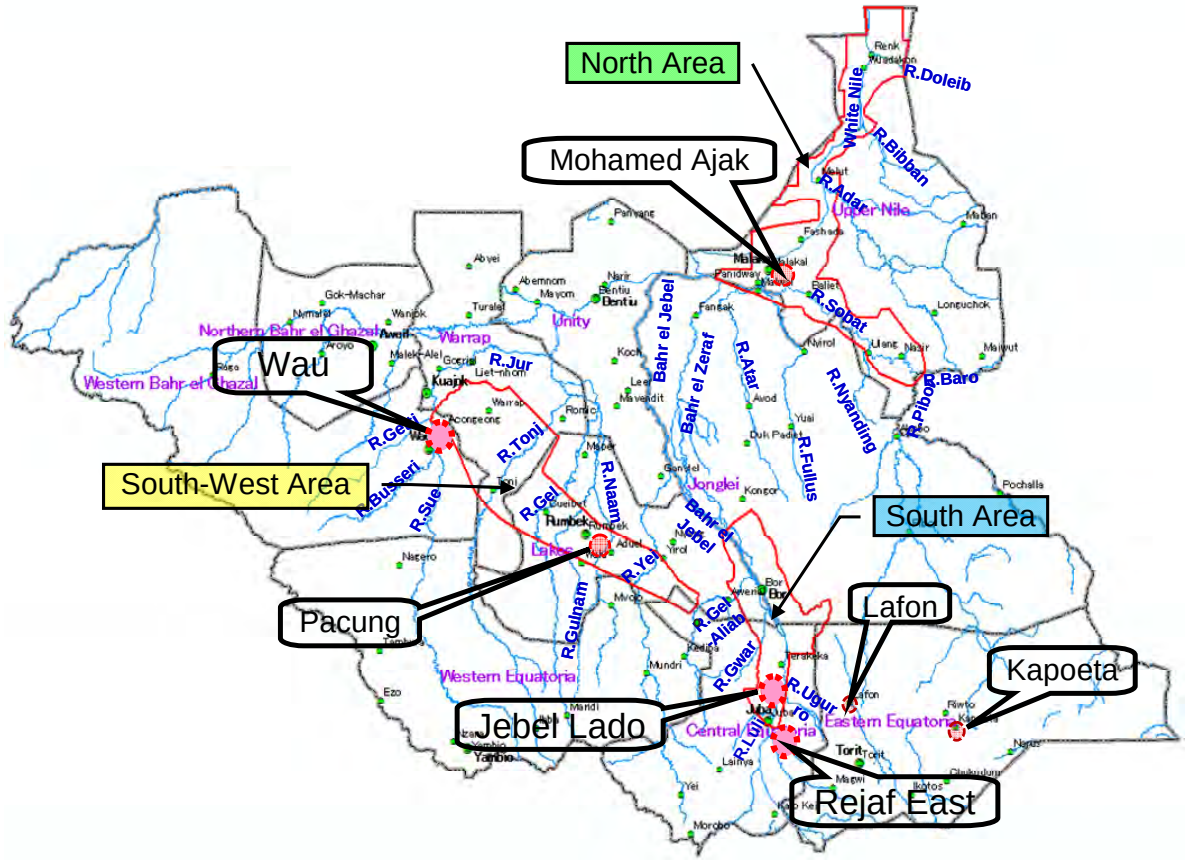


Figure 8.1.2 Selected Priority Projects

8.2 Present Situation of the Projects' Areas

Based on natural conditions; socio-economics; agricultural practices and plans; and development constrains and potential, the profiles of identified three project sites have been given in Table 8.1.1 Profile of the Project Areas.

8.2.1 Sites' Profiles

Following Table 8.2.1 summarizes the profiles of the project sites.

Table 8.2.1 Profile of the Project Areas

Site Name	Wau	Jebel Lado	Rejaf East
Location	Just east of Wau city.	20 km north of Juba, left bank of Bahr el-Jebel	Just south of Juba, on the right bank of Bahr el-Jebel
Water Source	River Jur	Bahr el Jebel	Bahr el-Jebel
Command Area	500 (ha)	1,330 (ha)	960 (ha)
Land Tenure	Government and community	Nyuwa and Peiti communities	Guduge, Migiri and Mugoro communities
Population (Related Community)	About 24,000 (Total population of Panamet Kuanya and eastern part of Wau Municipality) *Kuanya is located near the proposed dam site and Panamet is located north of Command area and Wau municipality is south.	About 2,800 (Total population of Nyuwa and Peiti)	N/A (Total population of Guduge, Migiri and Mugoro)
Surrounding Situation	Located close to Wau city, where there is much demand for agricultural produce. Land development for agricultural production project in Wau and Aweil, supported by UNDP and FAO, was started in 1974. One of the target crops was paddy. However, no activities in Wau irrigation scheme have been carried out, because Aweil Irrigation scheme has not yet worked properly yet.	Located close to Juba, where there is high demand for food supply due to its large population. Hence, there is a high potential to generate cash income by producing cash crops. Especially, leafy vegetables, which are not imported because of its perishability, are likely to make a good profit.	Also, located in the vicinity of Juba, where there is high demand for food supply due to its large population. Hence, there is a high potential to generate cash income by producing cash crops. There are some farmers who have already been cultivating crops by irrigation using portable pump. Land holding there is complicated, hence needs careful consideration.

Figure 8.2.1 Location of Wau Irrigation Scheme Project Site

Figure 8.2.2 Location of Jabel Lado Irrigation Scheme Project Site

Figure 8.2.3 Location of Rejaf East Irrigation Scheme Project Site

8.2.2 Natural Conditions

Natural condition surveys consisting of topography, geology and soil were carried out in the target project areas. In the target field, the surveys were carried out by sub-contracting with survey companies except for soil survey, which was carried out by the RSS-TT. Table 8.2.2 below summarizes the natural conditions of the project areas.

Table 8.2.2 Natural Conditions of the Project Areas

Area / Feature	Wau	Jebel Lado	Rejaf East
Topography	Command area is located beside Wau town, and has the feature of bare land without planting in the flood plain. The land is approximately flat and the land gradient toward right bank of River Jur shows around 0.2% slope. Dam site is located 9.5-km from Wau town at the eastern banks of Jur and River Swe. The land cover in the site is bushes and grasses. Pump station and canal line are located between the command area and the dam site. There are trees, small communities, farms, etc. along the line.	Command area is located 3.5-km from Bahr el-Jebel. Bushes, trees and grasses dominate in the site. Generally, the terrain is almost flat and the land gradient towards the west from left bank shows around 0.9% slope. Pump station site is located beside Bahr el-Jebel. The land is almost bare, but some trees exist. In the pipe line and canal line, there are community roads among some small communities, bushes and trees, etc. along the lines.	Command area is located at the right bank of Bahr el-Jebel and stretch 2-km toward the hillside. The terrain between riverside and Juba-Rejaf-Nimule Road is flat, and many small irrigation farms are scattered along the river. The terrain of hillside is undulant, and many bushes, trees and grasses dominate in the site. Pump station site has some big trees. In the pipe line and canal line, the conditions are almost the same as the command area.
Geology	In the dam site, dense/ very dense layer such as sand, gravel and rock are distributed below the depth of 6-m at dam centre and right side. The soils are classified into silty sands (SM) and Clay loam (CL), which are useful for dam embankment materials. In the canal line, clay or silt layer covered the ground surface and the subsurface soils are predominantly sand. According to N value (as per soil penetration test, SPT), these soils are generally suitable for the foundation of structures.	In the pump station site, the subsurface soils are predominantly sandy clays (SC) and poorly graded sands (SP). Bearing capacity, ranges from low to middle for the foundation structures. In the canal line, the subsurface soils vary by area, such as sands (SP and SC) to gravels (GW), inorganic clays of high plasticity (CH)) and silty sands (SM). Bearing capacity is high for the foundation of structures.	The pump site area is covered by thick (3 m - 8 m) layer of soils（ML, CL, SM, SC, SP）, the River deposit along the river bank and the base rock is Gneiss. The command area is covered by relatively thin (2m-3m) layer of soil (SW). There are outcrops of sound bed rock in the command area. The rock underlying the thin soil layer is moderately weathered Gneiss and is found slightly weathered and well jointed granite.
Soil	Its texture ranges mainly from Loam to clay loam. Orange coloured mottles of oxidized iron were observed on the section, indicating the area has been flooded and dried up repeatedly. High clay soil in deeper layer can help maintain water in rooting zone. Phosphorus and Magnesium are not contained enough, which should be supplemented by fertilizer. Soil pH is relatively low. It should be modified because soil acidity can constrain nutrient absorption by crop.	Its texture ranges from Clay loam to high clay, while soil near small streams, ranges from Sandy loam to Silt loam. Soil pH is relatively high, tends to be alkaline. It should be modified because pH directly affects the availability of nutrients in soil. Relatively fertile with high content of humus and caption exchange capacity (CEC). It allows cultivation of various crops with appropriate control of soil pH.	Its texture mainly ranges from Sand to Loam, which relatively tends to be sandy in texture compared to the other 2 sites. Soil pH values were mainly from 6.0-7.1, which is suitable for common vegetables, however, one point showed 8.9 so that some points in the area would have to be managed by pH modification. Humus content ratio and other nutrient contents vary; however Phosphorus, Magnesium and potassium contents tend to be low at some points.
Hydrology	Annual rainfall is about 1,100mm, and annual river discharge of R. Jur is about 5,100 MCM. In rainy season, irrigable area is flooded by water from the river.	Annual rainfall is about 1,000-mm. Bahr el-Jebel has dependable source of water for irrigation water, as it is a perennial river.	Annual rainfall is about 1,000-mm. Bahr el-Jebel has dependable source of water for irrigation water, as it is a perennial river.

8.2.3 Socio-economic

Socio-economic survey including agricultural survey was carried out by the RSS-TT. The survey was carried out with interviews to key-informants of the project areas and questionnaire survey to the community members in the areas. The questionnaire survey was conducted to 26, 23 and 26 samples in Wau, Jebel Lado and Rejaf East respectively. The following table summarizes the socio-economy in and around the project areas:

Table 8.2.3 Farmers' Capacity in the Project Areas

Wau	Jebel Lado	Rejaf East
Farmers in the community have an experience of irrigated farming along river using buckets in the dry season. They cultivate tomatoes, eggplants and okra. They are currently cultivating cereals such as maize, millet, sorghum, rice and cash crops such as sesame and vegetables. Their produce is sometimes not enough even for their own consumption due to small farmland.	There are 2 communities and one of them has an experience of irrigated agriculture using buckets near the river. They are currently cultivating staple crops, such as maize and sorghum mainly for consumption, while vegetables mainly for selling. It seems they have potential to cultivate cash crops in the dry season.	There are 3 communities. Some farmers are practicing irrigated agriculture using small pump along the Bahr el-Jebel and they are cultivating bananas and vegetables, which are mainly for selling. It seems they have potential to cultivate cash crops in the dry season.

8.2.4 Agricultural Practices

(1) Farming Area and Land Use

Table 8.2.4 shows the average land holding size of the sample farmers in each project site. The average land holding sizes of the projects sites are 2.8 ha (6.7 feddan), 1.8 ha (4.3 feddan) and 2.3 ha (5.5 feddan) in Wau, Jebel Lado and Rejaf East respectively. Among the lands, around 80% to 85% are used for farming. It is reported that only one farmer owns a tractor in Wau among all the samples of the three (3) sites and few farmers rent the tractor for cultivation from the governments or community. This indicates the practice of extensive agriculture considering the size of the lands.

It is significant that on average about a half of the farm land is irrigated in Rejaf East, while the share of irrigated land in other sites is low. The farmers in Rejaf East have been practicing irrigated farming along the Nile with individual portable pumps. However, as it is shown in the following section, the farmers practicing farming in the dry season are still limited, partly due to the fuel cost of the pump.

Table 8.2.4 Average Farm Land Area (ha/Household)

	Total area (ha/household))						
		Irrigated		Non-irrigated		Homestead	
Wau	2.8	0.1	(3.0%)	2.3	(83.6%)	0.4	(13.4%)
Jebel Lado	1.8	0.25	(14.0%)	1.3	(72.0%)	0.25	(14.0%)
Rejaf East	2.3	1.1	(49.1%)	0.7	(29.1%)	0.5	(21.8%)

Adopted from: IDMP TT (Socio-economic survey, 2015)

(2) Present Cropping Pattern

Figure 8.2.4 shows the share of cultivated crops in each site. Overall cropping intensity is around 80% in Wau and Rejaf East and 95% in Jebel Lado. It is evident that the farmers are cultivating only during or around the wet season and while dry season crop is still minor even in Rejaf East, though half of the land of the sample farmers is reported as irrigated. Major crops are maize and sorghum and the share of groundnut is significant in Wau, while the share of the vegetables in Jebel Lado and Rejaf East are relatively high. Figure from 8.2.5 shows the present cropping pattern in Rejaf East. The patterns in other sites are attached in Annex 6 and they are more or less similar to the one in Rejaf East.

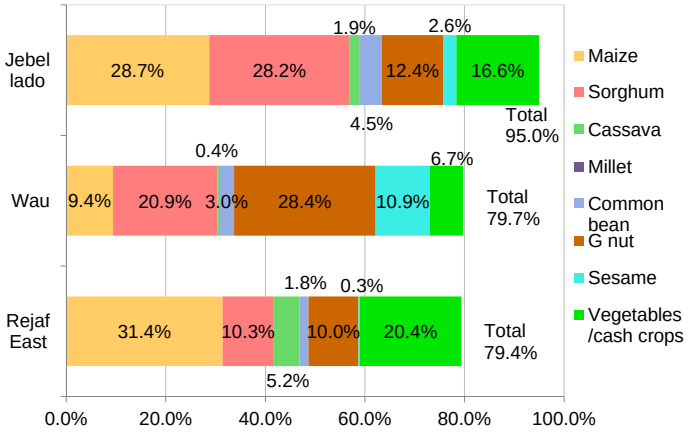


Figure 8.2.4 Share of Crops and Cropping Intensity

(Adopted from: IDMP-TT Socio-economic Survey, 2015)

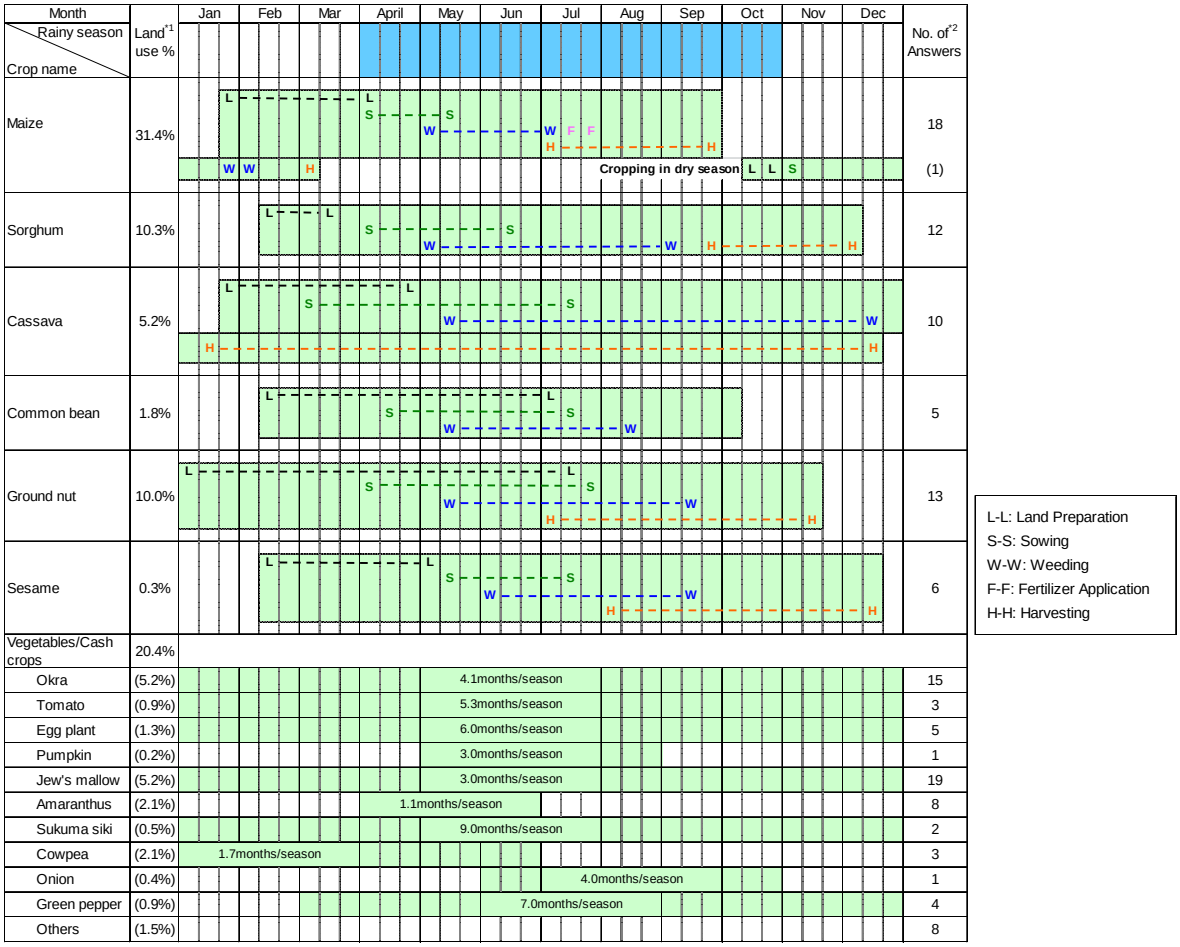


Figure 8.2.5 Cropping Pattern in Rejaf East

Adopted from: IDMP TT (Socio-economic survey,2015)

*1: Parenthesized numbers show the breakdown of the above percentage.

*2: Parenthesized numbers shows the breakdown of the above number

*3: Cultivation period of vegetables shown in the figure above, is the average period of each crops' samples.

(3) Productivity

Table 8.2.5 shows the average unit yield of major crops in each project area. Generally the yield level is low because of depending mainly on rain-fed farming, little use of agro-chemicals, mostly limited home seed-raising (low yielding variety and poor quality seeds), etc. But this would show the potentiality of drastic increase of yield with the improvement of farming practices, e.g. through irrigation, inputs, cultivation methods, etc. For instance the yield levels of maize and sorghum could be expected to reach 3 to 4 t/ha with irrigation.

Table 8.2.5 Average Crop Yield in the Project Sites

Crop	Wau (t/ha)	Jebel Lado (t/ha)	Rejaf East (t/ha)	Total No. of sample	Average (t/ha)
Maize	0.8	0.7	0.7	49	0.7
Sorghum	1.3	1.2	0.9	38	1.2
Cassava	1.4	1.6	1.6	10	1.6
Common bean	0.6	0.9	0.3	10	0.6
Groundnut	1.6	1.7	0.8	45	1.5
Sesame	0.6	0.3	0.5	21	0.6
Vegetables					
Okra	1.0	2.8	1.1	42	1.8
Tomato	2.5	2.4	3.6	14	2.8
Egg plant	2.1	-	1.8	6	1.8
Jew's mallow	2.1	5.0	2.2	35	3.1
Onion	2.4	-	2.9	3	2.5
Amaranthus	-	3.2	3.2	12	3.2
Cowpea	-	0.8	0.7	6	0.8
Green pepper	-	-	0.8	4	0.8

Adopted from: IDMP TT (Socio-economic survey, 2015)

(4) Profitability

Table 8.2.6 shows the calculation of the average net income per hectare by crop in each project area. The net income was calculated with the averages of yield, farm-gate price, and production cost in each area. The net incomes of staple crops, namely maize and sorghum are relatively higher in Wau mainly due to high farm-gate prices there. The net incomes of the vegetables are relatively higher in Jebel Lado and Rejaf East, which may be caused by high demand in the capital city, Juba.

Table 8.2.6 Average Net Income per ha by Crop in the Project Sites

Crop	Wau (SSP/ha)	Jebel Lado (SSP/ha)	Rejaf East (SSP/ha)	Total No. of sample	Average (SSP/ha)
Maize	4,880	2,581	2,465	49	3,309
Sorghum	6,142	3,860	3,682	38	4,561
Cassava	6,286	9,320	7,559	10	7,772
Common bean	2,289	4,497	1,364	10	2,717
Groundnut	6,454	5,519	2,966	45	4,980
Sesame	2,778	1,392	2,400	21	2,190
Vegetables					
Okra	6,166	14,680	9,005	42	9,950
Tomato	6,292	11,759	14,909	14	10,987
Jew's mallow	5,594	17,079	9,210	35	10,628
Onion	4,538	-	5,800	3	5,169
Amaranthus	-	7,796	7,669	12	7,748
Cowpea	-	2,337	2,345	6	2,341
Green pepper	-	-	10,029	4	10,029

Adopted from: IDMP TT (Socio-economic survey, 2015)

8.2.5 Existing Development Constraints

Table 8.2.7 summarises the problems raised from the sample farmers for the socio-economic survey. It shows that the damage from pests, diseases and animals are major concerns of the farmers in the three (3) areas. Also, the water shortage concerns have been raised as a major issue by the farmers.

Below are the existing constraints for irrigation development in the three (3) project areas based on situation analysis as well as the result of the socio- economic survey:

Table 8.2.7 Problems of Farming in the Project Areas

Problems in farming	Wau	Jebel Lado	Rejaf East	Total	Rank
Water shortage	22	17	20	59	2
Drought damage	18	10	13	41	9
Low yield of crops	17	15	12	44	6
Drainage problems	8	8	12	28	13
Damage by pests and diseases	23	19	24	66	1
Weed damage	18	9	15	42	7
Damage by wild animal	22	19	18	59	2
Difficulty in hiring animal/mechanical power	10	10	6	26	14
Labor shortage	9	4	8	21	16
Difficulty in obtaining seeds	15	10	5	30	12
Difficulty in purchasing agro-chemicals	8	14	12	34	10
Difficulty in purchasing fertilizer	10	6	10	26	14
Lack of farm roads	19	17	14	50	5
Damage by domestic animal	18	19	15	52	4
Shortage of selling opportunity	17	15	10	42	7
Lack of storage facilities	14	10	10	34	10
Problems related to loans	11	5	5	21	16
Others	5	1	11	17	18
Total	264	208	220	692	

Adopted from: IDMP TT (Socio-economic survey, 2015)
* The questionnaire allowed multiple answers to the interviewee

(1) Promotion of Irrigation Development

According to the socio-economic survey, problems related to water such as water shortage, drought damage and drainage problem are recognized as common issues in the three (3) project areas. Irrigated agriculture is not much practiced in the three (3) areas; therefore, awareness creation activities for irrigation development may be required as a solution for water problems.

On other hand, some of farmers in related communities in the three (3) areas have an experience of irrigated agriculture, especially in Rejaf East, which means it would be easier for them to learn how to manage irrigated agriculture compared to farmers with no experience. Therefore, the intervention for irrigation development could incorporate cooperation mechanisms with these farmers to disseminate the significance of the irrigation to the other concerned communities.

(2) Farming Technology with Input Application

Almost all the farmers in th**e** related communities of the three (3) areas have no practice of agro-chemical (fertilizer, pesticide, etc.). This fact could be making the problem of pests and diseases more serious to the farmers, as this problem was raised as the most concern for the farmers in all the three (3) areas.

Hence, it would be necessary to train farmers to apply such chemicals properly and promote the agro-inputs industry for easier procurement and supply. Irrigation scheme development could encourage such entrepreneurs to run the business of agro-inputs.

Soil management such as pH control should also be conducted at implementation stage in the future, as the result of the soil survey indicates the necessity of pH control and other treatment, to improve the soil fertility. Especially the irrigation will enable the farmers' year-round cultivation, i.e. cropping in both wet and dry seasons. This will also bring the issue of maintaining the soil fertility, so both the soil and water management will be crucial.

(3) Advantages for Marketing

Three (3) priority project areas are located near the big cities, namely Juba and Wau, where there is high demand for food supply and there are various market places. Therefore, there is an opportunity to grow and sell the agricultural produces. Especially perishable vegetables are prospective ones to sell to the city markets, since the perishables are less advantageous for long distance transport coming from outside the country.

Also dry season crop is still minor in South Sudan and therefore, the farming in the dry season will have a big advantage for profitable selling price for farmers. As in all the three (3) areas, there are water sources to irrigate during the dry season. This potential could be tapped for irrigation development.

(4) Farm Road Conditions

The farmers also raised the problem of lack of farm roads as a high concern in all the three (3) areas. The priority project areas are close to the cities, i.e. the trunk roads have been improved, but the feeder roads from farms to the trunk roads are not well constructed. This fact would hinder the promotion of cash crop cultivation in the areas. Irrigation scheme design therefore, should include the farm roads along the canals (link to the trunk road where appropriate), which can contribute to mitigating the problem of the roads.

8.3 Irrigation Scheme Plan

This planning is carried out based on delineation of roles and responsibilities among organisations and stakeholders involved as captured in Chapter 5, Section 5.6.

8.3.1 Institutional Set-up of the Irrigation Scheme

All the three (3) planned priority schemes, namely Wau, Jebel Lado and Rejaf East Irrigation Schemes will be developed under the National Irrigation Scheme Development Programme (NISDP). The NISDP is owned by the national government with large/medium scale command area. They were initiated under the IDMP process at national level; but states, counties and communities concerned were involved in implementation planning and irrigation facilities are to be developed by the national government.

(1) Category of Irrigation Scheme

Definition of the NISDP is summarized in Table 8.3.1 below.

Table 8.3.1 Categorization of Irrigation Scheme Development

Programme	Scheme /Farm Size	Definition	Responsible Organization for Land Allocation	Technical Assistance	Ownership	Capital Investment i.e. funding source for implementation	O&M (short-medium term)/a	Supervision of Scheme/Farm and Management (short-medium term)/b
National Irrigation Scheme Development Programme (NISDP)	500 ha or more	Large scale	National/ Community	National/ DPs/ NGOs	Land property acquired by National Government	National/Private Sector (Bank)/ International Development Bank/ DPs (grant)	National/IB/ WUA	National

Note: a/ Operation and maintenance of irrigation schemes/farms could transfer irrigation boards (IBs), water users' associations (WUAs), farmers in medium to long-term, depending on their capabilities; b/ Supervision of scheme/farm management could transfers to states' governments, local governments and community development committees in the long-term, depending on their capabilities.

(2) Division of Role in an Irrigation Scheme

MEDIWR takes primal responsibility to develop the three (3) schemes, from planning, designing, implementation, and O&M. The line ministries/institutions at national and state level; and the local governments also play key roles in irrigation development planning in terms of coordination and M&E of the irrigation programmes/projects.

Community participation in planning, implementation, operation and maintenance of on-farm level irrigation scheme is a key for successful implementation of the irrigation schemes. In some cases, land belongs to communities, and the government cannot start any irrigation development procedures without permission and participation of communities. Table 8.2.2 shows the role and responsibility for implementation of the three (3) priority schemes/projects.

Table 8.3.2 Role and Responsibility of Programme and Project Implementation

Type of programme/project	Responsibilities				
	National Government/DPs	State Government/DPs	County or LG/DPs	Community /DPs	Private Sector
National programme/project (Nationally planned and nationally implemented)	・Planning ・Financing ・Implementation ・M&E	・Coordination ・M&E	・Coordination ・M&E	・Contribution ・Coordination ・M&E	

(3) Private Sector Involvement

In irrigation development, there are several types of private sector involvement, including participatory irrigation management (PIM), irrigation management transfer (IMT), and public private partnership (PPP). In RSS, a well-structured irrigation development under the current government has just started through the IDMP, and establishment of organizational structure and capacity development of the government officials are progressing at the national level. Technical and administrative capacity development at state, county and community level will be conducted afterward.

When we consider current constraints on irrigation development including sophisticated land holding system, capacity of the government in terms of financial and human resources, introduction of PIM must be necessary to promote the irrigation development nationwide.

In this regard, community participation in irrigation development should be considered right from planning stage till operation and maintenance of irrigation facilities. Therefore, water users association (WUA) by the community beneficiaries is planned to be established. The shared management between the government authorities and communities in form of WUA is the suitable institutional arrangement for the schemes.

8.3.2 Agricultural Planning

(1) Basic Concept of Agricultural Planning for the Priority Project Areas

The priority project areas will be the model of irrigated agriculture in RSS in future after IDMP actual implementation starts. Therefore, the farming plans of priority projects should be formulated so as to contribute to the strategic plans and policies related to agriculture sub-sectors, e.g. in SSDP/SSDI and ASPF as mentioned in Chapters 3, 5, 6 and Annex1.

In addition, it is necessary to examine the agricultural potential of each project area from various aspects, such as natural conditions, marketing of agricultural products, and beneficiaries' capacity and their technical potential. To make farming systems of the priority projects to follow the above strategic plans of the government, the following should be incorporated into the farming plans.

- Mechanized and intensive farming system
- To grow staple crops for subsistence
- To grow commercial crops for cash generation

(2) Proposed Cropping Pattern with Project

With setting the above as the basic concepts of farming plan for the priority projects, crops to be cultivated and cropping pattern for each area are examined considering the specific conditions in each area. The following describe the specific conditions of the three (3) project areas and the planned cropping patterns in figure as the result of examining the specific conditions:

a) Wau

The target area is public land. Hence, settlers from outside could be the beneficiaries, but it is highly recommended to involve the communities around the scheme to share the benefits of the project. Assuming the above situation, organized farming plan would be suitable for new settlers as they have no social connection with each other. The government is supposed to play a role to assist and facilitate settlers to organise and achieve productive farming in an effective way.

Another important matter is the flood in the rainy season. Under the flooded condition, upland crops cannot be grown, but paddy grow preferably as far as appropriate flood control and drainage systems are managed. Furthermore, the demand for rice is increasing especially in urban area. Also leafy vegetables are high potential crops for cash generation. The other essential points are high temperature in the dry season, soil type and soil acidity. Water melon has higher tolerance to acid soil and it is estimated that it has relatively high profitability. With the above reasons, paddy, water melon and Jew's mallow have been selected.

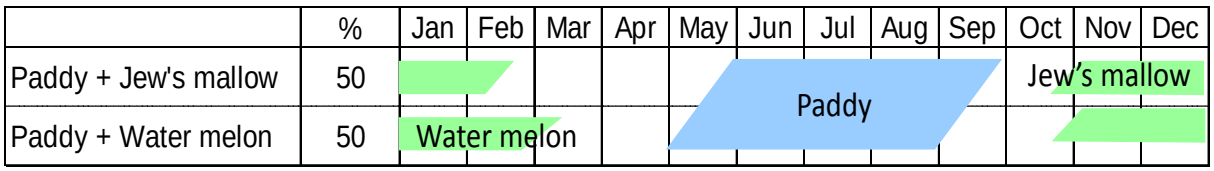


Figure 8.3.1 Planned Cropping Pattern: Wau

b) Jebel Lado

The target area belongs to two (2) communities; Nyuwa and Piytie communities, hence, their potentiality and intension should be taken into consideration. The farmers in the communities seem to prioritize staple crop cultivation. On the other hand, the farmers are producing vegetables with fairly good yield and low production cost. They seem to have a technical potential for commercial farming. A commercial crop like bananas can be tried for cash generation. Also daily consumed leafy perishable vegetables are high potential crops for cash generation taking the advantage of closeness to Juba.

The socio-economy survey reveals that the farmers have intentions to cultivate sorghum, maize, and groundnuts. Among the vegetables, tomatoes were the most popular, followed by okra and Jew's mallow. Considering the general condition of soil in the target area, groundnut cannot be selected as a representative crop due to heavy clay soil, which can cause damage during the harvesting time. Likewise considering the natural conditions such as high temperature in the dry season, soil alkalinity, maize, tomatoes, Jew's mallow and banana have been selected for farming plan.

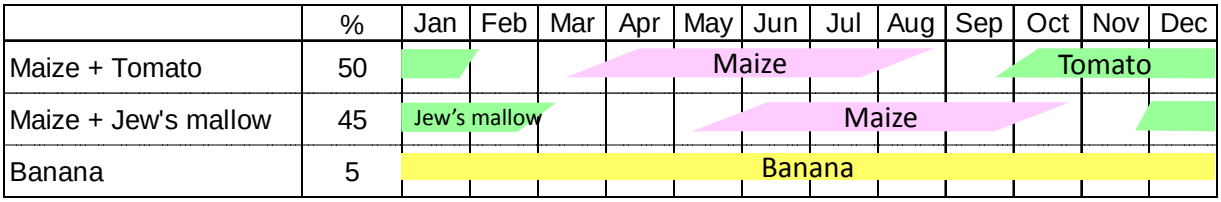


Figure 8.3.2 Planned Cropping Pattern: Jebel Lado

c) Rejaf East

The target area is owned by three (3) communities; Guduge, Migiri and Mugoro. Hence, their potentiality and intension should be taken into consideration for the plan. According to the socio economic survey, farmers in the communities allocate large area to vegetable cultivation and their irrigated farmland per household is the largest among the three (3) areas. Above all, the farmers in Rejaf East seem to be more familiar with irrigated farming, and also relatively experienced in using agro-chemicals or agricultural machinery use rather than other two (2) areas.

Farmers in Rejaf East seem to be eager to produce vegetables as a mean of cash generation. Among the vegetables, okra and Jew's mallow ranked at the highest, followed by tomatoes and eggplants. There is no crucial obstacle regarding soil condition and sandy to sandy loam soils in this area are generally suitable for vegetable production. However, there is damp area near the river. Drainage management should be applied in such area. With the considerations above, maize, groundnut, okra, Jew's mallow, tomato and eggplant have been selected as the representative crops of the farming plan.

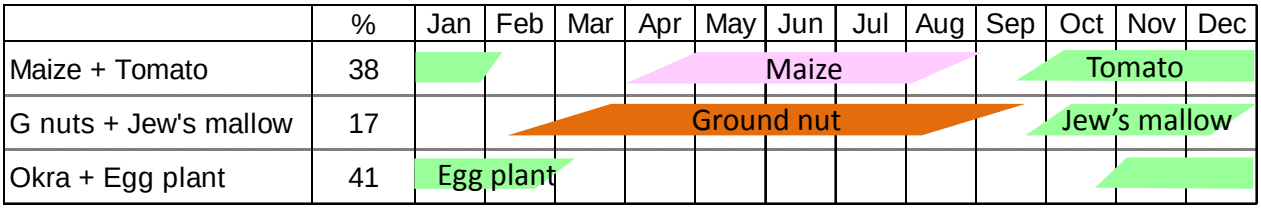


Figure 8.3.3 Planned Cropping Pattern: Rejaf East

8.3.3 Irrigation and Drainage Plan

This section proposes the irrigation and drainage plan specifically the water requirement by irrigation in the project areas. The following summarise the estimation method and the result of the water requirement in each area. The detail explanation is shown in Annex 9.

(1) Parameters for Irrigation Water Requirement Estimation

A guideline of FAO; Irrigation and Drainage Paper No. 24[1], Crop Water Requirements is applied to estimate the water requirement. Among the presented methods in the guideline, the FAO Penman-Monteith method is recommended as the sole standard method. It is a method with strong likelihood of correctly predicting evapotranspiration (ETo) in a wide range of locations and climates and suitable for the occasion of limited available data. Hence the IDMP-TT adopted this method. Necessary climate data for the water requirement estimation were obtained as follows:

a) Cropping pattern: planned ones in the previous Figures 8.2.1 up to 8.2.3 in section 8.2.2 are applied as a basis to estimate the monthly water requirement in each area.

b) Meteorological data: necessary data (rainfall, temperature, sunshine hours, relative humidity and wind speed) were obtained from nearby stations of the project areas as follows:

Table 8.3.3 Meteorological Stations for Necessary Climate Data

Site	Climate Data	Meteorological Station	Remarks
Wau	Temperature, Rainfall	Wau	
	Relative Humidity, Wind Speed	Kauajok	No data in the Wau station
Jebel Lado	Temperature, Rainfall Relative Humidity, Wind Speed	Juba	The nearest meteorological station
Rejaf East	Temperature, Rainfall Relative Humidity, Wind Speed	Juba	The nearest meteorological station

(2) Estimation of Irrigation Water Requirement

Based on the data obtained from the stations above and the applied method, the following are the basic elements of the estimation to apply the form of calculation below and eventually the water requirement in each project site (irrigation water requirement) are summarized in the Table 8.3.8 below.

Scheme/Farm Irrigation Water Requirement: Q = q x A
q = Et.crop/Ep x 0.1157 (10,000 m^2/86,400 sec: conversion from millimeter to liter/sec/ha)
Et.crop = ETo x Kc (crop water requirement)
Irrigation Water Requirement = Et.crop –Pe
Where:
Q: Irrigation Water requirement (m^3/s)
q: Unit water requirement or irrigation scheme/farm design factor (lit/sec/ha)
A: Scheme/farm Area (ha)
Et.crop: Crop evapo-transpiration (mm)
Ep: Irrigation Efficiency
ETo: Refrence evapo-transpiration (mm)
Kc: Crop coefficient
Pe: Effective Rainfall (mm/day)
Conversion factor 0.1157 is calculated as follows:
Depth of Irrigation Water Requirement= mm/day
= {(mm x ha) / (day x ha)}, i.e. by multiply and divide by ha
= {(mm x 10^4 m^2) / (ha x day)}, i.e. by converting ha,
the hectare in the numerator into square metre while keeping the one in the denominator
Depth of Irrigation Water Requirement = {(10^4 m^2 x 10^{-3} m) / (ha x 86400 sec)}, i.e. by converting mm into metre and the day into seconds
Depth of Irrigation Water Requirement = {(10^4 x 10^{-3} m^3) / (ha x 86400 sec)}, i.e. by multiplying metre square with metre to become cubic metre

[1] This paper has been modified into paper number 56 and during the feasibility, the two will be crosscheck

Depth of Irrigation Water Requirement = {(10^4/86400) litre / (ha x sec)}, i.e. by replacing 10^{-3} m^3 with litre as 1 m^3 equals 1 litre
Therefore, Depth of Irrigation Water Requirement = 0.1157 litre/sec/ha

a) Evapotranspiration (ETo):

Estimated ETo in each site is shown in the table below:

Table 8.3.4 Evapo-transpiration (ETo) Estimated by Penman-Monteith (mm/day)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wau	4.88	5.09	5.72	6.74	6.21	5.67	5.59	5.60	5.58	5.55	5.25	5.00
Jebel Lado	5.84	6.64	7.20	7.08	5.96	5.35	5.30	5.39	5.66	5.67	5.56	5.66
Rejaf East	5.84	6.64	7.20	7.08	5.96	5.35	5.30	5.39	5.66	5.67	5.56	5.66

Source: IDMP-TT

b) Crop coefficient (Kc):

Kc depends on the crop growth stages from initial to end. Kc estimated is shown in the table 8.2.5 below, which varies from the initial stage to the peak stage. Estimation of Kc refers to the recommended figures in the FAO paper No.24.

Table 8.3.5 Crop Coefficient by Each Crop

Crop	Kc initial stage	Kc mid stage	Kc end stage
Rice	1.10	1.10	0.95
Maize	0.90	1.15	0.60
Egg plant / Okra	0.90	1.05	0.85
Tomato	0.90	1.20	0.65
Jew's mallow*	0.90	1.10	1.10
Groundnut	0.90	1.05	0.60

Source: referred to FAO Crop Water Requirements No. 24 Irrigation and Drainage Paper
Note: Kc of Jew's mallow is applied Kc of celery

c) Effective Rainfall (Pe):

Pe is estimated with "Dependable Rainfall (Pd)" and the Pd of Probability=80% is used for the design of irrigation system capacity. The following table 8.2.6 shows the Pe in each site:

Table 8.3.6 Effective Rainfall Estimated (mm/day)

Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wau	0.0	0.0	0.0	0.8	2.2	3.1	3.7	4.1	3.1	2.0	0.0	0.0
Jebel Lado	0.0	0.0	0.4	1.7	2.7	1.9	2.3	2.4	1.8	1.8	0.4	0.0
Rejaf East	0.0	0.0	0.4	1.7	2.7	1.9	2.3	2.4	1.8	1.8	0.4	0.0

Source: IDMP-TT

d) Irrigation Efficiency (Ep):

Overall irrigation efficiency composed of conveyance efficiency, field canal efficiency and field application efficiency was estimated referring to the FAO paper No.24.

Table 8.3.7 Overall Irrigation Efficiencies

Wau (rice crop)	Wau (vegetable crop)	Jebel Lado (vegetable)	Rejaf East (vegetable)
0.26	0.57	0.49	0.49

Source: IDMP-TT based on Crop water requirements No.24 FAO irrigation and drainage paper

e) Estimation of irrigation water requirement:

The estimation of irrigation water requirement each project site is summarised in Table 8.3.8 below:

Table 8.3.8 Irrigation Water Requirements in the Project Sites

Site	Wau	Jebel Lado	Rejaf East
Target Area	500 ha	1,330 ha	960 ha
Water Source	Dam or River	River	River
Irrigation Facility	Dam/Reservoir and Pump	Pump	Pump
Required Flows	Dam/Reservoir: 5,000,000 m^3/year (0.005BCM) (Vegetables, dry season) Pump: 0.70 m^3/s (Rice, rainy season)	Pump: 1.92 m^3/s	Pump: 1.32m^3/s
Irrigation Scheme/Farm Design Factor	q= 1.400 l/s/ha	q = 1.444l/s/ha	q = 1.430l/s/ha
Annual Irrigation Water Requirement	10,121,760 m^3 (0.01 BCM)	29,790,115 m^3 (0.03 BCM)	20,444,535 m^3 (0.02 BCM)

8.3.4 Preliminary Facility Plan and Design

Based on the estimated water requirement, the results of the topographic and geological surveys, the irrigation facilities in the project sites have been designed. The following Table 8.3.9 summarises the major facilities in each project site and Figures 8.3.4 up to 8.3.9 summarises the drawings.

Table 8.3.9 Planned Major Facilities in the Project Sites

Site	Wau	Jebel Lado	Rejaf East
Command Area (ha)	500 ha	1,330 ha (Northern block 560ha, Southern block 770ha)	960 ha
Major Facilities	- Dam: 1 place - Pump station: 1 place - Distribution canal: 6.2km - Main canal: 7.1km -Secondary canal, drain, roads, etc. (1LS) - Main drain: 7.3km - Flood protection dike:9.7km	- Pump station: 1 place - Northern main canal: 6.4km - Southern main canal: 7.0km -Secondary canal, tertiary canal, feeder canal, drain, roads, road crossing, gate, water measurement facility, etc. (1LS)	- Pump station: 4 places - Riverside main canal: 2.4km - Hillside main canal: 5.6km -Secondary canal, tertiary canal, feeder canal, drain, roads, road crossing, gate, water measurement facility, etc. (1LS)

(1) Drawings of Wau

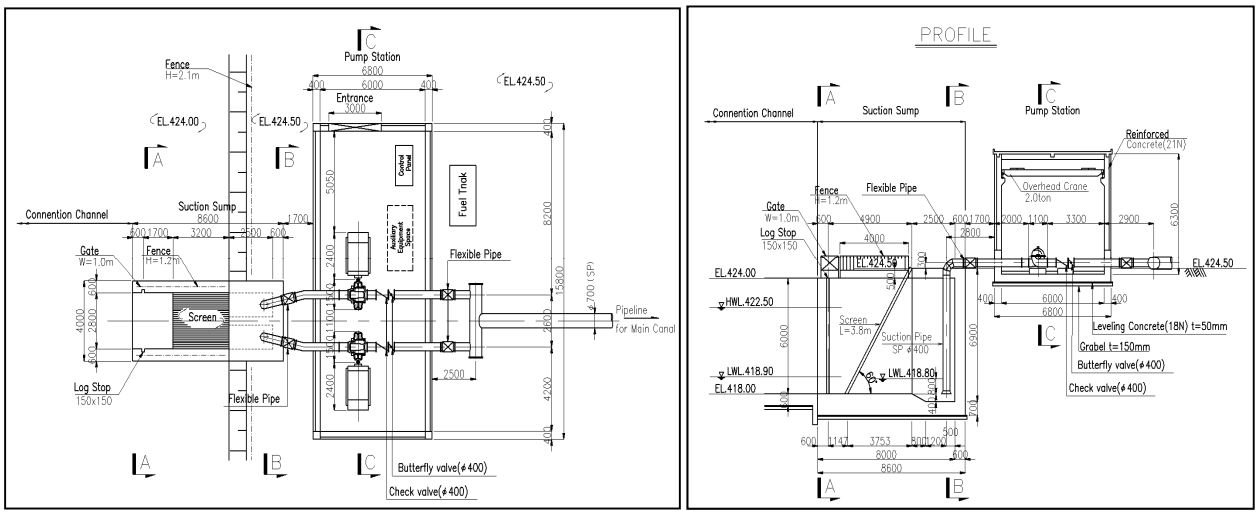


Figure 8.3.4 Plan and Section of Pump Station Building (Wau)

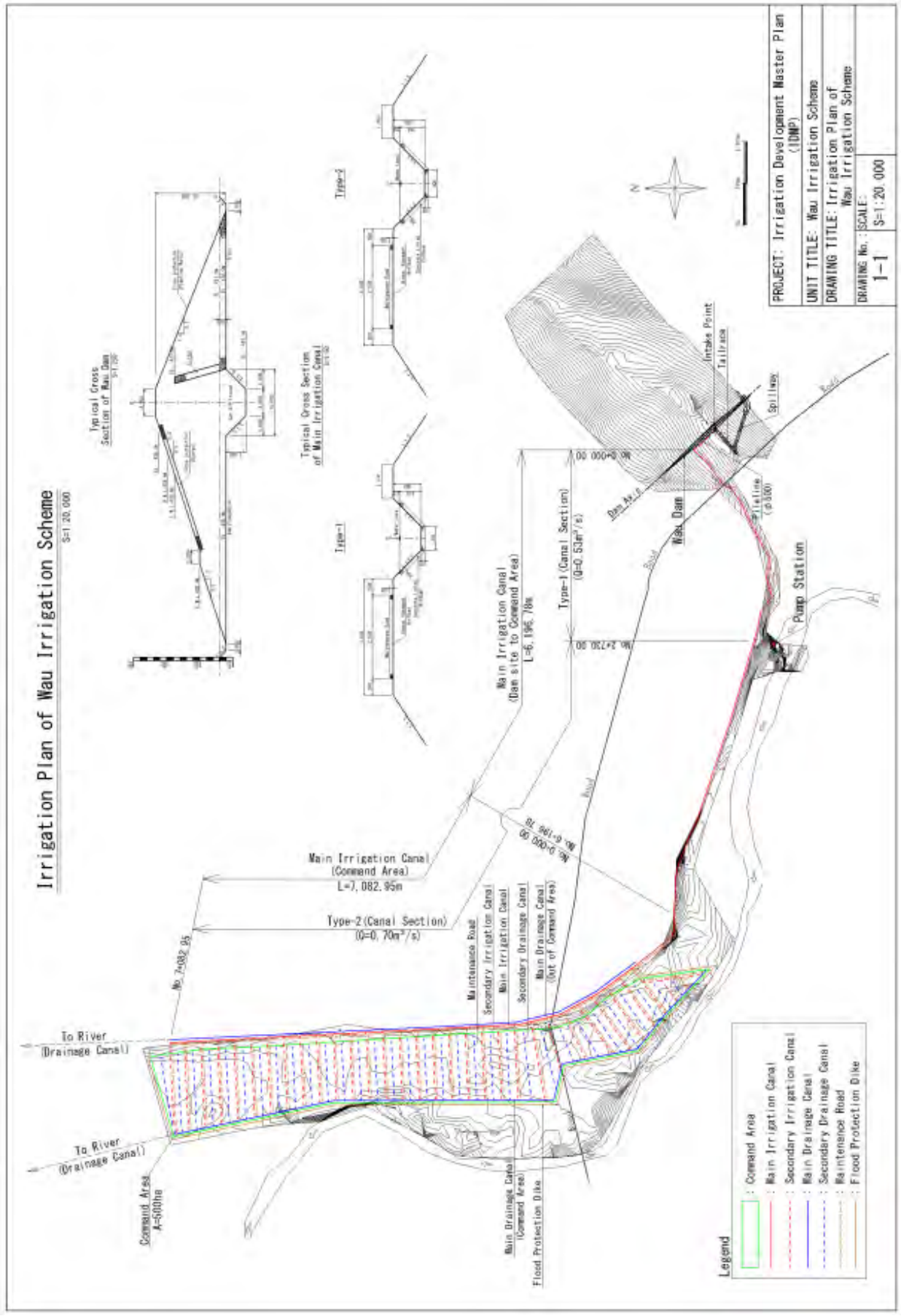


Figure 8.3.5 Plan of Wau Irrigation Scheme

(2) Jebel Lado

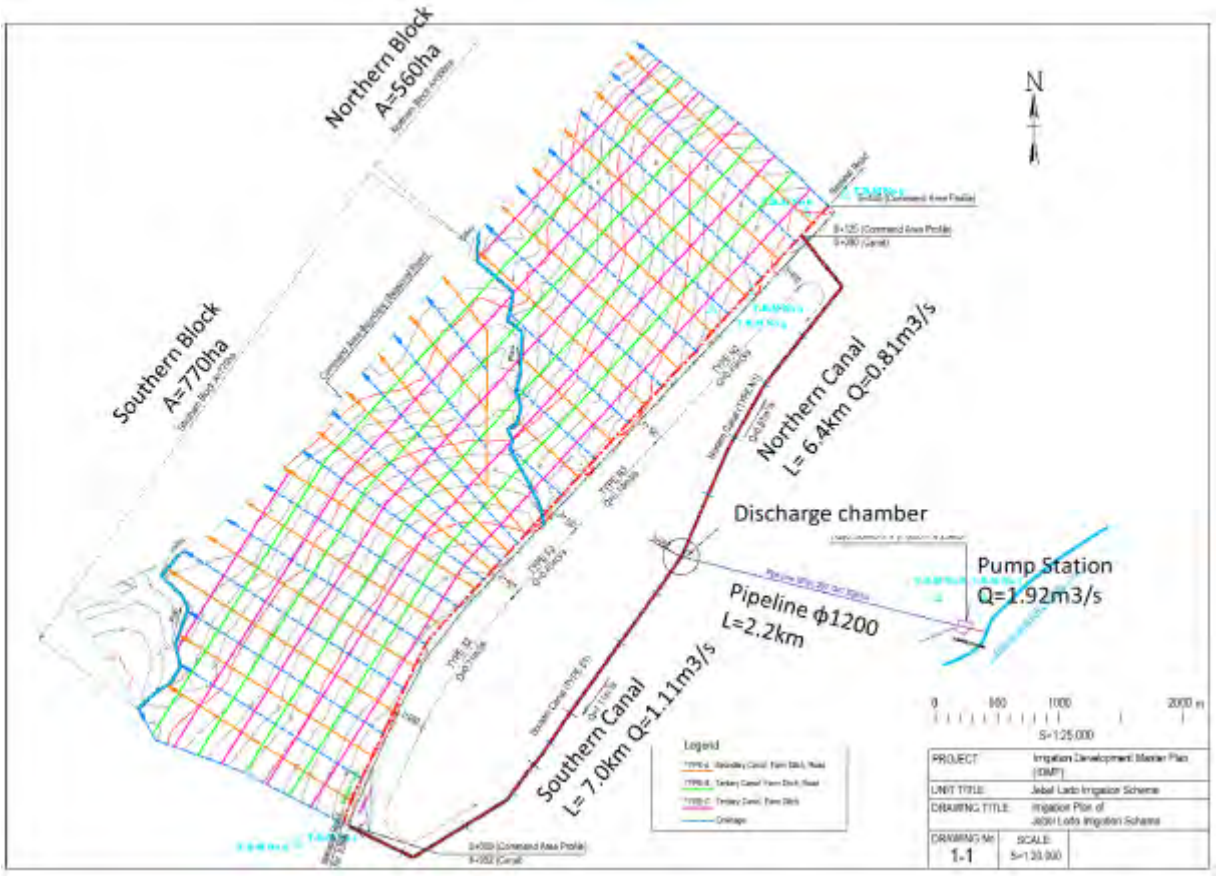


Figure 8.3.6 Plan of Jebel Lado Irrigation Scheme

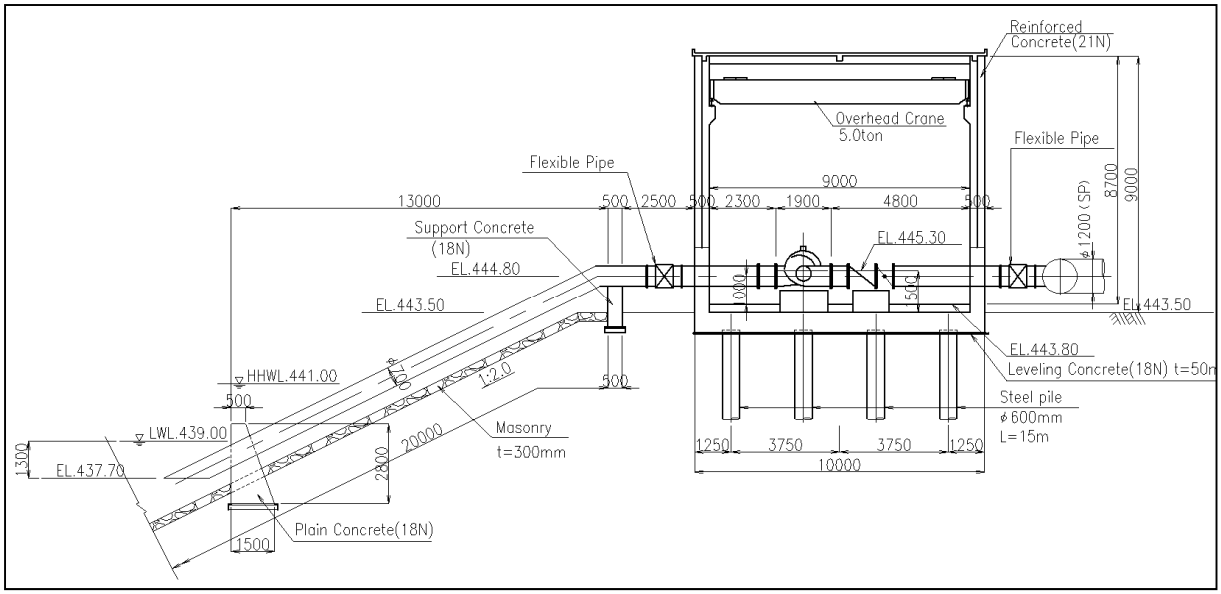


Figure 8.3.7 Plan and Section of Pump Station (Jebel Lado)

(3) Rejaf East

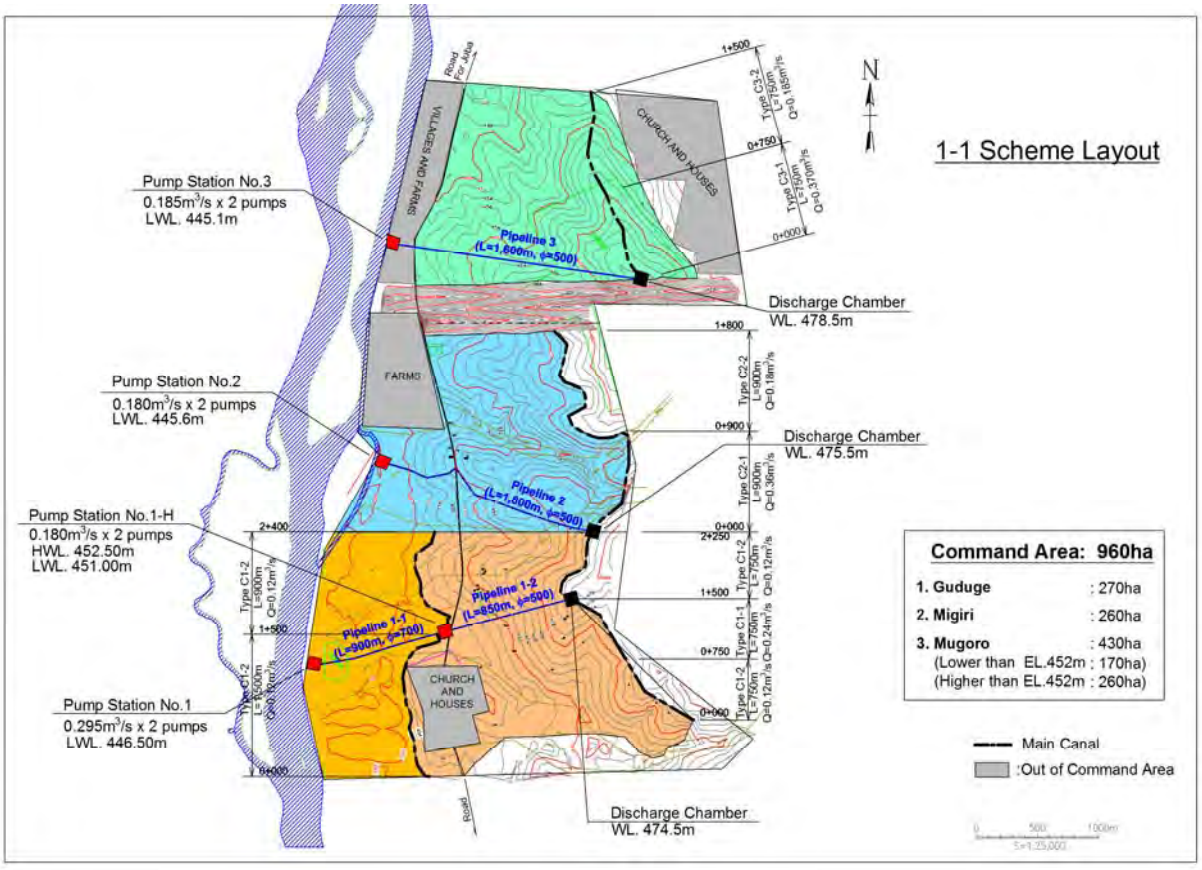
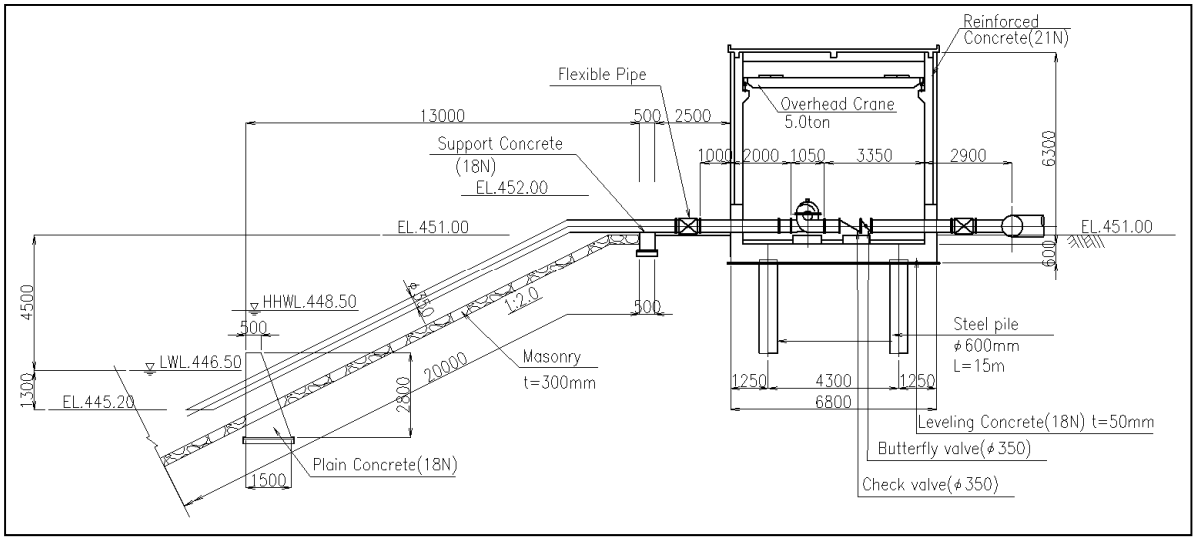


Figure 8.3.8 Plan of Rejaf East Irrigation Scheme



Note: Discharges (m^3/s) of the 4 stations are 0.59 (No.1), 0.36 (No.1-H), 0.36 (No.2) and 0.37 (No.3)

Figure 8.3.9 Plan and Section of Pump Station (Rejaf East)

8.2.5 Operation and Maintenance Plan

(1) Establishment of Scheme Management Office

Establishment of the scheme management office is quite effective since all resources related to the scheme management are placed in one place. Therefore, it is recommended to establish Irrigation Scheme Management Office at each irrigation site.

Table 8.3.10 shows the suggested management structure of the irrigation schemes. In case of Wau, there is a plan of constructing a dam and the major crop is rice, unlike other schemes. From these particular points, the staff of Wau should include a civil engineer trained in dams and irrigation infrastructure operations; an electro-mechanical engineer and an agricultural engineer to be responsible for scheme machinery and an agronomist in charge of rice seed multiplication. It is also recommended that like AIRS the management office of Wau should install rice mill facility and provide milling service for the farmers, as well as tractor lease or ploughing and harvesting services, which can be the means of income generation for the management office.

Table 8.3.10 Management Structure of Irrigation Schemes

Department	Functions and Responsibilities	Required Staff	Proposed No.		
			W	JL	RE
1. Admin.	• Overall management of the scheme • Coordination among stakeholders	Manager (Irrigation/Dam Eng.)	1	1	1
		Deputy Manager (Electromechanical Eng.)	1	1	1
	• Marketing • Procurement • Assets tracking • Keeping books of accounts for scheme operations • Irrigation fee collection • Administration of salaries, wages and other disbursements	Senior Accountant	1	1	1
		Cooperative Officer	1	1	1
		Asst. Accountant	1	1	1
		Asst. Cooperative Officer	1	1	1
		Tariff Collector	2	2	2
		Messenger/Guard/Driver	6	6	6
2. Irrigation/Dam O&M	• Annual planning and monitoring of dam/ pump operations, water distribution, etc. • Maintenance of dam/pump facilities, distribution network, etc. • Hydromet data recording, monitoring and reporting	Senior Irri./Dam Eng. (Dams, Pumps, Canals, etc)	1	1	1
		Electromechanical Eng.	1	1	1
		Planning and Bugeting Officer	1	1	1
		Asst. Irrigation/Dam Eng.	1	1	1
		Asst. Planning/Budgeting Officer	1	1	1
	• Opening, closure and maintenance of water control and distribution gates • Supervision of canals maintenance • Safeguarding of supplies and the facilities	Irrigation Technician	2	2	2
		Pump operator	2	2	2
		Irrigation Water Controller (Gate Keeper)	2	2	2
		Facilities' Guards	4	4	4
3. Farm Level O&M	• Seed multiplication, observation trials for new rice varieties • Annual planning and monitoring of cropping plan and water requirement • Extension of irrigated agriculture • On-farm water management planning and supervision	Senior Agronomist	1	1	1
		Agronomist	1	1	1
		Agricultural Engineer	1	1	1
		Asst. Agricultural Engineer	1	1	1
	• Provision of outreach services to farmers • On-farm water management among farmers • Supervision of distribution and field canals maintenance	Extension Worker	2	2	2
		Tractor Operator	1	1	1
		Asst. Tractor Operator	1	1	1
4. Processing O&M	• Collection, drying, milling of rice • Storing rice with proper pesticide control	Rice mill operator	1	0	0
		Asst. Rice mill operator	1	0	0
Total			39	37	37

Note: W =Wau, JL =Jebel Lado, RE = Rejaf East

MEDIWR takes an initiative to organize the Irrigation Scheme Management Office. However, the Scheme Management Office cannot be managed by officials from MEDIWR alone, hence collaboration with relevant stakeholders especially MAFCRD and state governments are inevitable. Right from the time of planning and design work (detail design stage of the irrigation development planning), it is recommended to establish the management office through close collaboration with the other stakeholders on functions of the management office, demarcation of responsibility, staff assignment and budget allocation.

Also, it is important to discuss the delineation of roles with Water Users Associations (WUAs) that are to be established. Table 8.3.11 below shows an ideal demarcation of responsibilities among stakeholders.

Table 8.3.11 Ideal Demarcations of Responsibilities among Stakeholders

Stakeholders	Demarcation
1. National Government	・ Taking initiative to establish SMO (MEDIWR) ・ Based on the report from SMO, taking necessary measures to repair or rehabilitate the irrigation system (MEDIWR) ・ Assign relevant officials to SMO (MEDIWR, MAFCRD)
2. State Government and County/LG	・ Assign relevant officials to SMO ・ coordinating and supporting SMO's activities ・ Mobilization and organisation of communities
3. Irrigation Scheme Management Office (SMO)	・ Coordinate and facilitate the formation and activities of WUAs ・ O&M of main irrigation facilities (dam, pump station, main and secondary canal, intake gate until on-farm) ・ Provision of seeds and other inputs Collection of irrigation service fee
4. WUAs	・ On-farm level operation and maintenance ・ Payment of irrigation service fee

(2) Operation Plan

Operation plan includes basic plans at feasibility planning stage, and annual operation plan after establishment of the scheme. The objective of the basic operation plans is to put in place basic methods of operation, such as selection of water distribution methods and order of the water distribution among upstream/downstream or large-/small-holder farmers. Responsible organizations at this stage are the scheme management officials from MEDIWR and MAFCRD, in collaboration with farmers' organizations and communities. Table 8.3.12 below shows a typical operation activities and their responsible organization.

Table 8.3.12 Typical Operation Activities and Responsible Organization

Planning	Activity	Details	Timing	Responsible Organization
Basic Operation Planning (before construction)	Establishment of basic method of operation	Whether to adopt Flow Sharing (proportional delivery) Method or Time Sharing (rotation) Method. How to coordinate the intention of large-holder farmers and small-holder farmers, upstream farmers and downstream farmers.	at the F/S stage, design work stage, at the start of every season or every two seasons	MEDIWR/ MAFCRD
Annual Irrigation Planning (after construction)	Preparation of cropping calendar	Develop cropping calendar by season (dry and rainy season), per month, taking into consideration of pattern of planting (gradual increase in planting season and gradual decrease in harvesting season)	at the start of every season or every two seasons	Scheme Management Office (MAFCRD)
	Estimation of expected water demand and supply	Estimation of crop water requirement, based on cropping calendar. Water demand is estimated by considering effective rainfall, runoff, evaporation, transpiration, percolation, and conveyance loss.	at the start of every season or every two seasons	Scheme Management Office (MAFCRD)
	Irrigation scheduling and facility operation planning	Water distribution plan (including dam operation and pump operation plans) is developed based on water distribution method, irrigation water availability, and management capacity of gate operator.	at the start of every season or every two seasons	Scheme Management Office (MEDIWR)

(3) Maintenance Plan

Maintenance work consists of routine maintenance, periodical maintenance and emergency maintenance. The routine maintenance is a day-to-day maintenance work, including cleaning silt at flow measuring devices, removal of floating debris, minor repair of canal and structures and greasing or oiling of gates of facilities. WUA should actively participate in this activity at least for on-farm level structure.

Periodical maintenance is works to be done at a certain interval, after harvest season or before planting season for example. Basically, WUA bears a responsibility for on-farm level maintenance, whereas the Irrigation Scheme Management Office is obligated to main facilities such as intake facilities, main and second canals, and gate structures. Emergency maintenance is work done at the time of natural disasters which causes damages on irrigation structures. This type of maintenance requires large investment for long term and/or large scale of replacement, and the main responsible organization should be the National Government (MEDIWR), except on-farm level structures. The following Table 8.3.13 shows ideal demarcation of each stakeholder in maintenance works.

Table 8.3.13 Typical Maintenance Activities and Responsible Organization

Maintenance Level	Description	Activities	Responsible Organization
Routine Maintenance	Day-to-day maintenance work.	- Removal of earth weeds and waterweeds - Cleaning silt at flow measuring devices - Removal of floating debris - Minor repair of canal and structure - Greasing or oiling of bearing, gates, and other metal structures	- On-farm: WUA/Community - Main facilities: Scheme Management Office
Periodical Maintenance	Works to be done at a certain interval.	- Strengthening of banks and structures - Removal solid deposition & silt - Grass cutting of embankment & canal banks - Repair of damaged structures /a - Repair of damaged equipment /b - Painting of structures - Checking of tightness of bolts, nuts, inside valves, & accessories at pump station	- On-farm: WUA/Community - Main facilities: Scheme Management Office
Emergency Maintenance /a	Emergency work	- Repair of damaged structure caused by unforeseen disasters, including floods, heavy rainfall, earthquake, theft, etc.	- Main facilities: Scheme Management Office/ County/ State/National - On-farm: WUA/Community

Note: a/ Diagnosis of damaged structures (e.g. dam embankment, gate, etc.) is outsourced to engineering firms.
b/ Maintenance of equipment (pump, electric supply, etc.) is outsourced to suppliers and manufacturer.

(4) Financial Management plan for Irrigation Scheme

a) Cost Recovery through Irrigation Service Fee

Whether an irrigation system is operated and maintained by a government agency or a private organization, it always requires budget to undertake O&M activities. It needs budget for; 1) the services rendered by people in the delivery and distribution of irrigation water, 2) the normal maintenance of irrigation facilities and structures, and 3) the periodic and emergency repair of irrigation facilities and structures. Therefore, generating budget for these O&M activities is one of the major function of the Scheme Management Office.

It is an important issue to determine, to which extent, the irrigation service fee (ISF) should cover costs of irrigation management, so called cost recovery principle. The costs to be discussed in the ISF estimation of the irrigation schemes are shown in Table 8.3.14 below.

Table 8.3.14 Annual Recurrent Cost of Irrigation Schemes

Cost Items	Amount (SSP/year)		
	Wau	Jebel Lado	Rejaf East
Annual Operation and Maintenance Cost			
Personnel Expenses	665,430	626,472	626,472
Pump Operation	250,000	4,106,400	4,100,600
Equipment and Machineries (fuel, lubricant, etc.)	91,100	99,000	89,500
Normal Maintenance Cost of Irrigation Facilities	181,600	90,800	73,200
Depreciation Cost /a			
Project Facilities	5,629,500	4,197,600	3,168,100
Equipment and Machineries	626,500	728,000	640,200
Total Costs (SSP/year)	7,444,130	9,848,272	8,698,072
Average Cost (SSP/ha)	9,316		
Total Costs (USD/year)	2,523,434	3,338,397	2,948,499
Average Cost (USD/ha)	3,158		

Note: a/ Straight line method is adopted to estimate depreciation cost.

For small-scale irrigation schemes, farmers can manage to repay investment cost for facilities/infrastructure; but for the medium and large-scale irrigation schemes, government needs to invest and then engage farmers on operation & maintenance cost recovery. Therefore, even though cost recovery is a basic principle of ISF introduction, it is recommended to start at a lower level in the beginning. The main focus at this stage is to let farmers develop the healthy habit of paying ISF regularly for the supply service of irrigation water, and enjoy timely and sufficient volume of water for crop production. Thereafter, the consumers, upon recognizing that their farming is indispensable to irrigation water, will be more open to a higher ISF level and the next round of increases can be made to meet the cost recovery requirement.

Therefore, it is recommended to take step-wise targets using cost recovery as a financial management mechanism for an irrigation scheme such as Jebel Lado, Rejaf East and Wau Irrigation Schemes, so as to gradually achieve sustainable operation and maintenance of the scheme.

- Short-term target is to make farmers familiar with irrigation farming and develop motivation and interest in paying ISF regularly for irrigation water supply
- Mid-term target is to materialize cost recovery of annual O&M costs, including personnel expenses, pump operation fee, equipment and machinery operation costs, and normal maintenance cost of irrigation facilities
- Long-term target is to accumulate earning retention for periodic and emergency repair of irrigation facilities and structures

b) Pricing of ISF

To identify the reasonable level of ISF, the planner sometime conducts interviews survey with farmers for grasping their willingness-to-pay (WTP) and affordability-to-pay (ATP). Usually, WTP is estimated based on the socio-economic survey, and the survey was conducted in the course of IDMP formulation. However, since most farmers had no idea for systematic provision of irrigation water, it was difficult to obtain proper reply to estimate WTP. Therefore, in this ISF estimation, ATP was figured out to obtain proper level of ISF. In water sector, ATP is usually estimated at 3 to 5% of disposable income. By following the precedent, the lowest figure of 3% was applied in this analysis, and ATP was estimated based on net income of planned crops in each irrigation scheme. In this analysis, the area-based pricing method is adopted. The O&M costs are composed of fixed parts and variable parts. The former is depreciation costs which are constant during economic life of the equipment, machineries and facilities, whereas the latter is changeable in accordance to irrigation scheme management.

The followings are assumption of the ISF estimation.

- Depreciation cost of project facilities were excluded from the fixed charge estimation, since investment cost of the project facilities are too heavy for farmers to shoulder, and can be regarded as the national government's expenditure and property.
- On the other hand, equipment and machineries, including tractors and its attachments, could be regarded as expenditure and properties of the irrigation management office, since their economic life were relatively short, and should be reinvested by the users.
- As for the variable part, in this analysis, it includes personnel expenses, pump operation fee, equipment and machinery operation costs, and normal maintenance cost of irrigation facilities. This part was divided by proportion of water consumption volume of each crop, and then divided by planted area of each crops, so that ISF rate of each crop can be obtained.
- Minimum farm lot size is set as 1 feddan (0.42 ha).

Based on the above assumptions, following formulas are applied to obtain the ISF:

Fixed Charge (Member Fee) = Dem ÷ Nl

Where: Dem = Depreciation cost of equipment and machineries
Nl = Number of farming lot

$$\textbf{Variable Charge } (ISF_{C1}) = O\&M \times \frac{VC_1}{\Sigma VC_{1\sim3}} \div Ac_1$$

Where: ISF_{C1} = ISF of Crop1
O&M = Annual O&M costs
$VC_{1\sim3}$ = Total volume of water consumption of crops
Ac_1 = Cropped area of Crop1

Based on the above formula, fixed charge as a member fee, and variable charge as an ISF were estimated. Then, on one hand, ISF was adjusted by ATP to obtain payable and practical level of ISF. On the other hand, member fee is not adjusted by ATP, but can be paid by in kind. The following Tables 8.3.15 up to 8.3.17 shows proposed ISF and members' fee in Wau, Jebel Lado and Rejaf East Irrigation Schemes respectively.

Table 8.3.15 Proposed ISF and Members' Fee in Wau Irrigation Scheme

Crop	ISF			Members Fee	
	Estimated ISF (SSP/ha)	ATP (SSP/ha)	Adjusted ISF (SSP/ha)	Members' Fee (SSP/ha)	In Kind (=Labour in Days)
Rice	1,190	250	250	1,074	27 days
Leaf Vegetables	1,190	160	160		
Fruits Vegetables	1,190	1,880	1,190		

Table 8.3.16 Proposed ISF and Members' Fee in Jebel Lado Irrigation Scheme

Crop	ISF			Members Fee	
	Estimated ISF (SSP/ha)	ATP (SSP/ha)	Adjusted ISF (SSP/ha)	Members' Fee (SSP/ha)	In Kind (=Labour in Days)
Maize	1,667	160	160	548	14 days
Vegetables	2,143	2,680	2,143		
Banana	4,286	1,050	1,050		

Table 8.3.17 Proposed ISF and Members' Fee in Rejaf East Irrigation Scheme

Crop	ISF			Members Fee	
	Estimated ISF (SSP/ha)	ATP (SSP/ha)	Adjusted ISF (SSP/ha)	Members' Fee (SSP/ha)	In Kind (=Labour in Days)
Maize	2,381	140	140	695	17 days
Vegetables	4,524	7,960	4,524		
Groundnut	3,571	130	130		

8.3.6 Cost Estimate

The project cost (investment cost) was estimated at USD. The unit price is set up on the basis of the actual previous construction costs by a number of companies across South Sudan under MEDIWR. Table 8.3.18 presents the conditions commonly used for the three (3) sites.

Table 8.3.18 Conditions for Cost Estimate

Items	Contents and Conditions
a) Direct Construction cost	Labor, materials, machinery, etc. and including pump and relative facilities, etc
b) Indirection construction cost	45% of the above a), as overhead cost
c) Administration	4% of the above a)
d) Consultant Fee	5% of the above a)
e) Physical Contingency	5% of the above a)

The Project costs of Wau, Jebel Lado and Rejaf East irrigation schemes are shown in Tables 8.3.19 to 8.3.21. The total investment costs of Wau, Jebel Lado and Rejaf East are USD 67 million, USD 34 million and USD 23 million respectively. The investment costs per ha are estimated at 134,000 USD/ha, 25,600 USD/ha and 24,000 USD/ha in Wau, Jebel Lado and Rejaf East respectively. The cost per ha of Wau is much higher than the other sites due to the high construction cost of the dam. Also the command area of Wau is smaller than the other sites.

Table 8.3.19 Project Cost for Wau Irrigation Scheme

No.	Work Description	Unit	Quantity	Price (million US$)	Rate (%)
1.	Direct Construction Cost				
1-1	Dam	L.S.	1	21.1	31.53
1-2	Pump Station	L.S.	1	1.4	2.1
1-3	Irrigation Canal	L.S.	1	9.1	13.6
1-4	Drainage Canal	L.S.	1	2.3	3.4
1-5	Flood Protection Dike	L.S.	1	6.5	9.7
	Sub-total (A)			40.4	60.3
2.	Overhead (B=A*45%)	L.S.	1	18.2	27.2
	C=A+B	L.S.	1	58.6	87.5
3.	Administration (D=C*4%)	L.S.	1	2.4	3.5
4.	Consultant Fee (E=C*5%)	L.S.	1	3.0	4.5
5.	Physical Contingency (F=C*5%)	L.S.	1	3.0	4.5
	Total			67.0	100.0
	Command Area A=500ha			134,000 US$/ha	

Table 8.3.20 Project Cost for Jebel Lado Irrigation Scheme

No.	Work Description	Unit	Quantity	Price (million US$)	Rate (%)
1.	Direct Construction Cost				
1-1	Pump Station	L.S.	1	2.0	5.9
1-2	Pipeline	L.S.	1	3.4	10.0
1-3	Main Irrigation Canal	L.S.	1	7.0	23.2
1-4	Facilities in Farmlands	L.S.	1	7.2	21.2
	Sub-total (A)			20.5	60.3
2.	Overhead (B=A*45%)	L.S.	1	9.2	27.1
	C=A+B	L.S.	1	29.7	87.4
3.	Administration (D=C*4%)	L.S.	1	1.2	3.8
4.	Consultant Fee (E=C*5%)	L.S.	1	1.5	4.4
5.	Physical Contingency (F=C*5%)	L.S.	1	1.5	4.4
	Total			34.0	100.0
	Command Area A=1330ha			25,600 US$/ha	

Table 8.3.21 Project Cost for Rejaf East Irrigation Scheme

No.	Work Description	Unit	Quantity	Price (million US$)	Rate (%)
1.	Direct Construction Cost				
1-1	Pump Station	L.S.	1	4.4	19.1
1-2	Pipeline	L.S.	1	2.5	10.9
1-3	Main Irrigation Canal	L.S.	1	1.4	6.1
1-4	Facilities in Farmlands	L.S.	1	5.7	24.8
	Sub-total (A)			14.0	60.9
2.	Overhead (B=A*45%)	L.S.	1	6.3	27.4
	C=A+B	L.S.	1	20.3	88.3
3.	Administration (D=C*4%)	L.S.	1	0.7	3.1
4.	Consultant Fee (E=C*5%)	L.S.	1	1.0	4.3
5.	Physical Contingency (F=C*5%)	L.S.	1	1.0	4.3
	Total			23.0	100.0
	Command Area A=960ha			24,000 US$/ha	

8.3.7 Implementation Plan

Implementation plan of an irrigation development scheme is made taking into consideration the climate condition, e.g. rainy season, since the earthwork of the project will be strongly influenced by rainfall. Tables 8.3.22 to 8.3.24 show the proposed implementation schedule of each priority project site of Wau, Jebel Lado and Rejaf East respectively.

Table 8.3.22 Implementation Schedule of Wau Irrigation Scheme

Work Description	Project Cost	Quantity	Year				
			1st	2nd	3rd	4th	5th
Dam	34.9	Investigation, Detail Design, Embank 256,000m^3, Spillway Concrete 15,700m^3					
Pump Station	2.3	Investigation, Detail Design, Procurement: Pump etc. Construction					
Irrigation Canal	15.0	Investigation, Detail Design, Main Canal L=13.3km, Canal & Drainage A=500ha					
Drainage Canal	4.0	Investigation, Detail Design, Main Drainage L=7.3km, Excavation 54,000m^3					
Flood Protection Dike	10.8	Investigation, Detail Design, Main Drainage L=7.3km, Embankment 134,000m^3					
Total	67.0	(million US$)					

Table 8.3.23 Implementation Schedule of Jebel Lado Irrigation Scheme

Work Description	Project Cost	Quantity	Year		
			1st	2nd	3rd
Pump Station	3.3	Investigation, Detail Design, Procurement: Pump etc. Construction			
Pipeline	5.7	Investigation, Detail Design, Procurement: Steel Pipe SPϕ1200, L=2.2km			
Main Irrigation Canal	13.1	Investigation, Detail Design, Main Canal L=13.4km			
Facilities in Farmlands	11.9	Investigation, Detail Design, Canal & Drainage A=1330ha			
Total	34.0	(million US$)			

Table 8.3.24 Implementation Schedule of Rejaf East Irrigation Scheme

Work Description	Project Cost	Quantity	Year		
			1st	2nd	3rd
Pump Station	7.2	Investigation, Detail Design, Procurement: Pump etc. Construction (4 stations)			
Pipeline	4.0	Investigation, Detail Design, Procurement: Steel Pipe SPϕ700/ϕ500, L=5.15km			
Main Irrigation Canal	2.3	Investigation, Detail Design, Main Canal L=7.95km			
Facilities in Farmlands	9.5	Investigation, Detail Design, Canal & Drainage A=960ha			
Total	23.0	(million US$)			

8.3.8 Environmental and Social Considerations

(1) Purposes

IDMP has selected three priority projects of Wau, Jebel Lado and Rejaf East. Those projects are expected to contribute to agricultural improvement in RSS; while it is also important to avoid and/or mitigate any environmental and social impact.

A draft environmental and social considerations for irrigation development (ESCID) Guideline has been developed during the formulation of IDMP (see Annex 5). An initial environmental examination (IEE) study was taken for one of the priority projects, in Wau by using the ESCID Guideline.

The purposes of the IEE study are:

- To figure out current environmental and social aspects in the project site;
- To preliminarily assess the impacts likely impacted by the priority projects;
- To indicate scope of works of an environmental impact assessment in the further process of feasibility study.

(2) Methods

According to the draft ESCID Guideline, the IEE is taken through the following main process:

1. Screening process, to identify whether or not further environmental and social considerations are necessary;
2. Preliminary Survey, to find out key environmental aspects; and
3. Scoping, to indicate highlighted impacts and the impact levels, and also to evaluate the study method for a further study.

The preliminary survey was taken in the manner of hearing with local communities, government organizations (county government, ministry, e.g.), visual observations, etc. Table 8.3.25 shows summary of the methods.

Table 8.3.25 Summary of Preliminary Survey Methods

Survey Methods	Target Items
Data collection	Protected wildlife
Interview with Local communities County government Wau Univ., zoo, wildlife officials	 Community profile, local economy, wildlife, flood records Current plan, program, project, etc., flood records, wildlife Wildlife
Visual observation	Land use, wildlife, local economy, water use, etc.
Topographic and geographic survey (conducted under the IDMP)	Topographic and geographic condition

(3) Results and Recommendations

a) Wau

Results are:

- The most significant impacts are related to land possession. Though the proposed command area is located on the river bank, and under government control, although some temporary activities such as brick productions, cattle grazing are observed. A gas station has been operated, water supply facility is under construction, and construction of hotels is planned. While there are several houses observed near/in the proposed dam site and canal route. Resettlement and change of land use must be considerable impacts.
- Land possession can also affect ecosystem even though the project site is not located in/near protected areas. Important habitats of wildlife, especially endangered/rare/threatened species could not be denied.
- Hydrological feature, especially caused by existence of the command area may raise possible risks of flooding and erosion.
- Pollutions related to air, water, noise, etc. can be controlled by moderate measures.
- The project is expected to effectively contribute to improvement of agricultural production and productivity.

Recommendations are:

- Since certain tourism developments (construction of hotels) are planned, consistency and arrangement between those plans shall be investigated.
- Possible change of hydrological feature especially river water flow must be examined. And the project design shall be confirmed, or revised if necessary, based on the survey.
- Ecosystem in/around the project site has been hardly studied. Therefore appropriate scientific survey is recommended.
- Though workshops were conducted under the IDMP, public consultation with the communities is useful to know their opinions, concerns etc., in order to reach consensus building among them, and to formulate adequate compensation plan.
- Most of the group who benefits from the project are farmers, on the other hand the people who are engaged in fishery, hunting, cattle grazing, manufactures could be less benefited. Adequate compensation must be given in order to avoid social conflict. In addition benefits from the project must be fairly allocated among the communities.
- Further environmental assessment will be required in a feasibility study.

b) Jebel Lado

Results are:

- The most significant impacts are related to land possession. The command area occupies large land. According to the communities, the proposed area seems to be low production, and few community houses, facilities, etc. have been existed. But further study is needed.
- Land possession can also affect ecosystem even though the project site is not located adjacent Bandingili/Mongala National Park. Recently no important habitats of wildlife, especially endangered/rare/threatened species have been recorded, however possibility of living of those animals could not be denied.
- On the other hand it is expected to improve community's livelihood, local economy through raise of agricultural production and productivity.
- Pollutions related to air, water, noise, etc. can be controlled by moderate measures.
- The project is expected to effectively contribute to improvement of agricultural production and productivity.

Recommendations are:

- Yet less significant risk on resettlement is expected, further study in order to identify land use, location of community houses and other facilities is required.
- Ecosystem in/around the project site has been hardly studied. Therefore appropriate scientific survey is recommended.
- Though workshops were conducted under the IDMP, public consultation with the communities is useful to know their opinions, concerns etc., in order to reach consensus building among them, and to formulate adequate compensation plan.
- Most of the group who benefits from the project are farmers; on the other hand the people who are engaged in fishery, hunting, cattle grazing could be less benefited. Adequate compensation must be given in order to avoid social conflict. In addition benefits from the project must be fairly allocated among the communities.
- Further environmental assessment will be required in a feasibility study

c) Rejaf East

Results are:

- The most significant impacts are related to land possession. The command area occupies large land. Considerable parts of the project site have been used for community farmlands, private farmlands as well. Residential zones have spread in the project site.
- Land holding is complicated. Therefore careful consensus building, a study to identify condition of land use and land title, and proper plans for resettlement/compensation are important.
- It is expected to improve community's livelihood, local economy through increase of agricultural production and productivity. On the other hand, obstruction on existing land use, agricultural works by project construction can lead to social conflict. In addition, careful consideration with other further projects related to land use/land possession is important.
- Pollutions related to air, water, noise, etc. can be controlled by moderate measures.
- The project is expected to effectively contribute to improvement of agricultural production and productivity.

Recommendations are:

- Further study in order to identify land use, location of community houses and other facilities is required.
- Existing or further planned land development, investment shall be investigated.

- Though impacts on ecosystem are expected to be small, this condition has been hardly studied. Therefore appropriate scientific survey is recommended.
- Though workshops were conducted under the IDMP, public consultation with the communities is useful to know their opinions, concerns etc., in order to reach consensus building among them, and to formulate adequate compensation plan.
- Fare allocation of the project benefit among stakeholders is important. In the same manner, adequate compensation plan must be given in order to avoid social conflict.
- Further environmental assessment will be required in a feasibility study.

8.3.9 Project Evaluation

(1) Basic Assumptions for Economic Analysis

Upon conducting the economic analysis of the projects, the following assumptions are set:

- Financial prices of farming commodities are based on the results of agriculture and socio-economic survey in May 2015 by IDMP-TT.
- Financial prices are converted into economic prices using Standard Conversion Factor (SCF) of 0.90 and Labor Conversion Factor (LCF) of 0.45 (0.5 × SCF).
- Project cost at financial price was categorized into foreign currency portion (F/C), local currency portion (L/C) and transfer payments such as taxes. Local currency portion was further divided into skilled labor, unskilled labor, and others. Relevant conversion factors (C/F) were applied for respective categories of cost.
- Cash flow analysis was conducted for the duration 30 years, since there is no significant replacement cost which will influence the economic efficiency and present value of cash flow. Values after 30 years will become very low as the influence in calculation is considered very little.

(2) Project Cost (Investment Cost)

In case of Wau, it is required to introduce a dam into the irrigation system to stabilize intake of water. Though the dam can reduce the operation cost of pumps, it needs huge amount of investment cost. Considering these conditions, the irrigation system is planned with two (2) cases. Case 1 is pump irrigation without dam and Case 2 is pump irrigation plus dam.

Case 1 and Case 2 will take the same amount of water. The difference between Case 1 and Case 2 is the operation period of the pump. The duration of pumping-up water in Case 2 is only in the wet season, from May to September (taking water from River Swe) for paddy cultivation. Irrigation water in the dry season, from October to April can be taken from the reservoir by gravity because of discharge from the dam storage.

Essentially, it is necessary to workout affordable options (in terms of initial investment cost) for constructing the dam, since chances for irrigating in the dry season with pumps are very limited. However, in the meantime after installation of the pumping station, it is possible to irrigate some plots in the scheme for vegetables production, especially in the years of enough water occurrences, without affecting other demands.

The investment cost of the three (3) project sites including the two (2) cases in Wau, expressed at financial and economic prices are shown in Table 8.3.26 below.

Table 8.3.26 Investment Costs at Financial and Economic Prices

Site	Wau (Case 1)	Wau (Case 2)	Jebel Lado	Rejaf East
Target Area (ha)	500 ha	500 ha	1,330 ha	960 ha
Financial Price (USD) (USD/ha)	31,952,000 (63,904)	66,762,000 (133,524)	33,897,000 (25,486)	23,171,000 (24,136)
Economic Price (USD) (USD/ha)	27,892,000 (55,784)	58,280,000 (116,560)	29,590,000 (22,248)	20,228,000 (21,071)

Source: IDMP-TT

(3) Project Benefits

The expected benefits compared with existing farming in surrounding area of the sites will be as follows:

- Increase of crop yield by irrigation
- Increase of cropping intensity
- Reduction of farming cost by increasing farming efficiency

Based on the estimations of net benefit (gross output – production cost including family labor value) by crop, the net incremental benefits at financial price were calculated. The project benefits at financial price were converted into the ones at economic prices, using conversion factors and import part prices as it has been mentioned. For economic analysis, incremental benefit (e,g, count family labor as cost) will be also considered since economic analysis stands on the viewpoint of the national economy to examine the efficiency of resources use in the country. Table 8.3.27 summarises the project benefits at financial and economic prices in each project area.

Table 8.3.27 Project Benefits at Financial and Economic Prices

Site	Wau (Case 1)	Wau (Case 2)	Jebel Lado	Rejaf East
Target Area (ha)	500 ha	500 ha	1,330 ha	960 ha
Cropping Intensity (%)	200%	200%	195%	192%
Crops	Rice, Jew's mallow, Watermelon	Rice, Jew's mallow, Watermelon	Maize, Tomato, Jew's mallow, Banana	Maize, Tomato, Groundnut, Jew's mallow, Okra, Egg plant
Financial Price (USD/yr) (USD/ha/yr)	5,319,000 (10,637)	5,319,000 (10,637)	7,928,000 (5,961)	16,076,000 (16,746)
Economic Price (USD/yr) (USD/ha/yr)	5,206,000 (10,411)	5,206,000 (10,411)	9,406,000 (7,072)	14,607,000 (15,216)

Source: IDMP-TT

(4) Project Evaluation

Project evaluation was carried out with the calculation of economic indicators: internal rate of return (IRR), net present value (NPV) and cost-benefit ratio (B/C) in financial term and economic term. The cash flows of the cost and benefit in each site was set as follows.

Cost:

Construction: Construction including survey, examination, etc. will be implemented in the first and second year.

O & M: Annual Operation and Maintenance (O&M) cost excluding the fuel of the pump is assumed 5 % of the total construction cost.

Replacement: Introduced suction pump has to be replaced in the 21st year after 20 years of service life. Other irrigation facilities have durability of more than 30 years.

Benefit:

Crop production: Benefit will start fully realizing three/ four years after implementation of planned farming, namely from the fourth/ fifth year of cultivation.

For calculating NPV and B/C, the discount rates of 8.83% and 7.5% are applied for financial and economic analyses respectively. The discount rate for financial analysis is the short-term lending interest rate of commercial banks in South Sudan and the discount rate of economic analysis is the considered opportunity cost of capital in South Sudan. The economic indicators calculated based on the flow at financial and economic prices are summarized in the table 8.3.28 below.

Table 8.3.28 Result of Project Evaluation

Site	Wau (Case 1)	Wau (Case 2)	Jebel Lado	Rejaf East
Financial IRR (FIRR)	9.0 %	-	10.9 %	36.8 %
Financial NPV (FNPV)	USD 591,000	USD -44,630,000	USD 6,795,000	USD 85,454,000
Financial B/C	1.01	0.50	1.12	2.92
Economic IRR (EIRR)	10.7 %	0.1 %	16.8 %	38.0 %
Economic NPV (ENPV)	USD 9,307,000	USD -33,156,000	USD 33,782,000	USD 94,807,000
Economic B/C	1.22	0.61	1.61	3.18

Source: IDMP-TT

8.3.10 Results

Evaluation criteria is based on the established acceptable opportunity cost of capital by the World Bank, which is (5-10%) in RSS.

(1) Wau

EIRR of Case 1 is calculated at 10.7 %, which is over the opportunity cost of capital, and therefore the Case 1 of Wau is judged economically feasible. However, the economic efficiency of Case 2 is very low due to the huge cost of the dam. Hence, the Case 2 is not economically feasible. On the other hand, the dam will make it possible to stably provide bulk amount of water flow into the river. Then it is expected that some indirect effects of Case 2, such as the increase of domestic water for people and animals, and also water for fisheries. These indirect effects and impacts for food and human security could be taken into consideration as an alternative case for further study.

(2) Jebel Lado

EIRR is calculated at 16.8 %, which exceeds the opportunity cost of capital enough, and then the project is judged economically feasible. In terms of the selection of crops, the most profitable crop among the planned crops is tomato. Banana is also considered to be a good introducing crop. Beneficiary farmers in Jebel Lado can bring their produce easily to market in Juba: however, there is hard competition with imports from neighbouring countries. Leafy vegetables have an advantage in suburban areas of Juba since they are easy to be damaged and not suitable for transportation.

(3) Rejaf East

EIRR is calculated at 38.0 %, which is very high and then the project is judged economically feasible. This high return is due to high profitability of vegetables such as egg plant and the relatively higher share of vegetable crop in the cropping pattern. Beneficiary farmers in Rejaf East can bring their produce easily to market in Juba: however, there is hard competition with imports from neighbouring countries. Leafy vegetables have an advantage in suburban areas of Juba since they are easy to be damaged and not suitable for transportation.

CONCLUDING REMARKS

CONCLUDING REMARKS

This Irrigation Development Master Plan (IDMP) of the Republic of South Sudan (RSS) has been formulated on the basis of the analyses of information available in and outside the country; in addition to field surveys. In the course of the formulation, intensive consultations with relevant stakeholders contributed to the comprehensiveness and quality of the documents.

IDMP has identified available surface water resources by watershed and the groundwater development potential of the whole country. Also, among the outputs of IDMP, are the river delineation map and river network diagrams, which are the particular products that never existed before conclusion of IDMP. With consideration of water resources, socio-economic and land productivity potentials, a high potentiality of a total irrigable land countrywide has been assessed. This culminated with a conclusion that irrespective of terrain; soil type; source of water; weather conditions; and farm size, irrigation should be introduced and practiced using different models and techniques, so as to: Address inevitable climate and seasonal changes; food and nutrition security; and achieve diversification and scaling up of crops production and productivity.

During the study, a number of irrigation schemes and other productive uses projects have been identified, prioritized and categorised under the core programmes, along with the soft component programmes' activities. The envisaged interventions are to address the existing challenges and make use of available opportunities in a strategic manner. They were selected through the irrigation development potential assessment (detailed assessment); proposals from the relevant state ministries; and consideration of existing and well-known irrigation potential areas. In addition, the on-going related initiatives in the water sector with the assistance of development partners and regional intergovernmental organisations; and the linkages with the comprehensive agriculture master plan (CAMP) projects were considered.

Through the IDMP formulation process, the capacity of the RSS Task Team members have been developed by Japanese experts that enabled them to effectively participate in the completion of vital formulation activities. It is recommendable that the acquired knowledge and skills should be made use of through appropriate redeployment and provision of opportunities for the immediate implementation of the priority projects. This way, a sound basis for the effective implementation of the master plan can be set; and training of trainers (TOT) to the incoming recruits can be carried out by the nationals. TOT can help in production of skilled and knowledgeable staff, to continuously provide extension and outreach services to farms/farmers.

This study concludes that the irrigation development master plan formulated here will serve the sustainable utilisation and management of land and water resources through efficient implementation of irrigation schemes/farms and other projects related to agricultural production and productivity: Thus contributing to achieving of national development goals, without jeopardising the needs of other sectors and stakeholders.

It was observed that the Natural Resources Budget Sector Working Group (NRBSWG) of the Government of the Republic of South Sudan (GRSS) does not include MEDIWR, and this arrangement may hinder effective coordination and planning of natural resources management, development and utilisation between the ministries within the Sector and MEDIWR. Therefore inclusion of MEDIWR in NRBSWG will be critical; because of the importance of water resources for the sector, in realizing the outcomes and impacts of the irrigated agriculture and the other productive uses of water through a broader coordination mechanism.

Further, MEDIWR needs close communication and exchange of hydromet and other related information with the regional organisations such as the Nile Basin Initiative (NBI); Intergovernmental Authority on Development (IGAD); African Ministers Council on Water (AMCOW); and the development partners, for implementing IDMP in harmony with the regional and international best practices.

Preliminary irrigation development guidelines have been prepared as the onset of the irrigation development guidelines formulation programme (IDGFP) and they include the introduction of technical standards for design and construction works for irrigation in Japan. The standards introduced will of course be adjusted to the circumstances of South Sudan. In the course of the full-scale irrigation development guidelines formulation, the establishment of technical standards by GRSS should be particularly emphasized due to its importance and as a priority. The preliminary guidelines also include irrigation development process; identification of projects; land acquisition; procurement of sub-contractors; environmental & social considerations; economic & financial analysis; general institutional arrangements; and irrigation schemes management establishment.

On a special note, irrigation management systems have to be established on cost-recovery basis, which means that public institutions should not seek profits from the schemes; but just to recover costs of inputs and services they provide. For small-scale irrigation, farmers can manage to repay investment cost for facilities/infrastructure; but for the large-scale irrigation schemes, government needs to invest and then engage farmers on operation & maintenance cost recovery basis.

Development partners; private sector; communities; and government institutions/authorities, are urged to immediately embrace implementation of the wide range of IDMP/CAMP programmes, projects and activities as outlined in the frameworks of the two correlated and jointly processed master plans. For instance, the authorities need to demarcate and gazette the earmarked areas/sites; and start to promote them, including through presentation to investors.

Experience during the planning and preparation of priority projects shows that embracing the community consultation is importance, although it is a very cumbersome process, yet it is crucial for the start of cultivating ownership and ensuring sustainability. In fact, not only the communities, but ensuring participation by all the stakeholders at the critical stages of planning, decision-making, resources mobilisation and execution is necessary for realisation of the projected outcomes. Promotion of wider stakeholder involvement with different roles, builds mutual trust between various players; therefore, an important step for the start of buying-in and success of implementation through different means of contributions.

IDMP will continuously provide information on hydrometeorology, topography, land use and other engineering aspects pertaining to water control and delivery infrastructure at some farming, aquaculture, forestry and livestock projects'/schemes' sites. Hence, CAMP and IDMP will be implemented together under one Implementation Coordination Structure (ICS). CAMP/IDMP ICS defines levels of authority and functions given to each related entities within a defined decision-making process of the overarching GRSS establishment at all levels. It is aligned with the government's Public Financial Management System (PFMS), under which IDMP workflow will consist of Annual Work Plan and Budget (AWPB). It is planned to carry out a mid-term evaluation after every three (3) years, taking into consideration the change of situations and progress of programmes implementation; and make decision, which will make it possible to renew the priorities and to revise the details of the programmes' activities.

GLOSSARY OF TERMS AND CONVERSION FACTORS

GLOSSARY OF TERMS AND CONVERSION FACTORS

In the IDMP formulation process, a number of scientific terminologies either emerged or used with special emphasis. Also, certain words with diverse connotation appeared several times throughout the text; in addition to the use of different type of units. For ease understanding and correct interpretation of the document, definitions of important terms and other relevant information[1] are given below, by topic and logical sequencing.

1. Glossary of Terms

1.1 Hydrometeorology

1) **Hydrology:** Is a science that deals with natural occurrence and distribution of water on surface and underneath of the ground, including river flows, aquifers recharge, etc.
2) **Hydrological Boundary:** Is a line that divides neighbouring land drainage systems of interconnected water courses, e.g. hydrologic units such as rivers and streams, in such a way that water flows into one system does not interact with that in the other, forming separate river basins or watersheds.
3) **Watercourse:** Means any natural channel in which water flows regularly or intermittently.
4) **Watershed:** Drainage divide, the line that separates neighbouring drainage basins.
5) **Drainage Basin:** Also described as **catchment or catchment area**, is an extent or an area of land where surface water from rain converges to a single point, usually where the waters join another water body such as a river, lake, wetland, etc.
6) **Hydrologic Unit:** Is a drainage area delineated so as to join into a multi-level hierarchical drainage system. Hydrologic units are designed to allow multiple inlets and outlets from and out of water bodies. Drainage basins are therefore similar but not identical to hydrologic units. Logically, all drainage basins are hydrologic units but not all hydrologic units are drainage basins.
7) **River Basin:** The entire land drained by a river and its tributaries.
8) **Oxbow:** Rivers in alluvial soils frequently change their courses, following a curving spiral while meandering across lowland areas, resulting in a series of bends known as “oxbows”. The process follows a scouring and deposition mechanism; in such a way that scouring occurs at the outer bend and the deposition takes place at the inner bend. In this way the oxbows eventually become cut off forming small lakes with a rather straight reach of a river in between.
9) **Bahr:** Is an Arabic word for sea, used then in South Sudan by the Arabs to describe some of the wider rivers of the territory; hence the names of main rivers of South Sudan of Bahr el-Jebel, Bahr el-Ghazal and Bahr el-Zeraf. The exception being River Sobat[2] that when in flood produces enormous fast flowing discharge carrying white sediment, which might have given the White Nile[3] its name.
10) **Khor:** Is an Arabic terminology for a small seasonal gouge watercourse (usually a narrow rather deep flow course scoured into clayey or rocky lands).

[1] The definitions and other relevant inform are sourced from different references, including Wikipedia, strictly in the context of RSS IDMP.
[2] Sob is a verb meaning to uncontrollably cry noisily, which might have given the Sobat its name.
[3] The origin and rise of the Nile have been conflicting; and one etymological possibility is that the word Nile derives from the Latin Nilus or ancient Greek Neilos, meaning "unknown" as the source of this river was (Madouh Shahin et al, 1985).

11) **Wadi:** Is an Arabic terminology for an ephemeral (or a transient watercourse) e.g. a seasonal stream channel bed that flows only during the rainy season; usually a wide and shallow flow course through sandy soils).
12) **The Sudd:** A huge area of wetlands of the Nile in South Sudan, which can absorb and dissipate half or more of the water it receives". Therefore, since part of a river discharge entering this area does not flow out, the region was termed Sudd (barrier/blockage in Arabic); hence pronounced SΛDD.
13) **Wetland:** An area that is regularly or permanently saturated by surface or groundwater, and where vegetation is adapted for life in saturated soil.
14) **Aquifer:** An underground layer of earth, sediment, gravels or rocks that contains water.
15) **Meteorology:** Is a sub-discipline of atmospheric sciences that deals with observation and recording of weather events such as temperature, humidity, sunshine, wind, etc; and it studies how they change over time and space.
16) **Climate:** Is scientifically defined as weather conditions averaged over a period of time. Climate models are used for shorter term weather forecasting and projections of future climate.
17) **Hydrometeorology:** Hydrology and meteorology compose the interdisciplinary field of hydrometeorology, e.g. measurement of rainfall, evaporation, etc, as part of hydrologic cycle.
18) **Runoff:** Also referred to as **surface runoff or overland flow** as a major component of the water cycle is the flow of water over land as a result of rain or other sources. Runoff that occurs on the ground surface before reaching a channel is also called a nonpoint source.
19) **Specific Yield:** Also referred to as **run-off specific yield,** is a run-off discharge per unit drainage or catchment area, which generates flow of water in a watercourse such as stream. Monthly stream flow values, calculated by averaging daily flows within a month and the drainage area are important parameters for hydrological regionalization, e.g. creation of river network diagrams.
20) **River Network Diagram:** Is a technique for illustrating sequence of river basins' drainage systems, including stream flows original directions and where they enter to, converge or bifurcate with the other water courses/bodies.
21) **Discharge:** Is a volume of water, including any suspended solids (e.g. sediment), dissolved chemicals or biologic material, which is transported through a given cross-sectional area of a channel that flow out of a catchment/drainage area or which flow into or out of a water body. In hydrology, a **flow rating curve** is used to establish a relationship between discharge and stage.
22) **Flow Rating Curve:** A rating curve is a graph of discharge versus stage for a given point on a stream/river, usually at gauging stations, where the stream discharge is measured across the stream channel. The development of a rating curve involves two steps. In the first step the relationship between stage and discharge is established by measuring the stage and corresponding discharge in the river. And in the second part, stage of river is measured and discharge is calculated by using the relationship established in the first part. Stage is measured by reading a gauge installed in the river.
23) On the other hand, in the field of hydrogeology, **specific yield** is also a measure of the capacity of an aquifer to release groundwater, also known as **the drainable porosity**.
24) **Hydrogeology:** Is the area of geology that deals with the distribution and movement of groundwater in the soil and rocks (commonly in aquifers).
25) **Drainable Porosity:** Is a ratio less than or equal to the effective porosity, indicating the volumetric fraction of the bulk aquifer specific storage, which it will yield when all the stored water is allowed to drain out under the forces of gravity.
26) **Storability:** Also, known as the storage coefficient, is the volume of water released from storage per unit decline in hydraulic head in the aquifer, per unit area of the aquifer.

1.2 Water Resources Management, Development and Utilisation; and Sanitation Services

1) **Integrated Water Resources Management (IWRM):** Is a process which promotes co-ordinated development and management of water and related resources such as land, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. IWRM is therefore an advanced form of WRM that takes into account both the various sources and uses of water; and aims at developing equity and sustainability based multi-level, multi-sectoral and multi-stakeholder water resources management and development approach.
2) **Ramsar Convention:** The Convention on Wetlands, adopted in Ramsar, Iran, in 1971 came to force in 1975, as a global intergovernmental treaty designed to protect the natural environment and preserve natural resources.
3) **Safe water:** Water which is considered safe for drinking because it does not contain dangerous bacteria, toxic chemicals or other harmful substances. Safe water is protected from such contaminants and pollutants.
4) **Sanitation:** The safe and hygienic disposal of human wastes, including domestic wastewater. It involves physical interventions, e.g. construction and provision of convenient facilities that ensure safe excreta and sludge disposal and management, in preventing human contact with wastes' hazards.
5) **Hygiene:** Behaviours, practices and routines such as safe collection, storage and use of water; hand-washing; and proper use of sanitary facilities, to break the chain of contamination and infection at personal, household and community levels.
6) **Haffir:** Subsurface open reservoir, constructed through excavation and embankment process.
7) **Pollution:** In relation to water resources, means any direct or indirect alteration of the physical, chemical or biological properties of water, so as to make it less fit, harmful or potentially harmful for any purpose for which it is to be used.
8) **Nonpoint Source Pollution:** When runoff flows along the ground, it can pick up soil contaminants including, but not limited to petroleum, pesticides, or fertilizers that become discharge or nonpoint source pollution. If a nonpoint source contains man-made contaminants, or natural forms of pollution (such as rotting leaves) the runoff is called nonpoint source pollution.
9) **Use of Water:** In relation to water resources includes: Abstraction, obstruction, impoundment or diversion of water forming part of a water resource; discharge of materials or substances into a water resource; and move or movement of objects in water.

1.3 Irrigation

1) **Irrigation Development Potential:** Refers to suitability of land for irrigated agriculture, in consideration of the land productivity, socio-economic and water resources potentials.
2) **Land Productivity Potential:** Refers to suitability of soil for certain crops, in consideration of impact of other factors such as land cover, slope, wetness, temperature and river accessibility.
3) **Socio-economic Potential:** Refers to suitability of a location, in consideration of impact of other factors such as road accessibility, population density, protected areas and other economic activities.
4) **Wetlands and river corridors:** Is an irrigation potential zone delineated separately from the plains due to the distinct characteristics of using residual soil moisture after recede of floods; in addition to direct withdrawal from the rivers, lakes and wetlands.
5) **Irrigation:** Is the artificial application of water to the land or soil, to support crops during the growing season, and re-vegetation in dry areas/seasons and during periods of inadequate rainfall.

Agriculture that relies only on direct natural rainfall is referred to as rain-fed, in contrast to irrigated agriculture.

6) **Drainage:** Irrigation is often studied together with drainage, which is the natural or artificial removal of surface and sub-surface water from a given area.
7) **Irrigation Systems:** Are additionally used at crop production fields, for protecting plants against floods. Therefore, irrigation and drainage is an intervention to control, provide and manage water for agriculture. It is a system of hydraulic infrastructure installations and constructions, comprising a network of naturally and manually powered; animal driven; and motorized lifting, pumping, flowing or retaining of water.
8) **Types of Irrigation:** Various modes of irrigation differ in how the water obtained from the source is distributed on the farmland, e.g.:
   a. **Pressurised irrigation;** is a system where water is delivered through pipes by pressure and distributed using a piped network.
   b. **Gravity irrigation;** is a system where water is delivered through rather horizontal gently sloping canals that distribute water gravitationally in a matrix of open channels.
9) **Irrigation Techniques:** Various methods of irrigation differ in how the water is applied or discharged into farm plots or crops' fields, e.g.:
   a. **Sprinkler irrigation;** is a localised irrigation technique through which water is sprayed directly onto the leaves of the plants.
   b. **Drip irrigation;** is a much localised technique through which water falls drop by drop just at the position of roots of the plants.
   c. **Surface irrigation;** include basins, border-strips, furrows and terraces. Different irrigable field sizes are used, depending on type of soil and land surface slope.
10) **Basin Irrigation:** Depending on scale, basin irrigation practices include using wet season flooding or water harvesting storage reservoirs, to inundate a farmland/rangeland; or farm' plots which are divided with bunds and surrounded by dykes.
11) **Border Irrigation:** Are gently sloping strips of crops' fields.
12) **Furrow Irrigation:** Are sloping lines of alternating ridges and troughs, in crops' fields.
13) **Terrace Irrigation:** Is a sort of soil and water conservation method (also known as contour farming), done by building bunds or retaining structures along a line at the same levels (terracing).
14) **Irrigation Models:** Depending on topography, soil and geology, irrigation models are used during the design of irrigation systems as a tool to help in determining the amount of water from a water source to be used at certain scheme/farm. This will inform a decision to plant certain types of crops in certain season in certain area, using certain type of irrigation or certain irrigation technique.

1.4 Other Related Topics

1) **Capacity Development/Building:** Is a learning process by which individuals, groups, institutions or organizations increase their abilities to perform core functions, identify opportunities, solve problems and define and achieve objectives in an effective, efficient and sustainable manner.
2) **Community:** A social group of any size whose members reside in a specific locality; and often have a common cultural and historical heritage.
3) **Development Partner:** A bilateral or multilateral donor or development agency; and an international organization or system providing support to the Government and the people.
4) **Equity:** Providing equal opportunities and minimizing differences, e.g. between groups of people, areas, etc.

5) **Food and Nutrition Security:** Access at all times to enough and nutritious food for an active healthy life.
6) **Monitoring:** Is a routine tracking of the key elements of programme/project performance, usually inputs and outputs, through record-keeping, regular reporting and surveillance systems.
7) **Productivity:** The amount of output (e.g. tons of agricultural produces) per unit of input (e.g. cubic meters of water, feddan/hectare of land, etc).
8) **Stakeholder:** An individual, a group of people or an organisation/institution affected by or having an interest, e.g. in decisions regarding a project being promoted.

2. Conversion Factors

2.1 Currency Equivalents

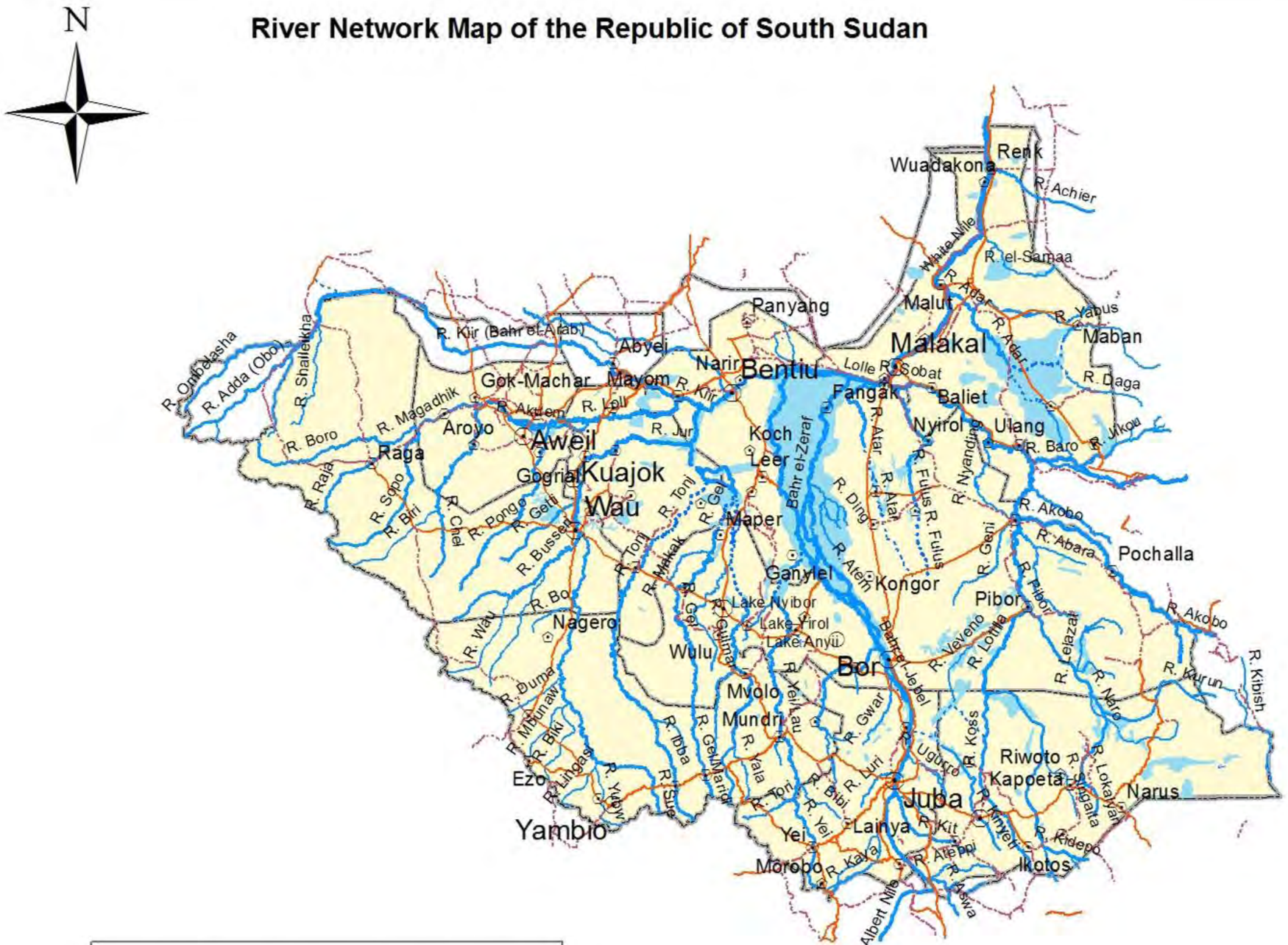
1) USD 1.00 = SSP 2.95 (Official Bank of South Sudan buying rate, as in October 2015).
2) JICA Exchange Rates (As of October 2015):
   - USD 1.00 = JPY 119.77; and
   - SSP 1.00 = JPY41.157

2.2 Measurements

1) 1 feddan (fed) = 0.42 hectare (ha)
2) 1 ha = 2.38 fed
3) 1 ha = 10^4 m^2
4) 1 km^2 = 10^2 ha
5) Million Cubic Metre (MCM) = 1×10^6 m^3
6) Billion Cubic Metre (BCM), also known as milliard = 1×10^9 m^3

RIVER NETWORK MAP OF THE REPUBLIC OF SOUTH SUDAN

River Network Map of the Republic of South Sudan



Legend

- Boundary1
- Boundary2
- Study Area
- Boundary3

River_Solid

R_Ord

- 0
- 1
- 2
- 3
- 4

RiverDotted_1

R_Ord

- 0
- 1
- 3

OverflowChannal

R_Ord

- 0
- 1
- 2
- 3
- 4
- Lake
- Waterbody

Capital1

Type

- Main
- Major
- Minor

Capital2

Type

- Main
- Major
- Minor
- Road_Primary
- Road_Secondary

Ministry and Electricity, Dams, Irrigation & Water resources

Water Sector

Irrigation Development Master Plan

0 70 140 280 420 560 Kilometers