REPUBLIC OF UGANDA

MINISTRY OF WATER AND ENVIRONMENT

DIRECTORATE OF WATER RESOURCES MANAGEMENT

UGANDA CATCHMENT MANAGEMENT PLANNING GUIDELINES

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Ministry Of Water and Environment

UGANDA

CATCHMENT MANAGEMENT PLANNING GUIDELINES 2019

Foreword

Water resources support key sectors of the economy namely; hydropower generation, agriculture, fisheries, domestic water supply, industry and navigation among others. However, efficiency and sustainability of investments under these sectors has recently been a concern in Uganda mainly due to; inadequate sectoral collaboration in planning and implementation, increasing frequency of floods and droughts, environmental degradation and pollution of water resources. This situation, therefore, calls for development of mechanisms for promoting integrated planning, development and management of water resources so as to create synergy among various sectors, promotion of efficiency in utilization of available water resources, reduction of water and environmental degradation, and ensuring more sustainable exploitation of water resources to meet various social and economic demands.

In 2014, my Ministry developed Catchment Management Planning Guidelines to guide the process of preparation of Catchment Management Plans (CMPs) as tools for ensuring equitable access to, and use of water resources, and safeguard of key natural resources for sustainable socio-economic development of the country.

A CMP provides a long-term strategy for sustainable development and utilization of water and related resources. Catchment based water resources planning and management is in line with the Integrated Water Resources Management (IWRM) paradigm, which ensures that land, water, and related resources are developed and managed in a coordinated manner without compromising sustainability of vital ecosystems. As the lead agency for implementation of Catchment based Water Resources Management (CbWRM) in Uganda, my ministry through the Directorate of Water Resources Management (DWRM) is operationalizing the CbWRM framework through the four Water Management Zones (WMZ) of Albert, Kyoga, Upper Nile and Victoria WMZ.

Based on the experiences gained in utilizing the 2014 Catchment Management Planning Guidelines, these guidelines were updated in 2017. My Ministry is, therefore, pleased to formally make the updated Catchment Management Planning Guidelines for use by various stakeholders in the Catchment Management Planning process. These Guidelines will significantly help and guide all planners of water and related resources at all levels. I, therefore, wish to call upon all the relevant government ministries and agencies at both national and local levels, the civil society, the private sector, academia and research institutions, cultural institutions, religious institutions and the local communities to utilize these guidelines in order to optimally plan for the development and management of water and related resources for prosperity.

In line with the provisions of Section 5 of the Water Act Cap 152, I therefore, formally approve these Catchment Management Planning Guidelines for use by various stakeholders.

For God and My Country

Hon. Sam Cheptoris

Minister of Water and Environment

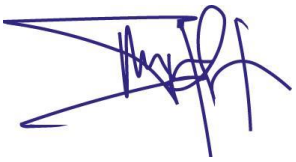
The Republic of Uganda

Acknowledgements

I would like to thank the Directorate of Water Resources Management for spearheading the preparation and updating of the Catchment Management Planning Guidelines in Uganda. These guidelines are utilised in a stakeholders' driven process that is key in ensuring that water resources are effectively planned for and sustainably developed and managed so as to support the achievement of the country's vision 2040.

Special thanks go to all the stakeholders at the national, regional and local levels for their active participation and involvement in the utilisation of the first version of guidelines which led to their update.

Finally, I wish to thank the World Bank for funding the 2014 edition, Expertise France for funding the 2017 edition and Adaptation Fund through the Sahara and Sahel Observatory for funding the professional review, editing and production of popular versions of the 2017 edition.



Alfred Okot Okidi

Permanent Secretary, Ministry of Water and Environment

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CbIWRM	Community-based Integrated Water Resources Management
CCD	Climate Change Department
AWMZ	Albert Water Management Zone
CBO	Community Based Organization
CDM	Clean Development Mechanism (CDM)
CMC	Catchment Management Committee
CMO	Catchment Management Organization
CMOs	Catchment Management Organisations
CMP	Catchment Management Plan
CMS	Catchment Management Secretariat
CP	Catchment Planning or Plan
CSF	Catchment Stakeholder Forum
CTC	Catchment Technical Committee
DEA	District Environment Officer
DEM	Digital Elevation Model
DEO	District Environment Officer
DHI	Danish Hydraulic Institute
DPO	District Population Officer
DSS	Decision support system
DWD	Directorate for Water Development
DWO	District Water Office (Officer)
DWRM	Directorate of Water Resource Management
EFRs	Environment Flow Requirements
EIA	Environmental Impact assessment
EQO	Environmental Quality Objectives
GHG	Green House Gases
GIS	Geographical information system
GoU	Government of Uganda
GSIs	Geotechnical Site Investigations
GW	Groundwater
HIV/AIDS	Human Immune Virus/ Acquired Immune Deficiency Syndrome
ICP	Integrated catchment plan
IWRM	Integrated water resource management
JSR	Joint Sector Review
KWMZ	Kyoga Water Management Zone
LACs	Limits of Acceptable Changes
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MDGs	Millennium Development Goals
MEMD	Ministry of Energy and Mineral Development
MoFPED	Ministry of Finance, Planning and Economic Development
MOH	Ministry of Health
MLG	Ministry of Local Government
MTTI	Ministry of Trade, Tourism and Industry
MTEF	Medium Term Expenditure Framework
MTI	Ministry of Tourism and Industry
MWE	Ministry of Water and Environment

NAM	Nedbør Affstrømnings Model (Rainfall Runoff model)
NBI	Nile Basin Initiatives
NDP	National Development Plan
NEL	Nile Equatorial Lakes
NEMA	National Environmental Management Authority
NFA	National Forest Authority
NGO	Non-governmental organization
NWRA	National Water Resources Assessment
NWP	National Water Policy
NWSC	National Water and Sewerage Corporation
O&M	Operation and Maintenance
PMF	Project Management Framework
SDGs	Sustainable Development Goals
SSEA	Strategic Social and Environmental Assessment
SSEMP	Strategic Social Environmental Management Plan
SW	Surface Water
SWAT	Soil and Water Assessment Tool
TSU	Technical Support Unit
UBOS	Uganda Bureau of Statistics
UGX	Ugandan Shillings
UN	United Nations
UNDP	United Nations Development Programme
UNMA	Uganda National Meteorological Authority
UNWMZ	Upper Nile Water Management Zone
UO	Umbrella Organizations
UWASNET	Uganda Water and Sanitation Network
VWMZ	Victoria Water Management Zone
WAC	Water Management Zone Advisory Committee
WAG	Wetlands Advisory Group
WEAP	Water Evaluation and Planning system
WfP	Water for Production
WHO	World Health Organisation
WIS	Water Information System
WMZ	Water Management Zone
WSDF	Water and Sanitation Development Facility
WSSBs	Water Supply and Sanitation Boards

1 INTRODUCTION

1.1 Definitions

1.1.1 Catchment Management

Catchment management is a subset of environmental planning which approaches sustainable resource management from a catchment perspective in contrast with a piece meal approach that artificially separates land management from water resources management.

1.1.2 A Catchment Management Plan

A catchment management plan provides a broad framework for water resources, land use practices and management decision making objectives. The plan identifies the ecological, cultural, historical, social and economic values within the catchment, whilst encompassing the necessary initiatives for coordinated future management and rehabilitation practices.

The benefits of catchment management planning are to ensure that the formulation and implementation of interventions are: (i) efficient, (ii) effective, (iii) feasible, (iv) viable, and (v) sustainable. In other words, the planning should ensure that the intended results are achieved at a reasonable cost. This requires comparing alternative approaches to attaining the same output, to ascertain that the most efficient process has been used (efficiency). The planning process should also ensure that the expected results contribute significantly to the project purpose and that appropriate assumptions are made and well planned for (effectiveness). The planning will also ensure that the benefits produced by the project continue to flow after external support has ended. It should consider issues concerning ownership, policy support, economic and financial factors, socio-cultural aspects, gender equality, appropriate technology, environmental aspects, institutional and management capacity (sustainability).

1.2 Background to Catchment Management Planning

In Uganda, the mandate for sustainable water resources management and development in an integrated manner in order to provide water of adequate quantity and quality for all social and economic needs for the present and future generations rests within the Ministry of Water and Environment. This Integrated Water Resource Management (IWRM) approach is well stipulated in the National Water Policy and provides an overall policy framework which defines the Government's policy objective as:

"To manage and develop the water resources of Uganda in an integrated and sustainable manner, so as to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations and with the full participation of all stakeholders."

As part of the realisation of this objective, the National Water Policy is based on the implementation of the objectives for water management within the IWRM framework. IWRM in a river-basin context is defined as "*a process that enables the coordinated management of water, land and related resources within the limits of a basin so as to optimise and equitably share the resulting socio-economic well-being without compromising the long term health of vital ecosystems*."

The Ministry of Water and Environment (MWE) agreed in the 2006 Joint Sector Review (JSR) to pilot participatory IWRM in at least one catchment. A pilot was undertaken in the Rwizi catchment and based on this experience and the lessons learned, the strategy to roll out IWRM at the catchment level was developed. It was envisaged that Catchment level IWRM should enable not only more effective water management but also accelerated development and sustainable water use. Based on a pilot catchment planning program in the Rwizi catchment, DWRM and MWE adopted a strategy (DWRM 2008) to "de-concentrate IWRM" – that is, rather than executing all the responsibilities and functions associated with IWRM (Figure 1) at the central level within the body of the Directorate of Water Resources Management (DWRM), these functions would wholly or in part be executed by new units within DWRM that are located in newly defined regions or zones closer to stakeholders and district local governments.

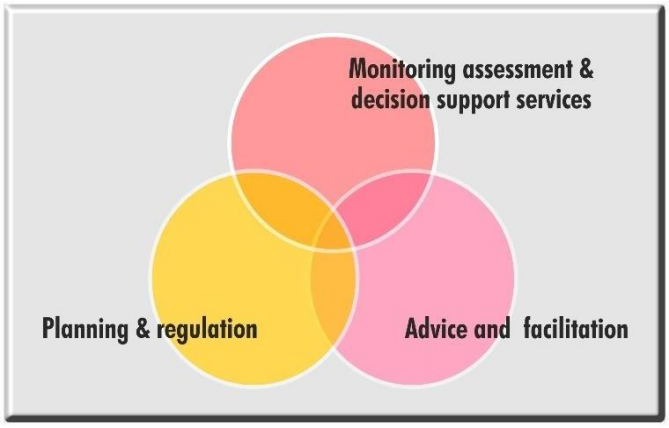
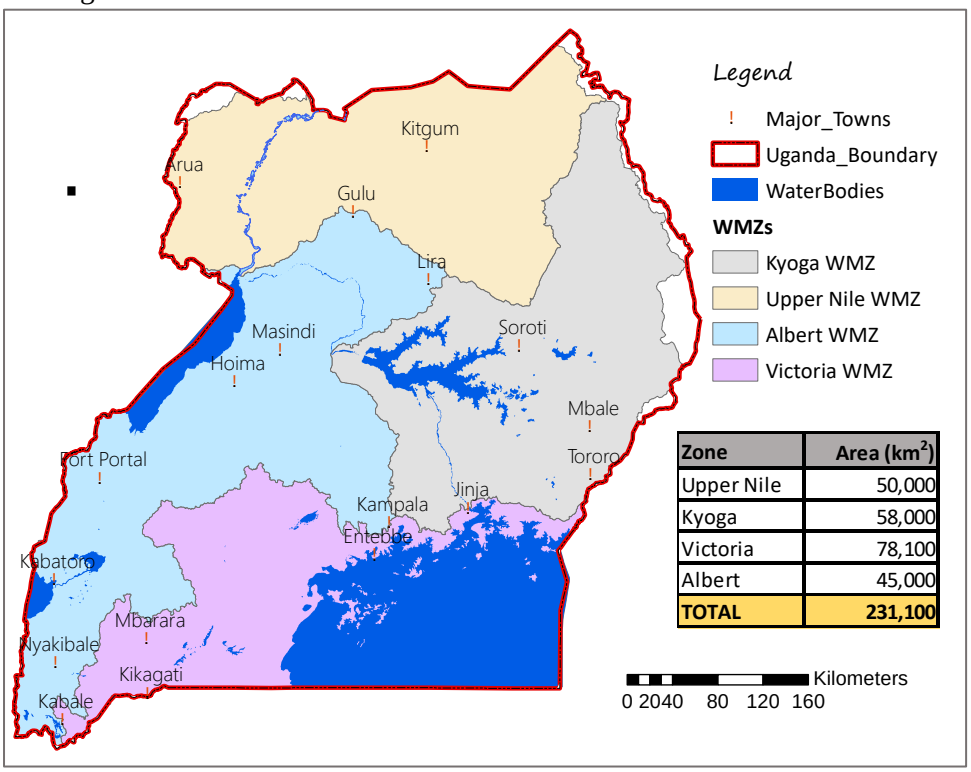


Figure 1: Core IWRM Functions

Therefore, a key feature of the implementation of IWRM in Uganda by the Ministry of Water and Environment (MWE) through the Directorate of Water Resources Management (DWRM) was to provide for the de-concentrated management of water resources to the local catchment level with the participation of all stakeholders. Following the recommendations of the National Water Policy, the Water Sector Reform Study (2005), the Joint Sector Review (2006) and other national and regional policies as well as steps already taken for implementation purposes, the country was delineated into four Water Management Zones (WMZs) along hydrological boundaries. Thus, the northern parts of the country are covered by the Upper Nile Water Management Zone (UNWMZ), the western parts by the Albert Water Management Zone (AWMZ), the south by the Victoria Water Management Zone (VWMZ) and the east by the Kyoga Water Management Zone (KWMZ), Figure 2. Within each Water Management Zone, there exists a number of smaller hydrological units called catchments, the appropriate level at which IWRM is being implemented, thus the need for catchment management planning.



Zone	Area (km^2)
Upper Nile	50,000
Kyoga	58,000
Victoria	78,100
Albert	45,000
TOTAL	**231,100**

Figure 2: Water Management Zones

1.3 Purpose of these Guidelines

To effectively implement the IWRM functions, the four WMZ teams require a common framework that guides the catchment planning process. This planning provides for learning and generating information about the catchment physical, socioeconomic and environmental conditions, catchment characteristics, people's aspirations and needs, potential development opportunities, challenges, risks and threats that need to be addressed. Being a comprehensive process involving many stakeholders, this type of planning requires guidelines for proper implementation across the country. Thus, the broad aim of these guidelines is to;

- Provide a common framework for the WMZ planning teams and other stakeholders;
- Provide the WMZ planning teams and other stakeholders an overview of the catchment management planning process and the outcomes they are seeking;
- Help to create awareness and understanding of the catchment management planning process and its value in supporting sustainable, equitable and more rapid economic growth and livelihoods.

These guidelines are a framework within which the WMZ team and other stakeholders will refine and develop, in detail, their approach according to the needs and conditions in their catchment and are therefore, not intended to be a detailed manual for water resources management planning at the catchment level. The purpose these guidelines is, therefore, to:

- Inform the WMZ planning team and other stakeholders on the scope of the catchment management planning process;
- To provide a common policy and institutional framework for catchment management planning;
- To provide a strategy and guidance on stakeholder participation;
- To provide a generalized step-by-step process that can be applied flexibly to take into account realities on the ground, yet would yield a plan that is technically and economically sound where stakeholders in the catchment have been substantially involved in its preparation;
- To provide guidance on different approaches that can be used to implement various steps and activities in the planning process;
- To help the planning team design its work plan and schedule its activities.

It is important to note that these guidelines describe processes for guiding planning at catchment, sub-catchment and micro-catchment scales. These guidelines present a reasonably comprehensive and well-thought-out multi-stakeholder consultative approach to establishing the institutional arrangements and developing strategies for a community-based integrated water resources management (CbIWRM) plans for catchments within the decentralised WMZs. By following these guidelines, the developed Catchment Management Plans (CMPs) would act as a catalyst for investments in water management and development projects within the respective catchments. That is, the CMPs should identify and clearly define specific water management and development activities and projects through a collaborative approach with catchment stakeholders, especially the community. These investments should not only be in infrastructure, but also in institutional arrangements and information management, systems – also known as the "hard" and the "soft" aspects of investments. The projects have to be clearly defined, for instance, as in concept notes, project identification notes, or project fact sheets that can form the basis for "bankable projects" that easily can be raised for interest and further development and preparation by financiers and donors.

1.4 Guidelines Review and Update

The Directorate of Water Resources Management developed the first version of Catchment Management Planning guidelines in the year 2014 which were reviewed in 2018 (current version) to include climate change aspects that were not comprehensively captured in the earlier version. Thus, these guidelines are a "living document" which requires continued refinement and strengthening based on experiences and lessons learned from ongoing catchment management planning activities.

These current guidelines assume a close working relationship between the central level DWRM departments and the WMZ teams and may therefore require review and/or updating once this assumption no longer holds.

It is important to note that in the early years of implementation of these guidelines, this relationship will be critical, particularly for the transfer of GIS technology, development of the knowledge base and the transfer of data, the acquisition and testing of models and building modelling capacity.

1.5 Structure of the Guidelines

These guidelinesare presented in six main sections, highlights of which are presented below:

1. **Introduction:** This section highlights the background to catchment management planning in Uganda, the purpose of these guidelines, and gives indications on when these guidelines need to be reviewed.
2. **Policy, Legal, and Institutional Framework:** This section discusses a number of policies and laws under which catchment management planning is implemented as well as the institutional arrangements that facilitate the operationalization of this process.
3. **Detailed Catchment Management Planning Guidelines:** This section presents the detailed catchment management planning guidelines, step by step, thus a core component that addresses the purpose of this report.
4. **Piloting Catchment Management Planning:** Having piloted and developed Catchment Management Plans for some catchments in Uganda, this section presents the lessons learnt from this process.
5. **References:** A list of all materials referred to during the development of these guidelines is presented in this section of the Document.
6. **Annexes:** All additional material that provides detailed information that may need to be used together with the main document, is provided in this part of the Document.

2 POLICY, LEGAL, AND INSTITUTIONAL FRAMEWORK

Optimal and sustainable water resources management and development requires appropriate legislation, policies, economic tools, institutions, and stakeholders involved in management, regulation, and utilisation of water resources which altogether, create an enabling environment for smooth planning and operationalization management plans. A strong cooperative approach between role-players and especially governmental institutions is, therefore, essential to work together within their respective legislative and policy mandates to promote the approach to IWRM and to ensure the best economic, social and environmental development. This section of the document presents the relevant policies, laws and institutions that enable effective catchment management planning in Uganda.

2.1 Policy and Legal Framework

The implementation and management of Integrated Water Resources Management in Uganda is legally provided for by:

- The Constitution of the Republic of Uganda,
- National Policies,
- National Legislation, and
- Trans-boundary and International considerations.

2.1.1 The Constitution of the Republic of Uganda (1995)

The Constitution of the Republic of Uganda sets a number of national guiding principles relating to, and supporting the principles of sustainable development including having balanced and equitable development, which requires that the State adopts an integrated and coordinated planning approach. It further stipulates that the State ensures balanced development between different areas of Uganda and between the rural and urban areas with special measures employed to favour the development of the least developed areas.

Through the constitution, the State is entrusted to protect important natural resources including land, water, wetlands, minerals, oil, and fauna and flora on behalf of the people of Uganda. The state must further endeavor to fulfil the fundamental rights of all Ugandans to social justice and economic development, with all developmental efforts directed at ensuring the maximum social and cultural well-being of the people. In terms of the Constitution, all Ugandans have a right to education, health services, clean and safe water, work, decent shelter, adequate clothing, food security, and pension and retirement benefits.

The State must promote sustainable development and public awareness of the need to manage land, air, water resources, as well as use of natural resources, in a balanced and sustainable manner for the present and future generations. All possible measures must be taken to prevent or minimise damage to land, air, and water resources resulting from pollution or other causes. The Constitution entrusts the State to ensure the conservation of natural resources and promote the rational use of natural resources to safeguard and protect the biodiversity of Uganda.

Through all this, the Constitution sets the scene for Integrated Water Resource Management in Uganda.

2.1.2 National Policies

2.1.2.1 National Water Policy (1999)

The 1999 National Water Policy provides an overall policy framework that defines the Government's policy objective as managing and developing water resources of Uganda in an integrated and sustainable manner, to secure and provide water of adequate quantity and quality for all social and economic needs sustainably, with the full participation of all stakeholders.

According to the National Water Policy and the Water Act Cap 152, the responsibilities to provide water services and to maintain facilities were devolved to local councils in districts and urban centres. The role of the Central

Government's Agencies is that of guiding and supporting as required. The Act thus emphasises the shared responsibilities in development and management of water resources among stakeholders, including the Private Sector and Non-Government Organisations (NGOs) to regulate human activities that can pose risks to water resources. It also provides for pollution control measures with associated penalties and fines.

The existing policy and legal framework promotes wise use of water resources from the lowest possible level, while considering roles to be played by different stakeholders at different levels. This offers an opportunity to ensure that communities can actively participate in the development and maintenance of water sources within a given catchment.

2.1.2.2 Climate Change Policy

The Uganda National Climate Change Policy (Ministry of Water and Environment, 2015) which is intended to guide all climate change activities and interventions in the country, aims at ensuring a harmonised and coordinated approach towards a climate-resilient and low carbon climate development pathway for sustainable development in Uganda. The overarching objective of the policy is to ensure that all stakeholders address climate change impacts and their causes through appropriate measures, while promoting sustainable development and a green economy. The guiding policy principles reflect many of the key underlying principles of Integrated Water Resources Management (IWRM):

- Mainstreaming and coordinated response to climate change
- Communicating effectively and promoting participatory approaches
- Promoting community-based approaches to adaptation
- Devoting adequate attention to capacity development and institutional setups
- Devoting adequate attention to technology needs, development and transfer
- Identifying, developing and influencing financing mechanisms
- Providing a credible delivery structure

The policy provides both adaptation and mitigation priorities and identifies specific strategies aimed at enhancing achievement of the policy priority for the water sector, thereby recognising the importance of catchment management planning.

2.1.2.3 Other National Policies

- National Policy for the Conservation and Management of Wetland Resources (1995) - aimed at restricting the continued loss of wetlands and their associated resources and aims to ensure that benefits derived from wetlands are sustainably and equitably distributed to all people of Uganda.
- The National Gender Policy of 1999, which recognises women and children as the key stakeholders of water.
- Uganda National Land Policy - provides a framework for articulating the role of land in national development, land ownership, distribution, utilisation, alienability, management, and control of land.
- National Forestry Policy - provides for the establishment, rehabilitation and conservation of watershed protection forests.

2.1.3 National legislation

2.1.3.1 Water Act Cap 152 (1997)

Uganda's Water Act Cap 152 provides for the use, protection and management of water resources and supply; and facilitates the devolution of water supply and sewerage undertakings. Its objectives are:

(i). To promote the rational management and use of the water resources of Uganda by:

- Use of appropriate standards and techniques for the investigation, use, control, protection, management and administration of water resources

- Coordinating all public and private activities which may influence the quality, quantity, distribution, use or management of water resources
- Coordinating, allocating and delegating responsibilities for the investigation, use, control, protection, management or administration of water resources.

(ii). To promote the provision of a clean, safe and sufficient supply of water for domestic purposes

(iii). To ensure appropriate development and use of water resources other than for domestic use, e.g. watering of stock, irrigation and agriculture, industrial, commercial and mining uses, generation of energy, navigation, fishing, preservation of flora and fauna and recreation in ways which minimise damage to the environment; and

(iv). To control pollution and promote the safe storage, treatment, discharge and disposal of waste, which may pollute water or otherwise harm the environment and human health.

2.1.3.2 National Environment Act (1995)

The National Environment Act (1995) provides for "sustainable management of the environment and Section 34 of the Act deals specifically with limitations in the use of rivers and lake systems and aims to minimise the negative impacts and control activities that have the potential to be detrimental to these systems. The Act goes on to make specific provisions for the protection of river banks and lake shores in Section 35 and protection and management of wetland systems in Section 36 and 37 respectively.

Hilly and mountainous areas have also been identified as areas requiring special attention and protection by the Act. The Act makes provision for the restoration of vegetative cover in these areas. This Act coupled with the provisions made in the Prohibition of the Burning of Grass Act (1974) and the Forest Act (1947) and the Cattle Grazing Act (1945) provides a good basis for restoration, protection and management of vegetative cover in hilly and mountainous areas.

2.1.3.3 The Local Government Act (1997)

The Local Government Act of 1997 underscores the role of Local Government in provision and management of water and sanitation, empowering the local authorities to plan and to implement development interventions according to local needs.

Article 8 of the Local Government Act (1997, revised 2015) provides that two or more district councils may cooperate (in accordance with article 178 of The Constitution) in areas of culture and development. To make this cooperation possible the cooperating district councils may establish and support joint institutions (councils, secretariats) or trust funds and appoint joint committees on matters of common interest.

2.1.3.4 Other Water Sector related laws

- The **Local Government Act of 1997**, which underscores the role of Local Government in provision and management of water and sanitation, empowering the local authorities to plan and to implement development interventions according to local needs
- The **1998 Land Act**, which stipulates the responsibility of the Central and Local Government in protecting environmentally sensitive areas such as natural lakes, rivers, groundwater, natural ponds, natural streams, wetlands, forest reserves, national parks and any other land reserved for ecological and tourist purposes; and
- The **1998 Water Abstraction and Wastewater Discharge Regulations** for controlling water abstraction and wastewater discharge, to promote sustainable and environmentally friendly development and use of water resources. Some issues feature at the level of the policy and regulatory framework while others are crucial at catchment level. For instance, plans to develop irrigation schemes necessitate the development of a proper mechanism to protect water use rights and to settle disputes, especially between upstream and downstream water users. Issues of equity exist, whereby some users, often powerful up-stream users, put their interests first. In establishing the mechanism to handle user rights and conflict resolution, issues of

active participation of all concerned stakeholders, including women, livestock keepers, and youths, should be taken into consideration.

The existing policy and legal framework promotes wise use of water resources from the lowest possible level, while considering roles to be played by different stakeholders at different levels. This offers an opportunity to ensure communities actively participate in development and maintenance of water sources. Other Water Sector related laws and policies form synergies with the Water Policy and Act in the way they reiterate the principles of IWRM.

2.1.4 Trans-boundary and International considerations

The trans-boundary nature of Uganda's water resources is such that there are a number of international conventions relating to management of water resources with which Uganda must comply. Currently, the key conventions/organisations to which Uganda is party are; the Protocol for Sustainable Development of Lake Victoria Basin and Nile Basin Initiative. Others for consideration include;

(i). Agreements on sharing Nile Water
(ii). Agreed Curve for the Lake Victoria Release
(iii). Nile Basin Cooperative Framework Agreement
(iv). Protocol for Sustainable Development of Lake Victoria Basin
(v). Ramsar Convention (1971)
(vi). UN Framework Convention on Climate Change (UNFCCC) and related Kyoto Protocol
(vii). UN Convention on Biological Diversity
(viii). International conventions for shared water resources

2.2 Institutional Framework

2.2.1 National Level

The Ministry of Water and Environment (MWE) plans and coordinates all water and environmental sector activities and is the ultimate authority responsible for water resources and environmental management in Uganda. The MWE has the overall responsibility for setting national policies and standards related to water and the environment, managing and regulating all water resources and determining priorities for water development and management. The MWE is divided into three directorates:

- Directorate of Water Resource Management (DWRM) – responsible for managing and developing water resources of Uganda in an integrated and sustainable manner in order to provide water of adequate quantity and quality for all social and economic needs for the present and future generations
- Directorate of Water Development (DWD) - responsible for providing overall technical oversight for the planning, implementation, and supervision of the delivery of urban and rural water and sanitation services across the country including water for production.
- Directorate of Environmental Affairs (DEA) - responsible for environmental policy, regulation, coordination, inspection, supervision and monitoring of the environment and natural resources as well as the restoration of degraded ecosystems and mitigating and adapting to climate change.

There also exist a number of departments and units within MWE (Figure 3) that play specialized roles. Among these is the Climate Change Department (CCD) which plays the role of coordinating national climate change actions (Mitigation and Adaptation) in different sectors, including the creation of awareness among various stakeholders to enable them internalize their roles and responsibilities. The department among many things ensures that climate change concerns are integrated into the overall national planning through coordination with the relevant ministries, departments and government agencies.

Also linked to MWE are parastatals with specific mandates; the National Environment Management Authority (NEMA), which is mandated with the coordination, monitoring, regulation, and supervision of environmental management; the National Water and Sewerage Corporation (NWSC) which is mandated to operate and provide water and sewerage services in the larger urban centers; the Uganda National Meteorological Authority (UNMA), which is mandated to promote, monitor weather and climate as well as

provide weather predictions and advisories to Government and other stakeholders for use in sustainable development of the country, and the National Forest Authority (NFA), whose mandate is to manage Central Forest Reserves and to supply high quality forestry related products and services. The institutional setup at the national level is shown in Figure 3. There exist other national entities which are significantly impacted by technical water management issues including the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF); the Ministry of Tourism and Industry (MTI); the Ministry of Energy and Mineral Development (MEMD), the Ministry of Education, Ministry of Health (MOH) among many others.

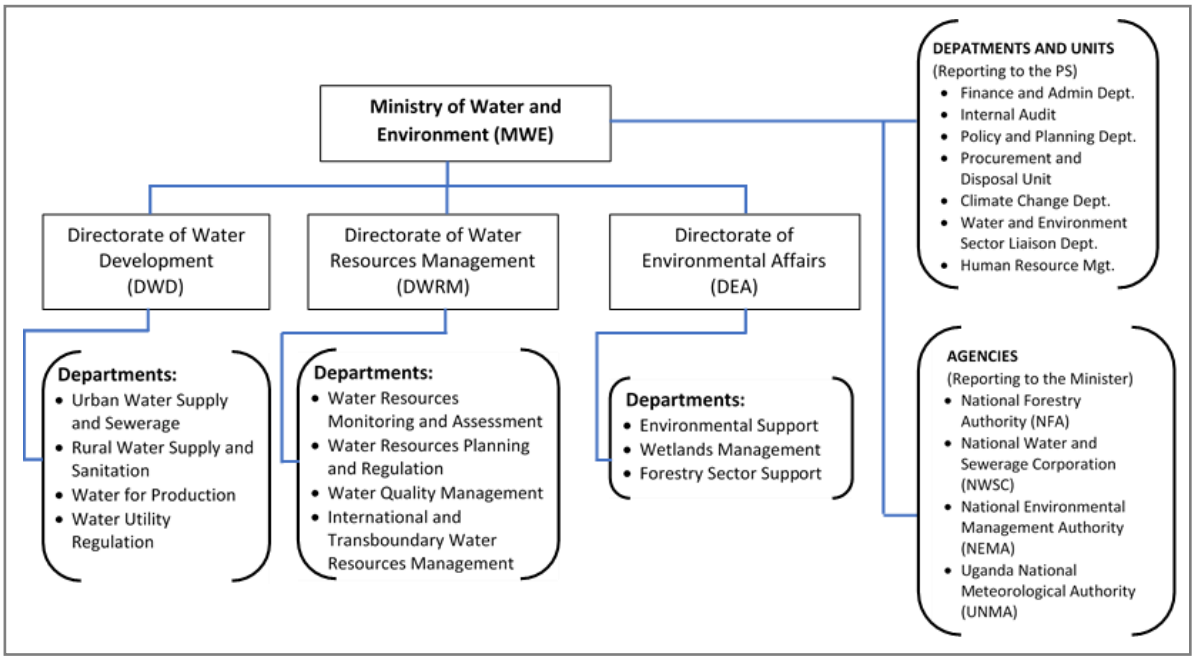


Figure 3: Institutional Setup at a National Level (MWE, 2009)

Coordination is a key process for Integrated Water Resources Management (IWRM), which involves multiple stakeholders from different sectors, on different scales, and with different structures and interests. At the national level, the following committees are relevant to integrated water resources management:

- The Policy Committee on Environment: chaired by the Prime Minister, at the highest level of political decision-making
- The Water Policy Committee, which is composed of directors, and enables high-level and strategic dialogue specifically in the water sector
- The IWRM Working group, which is an informal working group enabling technicians to coordinate
- The Water and Environment Sector Working Group (WESWG)
- The Inter-Ministerial Technical Committee regarding Water for Production, comprising members from the MWE, Ministry of Agriculture, Animal Industry and Fisheries (MAAIF), Office of the Prime Minister, National Planning Authority, and Ministry of Finance. It meets on a quarterly basis to coordinate investments and works regarding water for production
- The Wetlands Advisory Group (WAG), which is a technical group dedicated to wetlands. The WAG improves coordination on wetlands issues, particularly on the issue of dry land rice
- The MWE-DWRM has created Water Net, a network for building capacities of stakeholders connected to the water sector.
- The National Environment Management Authority (NEMA) is the apex body for environmental law enforcement in Uganda

2.2.2 Regional Level

As a result of the de-concentration of the management of water resources, DWRM created four Water Management Zones (WMZ) following hydrological boundaries, Figure 2. They operate at regional level with the objective to bring the central services closer to the stakeholders. Their primary role is to facilitate sustainable development of the water resources for the economic and social benefit of the people in the catchment and to implement the water management measures needed to protect and conserve the catchment and its water resources, ensure sustainability, and reduce or resolve conflicts over resource use.

To achieve this primary role, the WMZ team execute the following functions:

- Prepare catchment and zonal water development and management strategies and plans.
- Develop, maintain and expand the catchment and zonal knowledge database and information system, prepare knowledge products, and disseminate data and information including maps to support CMO and WMZ functions and facilitate catchment water management and development.
- Promote awareness and understanding of integrated and sustainable water management and development among stakeholders in the zone and catchment, present Government water policy, water conservation and protection values, the role and importance of the CMOs in ensuring sustainable and equitable access to water.
- Establish, support and facilitate an institutional framework for effective stakeholder participation in catchment management and development planning, and plan implementation including training and capacity building of stakeholders.
- Carry out holistic water resource assessments, estimate current water use and project future water demand, prepare water balances, and simulate and analyse integrated water use and infrastructure operations.
- Design, install, and operate a modern zonal and catchment water monitoring system for hydrologic and meteorological data on groundwater and surface water including data collection, analysis, storage and dissemination.
- Design, install, and operate a modern zonal and catchment water quality monitoring system, and operate and maintain a regional water quality laboratory.
- Regulate water allocation, water use, and infrastructure operations in accordance with the agreed and adopted water management plan, administer the water permitting system, and monitor and enforce compliance with regulations including the implementation of environmental management plans and project plans.
- Review project proposals for water development and water use, water use permit applications, proposals for modification of regulations or prior permits, and environmental impact assessments (EIAs) in the zone and catchment.
- Contribute to and support the formulation of new and revised regulations and laws, and national water development and management plans and strategies, and support Uganda participation in trans-boundary water resource forums and implementation of agreements
- Coordinate, facilitate and support the activities of central sector departments and agencies, regional and district level officers, NGOs and donor partners within zone and catchment, including activities such as investment in water development at the zonal and catchment level, project planning and project preparation studies.
- Guide and facilitate the continuing role and function of the CMOs in the implementation of the catchment management and development plans.

Other MWE directorates have established regional offices including;

- Water and Sanitation Development Facility (WSDF) as a mechanism for supporting water supply and sanitation facilities for rural growth centres and small towns; directly reports to DWD.

- Technical Support Units (TSU) that support capacity building of district-based structures; directly reports to DWD.
- Regional Wetlands offices that support the coordination, inspection, supervision and monitoring of the environment and natural resources functions; directly reports to DEA.
- Umbrella Organizations (UO) are also regional organisations constituted as associations of the local Water Supply and Sanitation Boards (WSSBs) with the principle objective of providing operation and maintenance (O&M) back-up support (training, technical, legal and organisational support, supervision of rehabilitation, and extension works as well as water quality monitoring).
- Forestry Sector Support Department (FSSD), and
- National Environmental Management Authority (NEMA)

2.2.3 Catchment Level - Catchment Management Organisations

Catchments can be quite complex and generally consist of several distinct but connected sub-catchments and micro-catchments. Each catchment is thus a multilevel water or hydrologic system consisting of integral hydrologic units. During the preparation of a catchment management plan, stakeholders need an institutional framework which brings them together to present and exchange their views and thus give the process legitimacy. Moreover, since catchment management plans, especially water management measures, take some time to implement and the plan itself will be reviewed and revised from time to time, an institutional framework for this continuing process over time is needed. Since the existing structures at the district level don't have sufficient spatial scope or jurisdiction to serve this purpose, the WMZs facilitate the process of establishing Catchment Management Organisations (CMOs) at a catchment level, which build on and utilise to the maximum practicable extent, existing structures and relationships. The CMO constitutes the most involved and collaborative stakeholder group who engage through related forums, which are consultative. The CMO Procedures Manual (DWRM 2019) has details of the CMO structure, Figure 4 which shows the composition, roles and responsibilities, as well as operations. The CMO structure provides for the following:

- The **Catchment Stakeholder Forum (CSF)** brings together all actors in the catchment. The CSF defines key issues related to water resources in the catchment that require consideration in order to effectively protect, manage, and develop water resources. It provides input to the CMP for coordinated, integrated and sustainable development and management of water and related resources in the catchment, including their implementation status.
- The **Catchment Management Committee (CMC)** is composed of representatives of all relevant stakeholder groups (government, politicians, and community based organisations, NGOs, water users, media, academic institutions, and private sector) and collaborates with the WMZ during the formulation of a Catchment Management Plan and plays a steering role during its implementation. The CMC responsibilities include: coordination of stakeholder-driven definition of key issues related to water resources, promotion of coordinated planning, and implementation as well as stakeholder-driven decision making related to integrated and sustainable development and management of water and related resources, development of plans for coordinated, integrated and sustainable development and management of water and related resources. It endorses the CMP and presents it to the Catchment Stakeholder Forum for information purposes. The CMC acts as an Executive Board for the Catchment Management Organisation.
- The **Catchment Management Secretariat (CMS)** provides support to the Catchment Management Committee in coordinating the planning and implementation of activities in the catchment as well as following up of recommended actions by the stakeholders. The CMS acts as an administrative secretariat for the Catchment Management Committee as well as the Catchment Technical Committee.

- The **Catchment Technical Committee (CTC)** forms the technical arm of the CMO and supports the CMC in their tasks. The CTC brings technical expertise and knowledge during the formulation of the Catchment Management Plan, operationalises and sometimes implements programmes and projects from the plan, and generally ensures that the different districts collaborate to implement the plan. It comprises of technical people from government, NGOs, private sector, development agencies, and other relevant organisations in the catchment.

The WMZ has to make sure that this structure is formed at the beginning because it ensures that they understand their roles and that they have capacity to play their part in the planning process. The WMZ will be able to rely on support from a number of national or regional level organisations including the ministerial water and environment coordination network.

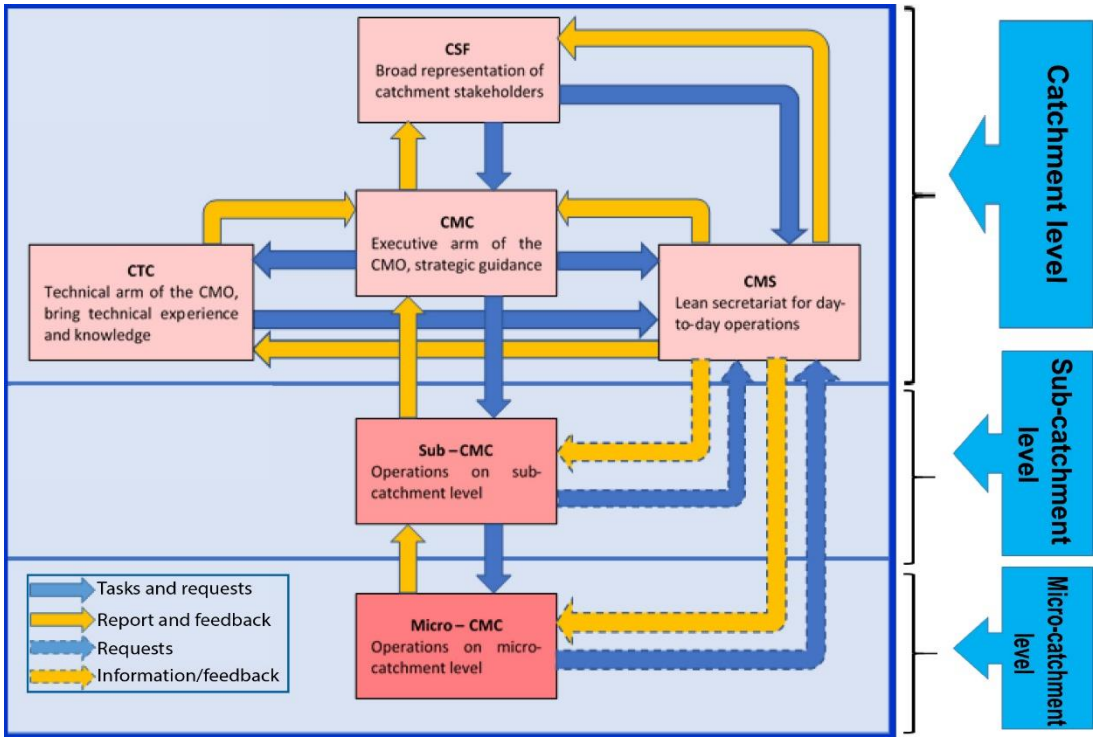


Figure 4: Catchment Management Organisation Structure (DWRM, 2017)

2.2.3.1 CMO Linkages

The roles and functions of the catchment CMO including its various constituent committees and forums cannot be sustained without support from the WMZ, the Ministry, the concerned local governments located in the catchment, and the stakeholders and water users. Figure 5 shows the relationship among CMO structures and between the CMO structures and other stakeholders, the details of which are contained in the CMO Procedures manual, 2019.

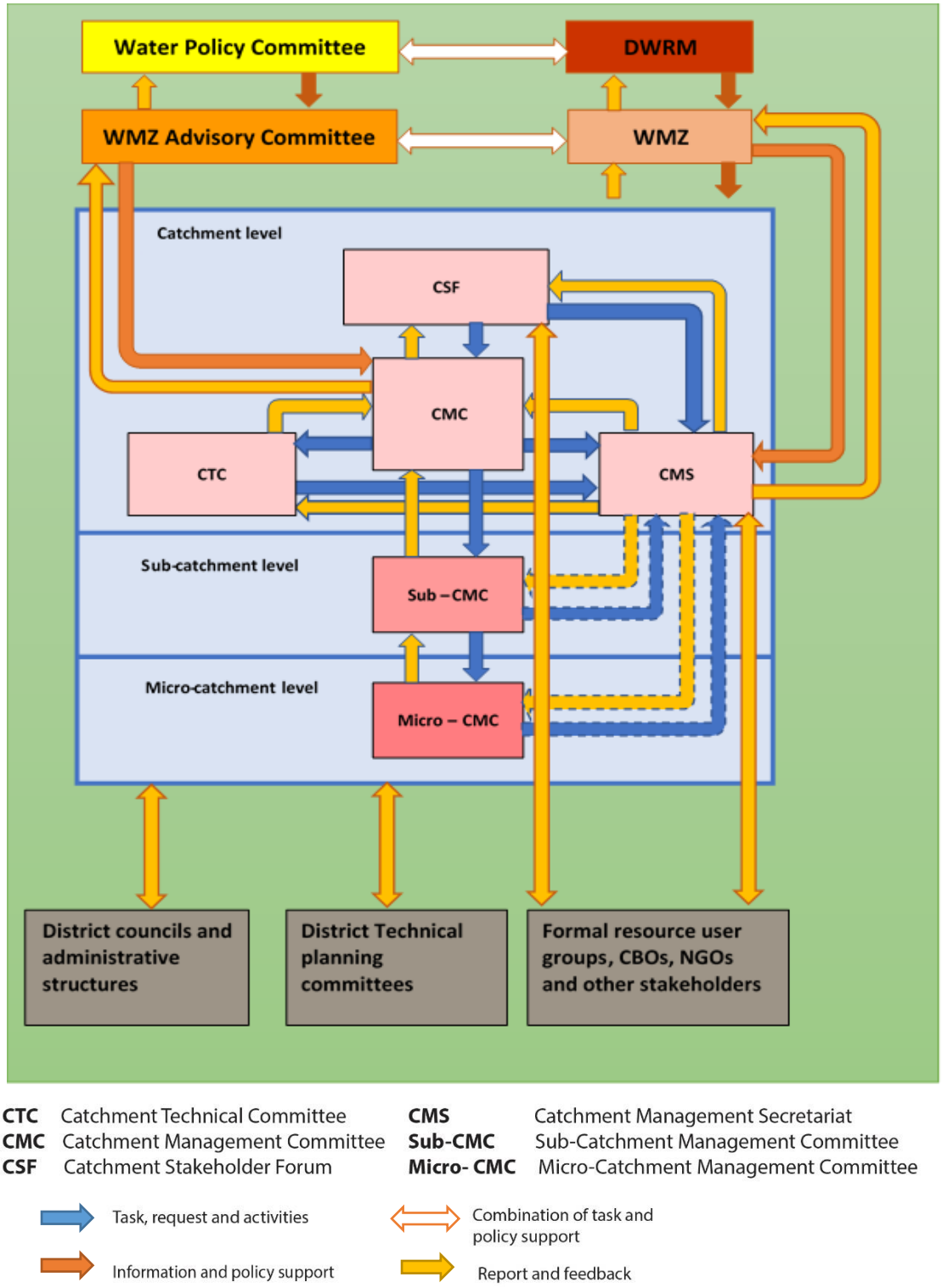


Figure 5: Relationship between the CMO (dashed box) and other stakeholders

3 DETAILED CATCHMENT MANAGEMENT PLANNING GUIDELINES

3.1 General Overview

The Catchment management planning process involves a series of steps each of which contains varying numbers of tasks, Figure 6. The steps and tasks are sometimes iterative and often interdependent. Each of these steps and the tasks they comprise are discussed in this section. It is important to note that these steps provide a framework within which the WMZ team and other stakeholders will refine and develop, in detail, their approach according to the needs and conditions in their catchment. They are not meant to be followed mechanically, but rather to provide guidance on the catchment management planning process. As experience is gained in undertaking catchment management planning in Uganda, these guidelines will be refined to reflect lessons learned.

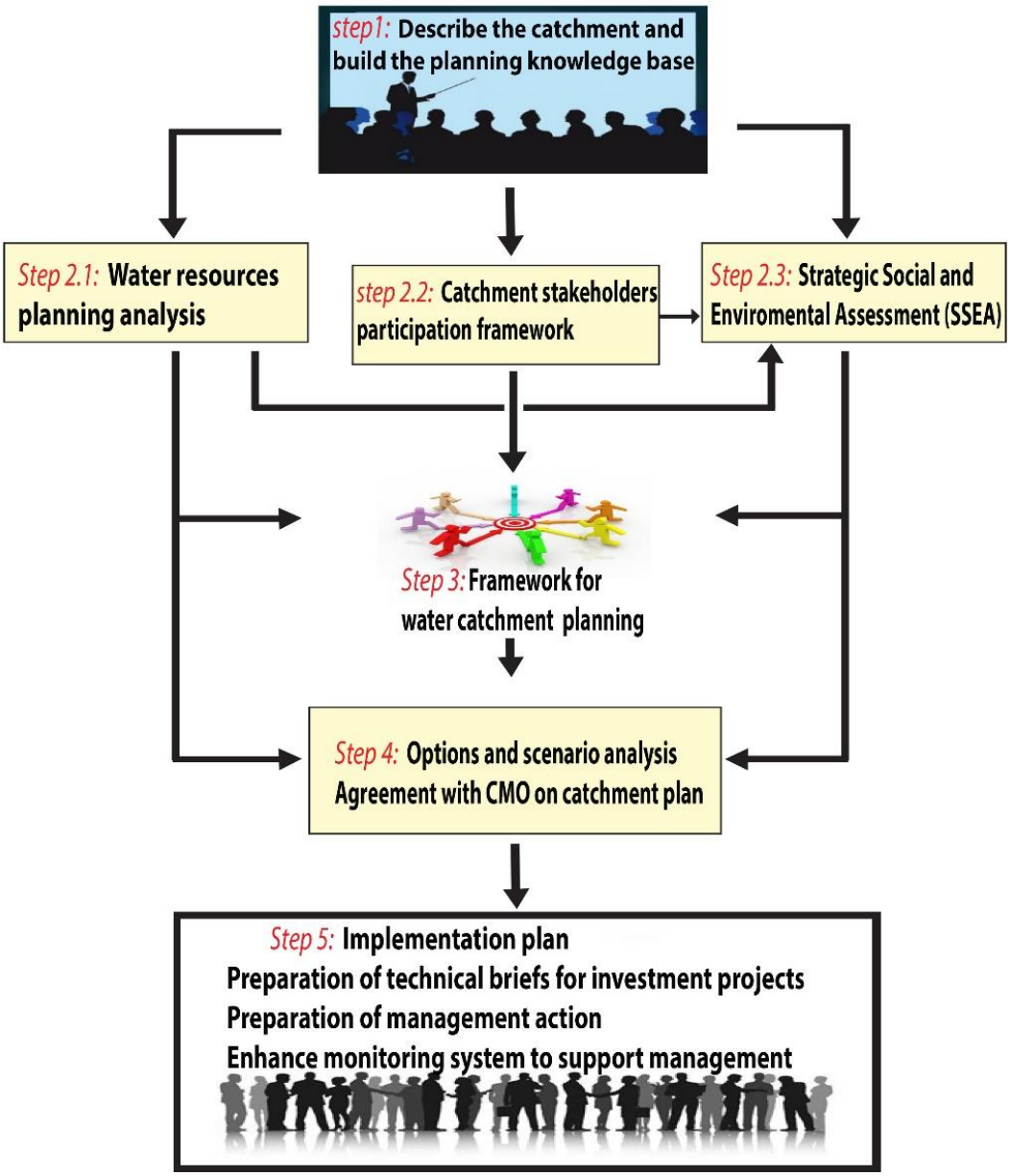


Figure 6: Overview of the catchment management planning process

The catchment management planning process has two broad stages;

a) Collecting the right information, which is mainly contained in Step 1
b) Analysis and Assessment, which is captured by Steps 2, 3, 4, and 5.

3.1.1 Main Stages of Catchment Management Planning

3.1.1.1 Collecting the right information

Step 1; **Describe the catchment and build the planning knowledge base**, establishes the information foundation on which the planning process rests. The aim is to delineate and describe the catchment, and to compile and organize the data and information – the **knowledge base** that is needed to support the planning process. Since the spatial qualities of much of the relevant data are critical to the planning process, it is also necessary to establish and operationalize a GIS system for the zone with the support of the DWRM GIS Centre.

It is important that work carried out under Step 1 is guided by the intended use of the generated information. It is not the purpose of the knowledge base to describe everything about the catchment, but rather to understand the issues, challenges and threats and to appreciate the opportunities within the catchment. At the same time, the water resources modelling and SSEA will require certain information and it is important that it is well defined before extensive fieldwork is undertaken.

3.1.1.2 Analysis and Assessment

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

- In **Step 2.1**; **Water Resources Planning Analysis**, the analytical framework for planning analysis in the catchment is established and operationalized including catchment hydrologic and water system simulation models. Analysis in this step includes a water resource assessment and water balance. At this stage, the analysis represents the baseline or current situation but the models should be configured so that they can be used to inform the options and scenario analysis under Step 4.
- In **Step 2.2**; **Catchment Stakeholders Participation Framework**, the framework for the participation of stakeholders in the preparation of the catchment management plan is established and operationalized – stakeholders are identified, mapped and mobilized; the CMO is created and membership identified and motivated; and the program to inform, train and operationalize the CMO is designed and implemented.
- **Step 2.3** is the critical **Strategic Social and Environmental Assessment** (SSEA) in which the key vulnerabilities in the catchment are identified, and linkages, cumulative impacts and options for mitigation are assessed. Since the SSEA process is participatory, this step must be planned and carried out in close coordination with Step 2.2. The SSEA also depends on outputs from the water resources modelling which will provide key outputs on cumulative impacts. The SSEA will also play a key role when comparing options under Step 5, Figure 6.

Step 3 is the **establishment of the framework for catchment water planning**, a highly participatory step that includes four tasks as outlined below. This is the first and one of the most important and substantive inputs to the planning process by the CMC and the CTC.

(i). Present to the CMC and CTC an overview of the catchment; the major issues, problems and trends; and the opportunities and options identified by the WMZ planning team in Step 1 and Step 2;
(ii). Review and agree with the CMC and CTC on planning objectives and indicators – this is a critical task since these objectives and the corresponding indicators will guide the formulation and evaluation of options and scenarios;
(iii). Review and agree with the CMC and CTC on the major issues, problems and trends in the catchment that need to be addressed by the catchment plan. This would include the aspirations and needs for water expressed by stakeholders;
(iv). Review and agree with the CMC and CTC on the range and scope of options to be considered – what stakeholders want done and what does the planning team see as being needed.

Step 4; Options and Scenario Analysis, involves the analysis of identified options and scenarios (using the tools developed and operationalized in Step 2.1 and Step 2.3) within the framework for planning developed in Step 3. This step is iterative and interactive. It is challenging for the CMC and CTC to follow the reasoning if the presentation is too complex. Hence, the WMZ planning team needs to carefully walk the CMC and CTC through the process and results in order to foster good understanding and a consensus draft catchment management plan.

Step 5 consists of a series of tasks that prepare the agreed draft catchment management plan for implementation, including its review and approval by MWE. It also includes the development of the monitoring and evaluation system and a framework for adaptive management.

3.1.1.3 Communication of Information

MWE developed a communications strategy that is designed to:

- Ensure that communication within the ministry is well coordinated, effectively managed and responsive to the diverse information needs of the people of Uganda;
- Provide mechanisms for provision of timely, accurate, clear, objective and complete information on Government policies, programs, services and initiatives related to water resources management to Ugandans;
- Provide a framework to enable MWE to communicate openly with the public on water resources management policies, programs, services and initiatives;
- Ensure that all stakeholders involved in water resources planning, development and overall management collaborate with each other and communicate with the public.

Effective communications with a wide range of stakeholders from government officials to members of civil society is important and will be necessary during the planning and operationalization processes. Hence, it is useful as a part of Step 2.2 in the planning process (see the next section) that the WMZs develop specific communication plans that are in unison with the existing MWE communication strategy and program for the WMZs.

STEP 1 - Describing the catchment and building the knowledge base

The process of gathering and generating information about a catchment forms the starting point in understanding and describing the catchment which ultimately leads to informed planning for sustainable management and development. This initial step involves;

- Delineating the catchment and sub-catchment boundaries
- Developing a catchment information management system
- Building the catchment knowledge base
- Preparing a schematic diagram of the catchment

Step 1.1: Delineating the Catchment and Sub-Catchment boundaries

1. Every catchment is complex from a hydrologic perspective and understanding the whole catchment requires delineation and analysis of its sub-catchments. For example, Figure 7 shows delineation of the Lake Kyoga basin where Catchment 1 is distinct from its primary upstream catchments, such as catchment 2. Each of these catchments can be further delineated into sub-catchments. In Figure 7, a-b constitutes one sub-catchment, and c-d-e constitutes another sub-catchment (note that they do not join but flow into the lake separately). Delineation generally begins with gathering and studying all available maps of the catchments including, in particular, topographic maps. Where maps are old, out of date or have significant gaps, remote sensing imagery should be used to obtain up-to-date maps.

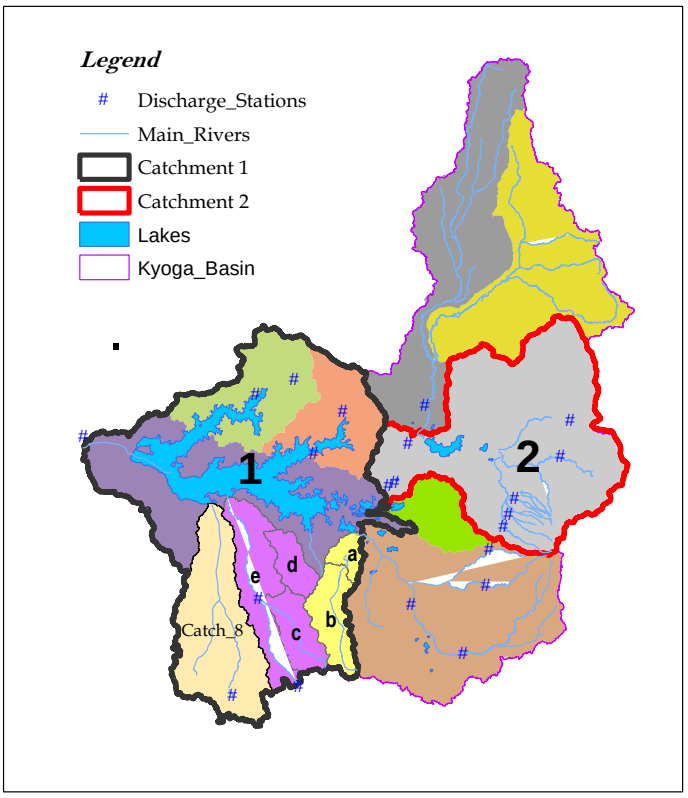


Figure 7: Delineation of catchments in the Kyoga WMZ

2. The delineation of catchments is useful for developing a water system simulation model. The delineation as in Figure 7 is not what the planning team needs initially, but it is a good model of how one might begin. The planning team can begin by sketching the boundaries of watersheds of the river network, and then further refining this as a greater understanding of the sub-catchments is gained.
3. Initially the team should identify not only the network and the sub-catchment boundaries but also locate and identify how and for what purpose people in the catchment are using water for and, in general, the status and spatial distribution of the catchments natural resources. The level of detail at this stage may be much greater than that which the team will use to model the catchment and these activities. The level of detail may vary according to availability of information, for example, in Figure 7 sub-catchments c, and e can obviously be further subdivided into two sub-catchments. Note that in Figure 7 there are a number of gauging stations (shown by blue triangles) which can be used as a guide for catchment delineation. Hence for modelling the catchment, many sub-catchments could be combined or lumped together. At this point the team should learn about the land, people, the resource base including the sensitive environment as assets, existing water use and other infrastructure, the major issues and problems, and what plans and development proposals exist in the sub-catchments. Later these data can be combined in ways that are convenient for modelling the catchment, but at the beginning that is not what is driving the process.

4. There is obviously a hierarchy of catchments and sub-catchments, but these guidelines are deliberately not separating names (other than sub-catchment and micro-catchment) to all the various levels. It is not necessary if the planning team focuses on the connectivity of the various sub-units and their relation to these other units (the team can of course give them real names as opposed to a generic or categorical name as it wishes or finds helpful).

5. How fine the delineation is made depends on whether the new sub-units convey important information about hydrology, people, water demand and use, or infrastructure options, etc., and to what extent this information can be taken into account given the scale of the catchment management plan. Where the catchment management plan is being developed for a larger catchment, it will not be possible to plan in detail all the required actions at the micro-catchment level. However, if actions addressing issues such as land degradation and the need for watershed management are relevant to the overall plan, it is important that smaller catchments are delineated, even if they are lumped together for parts of the analysis such as water balance and optimisation modelling.

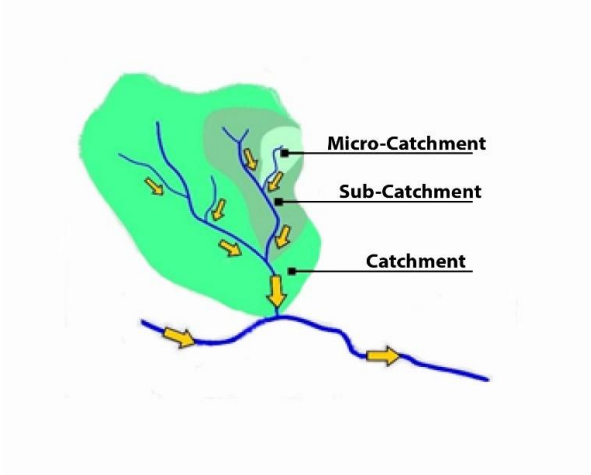


Figure 8: Catchments, sub-catchments and micro-catchments

6. It may not be realistic for large-scale plans to provide action plans for each micro-catchment, but they should at least:

   (i). Address the issues,
   (ii). Provide for remedial actions in the form of pilot demonstration projects covering some micro-catchments, and
   (iii). Develop a plan for scaling up.

   These three actions will at least require that micro-catchments are delineated, even if they are aggregated for basin-wide modelling tasks and other considerations.

7. This characteristic of multilevel interconnectedness of sub-catchments is demonstrated in the schematic diagram in Figure 8. Water users in the different connected sub-catchments are using a common shared resource, thus, what one group does or plans to do with water affects what upstream and downstream groups may do or plan to do with water. This principal applies to both groundwater and surface water. The effects of heavy upstream use of groundwater on dry season flows downstream are an example of how the use of surface water and groundwater are connected both spatially and temporally.

Step 1.2: Developing a Catchment Information Management System

1. The planning team has to have a way of organizing and manipulating the information and data it will compile for the catchment and each of the sub-catchments hence the need to begin developing a spatial database that can be used to support consultation and collaboration with stakeholders and planning analysis.

2. In collaboration with the DWRM GIS unit, each WMZ will develop a GIS spatial information system. This information system will include a 90x90 m^2 Digital Elevation Model (DEM) or an updated or improved version to provide a topographic base, which can be used to delineate sub-catchment boundaries. The DWRM GIS unit will provide technical support and backup, training, existing shape files from its library, and help the WMZ team to acquire new data files.

3. The first and one of the most powerful applications of the GIS should be the preparation of several thematic maps that can be used to inform stakeholders and to collect and document information including opinions that stakeholders can provide to the WMZ planning team.

4. The use of new technologies – especially remote sensing – to gather spatial information and data needs to be piloted by the WMZs. Not only are many new satellites available and accessible but also data from satellites can be obtained free of charge on the Internet.

Step 1.3: Building the Catchment Knowledge Base

Critical role of the knowledge base: Without good data and information, no real planning can be done and no informed decisions can be taken. At the onset of the planning process, therefore, an important task is to collect, compile, and organize the needed data. GIS is the tool needed to organize most of this data, but other tools and computer aided programs such as excel will also be needed.

1. The broad term "knowledge base" refers to the whole body of data and information that is generally needed to support the planning and decision-making process. The knowledge base may consist of all types of data and information including hardcopies or reports and maps as well as data in digital form. Moreover, as the planning process proceeds new data will be added to the knowledge base.

2. The knowledge base should be organized and implemented in a manner that facilitates wide access to the data and provides a focal point for water-related data and information in the Water Management Zone, with data collected by various national and other agencies being collated in the knowledge base. This suggests that there needs to be a seamless and mutually supportive interface between the zonal and national water information systems. In addition to the queries, analysis, the information and maps would be used to generate various knowledge products such as atlases, state of the Basin reports, etc.

3. To answer the questions surrounding the data needed for the catchment knowledge base requires focusing on key questions that need to be answered by the knowledge base, that is: what are the questions and issues that will drive the planning process and what data and information will be needed in order to answer these questions? This is the role of a scoping exercise, which should be carried out before too much effort is spent in the field. At the zonal and catchment level, questions that might help identify the data to be included in the knowledge base include:

    - What is the status of the resource base - Surface and groundwater availability? Seasonal patterns? Storage-yield relationships? What is the frequency and magnitude of droughts and floods? Are there threats to water quality?
    - What is the projected future water demand at different points in time (domestic use, irrigation, industrial use, hydropower, environmental, in-stream uses, etc.) and trends?
    - What is the baseline for the planning objectives and indicators?
    - What is the existing water regulation and monitoring infrastructure? Data? Reliability? Gaps?
    - What options are there for further developing and regulating the resource base and what are their economic, environmental, and social implications?

    A tentative list of data that might be compiled and used in preparing a catchment plan is given in Annex A. Also included in Annex A. are the sources of data in Uganda and elsewhere. This list includes potential sources of climate data for future "under climate change" conditions.

4. When compiling the list of data, including spatial datasets, it is important to identify the shortcomings or gaps, especially where action could be taken to address these shortcomings during implementation of the plan. This should include, but not be limited to:

    - Collection of climate, especially precipitation, data. In consideration of anticipated climate change, all new precipitation gauges should measure rainfall intensity (e.g. automatic tipping bucket). It is important to improve monitoring in source areas.
    - Surface and groundwater gauging stations.

5. Among the physical spatial data to be compiled initially are the stream network, water bodies including lakes, reservoirs and tanks; groundwater boreholes and dug wells; identification and location of existing important infrastructure (e.g. roads (all types), bridges, dams, diversions, pumps, canals, and hydro-met stations); villages, towns and urban areas; industries; commercial farms; mines; forests; protected areas and parks; important touristic assets; and wetlands; soils, land cover and land use.

   An important part of the spatial database is the district and country administrative boundaries. A large amount of important social and economic data are compiled and reported by districts and their sub-units. These data, including for example population and related census data, can be compiled into the WMZ GIS system as attributes of the districts and their sub-units.

6. Lakes, ponds and wetlands play an important role in the hydrology of a catchment, support specific water uses, and represent a special water management challenge. Lakes in particular are fragile, have a very long retention time, mix slowly and have a very long recovery time from shocks such as pollution discharges. Along with lakes, wetlands are one of the most ubiquitous features of the Uganda landscape. Together these two features represent most of the manageable water storages in the country. Hence in compiling this initial picture of the catchment, the WMZ team should pay particular attention to identifying, locating and describing lakes, ponds, and wetlands as key parts of the catchment water system.

7. A computer model or paper map is no substitute for field reconnaissance, i.e., for traveling throughout a catchment to see the many ways in which water is used, to observe the factors that govern the hydrology of the catchment such as soils, land cover, slope, land use and the stream network. This also provides an important opportunity for initial discussions with stakeholders – not necessarily through formal gatherings but primarily impromptu discussions in the field with local people. This is also an opportunity to assess land-use changes, especially the expansion of agriculture and to obtain an appreciation of the timeline associated with these changes. In some cases, these changes may be both large and relatively recent and highly significant in terms of observed changes to the hydrological regime (e.g. baseflow, floods, groundwater recharge etc.).

Step 1.4: Prepare a schematic diagram of the catchment

1. The fourth step, undertaken in parallel with the above, is to develop a schematic diagram which describes the stream network as a series of links and nodes (connections) and includes all existing and proposed water uses and water infrastructure of the catchment. This process is demonstrated in
2.
3. Figure **9** which shows all the existing demand centres, abstraction and return flow details for 2 sub-catchments in the Mpologoma catchment of the Lake Kyoga basin. Such a schematic diagram can be sketched quickly from the study of the maps and reports on studies that may have been done previously.

4. When building this network it is advisable to take into consideration both existing and possible future developments, even those that may not be in competition for the same water. This could include dams and reservoirs, hydropower developments, irrigation and water supply schemes and any water abstractions and return flows. It can also take into account the need to meet environmental flow requirements. When it comes to looking at alternative development options in Step 4, the modeller will be able to "switch on or off" those future developments that are to or not to be included in the option being investigated.

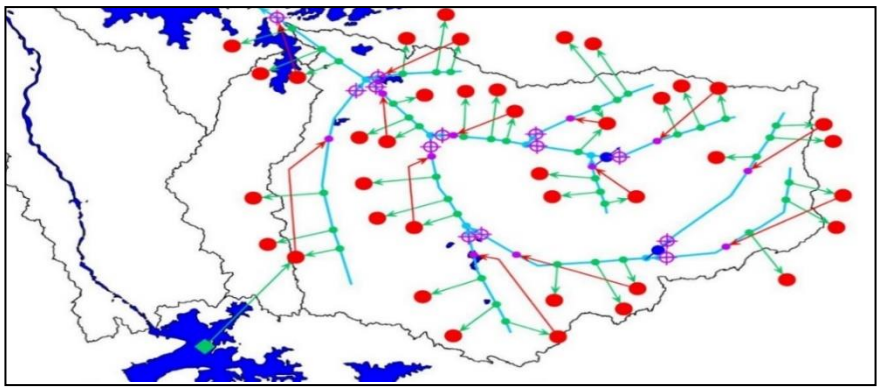


Figure 9: Schematic water resources/ demand flow in the Mpologoma catchment (Developed in WEAP)

STEP 2 - Water Resources Assessments and Stakeholder Participation

Step 2.1: Water Resources Planning Analysis

Task 1: Analytical Tools for Planning and Water Resources Management

Integrated Catchment Management Planning generally requires a set of analytical tools including water system models to undertake water balance studies and scenario analysis. Together with the Knowledge base these tools form the core of a Decision Support System (DSS). Annex B briefly describes the basic analytical tools that are typically needed in a water resources planning decision support system.

The Nile Basin Initiatives (NBI) developed the Nile Basin Decision Support which is a comprehensive analytic framework designed to meet the requirements of complex water resources planning. It provides diverse toolsets for data processing, modelling, scenario management, cost-benefit analysis, optimization and multi-criteria decision making. It also offers tools for integrating environmental, social and economic objectives, thus facilitating multi-sector water resources planning at river basin level. Member states, including Uganda, have been provided with a number of licenses which allow access to all the tools. Details are available through the DSS portal http://nbdss.nilebasin.org/support/home.

Agree on the decisions to be supported

1. An important step in developing a decision support system for water resources planning and operations is the definition of the range and nature of decisions that may be needed, and the use of this information to determine characteristics and elements of the decision support system that will be required to support the decisions. This is important and should be discussed exhaustively with stakeholders.

2. The requirements to support these decisions may be as simple as a map (often the case with a micro-catchment) or as complicated as a mathematical model of the water system. The DSS is likely to be made up of a number of very different tools using the information in the knowledge base in different ways to support different kinds of decisions. Experience suggests that these tools and the connections be kept as simple and transparent as possible while meeting the particular decision needs and requirements.

3. The planning team will have its own view of what the issues are and what decisions may be needed based on its reconnaissance of the catchment and analysis of the data in the knowledge base. Nevertheless, the team should hold discussions with stakeholders to define the basin operating, management and investment decisions to be supported by the DSS. Some examples include:

    - Decisions relating to investments that could impact flow patterns, water balances, water quantity and water quality, including irrigated agriculture developments, other growth related developments (e.g. floriculture/ greenhouses, tanneries, agro-industrial processing plants, etc.), and other consumptive water use developments;
    - Decisions relating to water storage and flow control investments and corresponding coordinated system operations to meet various objectives (e.g. hydropower, irrigation and drought mitigation, flood mitigation and prevention, lake level regulation, environmental flow regimes, etc.);
    - Decisions concerning investments for pollution and wastewater management, fisheries management, navigation, recreation and tourism, and environmental conservation and enhancement;
    - Decisions relating to optimal, equitable and coordinated operation Shire River hydropower schemes, irrigated agriculture schemes and environmental flow control and future projected surface and/or subsurface water control and withdrawal schemes, to be generated in the context of routine annual/ seasonal, monthly/ weekly and/ or daily/ sub-daily operational planning;
    - Decisions relating to the generation of operating rules and guidelines for development of future water infrastructure to achieve various objectives;

- Decisions concerning appropriate water control and use during periods of crisis, including drought flow apportionment and allocation priorities, distributions and schedules at times of shortage, and flood flow retentions and/ or diversions at times of excess, together with the nature and timing of key contingency plan actions in the event of emergencies.

Select the water system modelling tools

4. Annex B provides a quick summary of the types of tools typically used in catchment planning along with the kinds of tasks that can be done with them. The focus initially should not be on which model, but on what the team needs or wants to do, that is, focus first on questions such as:

    - What results do we need?
    - What kind of analysis do we need to do to get those results?
    - What data do we have?

5. Having answered the questions above, then the final question regarding what models could one use to address the questions with the data available (remembering that one needs to look beyond what is available in MWE can easily be answered by looking at the model descriptions in Annex B. Consideration has got to be made of all possible sources including the internet and other sources of public domain and remotely sensed data). The ease with which the models can be operationalized, the amount of training required, the cost and the intuitive nature of the interfaces are all important considerations.

6. The National Water Resources Assessment (NWRA) prepared by DWRM utilized the MIKE BASIN water system simulation model to carry out the analytical tasks in the water assessment including analysis of rainfall-runoff relationships, data gap filling, determination of water availability and the water balance. This model, developed by the Danish Hydraulic Institute (DHI), has been discontinued but replaced by MIKE Hydro Basin, which is included in the NBI DSS. This could be an important consideration in the selection of the modeling tool.

7. The NWRA simulation model should not be used for analysis in a particular catchment without an assessment of its suitability in its present form. The findings of Step 1 are likely to result in a much more detailed definition of the catchment in terms of sub-catchments than was used in the NWRA, which has a much more coarse representation. This will result in the need to use a more refined and detailed model for the catchment under study. In some cases DWRM may suggest and provide support for the use of a different model such as the hydrologic model SWAT (Soil and Water Assessment Tool) or NAM or a different system simulation model such as the WEAP model (Water Evaluation and Planning system). This is an area on intense collaboration between the WMZ teams and DWRM central level departments including the early organization and implementation of specific applied training.

8. The NAM model is a deterministic, lumped (catchment is looked upon as a single unit with average values of parameters) conceptual rainfall-runoff model. It can present the processes that take place in the surface zone storage, root zone storage and the ground water storage. This is important if there is a need to understand the impacts of changes in land use and/ or vegetation cover which could typically result from improved land management practices. In addition, it contains provision to deal with snow melt and irrigation schemes. Applications related to the NAM model include:

    - Runoff forecasts taking into consideration the status of the surface and groundwater storage zones;
    - Extension of runoff series; and
    - Estimation effects of climate change, for instance, on stream flow. Further details on the NAM model are provided in Annex B.

Task 2: Assessment of Baseline Water Resources Availability

9. Determination of the characteristics of water availability and the balance of water available with estimates of present and future water use and demand is a key step in catchment management planning. An estimate of the spatial and temporal characteristics of the catchment's water resources, combined with trends in potential water use, provides a picture of what issues may arise in meeting people's need for water, what opportunities appear to be available for development, and what actions may be required to manage water resources to ensure that conflict does not overtake opportunities. The present NWRA, which was also based on modelling catchments, provides a useful guide to the WMZs in formulating its approaches to undertake a water resources planning analysis.

10. The water resources assessment will describe the current status of water resources in the catchment at different spatial and temporal scales taking into account the constraints and opportunities in different sub-catchments, including the risks of extreme events (floods and droughts). The assessment will include a description of rainfall and stream flow variability and as well as evaporation. The assessment will be based on a detailed review of all available hydrologic and meteorological records and the use of suitable methods for filling data gaps. A key part of the modelling work will include the calibration of a "rainfall-runoff model" for key points in the catchment where runoff records are available.

Consideration of climate change

11. Calibrated rainfall-runoff models will be used to generate runoff series for the same key points, using climate change datasets rather than historical data. The results will be that two sets of catchment and sub-catchment hydrology are generated, one reflecting historic conditions, and one reflecting conditions under climate change. The process for incorporating climate change in water resources assessments is summarised in Figure 10 and details of the approach are provided in Annex C. For other water-related sectors, the Policy priorities and associated specific strategies for tackling them, are also summarised in Annex C. In this same annex, a checklist for building Climate Change in the CMP Process is also presented.

12. The first step under the knowledge base should provide data on topography, geology and hydrogeology, land cover and land use and other parameters necessary to estimate runoff from un-gauged watersheds and catchments.

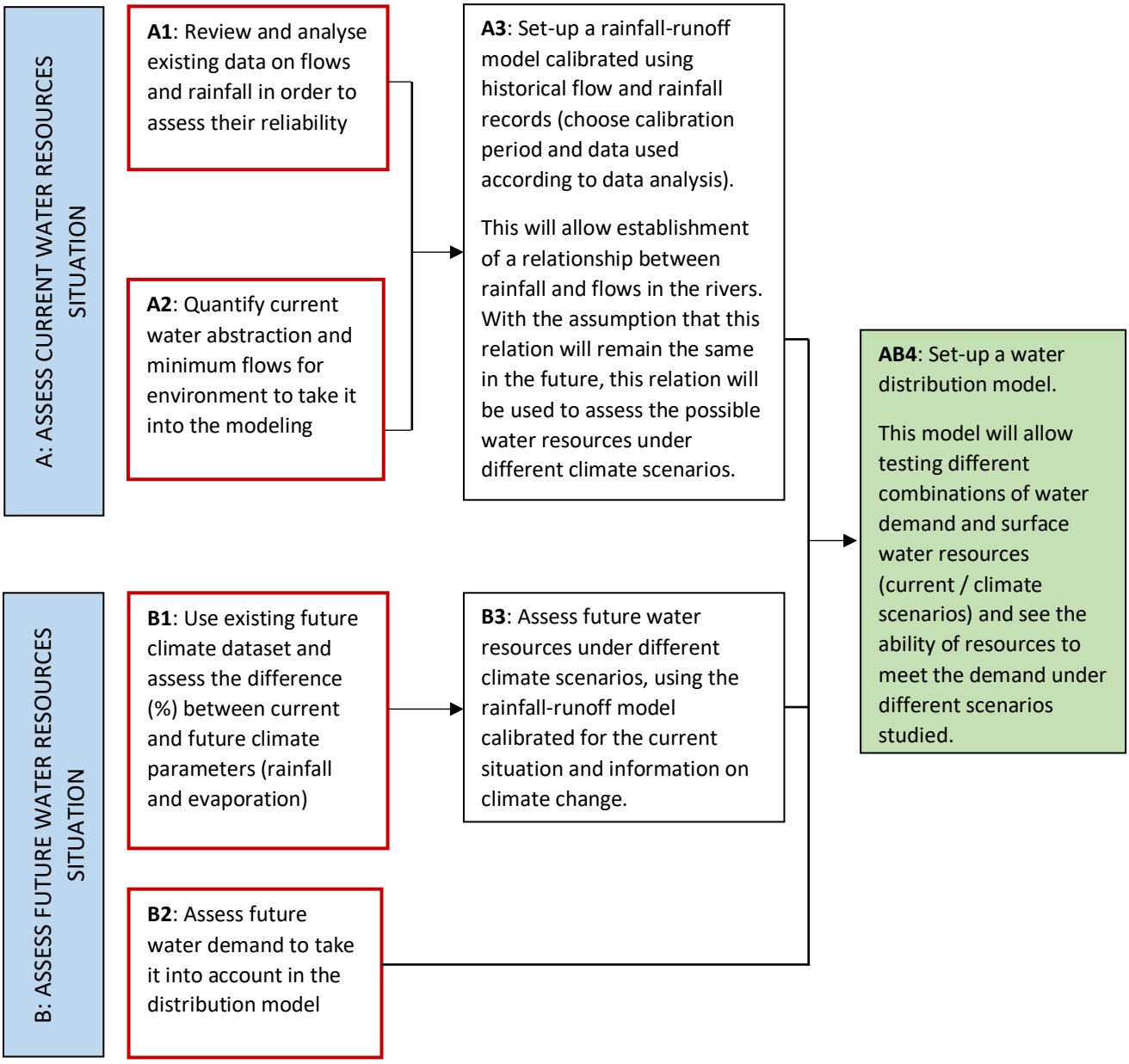


Figure 10: Climate change considerations during catchment management planning

Groundwater availability and mapping

13. Groundwater is an important resource of water for domestic, livestock use, agricultural and industrial production in nearly all catchments in Uganda. Assessment of groundwater availability, including its location and characteristics such as the type, depth and extent of aquifers, comparative well development and operating costs, and sustainable yield is, therefore, an important part of establishing the context and basis for an integrated catchment management plan.

14. The WMZ team should prepare detailed groundwater availability maps initially by district but wherever possible by sub-county. These maps should be used by local governments when planning development of new drinking water supplies and to approve the location of other major water uses that require groundwater supplies.

15. The initial data and information for this mapping will come from the analysis done as part of the NWRA. In the long-run, this data will prove inadequate, especially where groundwater development is intense, for example, because of population growth or large increases in other uses such as agriculture or mining. In

areas where this preliminary data suggests conditions are favourable for groundwater development for domestic, livestock, agriculture and industrial water use, the WMZ in collaboration with DWRM should prepare and implement a program of groundwater investigation and possibly detailed modelling to improve the estimates of groundwater availability and development potential.

Surface water availability and the environmental flow regime

16. Surface water assessment determines the amount of water available as stream flow in time and space. This is not the amount of water available for future use. The amount of existing use must be taken into account, as well as the amount of stream flow that is needed to maintain critical season flows for water quality management (reserving adequate capacity to assimilate pollution discharges), for environmental and ecological requirements (in rivers, lakes and wetlands), and to protect water off-takes that depend on river water levels to function. The balance between stream flow and the sum of existing water use and critical season flow requirements, is the amount of water that is available for future development.

17. Critical season flows depend, to a large extent (if not completely), on discharge from groundwater. In those catchments or sub-catchments where groundwater development is large, therefore, the consequent effect on critical season flow should be taken into account in determining the stream flow available for development.

18. Note that the determination of critical season flow requirements should take into account the views of stakeholders through consultation with the CMO, CTC and the Water Management Zone Advisory Committee (WAC). Because of the present lack of data and tested analytical tools for this purpose in Uganda, determination of critical season flow requirements might be called in part the "how much is enough" problem, whose resolution will require the WMZs to undertake wide ranging consultations.

Rainfall and stream flow extremes

Knowledge of rainfall and stream flow extremes is also an important input to the catchment planning process. The characteristics of extremely high rainfall and stream flows that are the cause of floods, and extremely low rainfall and stream flows that contribute to drought conditions need to be analysed since in most catchments these adverse conditions will be among the issues to be addressed in the planning process.

19. It is generally accepted that the magnitude and frequency of floods will increase under conditions of climate change. For now though, there is insufficient data to quantify these changes. This likely increased risk should, however, be taken into consideration. It is also important to check with the Climate Change Department on the availability of any new studies or analyses that could benefit the planning.

20. The assessment of flood risks should include mapping of areas with significant flood risk and an investigation and mapping of the causes of flooding. Flooding will always occur in a river valley because the channel is never large enough to accommodate extreme rainfall events, but this naturally occurring flooding can and often is exacerbated by changes in upstream land use (for example; deforestation, poor cultivation practice, soil and land cover degradation, stream channel degradation) that increases the amount of runoff and the degree (depth, duration, extent) of flooding. Where data is adequate, upstream measures to mitigate flooding should be modelled to estimate their potential effects and benefits.

21. In sub-catchments where stream flow records are available and adequate, the frequency and magnitude of flood flow or discharge can be estimated. The aim is to identify and map areas affected by floods of different frequency. These are areas with different degrees of flood risk, for example, areas flooded once in four years, or ten years or fifty years. Unfortunately, in many sub-catchments the stream flow records may be unavailable or inadequate for this type of analysis. In such cases, the flood affected areas in each sub-catchment should be mapped by means of field reconnaissance and consultation with local people to identify indirect evidence of flooding (such as change in vegetation, topography, or flood marks) and by interview and discussion with people living in potentially flood affected areas. In these cases, the WMZ team would not have an estimate of actual risk, but it would be able to identify how the flood affected areas are presently occupied (dwellings, other buildings, pasture, cropland, orchards, etc.), and it would be able to survey people in the affected areas to obtain information on past flood losses and possibly their frequency. This

will give a good picture of overall flood risk in the absence of stream flow records, and enable a useful discussion with stakeholders on alternative measures to mitigate these risks and losses.

22. Droughts are difficult to define and hence to assess since there is no single universally accepted definition of a drought because a drought, unlike a flood, is not a distinct event. A drought is often the result of many complex factors, and there is often no well-defined starting or end point. Furthermore, the impacts of a drought vary among different water users and sectors of economic and social activity, making the definition of a drought specific to particular affected groups. The most commonly used drought definitions are based on meteorological, agricultural, hydrological, and socio-economic considerations.

    (a) A meteorological drought often refers to a period of lower-than-normal precipitation duration and/ or intensity. These periods can be identified, for example, by comparing actual recorded monthly rainfall with the long-term average monthly rainfall.

    (b) An agricultural drought occurs when there is inadequate soil moisture to meet the needs of a particular crop at any given time. This is a significant risk in Uganda since rainfall is highly variable. Even though overall seasonal rainfall in a particular year is average or near average, there may be a deficit in months or portions of months that are critical for crop growth and yield. The occurrence of rainfall deficits was analysed extensively in the NWRA.

    (c) A hydrological drought refers to deficiencies in the availability of surface and groundwater s. This is the type of drought evident when stream flow records or records of groundwater levels are analysed. More often, ex-post indications of a hydrologic drought are extremely low water levels in boreholes or pumps failing to operate, water levels in rivers are too low for diversions to operate, or stream flow volume is insufficient.

    (d) A socio-economic drought may occur when physical water shortages start to affect the health, well-being, and quality of life of the people, or when the drought affects the supply and demand of the production of goods and services.

23. The WMZ planning team should undertake an analysis of the meteorological and hydrologic records to estimate the nature of droughts in the catchment. Where records are inadequate or absent, the WMZ team should survey stakeholders, including especially extension workers and farmers, to assess the different manifestations of drought.

24. The use of a “with climate change hydrology” in the water resources modelling will already have provided good insight into impacts on low flows, although this may be limited according to the time step being used. If a monthly time step is used, this will usually be sufficient to have good insight into the impacts on dry season flows.

Water quality assessment

25. The aim of a water quality assessment is twofold:

    - to determine if the quality of the surface water and groundwater available in the catchment is suitable for the different present and future uses; and
    - to determine the present status of surface and groundwater in terms of its capacity to absorb additional pollution without reaching an unacceptable degree of degradation.

Note that what can be absorbed in the future and the capacity to recover is very different for a river, a lake or a groundwater reservoir.

26. The scarcity of data on water quality makes it very difficult for the WMZ team to identify specific problem areas. Some data on the quality of drinking water supplies may be available and useful. Regardless, the WMZ team is likely to find these issues to be high on the list of priorities of many stakeholders. By using what little data may be available and anecdotal evidence from stakeholders and planning team field reconnaissance, the WMZ team should develop a map of problem areas and threats that can be discussed with the CMO and WAC and could form the basis for the design of a program of increased monitoring.

Task 3: Projection of Future Water Use

27. The basic objective of this task is to forecast future water use in the catchment. To do this, the WMZ planning team needs to identify all the sectors and types of water use in the catchment and the factors that will influence future water use by these activities. It may also be necessary to identify new categories of water users and forecast their demand.

28. Water uses or activities can be consumptive (e.g. agriculture) or non-consumptive (e.g. navigation, fisheries). Consumptive uses clearly reduce the stock of water available in the catchment, but non-consumptive uses can have important impacts on the spatial and temporal patterns of water availability including importantly water quality. While some uses can adversely affect water quality and quantity e.g. wastewater and storm drainage, others have a positive effect e.g. wetlands and land management.

29. The general categories of water use to be considered are listed below. Together with water use, the level and characteristics of wastewater generation and discharge into the catchment should be estimated for;

    - Agriculture – rain fed, recession, irrigated (centralized, decentralized)
    - Domestic water supply – rural, urban; industry; urbanization and settlement expansion
    - Livestock; Fisheries – commercial, subsistence
    - Navigation
    - Wetlands, forests, grazing land, protected areas, parks
    - Hydropower
    - Tourism – ecological, cultural
    - Environmental assets and services – recreation, livelihoods
    - Sand and gravel mining, other extractive mines and ore processing

30. The estimates of future water use depend on a number of assumptions including factors such as population growth rates, rates of urbanization, trends in agriculture practices (crop choices), rates of reforestation, etc. Estimates of these trends are generally maintained by the sector ministries, the Ministry of Finance, Planning and Economic Development (MoFPED), and the Uganda Bureau of Statistics (UBOS). Major international organizations such as the United Nations and the World Bank also provide important planning estimates and forecasts that are sometimes considered more apolitical than other sources. With the assistance of DWRM, the WMZ planning team will systematically collect data from the line ministries, MoFPED and UBOS on these factors, trends and estimates. Typically at an early stage in the planning process the DWRM in collaboration with the WMZ planning teams would agree on the estimates to be used in the planning process. The assumptions and methodologies used to arrive at the estimates should be understood and accepted by the planning team.

31. While there is considerable uncertainty over the sign and magnitude of precipitation under climate change conditions, it is universally accepted that temperatures will increase. If cropping choices and patterns remain the same, then the crop water requirements will increase as a result of increased evapotranspiration. However, the potential impact of climate change (especially temperature) on agriculture practices (crop choices) should be taken into account. It is worth looking carefully at this issue in the light of climate change which will result in the shifting of agro- ecological zones and hence in crop choices.

32. While the consumptive use of water by agriculture tends to be an order of magnitude greater than any other use, consumptive use is not the only factor that will influence the shape and content of the basin plan. In the economic sectors such as agriculture, hydropower, fisheries, livestock and tourism, the factors that influence and govern production are the key to understanding and determining the impact (benefits) of changes in water allocation and water use. In general, the WMZ planning team will seek to:

- Identify and analyse the spatial characteristics of existing and potential future activity;
- Identify the parameters that describe the activity in terms of water quantity, quality or ecological impact (for example, the parameters that determine crop water consumption - crop water use domestic water supply, wastewater, hydropower diversion, etc.), as well as the production models in each of these sectors;
- The current level or magnitude of these activities, including production in the economic sectors;
- Estimates of future water use, discharge or consumption at different points in time;
- Future values of these impacts or characteristics based on alternative future scenarios and development paths.

Task 4: Water Balance – Comparing Water Resource Use and Demand

33. Among other things, the catchment plan is based on a sustainable balance of water supply and water demand that optimizes the achievement of the planning objectives. Hence, one of the first planning outcomes to discuss with stakeholders is the picture of how water supply and demand compare based on the results of the water balance analyses. When this comparison is made over time (out to the end of the planning time horizon), surpluses suggest opportunities for increased water productive use, while deficits suggest that the plan will need to include measures to improve water use efficiency, manage water demand or use, or better manage supply. There may also be a need for measures to improve the condition of the watershed if degradation has had a negative impact on the availability of water through reduced groundwater recharge or dry-season stream flows.

34. The gap analysis is likely to differ spatially within the catchment and among aquifers, lakes and rivers. The aim is to identify the areas with the most critical gaps and the most promising opportunities. In the context of agreed planning objectives, the gap analysis along with other identified issues provides an opportunity for the initial identification of development options and management measures with the CMO and the WAC.

Step 2.2: Framework for Stakeholder Participation

Effective participation of catchment stakeholders is central to the IWRM approach, thus their involvement is essential at all stages of preparation and implementation of a catchment management plan. The operational environment of the WMZ team, in terms of stakeholders in the use, development and management of water resources in the catchment, is summarized in Figure 11. Above the WMZ at the central level is DWRM, the line departments in MWE (water supply, water development and environment) and the line departments in the other concerned sector ministries, especially agriculture, livestock, fisheries, hydropower and tourism that are responsible for investment projects and programs in the WMZ catchments.

Figure 11: Stakeholder interaction with the WMZs

At the regional or WMZ level, there are several active organisations in water resources development. These organizations are important partners whose technical and financial support needs to be mobilized for the success of both the preparation and implementation of catchment management plans. These organisations include NGOs and international partners working within the zones and the regional entities set up by the water supply sector, the Water and Sanitation Development Facilities (WSDF) and the Technical Support Units (TSUs), National Water and Sewerage Corporation (NWSC).

At the catchment level and especially at the sub catchment, district and county levels, there are bewildering array of officials, offices, and organizations as well as programs and projects that are of direct concern to the WMZ planning team and who have important interest in the work of the WMZ and the catchment management plan.

The WMZ planning team has several purposes in proactively engaging national, regional and catchment stakeholders. Among these are:

(a) To raise awareness and promote greater understanding and appreciation of the catchment water resource system, its potential and limits, and of the value and work of the WMZ team in preparing an integrated management plan for these valuable resources;

(b) To facilitate greater "buy-in" or commitment on the part of catchment stakeholders to the plans for water management and developments in the catchment that are ultimately agreed;

(c) To create continuing mechanisms and processes that are accepted by water users and other key stakeholders (e.g., local government) and institutionalized within the catchment for conflict resolution, water regulation and enforcement, and other water management measures.

Task 1: Stakeholder Identification and Mapping

1. The WMZ planning team must engage with three groups of stakeholders:

   (a) The CMO (CSF, CMC, CTC, CMS), and any sub-catchment committees that are formed (Sub-CMC, Micro-CMC) including those formed under the Water Source Protection Guidelines. These are the most important because they have an executive function to agree on and adopt a catchment plan (in which the CTC advises the CMC).

   (b) The WAC which brings together regional non-governmental partners as well as regional and central representatives of the line departments. Among other things this group should provide the WMZ planning team critical guidance on problems and workable solutions and technical advice and assistance on carrying out the various planning tasks.

   (c) The inter-district forum of district local government officials and the broader stakeholder forum that brings together self-identified representatives of the many parts of civil society. The inter-district forum is important because the WMZ planning team will want its members, some of whom may be on the CMC, to see the agreed plan as a positive development that they will support through their various mechanisms. Both of these forums should provide important feedback to the WMZ planning team. It is also important to bear in mind that District Government is responsible for the production of District Management Plans and that any catchment plans produced must be coherent with the district development plans developed for the districts within the catchment and vice versa. This requires the buy-in of the District Council.

2. The generalized stakeholder mapping for national, regional and catchment level stakeholders that the WMZ planning team needs to engage is shown in Table **1**. The WMZ would prepare a specific detailed table for the national and regional or zonal level while the CMC would prepare such a table for the catchment. These detailed tables would utilize the general categories of stakeholders in Table **1** to identify specific entities.

Table 1: Generalized stakeholder mapping for the WMZ

	Organizations with a direct Public and private interest in IWRM outcomes and/or that are able to provide support	**Public and private sector organizations including NGO and private voluntary organization**	**Organized groups centred or focused on specific locations or issues in the catchment**	**Individuals in the catchment or region representing themselves rather than organized groups**
WMZ – National Level	▪ Development partners ▪ Government departments, agencies ▪ Parastatals (NWSC, NFA, etc.) ▪ Universities and research centres ▪ Media	▪ National and international NGOs ▪ Business Assoc. ▪ Private sector including financial institutions	▪ Association of common interest and concern (environmental groups)	
WMZ – Regional Level	▪ Local government officials and bodies – land boards, councils, and various service departments ▪ Water utilities and community based water boards or companies ▪ Ministry district and regional officers including DWO, DEO, DPO and their associated committees		▪ Association of common interest and concern (environmental groups) ▪ Community based organizations - water users, farmers, fisherman, pastoralists, etc. ▪ Schools	▪ Business owners ▪ Land owners ▪ Commercial farmers ▪ Tourism operators
	▪ NGOs			
	▪ Agricultural research centres			

Task 2: Mobilize the Membership of the CMOs and Advisory Groups

3. Mobilisation of the CMOs includes the following activities

   - Prepare brief Terms of Reference for each of the stakeholder organizations – define their objectives, roles and functions, relationship with WMZ and other stakeholder organizations, and the expected outcomes of their participation;
   - Prepare briefing materials to inform stakeholders and potential CMO members about the WMZ, the Catchment Plan and the catchment planning process, explaining the role that stakeholders will have;
   - Consult with the regional and inter-district advisory groups to identify potential CMO members;
   - Mobilize the CMC and CTC membership.
   - Sharing with the relevant CMO parties, a program of meetings and activities (as presented in the CMO Procedures Manual, DWRM 2017).

Task 3: Design the CMO Program of Meetings and Activities

4. The task of planning and managing the effective participation of catchment stakeholders is a complicated one. There are at least five, and possibly more, entities whose participation has to be planned and managed.

   - The CMC, and possibly several sub-catchment committees;
   - The CTC;
   - The Inter-district Steering Forum;
   - A regional advisory committee; and
   - One or more General Public Forums covering different parts of particularly complicated or non-homogenous

5. The agenda for discussion with and input from the various stakeholder groups, changes as the planning progresses, as can be seen from Table 2. At each step, the planning team may need to inform stakeholders, consult with stakeholders to obtain feedback or input, involve stakeholders directly in the process carried out at that step, or collaborate to make decisions, deciding on what the catchment plan will contain. Moreover, depending on the goal of the interaction with and participation of the stakeholders, the method of interaction and the techniques used may also change.

Stakeholder Technical Tasks

6. The technical tasks and the corresponding stakeholder engagement activities that correspond to each of the Steps in the Guidelines for Catchment Management Planning are stipulated in Table 2.

Table 2: Stakeholder engagement in integrated catchment planning

Step 1: Describe the catchment and build the knowledge base	▪ Define catchment and sub-catchments; compile and organize the knowledge base ▪ Develop knowledge products – thematic maps, charts, posters, newspaper articles, videos and presentations	▪ Inform the public and key stakeholders about the work of the WMZ and the catchment planning process ▪ Increase public awareness to motivate participation

Step 2 & 3: Stakeholder engagement and the SSEA	▪ Stakeholder identification and mapping ▪ Terms of reference for stakeholder organizations ▪ Mobilize CMO membership ▪ Design CMO consultation programs including preparation of training and information materials ▪ Carry out strategic social and environmental assessment of the catchment	▪ Inform all catchment stakeholders about the ICP program and the WMZ by preparing and disseminating knowledge products ▪ Form WAC and consult with members ▪ Meet with and consult with district local government officials and district level technical officials in all the catchment districts to increase awareness of ICP and the role of CMO ▪ Involve district local government officials and district level technical officials in nomination of potential members of the CMO ▪ Promote membership in the CMC and CTC ▪ Begin formation of CMC and CTC
Step 4: The planning framework- Objectives, issues, and options	▪ Prepare a summary catchment situation report to present to the CMOs including maps and charts ▪ Collaborate with the CMO to prepare the catchment planning framework – ▪ Future vision of the catchment ▪ objectives, criteria and indicators; ▪ major issues and problems in the catchment; ▪ identification of options including those proposed by central line departments and regional officials	▪ Collaborate with the CMC and CTC to develop a future vision of the catchment and decide on the objectives, criteria and indicators that will guide planning ▪ Collaborate with the CMC and the CTC to review the results of the SSEA and the gap analysis, and to identify the specific needs, issues and problems that will be the focus of planning ▪ Hold one or more stakeholder forums to gather feedback and ideas from a broad spectrum of stakeholders on the planning framework. ▪ Consult with the WAC and the inter-district officials forum on the planning framework
Step 5 through 8: Acquire and test tools & carry out water resource assessment, water demand and water balance studies	▪ Acquire models, carry out training, operationalize models (adapt, calibrate and verify) ▪ Carry out water resources assessment ▪ Carry out water balance assessment and gap analysis	▪ Review the modelling approach and intermediate results with the CMC and the CTC ▪ Demonstrate the need and value of the models with examples from the analysis in the catchment
Step 9: Preparing an agreed catchment plan and an implementation plan	▪ Analysis of individual options: estimate of costs and benefits; O&M requirements; ownership and institutional arrangements; policy and regulatory requirements; monitoring ▪ Simulation of catchment scenarios with combinations of options ▪ Multi-criteria evaluation of scenarios ▪ Formulation of alternative plans	▪ Collaborate with the CMC and the CTC on the results of scenario simulation and the multi- criteria evaluation ▪ Consult with the WAC and the Inter-district forum on the simulation results and multi- criteria evaluation ▪ Facilitate a consensus among CMC and CTC members on the agreed plan (including priorities and sequencing)

Step 10: Project preparation and implementation	▪ Prepare a technical brief including specifications and cost estimate for each priority investment project or program to be implemented and submit to DWRM for review, determination of implementation modality and funding ▪ Prepare program to upgrade monitoring network (SW, GW) to meet the needs of the water management and regulatory measures in the agreed plan ▪ Prepare and submit proposals for projects and programs to be implemented though district local government	▪ Consult the members of the WAC on the modalities for implementation of the projects and programs in the agreed plan ▪ Collaborate with DWRM to develop process and procedures to facilitate preparation and funding of implementation

Communications Approach

7. The Communication plan, which includes the goal, promise, and techniques is presented in Table 3. It is not possible to know the detailed agenda for all the meetings and activities throughout the whole process at the very beginning, but the initial design of the program should schedule a series of meetings and activities, based on the CMO Procedures Manual, DWRM 2017. This general schedule and specification of the meetings should highlight the type of meeting, participants, timing, venue, objectives, and materials required, and outcomes sought that extends over the entire period of the planning program. Details will only be known confidently for the initial steps, for example Steps 1 and 2 but as the program moves forward, at each step, the details should be worked out and the schedule finalized for the next series of meetings and activities.

Table 3: Stakeholder participation spectrum - the how and why of participation

GOAL	To provide stakeholders with balanced information to assist them in understanding the problem, opportunities, threats, solutions and options	To obtain stakeholder feedback on analysis, options and decisions	To work directly with stakeholders throughout the process to ensure that public concerns are consistently understood and considered	To partner with stakeholders in each aspect of the decision-making process including the development of alternatives and the identification of preferred solutions
PROMISE	To ensure people are informed	To inform, to listen and to acknowledge concerns and aspirations, provide feedback on how stakeholder input influenced decisions	To work with stakeholders to ensure that concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how stakeholder input influenced decisions)	To look to stakeholders for direct advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible
TECHNIQUES	▪ Fact sheets ▪ Web sites ▪ Open-forums ▪ Press releases ▪ Videos for Television ▪ Advertisements ▪ Media	▪ Public comment ▪ Focus groups ▪ Surveys ▪ Circulars ▪ Email	▪ Workshops ▪ Face-to-face meetings ▪ Discussion groups ▪ Sector meetings	▪ Forums ▪ CMO – multiple stakeholder meetings ▪ Consensus building meetings ▪ Participatory decision making

8. Everyone on the planning team needs to monitor this schedule since there is a strong and continuous interaction between the technical steps highlighted in Figure 6. Nearly everyone will participate in most stakeholder meetings either to ask questions seeking new information or to provide information (including maps and charts depicting conditions on the ground and results of the ongoing planning analysis) and inform (train) stakeholders.

Step 2.3: Strategic Social and Environmental Assessment (SSEA)

Overview

Providing objective information to decision makers about the current social and environmental issues in the catchment as well as the potential issues in the future that the plan should foresee and attempt to mitigate, taking into account the resource base, development opportunity, and the goals and direction that stakeholders desire, is an important step in catchment management planning. Some of the issues could be as a result of impacts emerging from specific developments/projects, a combination, or the cumulative (considering all developments in a catchment) effect. To understand these issues and development impacts, a formal process of systematic analysis of the social and environmental impacts of development policies, plans, programs and other proposed strategic actions termed a Strategic Social and Environmental Assessment (SSEA), is conducted.

The SSEA is focused on the "big picture"; what has been the cumulative impact of water resource development and use in the catchment up to today, and what may be the impact in the future. This is the sense of the term "strategic" – the issues and impacts that may influence how well the catchment plan achieves the planning goals and objectives. A good example is an option or a group of options that is likely to produce high economic value but is not sustainable and hence the country's goal of sustainable growth cannot be achieved by this option or approach. Looking ahead in time and across the catchment by means of an SSEA is a way of avoiding these outcomes.

Broad understanding for discussion with stakeholders

It is important for the stakeholders to understand that the SSEA seeks to identify the major social and environmental issues and problems at an early stage in the planning process so that consideration of these issues are given equal weight and attention with other issues and needs, expanding the range of options and alternatives to be considered. The primary objectives of the catchment SSEA are:

a) Identify (at a strategic level) the most vulnerable social systems and communities, institutional systems, areas of natural habitat and sites of national heritage that are most likely to be affected by current and likely future development, and associated infrastructure;

b) Identify the important environmental issues resulting from the current and expected future main land-use and development activities in the sub-basin and the impacts these already have and will likely have on other economic activities, the environment, and socio-economic development.

The results and findings of the SSEA should be widely shared with stakeholders and thoroughly discussed with the CMC, CTC, the stakeholder forum and the WAC. The aim should be to improve awareness of the nature and significance of social and environmental issues in the catchment, to help stakeholders understand the potential implications of these issues and cumulative impacts, and to integrate them into the planning framework. Because GIS is a powerful communication tool, the data gathered during the SSEA study and the findings of the study should be compiled in the GIS in order to develop maps and other information products to inform stakeholders and facilitate discussion.

Task 1: Assessment of Land Use and Development in the Catchment

This step includes a number of concurrent activities, including a description of current and expected new activities (e.g. plans, programs and projects, as well as informal activities) in the catchment, an assessment of the vulnerable components of the environment and society, the availability/status of international and local safeguards, and the stakeholders and partners who will need/want to be part of the SSEA process. This information needs to be quantified as much as possible and depicted on maps, graphs, etc.

When conducting a SSEA of a large and complex area that supports multiple development sectors as well as traditional land use, the broader forces that determine how the area may evolve in the foreseeable future need to be appreciated. This requires the construction of at least three scenarios that could become reality in a 10-15 year time horizon, depending on how external and internal factors play out.

Macro-economic issues, market trends relevant to Uganda, the zone and the catchment, business opportunities and other regional and global trends (opening of agriculture export markets for example), as well as an understanding of internal opportunities and constraints, provide a useful background for analysis of sustainable development options for the catchment and their social and environmental implications. Table **4** provides some examples of global, regional, national and local level factors that could affect future development trajectories in a catchment.

Table 4: Factors that influence future development scenarios

Global factors	Regional factors	National factors	Local factors
▪ Economic crisis in Europe and USA – may suppress tourism and export markets ▪ Growth of Chinese and other emerging economies may improve viability of some mines ▪ Climate change may reduce prospects for rainfed cropping and increased parasites may threaten livestock health ▪ Rising oil prices will increase transport costs, with negative impacts on the formal agriculture sector and tourism	▪ Political instability in surrounding countries may affect tourism negatively, and may result in an influx of refugees that will place increased pressure on social infrastructure and local communities (including increased crime, STDs, etc.) ▪ Alternatively, peace and prosperity in neighbouring countries may improve the regional economic environment, and result in more cross- border trade. This may increase heavy- vehicle road traffic and spread of STDs	▪ National policies, plans and programs (e.g. food security, energy self-sufficiency, economic liberalization, decentralization, etc.) will all likely have an effect on the way the sub- basin will develop – these PPPs need to be well understood ▪ A decision (hypothetical) to upgrade all airports and increase regional flights will likely stimulate economic growth and tourism ▪ Allocation of sufficient funding to economic sectors (e.g. mining, tourism, manufacturing, agriculture) will likely have a spin- off in the sub- basin	▪ Local health factors (e.g. HIV and AIDS) may limit growth potential ▪ Under investment in physical and service infrastructure (e.g. roads, communication, power supply and hotels) will likely limit future growth potential in almost all sectors (adequate investment obviously has opposite effect!) ▪ Competency (or otherwise) at local authority level will likely affect competitiveness of the area to attract and maintain investments. ▪ Trends in ecosystem health will affect viability of most sectors that rely on resources such as water, fish, etc.

Current and expected new developments

This step requires an inventory of all existing and planned new developments/projects. Fundamental to this is an understanding of how various development sectors operate, including process requirements, waste, water and power requirements, need for labour, skills and expertise, markets, and (if applicable) closure plans, rehabilitation and environmental restoration. At the very least, there must be an accurate assessment of the following in the case of each major project/sector:

- How much water and power will be used and where it is/will likely come from (source).
- How many employees and service providers are/will be required (and where they might come from or already live in nearby villages).
- Profile of employees so one can have an idea of income levels, family size, whether employees live as 'migrants' or with their families, number of school-going children, sex and age profiles, levels of education, etc.
- What chemicals are/likely to be used in the various industries, where will they are/will be obtained and how they are/will be transported, stored and disposed of.
- How much waste is/will be generated and how this is/will be managed.
- What infrastructure will be developed (roads, housing, sewerage systems, pipelines, fences, recreation facilities, power lines, schools, clinics, waste disposal sites, storage and packing facilities, etc.).
- The phases of the various projects, including anticipated closure (if applicable).
- The plans for funding the implementation of environmental and social safeguards and closure.
- The existence/planned environmental and social consultants (or in-house team) which the projects use/will use to help them monitor environmental and social impacts and management throughout the life of mine (and beyond if appropriate).

Given that many of the impacts in the area are generated by informal activities (e.g. mixed farming and artisanal fisheries), it may be necessary to make an aggregated assessment of the impacts based on expert opinion, or possibly glean information from existing reports.

Task 2: Assessment of the Vulnerable Environments in the Catchment

The receiving environment includes social, ecological, infrastructure, institutional, economic and other components. It is important for the SSEA to consider developments in the context of the following:

- Assessment of the protected natural and heritage areas which are/will be affected by current land use and proposed new developments – their status, their objectives and their existing/emerging management plans
- The current and likely future demands on labour, water, land, power and other critical resources
- The current catchment sediment yield and load assessments. This should include sediment/ erosion risk mapping of likely hotspots.

As noted earlier, the combination of many activities will likely result in strains on various types of infrastructure and social services, as well as on the physical environment including:

- Housing
- Health facilities
- Transport
- Education facilities
- Public administration (institutions)
- Impacts of project-specific and cumulative water abstraction on environment
- Impacts of project-specific and accumulative development on environment: species, communities, and sensitive landscapes

Task 3: Design a Stakeholder Participation program for the SSEA

Effective stakeholder engagement in SSEA and its independent review are critical ingredients in assuring its quality. To be successful, SSEA requires commitment from a variety of stakeholders, e.g. politicians, senior management, government officials from all interested and affected departments, community representatives and non-governmental organizations. Thus, a credible public participation process is fundamental to this SSEA.

Building on the earlier stakeholder engagement steps, the SSEA stakeholder participation involves planning on how stakeholders will be engaged throughout the SSEA process and beyond.

The program design will specify who will participate, what methods will be used to engage them, and whether there will either be information provision, consultation or negotiation with them (or a combination of all three), like it was done in stakeholder engagement. It is important to note that these are concurrent steps in the catchment management planning process.

Determination of Environmental Quality (sustainability) Objectives

The formulation of sustainability or Environmental Quality Objectives (EQOs) is important because it provides clear statements of intent and indicates the desired direction for the WMZ or catchment. EQOs thus provide a methodological 'yardstick' against which the positive or negative effects of the various land-use types (and different projects) can be tested. These objectives also guide the SSEA process in terms of the level of detail and type of information or data that is required. The EQOs and limits of acceptable changes (LACs) should be agreed upon by key stakeholders in the SSEA process.

The EQOs can be derived from various sources such as National Development Plan documents, National HIV/AIDS and education strategies, Water Management Strategies, WHO standards, local development parameters, Biodiversity Strategy and Action Plan, State of the Environment Reporting system, etc.

EQOs should also reflect the extremes of environmental quality (biophysical, social, sense of place, etc.) beyond which society would find further change unacceptable. An inherent aspect of setting EQOs is determining thresholds or limits of acceptable changes (LACs), which are defined as the point at which irreversible or serious damage could occur. Thus, EQOs are a combination between a desired common future, as well as a limit on what negative impacts would be allowed.

Given the time and other resource limitations, it might not initially be possible to set LACs based on 'high scientific confidence'. Instead, public opinion and best available expert knowledge might have to suffice until such time as more data becomes available. Thus, LACs may be adjusted as knowledge improves. When defining the EQOs there are several considerations that must be taken into account, e.g. the EQO should focus on the desired outcome, be clear and concise, be both ambitious and realistic, be measurable, and be compatible with each other.

Some examples of EQO topics may be:

- Economic diversification and value-adding
- Efficient use of land (e.g. optimal livelihood options and economic returns)
- Efficient water use (as above)
- Capacity building (e.g. government agencies, service providers, employees, civil society, etc.)
- "Wellness" and health targets (a basket of social parameters)
- Acceptable water quality
- Maintaining (or enhancing) ecological integrity
- Protection of heritage resources
- Improved social and physical infrastructure.

Task 4: Assessment of Linkages, Cumulative Impacts and Options

An assessment of cumulative impacts is the heart of the matter. The WMZ planning team and the catchment stakeholders must fully understand how all the different activities, both on their own and in combination, will impact (either positively or negatively) upon the environment and the social conditions in the catchment. There is no single best method to assess the cumulative impacts, possible linkages between activities and the adverse effects, so approaches should be selected based on the issues at stake and the nature of activities.

Assessment Tools – pivotal role of water resources modelling tools

The tools for this assessment include:

- Water resources modelling tools (Annex B)
- Use of GIS (particularly mapping of trends and vulnerable areas)
- Cost-benefit analysis
- Causal loop or causal chain analyses to determine the main pathways of impacts;

- Linkage diagrams, which try to plot the main positive and negative links between causes and effects and which highlight unintended consequences and cumulative impacts (positive and negative)
- Comparative risk assessment, etc.

Water resources modelling tools, as already introduced, are central to the SSEA. Water balance and optimisation models are often well-suited to providing an assessment of cumulative impacts of various combinations of developments.

Establishing an SSEA Analytical Framework

In this case, using a matrix to test the cumulative impacts of various sectors against sensitive environmental aspects might be a good way to obtain an initial overview, followed by the drawing of linkage diagrams so that intended and unintended consequences of actions may be understood. Key cumulative impacts could be negative:

- Unsustainable water and land-use (with resultant opportunity costs and loss of livelihood options)
- Pollution of water resources (as above)
- Social tension (including undermining of local cultures and governance systems)
- Increase in diseases
- Strain on social services and infrastructure (hospitals, clinics, schools, crime prevention)
- Deterioration of and/or congestion of physical infrastructure (e.g. roads, municipal facilities, communication networks)
- Loss of biodiversity, habitats and ecological integrity
- Damage to heritage resources
- Visual impacts and loss of sense of place (resulting in loss of tourism potential)

There are also positive impacts to be identified, including:

- Economic stimulation
- Socio-economic improvements
- Skills and capacity development
- New and/or improved social and physical infrastructure.

The assessment of cumulative impacts is essentially a continuation of the previous steps, where an understanding of the receiving environment was obtained. Having done this, the impacts can be assessed, and the SSEA must propose measures as to how they can be avoided/mitigated (or enhanced if they are positive impacts), in a similar way as is done in standard project-level EIA process. The main difference is that avoidance/mitigation/enhancement measures must take into account the desired future state of the WMZ or catchment. A key value of an SSEA (as compared to a project-level EIA) is that the SSEA may have greater scope in proposing alternative ways of achieving desired outcomes than those already articulated by existing development proponents. Also, the avoidance/mitigation/enhancement measures will be broad-brush initially, gradually becoming more detailed as one moves closer to project-level activities.

The Mitigation Hierarchy

In all cases, addressing negative impacts must follow a hierarchy of: impact avoidance, mitigation (e.g. rehabilitation and restoration), offsets and, as a last resort, financial compensation. This concept is illustrated for the issue of biodiversity in Figure 12, and is at the heart of the SSEA approach which is "upstream"[1] in nature.

[1] "upstream" is used in the sense of early or before, not in the hydrological sense of the word

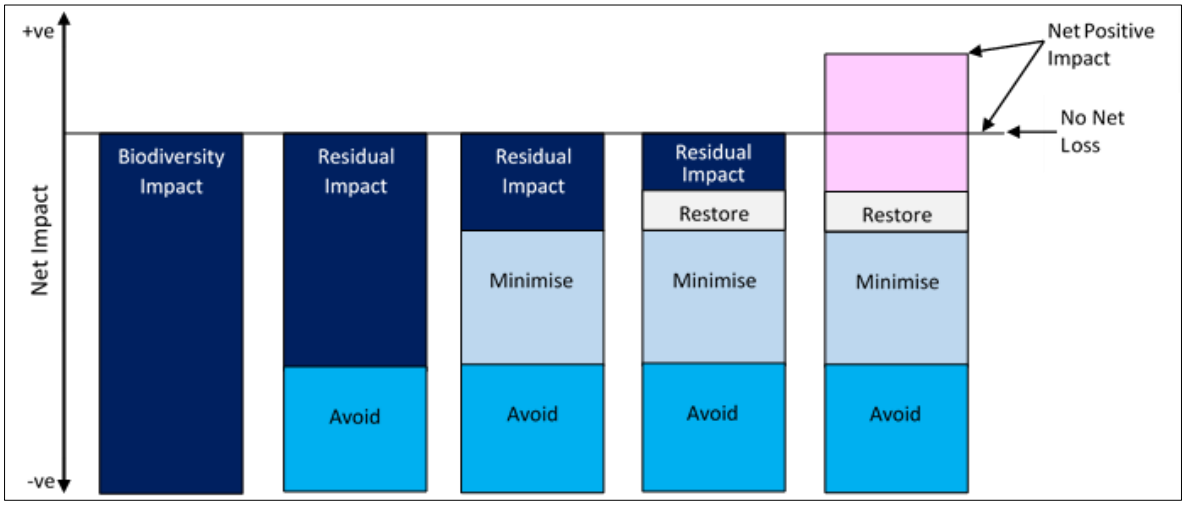


Figure 12: The Mitigation hierarchy is central to the SSEA concept

Task 5: SSEA Guidance Framework

Because SSEA provides important guidance for the preparation of the catchment management plan and for future project planning and development it is important to bring together the findings, conclusions, and recommendations of the SSEA process into an SSEA guidance framework. The framework might contain the following elements:

- Catchment overview – A brief (<10 pages) and well-illustrated (maps, graphs, statistics) overview of history, land-use, geography, socio-economics, demographics, biodiversity, water resources, physical infrastructure and climate of the catchment. This should emphasize trends rather than just provide a snapshot in time (e.g. land degradation over past 10 years)
- Forces and dynamics of the catchment – A brief (<10 pages) and well-illustrated (maps, graphs, statistics) overview of external and internal factors that shape current and especially future development options.
- Scenarios – A description of the scenarios used to conduct the analysis.
- A quick summary SSEA approach and methodology:
- Overview of SSEA approach, assumptions, limitations and constraints
- SSEA methodology
- Stakeholder engagement, thematic analyses, use of GIS, assessment of linkages and cumulative effects, construction of scenarios
- Legal, policy and institutional context (overview)
- Cumulative effects and analysis of alternatives
- Social structures, livelihoods and access to resources, human health, gender issues, tenure and community wellness
- Towns and settlements
- Transport and communications infrastructure
- Institutional functioning and governance
- Water resources
- Energy supply
- Recreation and tourism
- Biodiversity and ecological integrity
- Archaeological heritage
- Macroeconomics
- Linkages, antagonisms and synergies

- Strategic Social and Environmental Management Plan (SSEMP) with EQOs and indicators
- Conclusions and Recommendations

The SSEA guidance framework should also summarize the existing regulatory framework in the country for environmental management. A number of laws, policies, standards and guidelines exist both in Uganda and internationally to guide development. Decision makers need a good understanding of what these are, how they relate to each other and the implications for Uganda's local and international commitments. Much of this information exists in the various documents, but it needs to be synthesized in the SSEA.

Based on the previous steps, the SSEA should be able to provide recommendations on what could be done to make current and future developments more environmentally and socially acceptable and beneficial. From this, it is clear that the team required to conduct the SSEA is much more than the usual consortium of environmentalists. One needs a social scientist, agriculturalist, water resources management specialist, environmentalist and biodiversity expert, archaeologist, health expert, tourism specialist, and economist on the team.

Once the assessment of cumulative impacts is completed, it is possible to design a framework within which the individual and cumulative impacts relating to the development activities could be better managed. This framework could be regarded as a "Strategic Social and Environmental Management Plan" (SSEMP), which sets the actions that all the developers could follow and contribute to.

Step 3: Framework for Catchment Planning

1. Having completed Step 2.1 (Water Resources Planning Analysis), Step 2.2 (Stakeholder Participation Framework), Step 2.3 (Strategic Social and Environmental Assessment), and with the CMO in place, this establishes the basis for the planning team to develop the framework for planning with the stakeholders. This is an important step in the planning process because it provides the framework in terms of objectives, issues and options that drive the planning process in Step 4 & 5.

2. Developing the framework begins with a thorough briefing of the CMO (mainly the CMC and CTC) on the catchment's natural resources, their status, the water balance, the opportunities for development, and the potential constraints and limitations as they have emerged from the study and analysis carried out in Steps 1 and 2. The findings with respect to climate change trends should also be clearly understood by the CMO at this stage. This provides a basis for agreeing on the key results of this Step:
    - An agreed set of planning objectives, criteria and indicators – this will be the framework for evaluating projects and plans;
    - The results of a strategic social and environmental assessment –the major environmental and sustainability issues that need to be addressed in the catchment;
    - A preliminary view of the major water resource management and economic development issues in the basin and possible options and interventions.

3. Overarching these is the stakeholders' vision of the catchment in the future. Since they are only beginning to see themselves and their surroundings (farm, district, town or village, etc.) as a part of a "catchment", the catchment vision expressed by a group of stakeholders is initially most likely to be the sum of what they envisage for their immediate surroundings. When they see these brought together in a catchment context it helps the stakeholders to begin to see the implications of being a part of a "catchment". The WMZ planning team should facilitate a brainstorming session (or several sessions) with the CMC and CTC to develop a vision statement for the catchment, using this occasion to build greater understanding of IWRM and catchment planning.

Step 3.1: Summary Overview of the Catchment and Sub-Catchments

4. This provides a quick summary mainly in visual form (maps, videos, charts, etc.) of what the WMZ planning team has learned about the people, land, water and other natural resources in the catchment, what activities are going on that benefit from and impact on the catchment's water resources, and what the planning team and the stakeholders think the needs and issues will be in the future.

Step 3.2: Developing Planning Objectives and Indicators

5. In order not to lose sight of what the planning process desires to accomplish, the WMZ planning team and the CMO need to go through a process together to agree on the specific objectives and outcomes that the catchment plan should aim to achieve. No single objective will be sufficient to cover all the goals the stakeholders may share. There will be multiple goals and objectives (criteria). In discussing the goals of the catchment plan with various stakeholders, one is likely to hear objectives such as sustainability, equity, economic growth, food security and poverty reduction. Climate and short term weather resilience are also important goals.

6. It is necessary for the planning team to develop objectives that are consistent with the set goals, but also to provide a more operational framework for the evaluation of alternatives. Table 5 provides an indicative list of possible goals and objectives. Such a table is a useful way to begin the discussion of planning objectives and outcomes with the CMO, while being very careful with the use of complicated jargon or words that few people in the catchment are familiar with. The indicators, which are a measure of the achievement towards an objective, must be measurable.

Table 5: Goal, Objectives (criteria) and indicators for development planning

Goals	Objectives (Criteria)	Indicators
Economic Development	▪ Sustainable economic growth ▪ Increased farm income ▪ Increased energy production ▪ Poverty alleviation	▪ Agricultural Benefits ▪ Hydropower Benefits ▪ Reduced Flood Damages ▪ Drought Protection (reliability of supply) ▪ Benefits to priority regions and sectors
Social Development	▪ Water supply and sanitation provision ▪ Reduction in threat of water borne disease ▪ Increased employment opportunities ▪ Minimize resettlement	▪ Drinking water supply and sanitation coverage ▪ Additional jobs created/income increases expected ▪ Expected resettlement from proposed investments ▪ Reduction in water borne and water related diseases
Environmental Sustainability	▪ Minimize adverse project impacts ▪ Minimum flow provision ▪ Biodiversity protection ▪ Reduced water pollution	▪ Area inundated/impacted by projects that is environmentally sensitive ▪ Flow at sensitive environmental stretches ▪ Benefits to sensitive habitats
Implementability (with filter for technical environmental and social feasibility or risk)	▪ Minimize adverse project impacts ▪ Minimum flow provision ▪ Biodiversity protection	▪ Financial Requirements & Financial Rate of Return ▪ Economic Rate of Return (Econ Anal outputs) ▪ Stakeholder views on acceptability (rating
Climate change adaptability	▪ Minimize climate change effect on stream flows ▪ Minimize impacts on water resources development ▪ Continued monitoring of weather and climate parameters	▪ Climate change knowledge base ▪ Regulated water abstractions ▪ Monitoring network ▪ Climate change integration into water resources developments ▪ Greenhouse gas emissions ▪ Vegetation cover

7. Annex D provides an example of a multi-criteria framework and tool that can be used to evaluate alternative scenarios for catchment planning. Figure 13 is an example of a multi-criteria evaluation framework that is currently being used in a water resource planning program in Sri Lanka to evaluate river basin development scenarios (not so different from what should be done in a catchment). The Sri Lankan planning team began by building a table like Figure 13, went through a process of consultation with stakeholders at the district and central policy levels, and then converted the last column of its version of Table 5 into an operational framework for evaluating multiple scenarios as shown in Figure 13.

Scenario Name		Mundeni Aru_Scenario_D	Mundeni Aru_Scenario_t3	Mundeni Aru_Scenario_t3	Mundeni Aru_Scenario_t3
Reference scenario (Baseline)	**Unit**	**Au_Scenario_A**	**Aru_Scenario_A**	**Aru_Scenario_A**	**Aru_Scenario_A**
Economic Development					
Net Annual Economic Benefits:	Millions SLR	367	550	400	367
Net Annual Agricultural Benefits	Millions SLR	-40	100	50	244
Net Annual Industrial Benefits	Millions SLR	4	300	100	20
Net Annual Hydropower Benefits	Millions SLR		50	50	3
Net Annual Domestic Benefits	Millions SLR	404	100	200	100
Contribution to National Rice Production Target	%	0	2	2	2
Financial Viability					
Total Investment	Millions SLR	3000	2000	4000	3000
Net Present Value	Millions SLR	200	2000	400	300
Internal Rate of Return	%	0	7.3	3	5
Social Development					
Increase in Employment	Jobs	-200	50000	10000	30000
Resettlement Needed	Persons	-	500	500	3000
Rise in Income Levels	SLR/Year	27	20000	2000	27
Total Benefits in Post War Zones	%	10	20	50	70
Total Benefits in Dry Zones	%	60	60	50	70
Environmental Sustainability					
Affected Rivers Violating Target	%	-	-	20	10
Total Length of Reaches Violating Flow Target	km	-	-	100	20
Average Modification in Classes	-	1	1	1.5	1.1

Figure 13: An example of a multi-criteria analysis (SLR is Sri Lanka Rupees)

8. Note in Figure 13 that the goal of "environmental sustainability" is explicitly defined as three objectives that measure how river flow regimes are affected and whether there is an acceptable change in river (water quality) classification. The first two objectives were the subject of extensive debate because the country lacked the data or policies needed to establish environment flow requirements (EFRs) on any other basis. The third objective was highly subjective because of the lack of water quality data, a situation that prevails in Uganda as well. The critical point is not the sophistication or lack thereof of the methodology of measuring these indicators but to debate and agree on a set of "environmental quality objectives" for the catchment in collaboration with stakeholders. Regardless of how well they can be measured or assessed today, data will improve in the future and having adopted these objectives establishes the intent to ensure that these will not be allowed to cross a threshold or limit of acceptable change. For the time being, public opinion, and impartial and best available expert opinion, may be the only means to establish these limits.

Comparing the proposed catchment planning objectives and the NDP objectives

9. The National Development Plan (NDP) is the country's road map to prosperity, and the NDP objectives represent the development and management agenda for each of the line ministries in the government, including MWE. Hence, the aim of establishing catchment planning objectives is to develop a set of objectives for the catchment plan that are consonant with the NDP objectives and lead to achievement of the goals of stakeholders in the catchment. The catchment plan objectives might be expressed differently from the NDP objectives, or as is more likely, they may be expressed more directly and explicitly. There might also be additional objectives that are not mentioned in the NDP but are considered important by the catchment stakeholders. In this sense the NDP objectives provide an overarching framework for the catchment level objectives.

10. The current theme of the National Development Plan (NDP II), the country's development strategy for the period 2015 - 2020 is to propel the country to middle income status by 2020 in order to realize the country's vision of growth, employment and socio-economic transformation for prosperity by the year 2040. The plan is the second in a series of six plans intended to transform Uganda over thirty years into a modern and prosperous economy. Promoting the inclusive and sustainable growth that is enshrined in the NDP requires sustainable exploitation of development opportunities, including agriculture and natural resources.

Water can be both a positive force by providing productive input to agriculture, industry, energy and tourism, and sustaining human and environmental health as well as a destructive one to which the devastating consequences of floods and droughts can attest.

11. A growing Ugandan economy and population will require more water in the future and since many parts of the country will experience increasing water scarcity, water resources must also be used more productively and efficiently than at present. The Uganda NDP reflects this need by placing emphasis on productive investment in water for agriculture, fisheries, livestock, hydropower (and possibly thermal power), drinking water, and industry including agro-processing. However, increasing pressures on the water and natural resource base mean that Uganda's natural resources, including wetlands and forests, are being degraded at an alarming rate. Each of the NDP II objectives, which are closely linked to objectives of NDP I, are discussed in Table **6** in terms of the ways in which the elements of an integrated catchment plan could support their achievement.

Table 6: Integrated catchment planning and the achievement of the NDP objectives

NDPII Objectives	Development indicator	How CMP can support their achievement
Objective 1: Increase sustainable production, productivity and value addition in key growth opportunities	• Manufactured exports as a percentage of total exports	• A key 'binding constraint' to Uganda's industrial production is the poor supply of electricity, yet development of the main source of electricity in the country, i.e., hydropower, is not keeping up with demand. • Hydropower is the least cost energy expansion path for Uganda, • Future expansion of small and large hydropower capacity should be planned. • Strengthening water quality regulations will provide an incentive for industries to adopt international best- practices while also reducing water pollution and thereby providing spill-over effects into other water- dependent sectors.
	• Labour Productivity	•
	• Forest Cover	• Water and catchment management initiatives can be tailored to ensure sustainable exploitation of natural resources. • Effective implementation of Uganda's environmental laws and regulations.
Objective 2: Increase the stock and quality of strategic infrastructure to accelerate the country's competitiveness	• Gross capital formation • Total national paved road network • Number of cargo freight on rail and water • Access to electricity	• Climate variability and frequent floods and droughts have severe consequences for the country's economic infrastructure, disrupting the road network and leading to shortfalls in drinking water supply and hydroelectric power. • In the longer run, hydrologic uncertainty acts as a disincentive to growth-enhancing investments. • Addressing these risks through flood preparedness and management can help maintain the stock and quality of Uganda's infrastructure • IWRM initiatives can ensure that there is accurate and up-to-date water resources data that can facilitate the planning of population centres and major infrastructure like road and rail networks and water piers/ports
Objective 3: Enhance human capital development	• Life Expectancy at birth • Infant mortality • live births • Under five mortality rate • live births • Maternal mortality rate per • Primary to secondary	• Effective development and management of water sources can increase the supply of clean and safe water to people and livestock, thereby reducing morbidity and mortality from water-borne diseases including cholera, typhoid and hepatitis B. This will lead to improved health and household standards of living resulting in improved labour productivity. • The problem of poor sanitation and hygiene exacts the highest toll on the poorest segments of society in both rural and urban areas. Investing in sanitation could bring

	school transition rate • Net Secondary completion rates	substantial returns and reduce costs in other sectors, including the curative health sector • Agricultural development for growth (e.g. irrigation development and commercial agriculture) and for poverty reduction (e.g. improved soil and water management in rain-fed areas) is critically dependent on availability of reliable water resources.
Objective 4: Strengthen mechanisms for quality, effective and efficient service delivery	• Government Effectiveness Index • Public Resources Allocated to Local Governments Level • Corruption Perception Index (CPI)	• A participatory and multi-stakeholder approach to water resources management can help to consolidate good governance and service delivery in water-related sectors. • Equitable allocation of water between communities and sectors (e.g. drinking, livestock rearing, industry, etc.) can minimize competition and conflicts between communities and sectors.

Step 3.3: Identifying and Summarising the Major Planning Issues and Options

12. In the course of conducting catchment situational assessment, the planning team will have recognized numerous problems and issues that warrant study and further investigation and that should perhaps be resolved in the catchment plan. These might include, among many others;

    - Water shortages or the need for expanded water supply not only for drinking but also for livestock and agriculture,
    - Forest, land and soil degradation,
    - Soil erosion evident from the field observation or stakeholder reports of silted tanks and river channels and progressive gully development,
    - Areas with high flood plain development including housing and other land uses that are at risk of economic loss.

13. If the WMZ planning team has been diligent in placing data concerning these issues and problems into the GIS (no matter how limited the data) it should be able to present a picture of the spatial distribution, location and extent of these problems in a series of readily understood maps. These maps provide an excellent tool to stimulate discussion among stakeholders in the various forums and in the CMC and CTC on what they see as the key problems related to water and development in their catchment or sub-catchment. Sometimes the problems or issues will be expressed as something that needed such as a borehole or a weir or a tank, other times as a problem to be fixed such as a degraded stream channel, polluted water or conflict among water users in a sub-catchment. The issues are thus generally a combination of problems to be fixed or improved and options or investments to be undertaken. In response to the problems and issues, one can think of a catchment plan as a body of actions to provide for:

    - Protection of the resource
    - Use and development of the resource
    - Conservation of the resource
    - Monitoring of the resource and building knowledge of the resource
    - Management (to ensure the agreed goals and objectives are achieved)
    - Regulation, particularly where scarcity or water quality degradation are issues

14. In addition to stakeholder views on what should be done, there are proposals of the various central or district level line department and agencies including for example, water for agriculture, water for livestock, land management, hydropower development, drinking water supplies for villages, towns and cities, wetland restoration and reforestation, mines and industrial developments, expansion of aquaculture. These proposals can also be mapped using the planning team's GIS. In fact an overlay of the three sources of information on problems and issues – the planning team's own reconnaissance, the stakeholders and the line departments

and agencies would present not only a comprehensive picture but also one that would stimulate intense discussion among stakeholders including the members of the WAC.

15. The WMZ planning team would now need to sift through all of these proposals and suggestions to identify two types of options;

    - Those that involve some type of investment to conserve, store, divert, extract, protect, convey or carry or otherwise control water for productive purposes (including domestic drinking water);
    - Those that involve management actions including water allocation, water use and wastewater discharge regulation including operating rules for storages, permitting, monitoring and measuring water, empowering user groups, facilitating and supporting actions by others such as district councils or inter-district mechanisms, or water demand management initiatives such as promoting changes in crops or cropping patterns, improving efficiency or water deficit management.

16. It is important to emphasise that while the planning may be strategic in nature, localized action is part of strategic thinking. A concern that emerges on several occasions during discussions with stakeholders is the risk that catchment plans, because they are supposed to be strategic in nature, do not attempt to include the micro-level IWRM interventions that are so critical to a sustainable approach to water resources and related natural resources management. If stakeholders are to be involved in the identification of issues and needs, it is important that the resultant Plan presents appropriate solutions, not just the planning and prioritizing of large-scale water resources development options. One way of dealing with this is to present a "programme" of local level interventions in the form of demonstration projects, which when taken to scale represent real basin wide solutions to some of the key challenges. This concept is very important for the mainstreaming of climate change since it is those communities, subsistence farmers etc., whose livelihoods are most intertwined with climate variability and also the status of natural resources, which are most vulnerable to climate change. Mainstreaming localized sustainable land and water management practices into catchment plans is, therefore, a key part of climate mainstreaming. The Plan should include a coherent plan of action for taking to scale. The action of replication and taking to scale should be clearly expressed as an action in catchment Management Plans. In this way, the strategic element is brought to the forefront.

17. A list of generic options of the first type of interventions is given in Annex E mainly including:

    - Surface water storage dams and reservoirs of various sizes for single and multiple purposes,
    - Rainwater harvesting (off-farms) including check dams and small valley tanks for soil and water conservation including groundwater recharge management,
    - Bulk water supply (storage, diversion, conveyance) for various purposes including irrigated agriculture, aquaculture, livestock etc.,
    - Introduction of new irrigation technology (low pressure pipe conveyance, small scale sprinkler, drip and bubbler water application, etc.) generally to improve efficiency and productivity,
    - Power generation, generally mini and micro scale,
    - Drinking water supply and distribution,
    - Flood risk management,
    - Land management to reduce erosion and runoff, increase soil moisture storage, improve groundwater recharge, and
    - Water source protection.

Step 3.4: Options for Catchment and Source Protection

18. The objective of environmental sustainability encompasses the concepts of managing, conserving and protecting the catchment itself, and hence its natural resources including land and water resources, as well as taking actions to sustain beneficial development of those resources. Hence issues discussed and reviewed with stakeholders in the previous section should include the status of the catchment, existing and proposed development, their present or potential vulnerability, and the threats that may be present or may arise in the future. The focus of this discussion would typically be on specific sub or micro-catchments where the problems and issues are most severe.

19. The main driving forces for catchment degradation in Uganda are poverty, food insecurity and exceptionally high population growth. The trio have led to the expansion of agriculture into more marginal and vulnerable areas, deforestation, encroachment into wetlands, degradation of soils and land cover, and excessive erosion. This ever increasing degradation of catchment natural resources undermines livelihoods thereby increasing poverty, reinforces low productivity and food insecurity, and threatens existing development of water for, e.g., drinking water and hydropower production, and increases flood and drought risk. It also has important effects on the catchments downstream (externalities) because this degradation changes the hydrology of the catchment, altering seasonal stream flow and groundwater recharge, and filling downstream channels and water bodies with silt and sediment.

20. From the strategic perspective, achieving economic, social and environmental objectives in these catchment areas requires putting in place measures (options) to reverse this degradation by managing the catchment. In this sense managing the catchment means managing the hydrologic and ecological processes in the catchment to prevent degradation, conserve water, protect water sources and in general to prevent the loss of resources important for local livelihoods, especially the loss of water resources and other natural and environmental services.

21. Note, however, that one cannot focus only on these important externalities. The problem is not just, for example, to improve land management or restore forest cover but also to alleviate poverty and food insecurity and strengthen livelihoods in the affected catchment area. That is the stakeholder's "stake". They are unlikely to be interested in reducing catchment degradation to the benefit of downstream water users and water sources unless they are substantial beneficiaries as well.

22. While it is fairly obvious how to technically implement most of the actions in a catchment plan, for example boreholes, small dams, weirs, etc., it is much less obvious how one undertakes to beneficially manage land use in a catchment since, for example, it involves significant changes in behaviors and assumption of risks by the inhabitants (who are likely to be very risk averse) as well as physical interventions. The overall catchment planning process is able to define what needs to be done and where it needs to be done, but in the case of these measures a very intensive and localized planning process in each sub or micro-catchment must be undertaken to define what is to be done, to mobilize people and local community-based organizations to support implementation, and to implement and monitor the agreed measures.

23. These problems are commonly approached from two different perspectives;

    - First is the integrated catchment management approach outlined in these guidelines; that is, the preparation of integrated sub or micro-catchment plans in collaboration with stakeholders in these catchment areas that seek to eliminate the adverse externalities and facilitate the economic, social and environmental development of the sub or micro-catchment. The generic measures or options that might typically be found in such sub or micro-catchment plans are outlined in Annex E.

    - Second is from the perspective of downstream water users whose source of water is threatened by these externalities; this perspective is referred to as source protection for which separate guidelines have been prepared. This is somewhat narrower than the more comprehensive integrated catchment management approach because the scope of the objective is much more limited in practice. The generic measures or options typically used in source protection plans are outlined in Annex F.

24. Since adoption and implementation of these measures, especially those summarized in Annex E, influences the hydrology of the catchment and hence the water balance and the efficacy of some downstream options and possibly the overall plan, the options for catchment management and source protection that have been adopted need to be added to the development options discussed with the CMO in the previous section as a part of the Option and Scenario Analysis, the next step.

Step 4: Options and Scenarios Analysis

Having decided on the specific or particular portfolio or universe of options and interventions for the catchment, the WMZ planning team should carry out the analysis described below.

Step 4.1: Preliminary conceptual Design of Options

1. First, the team should prepare a preliminary or conceptual design of each option to determine its main specification and characteristics. Small scale and repetitive infrastructure would use standard layouts and designs adapted to each circumstance. The purpose is to enable a preliminary estimate of its costs including operation, maintenance and construction cost. The design specifications should include its operating characteristics (flow rate, volume, time pattern, energy use) and outputs (area or number of people served, production, etc.).

2. The operating characteristics and outputs will be used to estimate the economic benefits of implementing the option. The modality of operation and maintenance should be specified including who will have this responsibility and what measures and actions need to be undertaken to ensure these critical responsibilities are fulfilled (legal requirements, training, funding, etc.). Since many of the options can be found in the portfolio of planned or completed projects lying with the sector departments (water for production in MWE, for example), layouts, design criteria, and cost and benefits should exist.

Step 4.2: Integrated analysis of Potential Development Options

3. One of the fundamental advantages and benefits of the integrated and analytical approach to catchment planning is the ability to test the sustainability and compatibility of a larger number of different types of development options and management actions simultaneously. This will be done by the WMZ planning team using the water system simulation model adopted for the catchment as discussed in the previous sections.

   Hence, the need for information on the technical specifications and operating characteristics of the various options. These data are needed for the model to be able to simulate the function and output of the option simultaneously with the others that are assumed to be implemented under the scenario being considered. However, note that there are two broad types of options; investment or physical options as outlined in Annex G, and management actions. The latter are also included in the model runs by identifying the result or outcome of the management action and modelling that outcome. For example, some management actions will affect the way reservoirs are operated or water is diverted, others will affect the hydrology of the sub-catchment by changing land use.

4. A scenario is a combination of assumptions about the options in place (which options are possible or assumed to be implemented), external factors that influence their performance (climate, economic conditions, etc.), projections or forecasts of the future (population growth rate, urbanization rate, agricultural productivity, water use or demand rates, economic parameters, climate change, etc.), and government policy affecting either selection or performance (priority, funding, regulations, institutional arrangements, etc.). Hence what the WMZ planning team is simulating and studying in this step is a series of scenarios.

5. The comparison and assessment of scenarios should be done in the context of the multi-criteria evaluation framework discussed above in section 3.2. Assuming a particular scenario is feasible (it does not use more water than is available, or violate other thresholds or limits, for example, level of pollution discharge) the model should estimate the value of each of the multi-criteria indicators based on the simulation of the scenario. This sets the ground for discussion of what is better or almost as good, or not good at all basing on the objectives and indicators the WMZ planning team and the CMO have set for the plan.

6. The work done in earlier steps means that there can now be two sets of hydrology (long time series of daily or monthly discharge data at key points around the basin. These are used as inputs to the “water system simulation model”. One hydrology set will correspond to the naturalized hydrology based on historic

observations. The other hydrology will correspond to naturalized hydrology as calculated from the climate change data.

7. If time and resources are available, each one of the different development scenarios can be investigated without climate change and with climate change. This is the best approach because it may be that one scenario will be more climate change resilient than another, which may lead to its selection. If time and resources are limited, it is recommended that all scenarios are run using the "without climate change" hydrology and then the most favourable two scenarios run again using the "with climate change" hydrology.

Step 4.3: Involving the CMO and CTC in the Evaluation of Scenarios

8. The challenge for the WMZ planning team at this point is to organize and present these results to the CTC and the CMC in a manner that is readily understood and promotes and facilitates productive discussion of these scenarios as the heart or core of alternative catchment plans. Options and scenarios that drop out of the analysis should be highlighted and explained. Stakeholders should be able to identify how their issues and proposed options or actions have been addressed or dropped, and in the latter case receive a good explanation of why (including the possibility that their concerns and proposals have been addressed in a new or different way). The first round of discussion would typically lead to a request for the WMZ planning team to analyse with the model several variations on the scenarios analysed in the first round.

Step 4.4: The Consensus Draft Catchment Management Plan

9. As it works through the evaluation of each of the scenarios with the CMC and CTC, the WMZ planning team needs to be thinking ahead as to what should constitute the catchment management plan in the sense of its form, substance, etc. The team might first ask, if this is to be an integrated catchment management plan what might constitute an "integrated plan" (as opposed to something else). What qualities would it have? Then, it might reflect on whether both of the earlier steps and its own thinking include these characteristics. For example:

    - Is it participatory? Did all stakeholders have a say at each step of the planning and decision making process?
    - Are all sectors and users are considered, in the present and the future?
    - Is the scope of the objectives (and indicators) appropriate? Do they include the following factors?
        - Economic (growth and incomes, poverty, food security)
        - Social (equity, health)
        - Environmental (sustainability, conservation and enhancement of environmental services)
        - Implementability.
    - Does the Plan encompasses conservation and protection of the resource, the catchment, and the hydrologic system?
    - Does the scope of the planning process include the assessment of resources and system analysis of water supply and water demand; surface water and groundwater; and flood and drought risk management?

10. The above questions help to review the adequacy of the process on one level but it is also useful to have a checklist at this point in the process of what the broad generic elements of the catchment management plan would include. The following might constitute the beginnings of such a checklist, which could be detailed further:

    - It presents an understanding the natural resource base and people of the catchment their economic and livelihood activities
    - It consists of two interrelated plans;
        - water development or investment - infrastructure, enabling water use to achieve stakeholder objectives; and

- water (and catchment) management – water allocation, permitting, regulation, operations

- It presents and discusses a water balance (surface water and groundwater), including the factors that govern or control the water balance. It presents a proposed allocation of water when and where limits to water use or development exist?

- It facilitates development of water resources to achieve stakeholder objectives by proposing projects and programs, and by proposing priorities

- It presents a plan for monitoring, regulation and permitting
  - Shows where water in the catchment needs to be measured in order to manage it;
  - Indicates what will be the rules for all stakeholders that enable equitable and sustainable water use

- Proposes measures to protect and conserve the natural resources of the catchment
  - Answers the question - Is the future sustainable? From the standpoint of the catchment hydrology? Water allocation and use? The environmental objectives? The economic and social objectives?
  - Demonstrates how the catchment's resources should be managed to ensure the long term viability of the plan.

11. The goal in evaluating different scenarios is to begin selecting the actual options, measures and actions that will constitute the heart of the plan.

12. When a consensus emerges or begins to emerge, the WMZ planning team should consult with the inter-district forum and the WAC on the emerging plan. Feedback from these consultations should then be brought to the CTC and CMC for their consideration. While the CMC has the executive authority to adopt the catchment plan, it is absolutely essential that such a plan be supported by key groups and key officials in the catchment community. Hence the WMZ planning team must work towards a very broad consensus to ensure that implementation will be supported.

Step 5: Moving to Implementation

This step defines an approach to setting the stage for preparation of bankable projects; and guides on the preparation and presentation of a concise "portfolio" of projects as concepts in the form of brief project identification notes, and briefs.

Step 5.1: Preparation of the summary draft CMP

1. An indicative outline of the draft catchment plan document is shown in Figure 14; a document that will be widely circulated in draft form for review by DWRM and the MWE. It should be a concise summary document that provides the key data, findings and recommendations of the planning process and the discussions with the CMC and CTC. Supporting technical data and analysis should be compiled in annexes that can be made available on request during the review process.

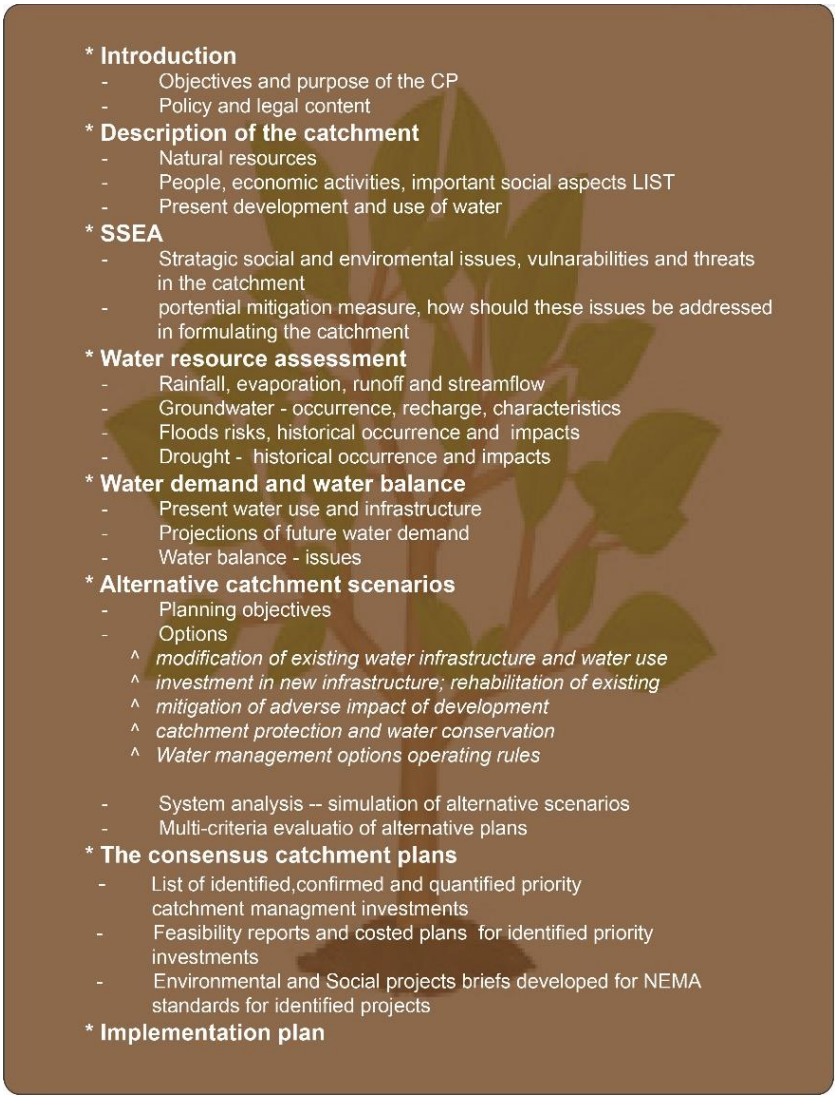


Figure 14: Indicative outline of the catchment management plan document

2. As a minimum, the CMP shall include a list of identified, confirmed and quantified priority catchment management investments; prepared to feasibility level and costed, ready for implementation, including associated environmental project briefs for each sub-projects in line with the NEMA regulations and the World Bank Environmental and social safeguards. This is done in consultation with stakeholders.

3. The consensus draft plan agreed with the CMC is likely to comprise the following elements:

- Infrastructure and project investments (small, medium and large scale) with O&M agreements and plans. These investments would be prioritized and sequenced over the planning horizon, perhaps bundled into three or five year programs.
- Water supply allocations and water storage operating rules.
- Water conservation initiatives (including investments), catchment management measures and water source protection initiatives, regulations, standards, and investment proposals to control pollution and improve water quality standards, and investment proposals to control pollution and improve water quality.
- Drought and water deficit management actions to enhance drought and water deficit resilience including soil and land cover management, water conservation and water harvesting, water use regulation and mechanisms for adjustment to shortages or deficits.
- Flood risk mitigation including flood plain use regulations and flood loss reduction measures.
- Measures and incentives to promote improved water use efficiency and productivity Catchment water resources monitoring plan including new or altered hydro-meteorological stations, water quality monitoring stations, and regulations on water measurement for major water users.
- A program of project preparation activities (pre-feasibility and feasibility studies) for larger scale infrastructure proposals.

WMZs shall take a central role in catalysing investments through the catchment management planning processes by for instance facilitating the preparation of a portfolio of bankable projects at a minimum to the "conceptual design" stage ready to be taken forward to further design and appraisal by one or more funding sources (e.g. multi-lateral International Financing Institutions (IFI), private, national/regional governments, and NGOs). The identified project description shall typically have the following key elements;

- Overall objective – i.e. what are is the main outcome(s) of the proposed project;
- Expected results and beneficiaries;
- Project scope, including possible components and type of activities to be financed;
- Possible implementation arrangements;
- Possible financing requirements and alternative project approaches;
- Possible risks; and
- Timeframe for project preparation, key steps, and possible resources required.

Step 5.2: Review and Adoption of the Draft CMP

4. The goal is to have a final CMP that not only is agreed between the WMZ and the catchment CMO and supported by the other stakeholder groups, but also has the sanction and support of the Government. This is important for attracting donors and budget allocations to support plan implementation. The final plan, as with the WMZ and the CMC, should have an appropriate legal status. This would facilitate adding elements of the plan to the District Development Plans and to the portfolios of the lead sector departments, and provide a basis for implementing the management actions that constitute a key part of the plan.

5. The process of moving from a draft plan to a final plan, in terms of the relationship between the WMZ, the CMC and the Ministry is shown in Figure 15 and again in Figure 16. Review and adoption of the WMZ-CMC adopted draft plan by the Government will be arranged and managed by DWRM in collaboration with the Water Sector Working Group and the WPC. The instrument of formal Government adoption of the final agreed plan would be issued by the Ministry.

6. The WMZ planning team will present the draft plan to these bodies and provide whatever support is needed to respond to comments, queries and suggestions. This process is likely to be iterative and involve at some point consultation with the CMC and CTC, and possibly other stakeholder groups; building a consensus between MWE, the WMZ and the CMC.

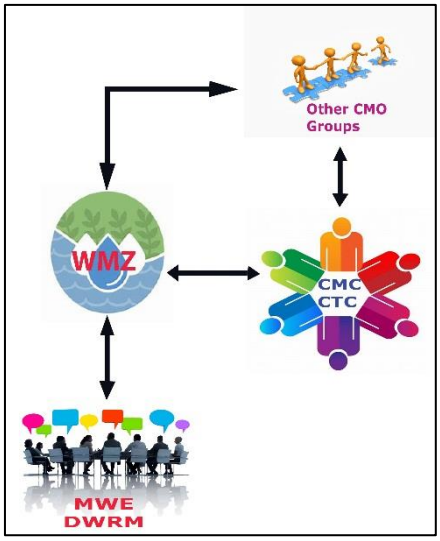


Figure 15: Moving from draft to final catchment management plan

The WMZ planning team will also support DWRM's efforts to brief other ministries and the Ministry of Finance, Planning and Economic Development on the proposed plan and its benefit. The Ministry would formally adopt the final plan document.

Step 5.3: Preparation of the Implementation Plan

7. There are so many activities and participants in the final CMP agreed between the Ministry, the WMZ and the CMC, and formally adopted by the Ministry that a systematic, phased plan for its implementation will be needed. Phasing over time is determined in part by priorities, but also by the availability of funds and implementation capacity (which may have to be created as a part of plan implementation). The implementation plan would include (among other things):

   - An action plan - a phased and sequenced plan of action in which the priorities and activities to be undertaken in each phase of plan implementation are clearly identified;
   - A plan for the "processing" of each project, program and activity in the action plan. Processing typically involves preparation (feasibility study, design, preparation of bills of quantity, tender documents, etc. or other technical activity necessary to implement the activity);
   - Identification of who will be responsible for the implementation of each project, program or activity, and what that organization's role will be in relation to the WMZ, the project, and the stakeholder;
   - The amount of financing (capital, operating, maintenance) needed, the potential sources of that financing, and identification of who is responsible for securing the financing;
   - Identification of changes required in existing policy, laws or regulation to implement the adopted plan; identification of who will be responsible for formulating, preparing and processing those changes;
   - A specific, targeted training and capacity building program that is design to directly support the institutions, stakeholders, and beneficiaries of plan implementation.
   - Monitoring and evaluation framework. A monitoring and evaluation system or is required to ensure that the various parts of the implementation of the catchment management plan are on track and that they will lead to the desired outcomes, essentially progress towards meeting the strategic objectives and realising the vision.

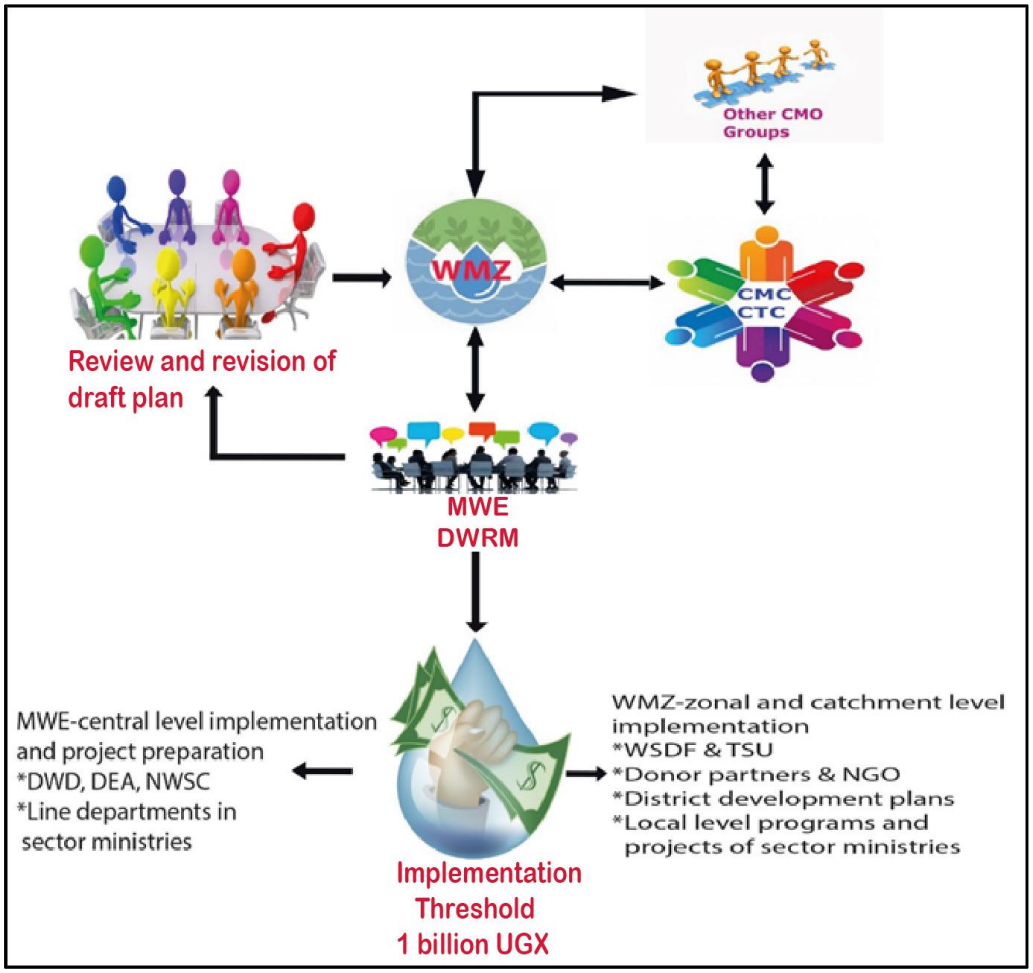


Figure 16: Implementation of the catchment management plan

The final implementation plan has to be costed and prioritised with clearly "packaged" projects described in an agreed format and based on requirements of targeted donors/financiers ready to put forward to potential financing organisations.

8. The roles of the various institutions in the implementation of the adopted plan is summarized in Table 7.

Table 7: Roles in Catchment Plan Implementation

WMZ	▪ Coordinate all implementation activities ▪ Facilitate and support DWRM coordination of central level implementation and financial resource mobilization ▪ Facilitate implementation of catchment plan projects by central departments ▪ Identify modalities for zonal and catchment level implantation among its public and private sector partners (Figure 15) ▪ Mobilize funds (MTEF, budget, donors, private sector) with the assistance of DWRM for implementation of zonal and catchment level projects ▪ Coordinate, manage and undertake project preparation for zonal and catchment level plan projects ▪ Assess water use permit applications under existing regulations ▪ Facilitate implementation and installation of upgraded and expanded monitoring network and WIS, and operate system within the zone ▪ Monitor hydrologic and meteorological conditions, compliance with regulations, implementation of sub-and micro catchment plans and source protection plans ▪ Support and facilitate the continuing role the CMC and CTC and other stakeholder groups including keeping all stakeholders informed of implementation progress
CMC & CTC	▪ Monitor plan implementation ▪ Promote and facilitate compliance with regulations and permitting system ▪ Facilitate and promote implementation of catchment management and source protection plans ▪ Facilitate inclusion of plan projects and programs into District development plans
MWE - DWRM	▪ Organize and coordinate review of the draft catchment plan and facilitate the Ministry's approval and adoption of the final agreed plan ▪ Organize and coordinate the technical review of plan project proposals and assignment of implementation to the appropriate department ▪ Mobilize funds for plan implementation and WMZ support ▪ Review policy, legal and regulatory revision needs based on plan recommendations and manage the process for updating and revision
MWE - NEMA	▪ Review the environmental regulatory needs (actions, new or revised regulations) based on the adopted final plan ▪ Issue required regulations, notices, and permits in accordance with legal and regulation requirements
MWE – Line departments	▪ Undertake preparation of projects and investments within their area of responsibility that are proposed in the adopted final catchment plan (feasibility studies) ▪ Supervise and manage project implementation (designs, tender and procurement, construction) ▪ Operate the completed project in accordance with the permit and operating rules agreed with the WMZ
Line departments in the concerned sector Ministries	▪ Undertake preparation of projects and investments within their area of responsibility that are proposed in the adopted final catchment plan (feasibility studies) ▪ Supervise and manage project implementation (designs, tender documents, procurement, construction) ▪ Operate the completed project in accordance with the permit and operating rules agreed with the WMZ
District government	▪ Facilitate and support implementation of the adopted final catchment plan ▪ Incorporate priority projects and program into the District development plan as appropriate
Donor partners & NGOs	▪ Implement priority projects and program in collaboration with the WMZ and stakeholders in accordance with agreements and Memoranda of Understanding with the WMZ and DWRM
Private sector	▪ Facilitate and support implementation of the adopted final catchment plan

Step 5.4: Preparation of the Monitoring and Evaluation Framework

9. Monitoring and evaluation is required to ensure that the various parts of the implementation of the CMP are on track and that they will lead to the desired outcomes, essentially progress towards meeting the strategic objectives and realising the catchment Vision. A monitoring and evaluation system is only effective if the understanding of the desired outcomes is clear and measurable in some way, hence the development of indicators is critical.

10. The overall aim of the monitoring and evaluation tasks can be seen in two distinct parts:

    - To develop a monitoring and evaluation framework aimed at tracking progress towards the achievement of the strategic objectives of the catchment management plan and
    - To provide feedback on the implementation process in terms of whether actions are being carried out according to the planned timeline and on budget.

11. There are clearly strong linkages between planning and monitoring and evaluation. Good planning provides the foundation for a robust monitoring and evaluation process. Planning, monitoring and evaluation all have important roles to play in ensuring the monitoring and evaluation is effective and useful and that adaptive management can keep the programme on track towards its desired outcomes.

12. Figure 17 below illustrates how the results based monitoring and evaluation framework is built during the planning process and takes full cognisance of the programme's vision and related strategic objectives and desired outcomes. If the results are to be achieved, clear indication of these results must be built into the framework. Process-based monitoring and evaluation (sometimes referred to as the traditional approach) is effectively based on whether the planned actions and activities are being carried out as planned. They do not take into account whether these actions are being effective or not.

13. It is worth bearing in mind some key points linking planning, monitoring and adaptive management:

    - Without proper planning and clear articulation of intended results, it is not clear what should be monitored and how; hence monitoring cannot be done well.
    - Without effective planning (clear results frameworks), the basis for evaluation is weak; hence evaluation cannot be done well.
    - Without careful monitoring, the necessary data is not collected; hence evaluation cannot be done well.
    - Monitoring is necessary, but not sufficient, for evaluation.
    - Monitoring facilitates evaluation, but evaluation uses additional new data collection and different frameworks for analysis.
    - Monitoring and evaluation of a programme will often lead to changes in programme plans. This may mean further changing or modifying data collection for monitoring purpose (part of the adaptive management process)

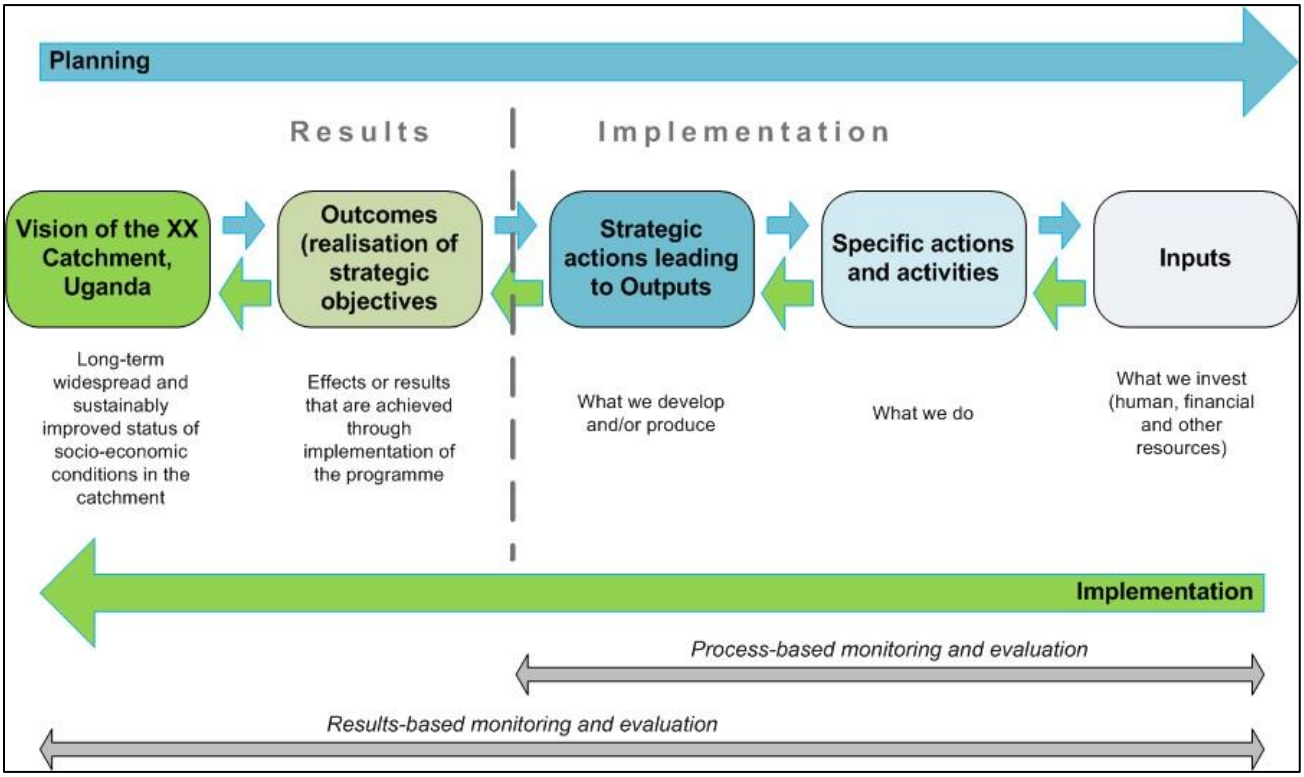


Figure 17: Results-based monitoring covers both planning and implementation (based on UNDP; 2016)

14. As a minimum, the main body of the report should include the logical framework ("logframe") and there should be a Project management Framework as illustrated in Annex H.

15. Logical Framework: A log frame is typically presented as a matrix with several columns and rows. While there are many different log frame formats, the NBI log frame is a 3-column matrix that captures the following:

    - The Goal and Objectives of the initiative, and results at all levels (impact, medium-term outcomes, short-term outcomes, outputs)
    - Performance indicators to measure the progress of each result
    - Assumptions and challenges and constraints that may affect achievement of results.
    - For each of the outputs, the main groups of associated activities may be included (the activities do not require indicators).

An example in the form of an extract from a log frame for a completed catchment management plan, Figure 18, is included in Annex H.

Results	Indicators	Assumptions and Challenges and constraints
Vision		
Impact	Impact Indicators	Assumptions and Challenges and constraints
Strategic Objective 1:		
Medium-Term Outcomes	Medium-Term Outcome Indicators	Assumptions and Challenges and constraints
1.		
2.		
Strategic Objective 2:		
Medium-Term Outcomes	Medium-Term Outcome Indicators	Assumptions and Challenges and constraints
3.		
4.		

Figure 18: Layout of Logical Framework

16. Project Management Framework (PMF): This is a tool to organize results of the monitoring and evaluation processes. The PMF links what you will monitor with how you will do it. It is designed at the start of a project, may be updated annually, as required and is used for baseline collection and later for comparison with actual progress. The elements of the PMF are presented in a 9-column matrix like the one shown below. An example in the form of an extract from a project management framework for a completed catchment management plan, Figure 19, is included in Annex H.

Level	Results	Performance Indicators	Data Source	Collection Methods	Frequency	Responsible	Data Use	Baseline	Target
Impact									
Short-term 1.0									
Medium-term 1.1									
Output 1.1.1									
Repeat for all results									

Figure 19: Layout of Project Management Framework

4 PILOTING CATCHMENT MANAGEMENT PLANNING

4.1 Rwizi Catchment Pilot

1. Piloting IWRM and Catchment based Water Resources management was done in the Rwizi catchment and it offered an opportunity to capture a number of important lessons that should guide the WMZ teams (DWRM 2009). These included:

   (i). A coordinator of IWRM, located within the catchment, is essential for successful implementation of IWRM – this suggests that at least one member of the WMZ team should be appointed "team leader or coordinator" for each catchment. That person is the visible point of contact within the WMZ for all stakeholders in that catchment;

   (ii). Cooperation is easier amongst Districts with a common factor such as shared culture and historical ties – this lesson highlights the importance of the WMZ team quickly developing an understanding of the social and cultural landscape of each catchment and taking that into account in the planning process;

   (iii). Data required for water resources situation description is scanty, of poor quality, has many gaps and difficult to obtain – this will be a major challenge in which DWRM and the WMZ team must play an important role to solve the associated problems. It also underscores the principal that an adopted plan is not "the plan forever" and that the plan is a living document that has to be revisited as knowledge grows and conditions change;

   (iv). Use of existing structures within the catchment complemented by a few new structures gets IWRM up and running much faster than introducing new structures – hence, in a way similar to the social and cultural issues, the WMZ team needs to map the formal and informal institutional landscape of the catchment, and facilitate harmonised coexistence of all stakeholders to avoid, whenever possible, harmful competition. The WMZ needs to avoid redundant organizations and meetings, and cumbersome procedures;

   (v). The WMZ team should be able to effectively explain the purpose and scope of the proposed catchment management planning program including how it is being funded, how the plan shall be funded and implemented, and what the long-term requirements for plan implementation are.

4.2 Other Lessons Learned

2. As part of the process to update these guidelines, DWRM carried out a review of the lessons learned from preparation of 15 catchment management plans that were prepared using the first edition of the CMP guidelines. The main points explicitly relate to the practitioners' experience in using and applying the first Edition of the Guidelines. The general experience in using the guidelines was very good. Many of the recommendations have been incorporated into these revised guidelines and are highlighted below:

   (i). **Scale:** The guidelines are focussed on larger catchments and the development of larger infrastructure. The use of non-process-oriented water balance and/or optimisation models such as Mike Hydro or WEAP are not really useful for smaller catchments where actions at the smaller scale (in micro catchments for example), such as watershed management, tackling degradation hotspots needs to be better taken into account in the options analysis.

   (ii). **Stakeholders' structures**: The institutional structure for stakeholders as set out in the guidelines is not clear in terms of roles and timing and the general engagement strategy. There are issues around sustainability, funding and legal status.

   (iii). **Communication:** More detail on the specific role of the communication strategy is required.

(iv). **District development plans/ other sectors**: the relationship of catchment management plans with district development plans should be clearer. There is a need to link better with lower level structures and their plans.

(v). **Modelling, DSS and knowledge base**: There are question marks over the choice of appropriate modelling tools. This relates to the question of scale. For issues related to watershed management and resultant impacts, there is a need for other modelling tools.

(vi). **Strategic framework, SSEA and options analysis**: Linkages between these different parts are not clear. How the SSEA is to be carried out can be confusing.

(vii). **Local expertise/ knowledge**: There is a need for local expertise on the planning team building the catchment management plan. There is also need to make more use of indigenous knowledge and practices.

(viii). **Groundwater**: Groundwater does not receive adequate coverage in the water resources planning analysis (Section 2.1). Once again, this is probably linked to the issue of scale since groundwater is not generally seen as a resource that can be shared and transferred around the basin. However, the role of groundwater at the micro catchment level is critical.

(ix). **Conflict Management:** Not adequately covered or stressed in the Guidelines.

(x). **Advocacy and Capacity Building**: Capacity building is not stressed adequately with respect to some stakeholders, especially CMCs.

4.3 Issues that Will Typically Confront The WMZ Planning Team

(i). **Scale:** The scale, or level of detail at which the planning exercise is to be carried out is an important consideration. For large catchments with major rivers and either existing or potential large-scale abstraction works for irrigation, hydropower or other purposes, the focus may be different than for small catchments where the issues may be more focused on "localised" problems such as the availability of water in streams during the dry season or localised competition for water and other natural resources.

Given that the CMC has a central role in guiding the development of the plan, the composition of this body should reflect the scale and the issues that the Plan will have to address. If the composition is representative of the issues and scale, the focus of the Plan is more likely to be appropriate.

(ii). **Choice of models and tools**: The choice of the appropriate models should be issue driven; where the main issues concern the choice between different options of hydropower and irrigation schemes and whether there is enough water remaining for potable water supply to various centres, a water balance/allocation and optimisation model may be the most appropriate. Where the focus is on underlining the benefit of watershed management investments, rainfall-runoff models that show the benefits of improved land use practices may be the priority.

(iii). The catchment is a natural system of land, water, and ecosystems, and the catchment management plan will have many aspects that address the problems of protecting, conserving and managing that natural system. But it is also much more than a natural system; it is also a unique social and economic system dependent upon the exploitation of the natural system of the catchment. This enlarges and expands the context and range of issues that are addressed in the catchment management plan. Among the many roles and functions of the WMZ team summarized in the previous sections, the implementation of the ones below highlights the complexity and range of issues that the WMZ team typically has to address:

- Development of water resources for economic and social benefits – people always want access to more reliable water supply, better sanitation, reliable water for livestock in the dry season, water for irrigation and to improve crop production, water for aquaculture, water for environmental services, especially in wetlands. Moreover, this accessibility should be improved and protected;

- Protection of the resource base that supports these economic and social benefits - many of these activities, singly or in combination, can result in adverse impacts on the catchment itself and on the water resource base of the catchment including impacts on groundwater recharge, stream flow, flood migration, soil erosion etc.;
- Conservation of the catchment resources will involve measures to ensure that water uses do not waste or diminish the resource, as for example through discharge of wastewater and pollutants into the catchment without meeting the regulatory requirements.

(iv). Specific examples of these issues were identified in all 17 priority catchments surveyed to help set priorities and identify some of the key issues as seen by catchment stakeholders (COWI 2009). There are also issues that are unique to particular catchments e.g. the high risk of adverse impacts of oil exploration and development in the Lake Albert Eastern Catchment and in the Lake Edward Catchment. But others occur frequently and in nearly all catchments. The latter include:

- Resource use conflicts – actual and potential; that is, presently or in the near future – this issue was identified by stakeholders in every priority catchment;
- Lack of operational management and appropriate regulation of multiple uses in the same catchments (irrigation, hydropower);
- Lack of enforcement of water regulations, particularly the discharge of untreated wastewater and harmful pollution;
- Catchment and river bank degradation, particularly where there is sand and gravel mining, but also in areas where population pressure and urbanization, deforestation, and extension of croplands are resulting in land degradation, increased erosion, and siltation of rivers, reservoirs and water bodies;
- Very limited hydro-meteorological monitoring with major gaps that are a hindrance to water development and management;
- Lack of coherent and comprehensive drought and flood risk mitigation plans and preparedness;
- Conservation and management of wetland water management and environmental services.

(v). There are also several overarching issues that are most easily seen from a distance. These include:

- The need to increase resilience to climate variability and change; the high annual average precipitation masks high seasonal and inter-annual variability that is manifested in frequent rainfall shortages that depress yields and productivity;
- Deteriorating water quality, especially the threats this poses for domestic and livestock water use and for the numerous lakes found in the WMZs;
- The need to prioritize and channel investment in ways and directions that ensure maximum and sustainable benefits to stakeholders from the water resources in each catchment.

Addressing these issues requires a basin or catchment natural resource planning and none can be addressed in isolation or completely from the perspective of a single sector or department.

(vi). This is the fundamental rationale for approaching catchment water resources development and management with an integrated approach. Holistic and integrated water resources plans that take into account the physical, economic, social and environmental resources in a catchment and that are based on the long term vision and short term concerns of stakeholders provide an appropriate framework for effective management and regulation of water resources. Equally important, they provide a framework for priority setting and investment on the part of sector authorities that ensures strong stakeholder awareness and partnership.

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ANNEXES

Annex A – An initial list of the kind of data needed for a WMZ Knowledge Base

BIO-PHYSICAL DESCRIPTION OF THE WMZ AND ITS CATCHMENTS

- Topography, DEM
- Existing infrastructure – roads, bridges, water storage, wells and water points, wastewater discharges, treatment plants, surface water diversions and conveyances
- Settlements, villages, towns and cities
- Climate – metrological, hydrologic and water quality records; station location and status,; temperature and evaporation; climate change trends (including global historic climate data sets), future climate datasets
- Land cover, land use, soils
- Forest cover
- Cultivable land, cropped area, irrigated area, typical crops and cropping patterns (commercial, smallholder, subsistence), crop productivity
- Industries, mines and mineral processing
- Water quality classification of streams; main sources of pollution (point and non-points)
- Valley tanks and reservoirs; lakes – size(area, volume); water level records; outlet controls, users
- Livestock and water points; livestock numbers, location
- Fisheries; riverine and floodplain; water bodies including ponds; - production by specie, catch, fisherfolk (numbers, origin)
- Water supply – boreholes, surface water diversion; conveyance and distribution networks
- Flood affected areas
- Geological and hydro-geological maps; groundwater assessments
- Project proposals by relevant Ministries & Departments

MAPPING AND CHARACTERIZATION OF MAJOR ISSUES

- Stream bank degradation
- Significant sources of erosion
- Areas affected by sedimentation
- Water use conflicts; water shortages
- Areas for potential irrigated agriculture
- Areas for fisheries development (capture, aquaculture)
- Areas with potential for enhanced livestock production
- Areas for potential water storage
- Areas needing improved access to safe drinking water supply
- Areas of low water supply reliability
- Areas with degraded water quality
- Areas with high flood risk

SOCIO-ECONOMIC DATA

- Population- numbers; growth rates and trends; spatial distribution
- Inflation and exchange rate trends

- Market prices for agriculture inputs and outputs; costs of materials and construction
- Employment
- District development plans- priorities and expenditures
- Poverty data (numbers, spatial distribution)
- Food availability trends, frequency of shortage

SOURCE OF THESE DATA IN UGANDA

- DWRM
  - Hydrologic records
  - Meteorological records
  - Water quality records
  - GIS lab - layers and shape files
  - National Water Assessment
  - Zonal sub-set of the NWA database
  - Water system simulation (Mikebasin) sub-model (zone, catchments)
  - Hard copies of maps (cadastral, topographic)
  - Satellite imagery
- The Climate Research Unit of East Anglia University
  - o Dataset of historical precipitation gridded at 0.50° x 0.50° resolution, on a monthly time step. This grid has been constructed from a total of over 11,800 stations worldwide. This database has the advantage of including long periods of rainfall historical data based on observations (data are available from 1901 to 2012). However on relatively small catchments and where rainfall spatial variability is high, this source of data may not be precise enough.
- Data from Global Precipitation Climatology Centre (GPCC).
  - o This Centre, operated by DWD (Germany's National Meteorological Service) under the auspices of the World Meteorological Organization (WMO) avails a full data re-analysis for the period 1901-2010, based on quality controlled data from all stations in GPCC's data base available at the time, with a varying coverage over time. Data set are available at different special resolution, including 0.5°*0.5° . As for the CRU database, GPCC has the advantage of presenting long period of data without gaps.
- Regional-scale Climate Change Projections of Annual, Seasonal and Monthly Near Surface Temperature and Rainfall in Uganda" (University of Pretoria, Baastel, 2014):
  - Two realistic greenhouse gas emission scenarios have been studied under the regional scale Climate Change study: a moderate concentration pathway (RCP 4.5), and a more extreme concentration pathway (RCP 8.5).
  - Four Global circulation Model were considered to generate historical and future climate projection (HadGEM2-ES, EC-EARTH, CNRM-CM5, MPI-ESM-LR, see the Regional scale Climate Change projection study report for more information on these model);and one downscaling method was then applied, to give climate projections at a 0.44°x0.44° grid resolution.
  - Both future rainfall and temperature data have been generated for the whole of Uganda
- Tools and guidelines for climate Change Adaptation" (BRLI, 2013) for NELSAP

- This includes a future climate modelling study that provides downscaled rainfall data under different climate change scenario at a 0.5°x0.5°grid resolution

- DWD (including WfP)
  - Inventory of towns, and their location and WSS status
  - Planning criteria for small towns (water production rate, losses, UAW)
  - Studies and surveys
  - Project proposals for the catchment (reservoirs and valley tanks, boreholes)
  - Feasibility studies of proposed projects

- NWSC
  - Location and status of urban areas;
  - existing and planned sources of water supply
  - Areas where micro-catchment planning for source protection will be needed
  - Urban water supply planning criteria (water production rate, losses, UAW)
- DEA - Wetland department
  - Surveys and investigations
- Bureau of Statistics
  - Population and demographic data and statistics; 2012 Census
  - Business and industry data and statistics
  - Environment statistics
  - Maps and data archives
  - Economic and financial statistics
- Ministry of Agriculture
  - Agriculture data - cultivated area (rainfed, irrigated) crops, productivity, fertilizer use, soil surveys, research results)
  - Livestock
  - Fisheries
- Ministry of Energy
- National Forest Authority (NFA)
- Ministry of Tourism

Annex B- Analytical Tools for Integrated Catchment Planning

Analytical Tools for Integrated Catchment Planning

Integrated catchment planning generally requires a set of analytical tools including water system models to undertake water balance studies and scenario analysis. Together with the Knowledge base these tools form the core of a decision support system (DSS). The models in a DSS might include one or more of the following:

RAINFALL-RUNOFF MODELS

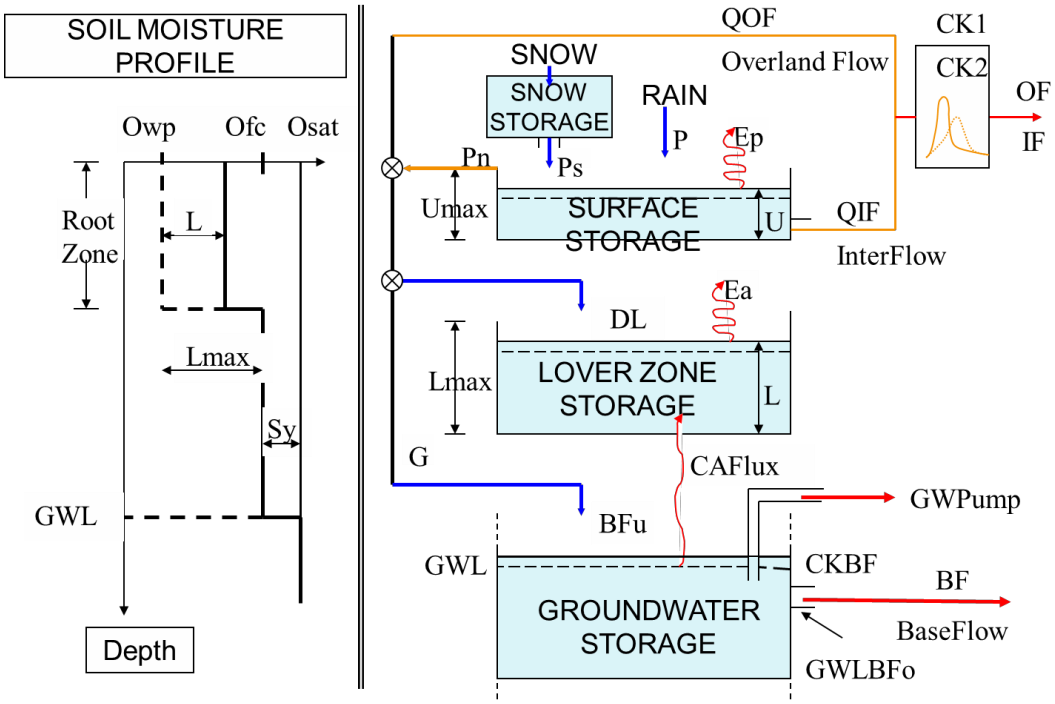
There are several different purposes that a rainfall-runoff model may be used for. These include:

- Understanding the catchment yield, and how this varies in time and space, particularly in response to climate variability
- Estimating the relative contributions of individual sub-catchments to water availability within a larger catchment
- Estimating how this catchment yield and water availability might change over time in response to changes in the catchment, such as development of valley dams, or changes in land-use and land management.

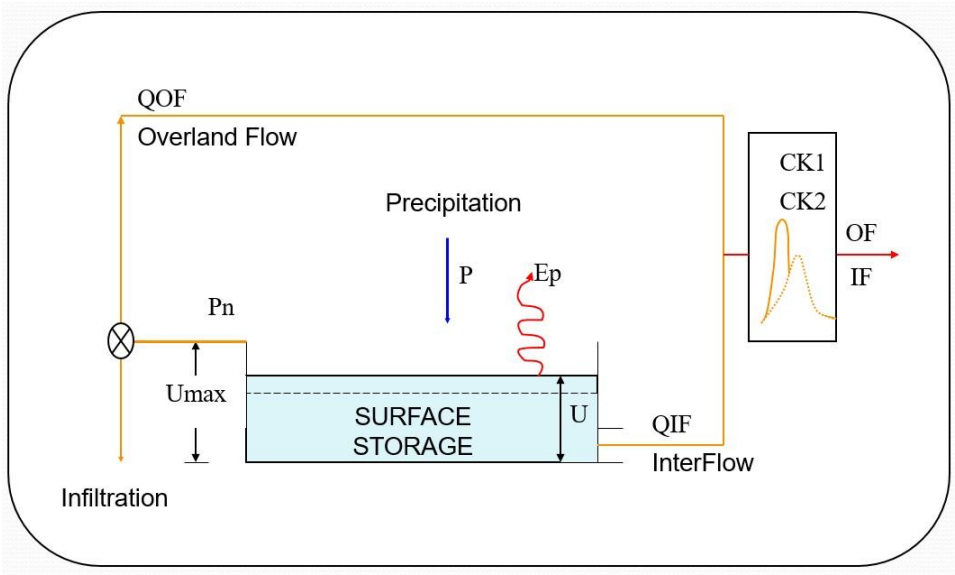
The third of these cases is particularly relevant for the situation in many catchments inUganda, where changes in land use or land degradation has caused negative changes to the hydrological regime. At the same time, since one of the aims of catchment management will be to improve the condition of the catchment, an improvement in the hydrological regime can be anticipated. It would be useful to be able to estimate these changes and take them into account in the planning process, including the evaluation of options.

Access to the NAM model is available through the NBI DSS portal. It is a deterministic, lumped (catchment is looked upon as a single unit with average values of parameters) and hybrid (mixture of statistical and process-oriented) rainfall-runoff model. It can present the **processes that take place in the surface zone storage, root zone storage and the ground water storage**. This is important if there is a need to understand the impacts of changes in land use and/or vegetation cover which could typically result from improved land management practices. In addition, it contains provision to deal with snow melt and Irrigation schemes. Applications related to the NAM include:

- Runoff forecasts taking into consideration the status of the surface and groundwater storage zones
- Extension of runoff series
- Estimate effects of Climate Change, for instance on stream flow”
- The model structure is shown overleaf:



Structure of the NAM model as described in the NBI DSS



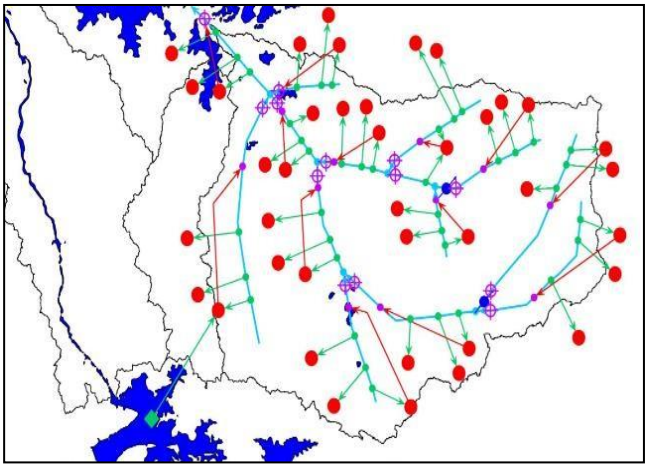
Component of the NAM model for differentiating overland and interflow (baseflow) contributions to catchment runoff as described in the NBI DSS

Access to the NAM model is available through the NBI DSS portal. It is a deterministic, lumped (catchment is looked upon as a single unit with average values of parameters) and conceptual Rainfall-runoff model. It can present the processes that take place in the surface zone storage, root zone storage and the ground water storage.

BASIN WATER SYSTEM SIMULATION MODELS

A basin simulation model typically forms the backbone or core of the decision support system. The model should be capable of accurately simulating the current hydrology and hydraulics of the basin and any or all scenarios for water resource systems development and operation that the stakeholders may wish to investigate.

For modelling purposes the catchment and its sub-catchments will be represented by a network schematic as indicated in the illustration below (the schematic shown here is of Mpologoma catchment). The modelling should allow for easy modifications to the catchment and sub- catchment network representation and analyses of the impacts of potential interventions and developments (e.g. new infrastructure, changes in water allocation and operating rules, revisions to the estimates of the basin hydrology, proposed management and regulatory changes, etc.).



The economic, social and environmental implications of the simulated scenarios are to be computed from database information and from the catchment modelling outputs. The outputs will include a comparison of the hydrologic, economic, social, and environmental criteria (measured with appropriate indicators – see Task 6) of various investment, management and operating scenarios.

Associated tools for output visualization (e.g. using graphical, tabular, schematic, and map-based formats) and statistical analysis, sensitivity analysis, economic and financial analysis (e.g. analysing net present value of streams of benefits and costs associated with each scenario), and scenario comparison and visualization (across environmental, social and economic criteria) will be needed.

BASIN OPTIMIZATION MODELS

Optimization models are formulated to maximize the net benefits of basin water resources development and management, subject to a variety of constraints (e.g. resource, technology, policy, budget, etc.). The optimization model should employ the same network schematic used in the simulation model to analyse and determine the optimal combination of investment, management and operational actions under various development scenarios. The optimization models would be developed to better understand the system limits and narrow down potential investment choices that could be simulated in detail. The optimization will consider economic, environmental, and social parameters (e.g. as objectives, decision variables or constraints) in scenario analysis to make best use of available information and better aid stakeholder discussions on investment decisions. In this case also, appropriate tools would be developed to visualize, analyse and compare outputs across scenarios.

BASIN MULTI-CRITERIA ANALYSIS TOOLS

A multi-criteria tools is very useful to compare various catchment scenarios (combinations of proposed investments or changed operational practices or management actions – as illustrated in the figure to the left) according to economic, environmental and social consequences defined from the objectives, criteria and Indicator framework agreed with stakeholders as a part of the planning framework). The suggested approach (described briefly in Annex I) avoids the necesssity of devising weights or other abstract parameterizations to reduce the multiple objectives and criteria typical of river basin planning to a single metric for each scenario. The approach results in the identification of the typically few objectives that really define the choice between scenarios and allows for the explicit consideration of trade-offs when there are multiple objectives

FUNCTIONAL SPECIFICATIONS OF THE SIMULATION AND OPTIMIZATION MODELS

The Simulation and Optimization Models should have:

- Compatibility with the planning framework developed (Task 2) and ability to answer the questions posed
- Ability to model key processes in the system as indicated in the adjoining table
- Ability to Drag-and-drop objects (sub-basins/watersheds, dam, regional transmission systems, confluence, irrigation systems, hydro-meteorological stations, connections, return flows) to define the water system and interactively add attributes/operating rules, choose scenario options, undertake sensitivity analyses, etc. and visualize and further analyse outputs.
- Ability to select/deselect individual proposed projects in defining scenarios
- Ability to estimate water supply under various scenarios (including climate variability/change) and demands (by location, sector and future scenarios)
- Ability to generate hydrograph and flow time-series at user-defined location
- Ability to estimate/optimize impacts of various operating rules for existing and proposed infrastructure

Type of Modeling		Description of Outputs
Primary	**Rainfall-runoff modeling**	▪ Estimation of relationships in each watershed (rainfall, runoff, evaporation, losses) ▪ Ability to incorporate climate change rainfall/temperature scenarios
	Water Systems modeling/ Hydrologic routing (the Water "Spine")	▪ Impacts of system storages and abstractions, return flows, losses, inter-basin diversions ▪ Assimilation (for error optimization)
	River-reach/ Hydraulic routing	▪ Generation of levels, inundated areas
	Reservoir operations	▪ Reservoir management
	Agricultural modeling (rainfed, irrigated, flood irrigation, pump schemes)	▪ Crop water requirements, return flows, efficiency, overall water demands, etc.
Supporting (initial versions based on available data)	**Groundwater model**	▪ Application to selected aquifers - expandable
	Economic optimization	▪ Approaches to maximize productivity of water – e.g. reservoir choice and operation and cropping systems to maximize multipurpose benefits
	Sediment modeling	▪ Watershed management scenarios and implications on sedimentation in reservoirs
	Water quality modeling	▪ Approx salinity computation based on flows, sea-level rise, land subsidence in delta

- Tools to assist with water resources analysis (e.g. time series analysis, synthetic streamflows/data generation)
- Tools to assist with economic analysis of various types of investments (e.g. using streams of costs and multi-purpose benefits to generate net benefits, IRRs)
- Tools to assist with environmental analysis of various types of investments (e.g. inundation of forest areas under large storage development scenarios, erosion

reduction through different watershed management measures)

- Tools to assist with social analysis of various types of investments (e.g. resettlement, employment generation for different investments based on input data)
- Tools to estimate impacts of uncertainty of various parameters on selected outputs (e.g. monte- carlo simulation)
- Inclusion of all software required for the knowledge base and modelling/DSS development with licensing (unlimited duration with upgrading potential) required to support use in all three counterpart teams (at least 3 licenses per location = 9 licenses on desktop/laptop) – this allows the Consultant flexibility to develop customized tools or customize off-the-shelf models as appropriate.
- Specific delineation of the spatial and temporal (e.g. daily/monthly) resolution and extent required for various modules
- Further elaboration of the spatial analysis (and use of GIS/remote sensing, including the use of accessible global, regional and national spatial datasets)
- Types of processes to be modelled in this 3-year period (e.g. rainfall-runoff, missing flow estimation, erosion, sediment transport, water quality, groundwater/conjunctive use management, reservoir operations, etc.) for both the simulation and optimization modelling proposed (based on outputs required)
- Development of appropriate user interfaces/workspaces/access at different levels (basic user, advanced user, administrator)
- Appropriate model calibration and validation
- Provision of online help and tutorials; Security arrangements; Log file for scenario run management
- Ability to store results of different scenarios for comparison

FUNCTIONAL SPECIFICATIONS OF THE MULTI-CRITERIA ANALYTICAL TOOLS

Decisions on investments are seldom made on hydrologic considerations alone, but on a range of objectives, criteria, and indicators and their intersection with the political economy. This set of tools seeks to better inform decisions by choosing a few focused criteria and indicators (Task
2) to compare various scenarios. Hence, the multi-criteria analytical tools developed should have:

- the ability to compare various scenarios from different perspectives (economic, social and environmental) using both quantitative and qualitative indicators (as described in Task 2) by developing *consequence tables* (e.g. indicating consequences to the indicators selected of different scenarios)
- easy-to-use visual, interactive tools for selecting scenarios, criteria, visual comparison (e.g. through color-coding consequence tables and charts/graphs) and saving/retrieval.

Many of these indicators will need to be assessed not only at an overall level, but at administrative and basin/sub-basin levels. Not all these indicators (that are representative of the types of considerations in investment decision making) will be computable using the modelling system. However, they do give an idea about the kinds of outputs that will be expected from the models, knowledge base, and stakeholder interaction. The indicators could be quantitative or normative (e.g. categories from 1-5) in nature depending on data availability and modelling possibilities. All these tools have to be developed in a customized fashion to support each Plan. Local language support (Sinhala, Tamil and English) will need to be provided in the interfaces and outputs of these tools.

Annex C – Mainstreaming Climate Change into catchment Management Planning

A: Mainstreaming climate change into rainfall-runoff modelling and water resources modelling

INTRODUCTION

In the study carried out for the Mpanga catchment,"Study on current and future potential water resources, under different climate scenarios, for the Mpanga River Basin (Uganda) (BRLi, 2015)", a methodology was used to develop a revised hydrology representing the hydrological characteristics under future climate change affected conditions.

The purpose of this annex is to summarise the approach and methodology that was used to assess the impact of different climate change scenarios on the water resources of the Mpanga River.

Preparatory work (bibliography) and field reconnaissance were undertaken to get a general understanding of the catchment. This allowed gathering the needed information and knowledge to perform the water resources modelling itself. The results were presented to stakeholders in the catchment in February 2015.The study essentially focused on the impact of climate change on low flows and did not enter into the modelling of climate change impact on floods and peak-flows. This would have required data that was not available (rainfall intensity data under current and future conditions etc.).

The approach and methodology used is such that it could be applied in any catchment aroundthe country.

AVAILABLE DATA SETS AND CHOICE OF THE CLIMATE CHANGE SCENARIOS STUDIED.

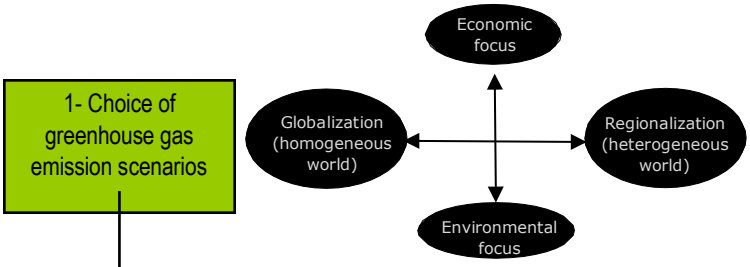
Generality on climate changemodelling

Prediction of future climate depends on many different hypotheses: hypothesis on future greenhouse gases emission; hypothesis on reaction and interaction of physical, atmospheric and climatic parameters etc. The schematic below (BRLi, 2015) shows the main steps of climate change modelling.

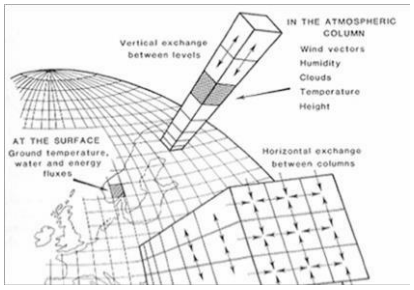
A "climate change scenario" is in fact the combination of choices on: the greenhouse gases emission scenario considered, the global circulation model used, and on the downscaling method applied. As shown in the figure below there are many choices and it is important that those involved in catchment management planning are comfortable with how to make choices so that they can take climate change into account in their catchment management plans.

Bearing in mind the objective of the study, the purpose of the climate change modelling was to provide a set of future climate data (especially rainfall and temperature) that could be used to investigate the impacts on water resources in the basin.

There are 40 different emission scenarios, each one making different assumptions for future greenhouse gas pollution, land-use and other driving forces.



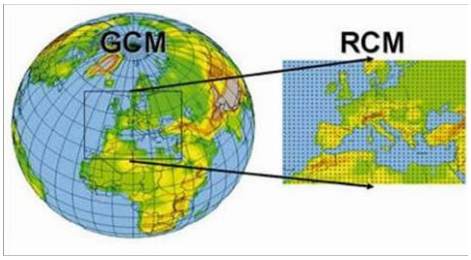
There are 22 general circulation models studied by the IPCC. GCM are mathematical representation of the climate and describe how the atmosphere, the oceans, the land, ice, energy from the sun etc. affect each other and Earth's climate. The models divide the earth, ocean and atmosphere into grid. The values of predicted variables (surface pressure, wind, temperature, rainfall…) are calculated at each grid point over time, to predict their future values. Due to the large number of calculation involved and given the current capacities of computers, simulation of the climate can't be done with a high spatial resolution.



Downscaling consist in taking global information on climate response and translating it to a finer spatial scale that is more meaningful in the context of local and regional impacts. Two general approaches are used in downscaling:

- Dynamical downscaling, where a high resolution climate model with a better representation of local terrain simulate climate processes over the region of interest
- Statistical downscaling, where large scale climate features are statistically related to fine scale climate for the region

The advantage of using dynamical downscaling is that a regional model can simulate local fine-scale feedback processes not anticipated with statistical methods. The disadvantage, however, is that the regional models are far more computationally requiring and that the end performance is highly dependent on the quality of the input



Data set of future climate characteristics (temperature and rainfall), to be used in hydrological modeling and assessment of future water resources.

Data sets used in the study

The study used two different future climate data sets:

- The "Regional-scale Climate Change Projections of Annual, Seasonal and Monthly Near Surface Temperature and Rainfall in Uganda" (University of Pretoria, Baastel, May 2014) This climate change modelling work was undertaken in the context of the study "Economic Assessment of Climate Change in Uganda" with the objective of generating

projections of future temperature and rainfall at regional scale for different greenhouse gas emission scenarios; and to proceed to downscaling in specific regions of Uganda used as case-studies, the Mpanga river basin is one of them.

- The: "Regional Downscaling of Precipitation and Temperature Data for Climate Change Impact Assessment in the Nile Equatorial Lakes (NEL) Region" – University of Stuttgart – 2011) undertaken as a component of the "Tools and guidelines for Climate Change Adaptation Mainstreaming in water Infrastructure development" NELSAP/NBI".

The table below summarizes the main characteristics of the climate change data available in the two studies (in line with normal practice, only a selection of those scenarios has been studied in the case of Mpanga catchment).

Presentation of the climate data sets used in the study on current and future potential water resources under different climate change scenarios in Mpanga catchment

Study	Baastel 2014	NELSAP/NBI 2011
Greenhouse gases emission scenario	2 scenarios from the 5th IPCC assessment (RCP 4.5 and RCP 8.5)	3 scenarios from the 4th IPCC assessment (A1B, A2, B1)
GCM	4 models	2 models
Downscaling	1 downscaling method	Statistical downscaling for 3 different climatic references
Data provided	Seasonal and monthly rainfall and temperature data series	Monthly rainfall data series. For temperature, the study recommends average seasonal temperature evolutions.
Comment	Advantage: uses greenhouse gases emission scenario from the latest released of IPCC assessment (5th) (scenario RCP 4.5 and RCP8.5). Inconvenient: downscaling applied only to a limited number of case study in Uganda and is not available for the entire country.	Advantage: available for the entire country. Inconvenient: use greenhouse gases emission scenario from the 4th IPCC assessment.

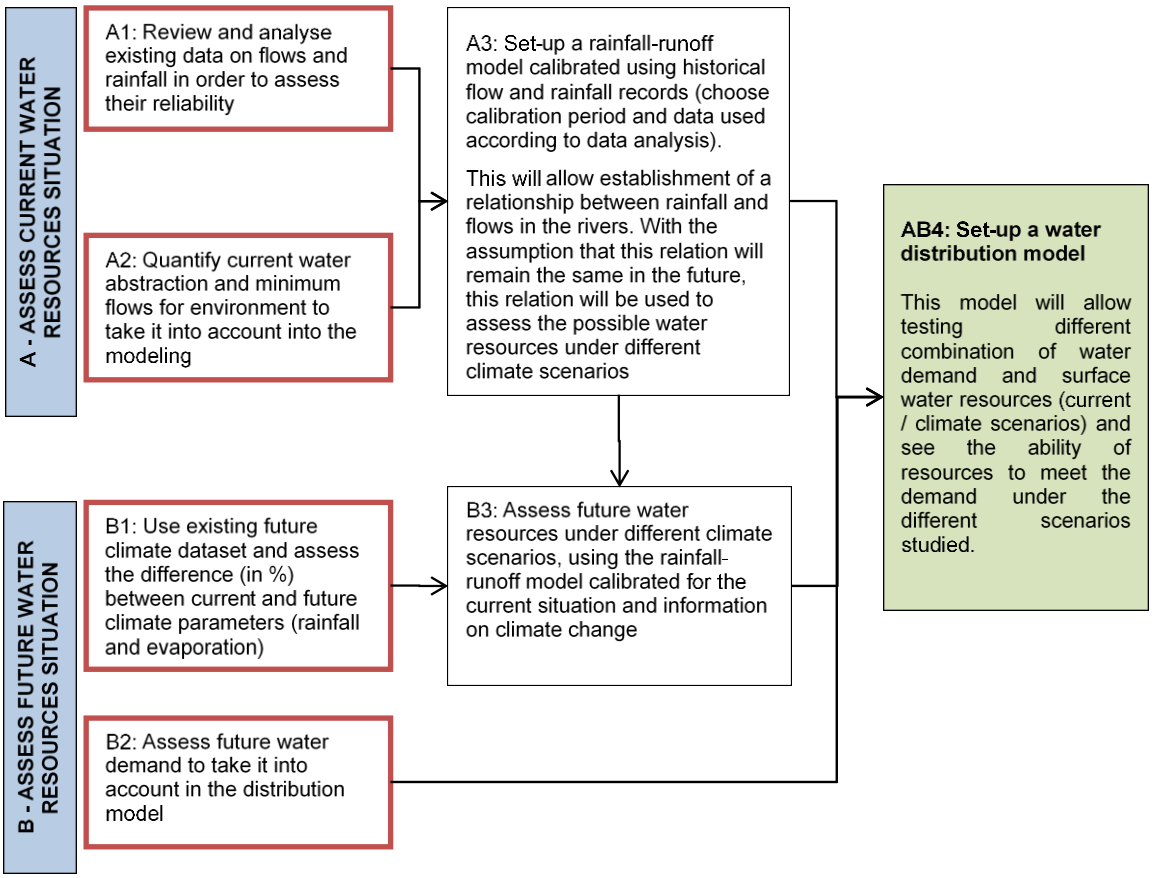
Conclusions on the availability of climate change datasets to be considered for mainstreaming climate change in the CMP guidelines:

The climate change scenarios studied are highly dependent on the data available. Where possible, the selected scenario should allow testing the sensitivity to the main hypothesis of climate change modelling, in particular include different greenhouse gases emission scenarios, and different global circulation models. Testing different downscaling methods can be difficult, as the downscaling is often the steps which limit the availability of data for a certain location.

International user-friendly climate data bases have been developing during the past few years. In particular, the Climate change knowledge Portal (http://sdwebx.worldbank.org/climateportal/index), an initiative from the World Bank, is a central hub of information, data and reports about climate change around the world. It provides easy access to climate change downscaled data series, for any location in the world, for different greenhouse gases emission scenarios (at the moment scenarios of the 4th IPCC assessment), and different GCM. (See http://climatewizard.ciat.cgiar.org/)

METHODOLOGY FOR MODELLING THE IMPACTS OF CLIMATE CHANGE ON WATER RESOURCES

The sketch below summarizes the main steps of the methodology applied in the study.



Main steps of the methodology applied in the study on current and future potential waterresources, under different climate scenarios for the Mpanga River catchment (adapted from BRLi, 2015)

B: Sector-specific priorities as per Uganda National Climate Change Policy

The sector-specific priorities for the water-related sectors, as presented in the Uganda National Climate Change Policy (see Section 4.2.1) are provided in this annex by way of extracts.

AGRICULTURE AND LIVESTOCK

Sectoral Context and Challenges

- Uganda depends largely on rain-fed agriculture, making rural livelihoods and food security highly vulnerable to the consequences of climate change and variability
- Climate change in Uganda is expected to severely influence the variability of rainfall and to cause increases in temperature and the potential for evapotranspiration
- Predicted increases in aridity, and hence droughts, will in turn influence agricultural production
- These impacts will negatively affect food availability and supply, therefore impacting food security
- There are currently a number of initiatives to mainstream climate change agricultural policy and practices, including sustainable land management
- Uganda is developing a National Agricultural Policy (NAP), whose major focus is on food security, increased household incomes, improved value chains, increased domestic and international trade, and improved sustainable natural resource management. The food and nutrition policy is intended to ensure that the entire food chain, from production to consumption, is efficiently managed within the overall development strategy, through building capacities at all levels for adequate action to improve household food security. Uganda's agricultural policy is also shaped by the Ministry of Agriculture, Animal Industry and Fisheries' (MAAIF's) Development Strategy and Investment Plan (DSIP) 2010/11–2014/15, whose major goal is agriculture for food and income security. The DSIP renews recognition of the fundamental importance of agriculture to the Ugandan economy and of the central role it has to play in development, economic growth and poverty reduction. The bulk of activities to adapt to climate change in the agricultural sector centres on capacity building

Policy Response

To address these challenges, the GoU will pursue the following policy priorities, building on efforts underway in the Ministry of Agriculture, Animal Industry and Fisheries:

- To promote climate change adaptation strategies that enhance resilient, productive and sustainable agricultural systems
- To promote value addition and improve food storage and management systems in order to ensure food security at all times, as a factor of resilience

Specific strategies for tackling these sectoral policy priorities will include the following:

- Promote and encourage highly adaptive and productive crop varieties and cultivars in drought- prone, flood-prone and rain-fed crop farming systems
- Promote and encourage highly adaptive and productive livestock breeds in communities and commercial areas
- Promote and encourage conservation agriculture and ecologically compatible cropping systems
- Promote sustainable management of rangelands and pastures through integrated rangeland management to avoid land degradation and deforestation

- Promote irrigated agriculture by developing irrigation schemes using sustainable and cost-effective water sources and by encouraging more efficient water use by irrigation production systems
- Promote and encourage increased agricultural production and diversification and improved post-harvest handling, storage and value addition in order to improve food security and increase household incomes
- Support Community-based adaptation strategies through stretched extension services and improved systems for conveying timely climate information to rural populations to enhance the resilience of agricultural systems to the impacts of climate change
- Develop innovative insurance schemes (low-premium micro-insurance policies) and low-interest credit facilities to insure farmers against crop failure due to droughts, pests, floods and other weather-related events
- Promote and encourage indigenous knowledge, along with research and dissemination of innovations that can enhance climate-smart agriculture and food preservation

FISHERIES AND AQUACULTURE

Sectoral Context and Challenges

- Uganda's lakes and rivers are a repository of aquatic resources, which support fisheries
  - Aquatic ecosystems are threatened by resource overexploitation, transformation and degradation of habitat, pollution, and now, climate change
  - Fish catches and fish stocks are declining, mainly due to over-fishing
  - With climate change, reduction in water levels will lead to decline in fish stocks and other aquatic resources. To reverse the decline of the fishing industry, interventions are urgently required to stop illegal activities and to exploit existing opportunities
- Uganda's 2004 National Fisheries Policy recognises the need to develop fisheries in a socially and environmentally sustainable manner and emphasises the protection of aquatic ecosystems to meet the needs of current and future generations. The policy provides guidance on the development of flexible systems of managing, utilising and conserving the country's fisheries
- Under the MAAIF's DSIP, the government focuses on strengthening controls of illegal fishing, promoting and supporting aquaculture and cage farming—especially of tilapia (currently at negligible levels but with clear potential for export to neighbouring countries), and stocking small water bodies, including dams. Emphasis will also be placed on ensuring fish quality at all levels. These focuses need to be further strengthened by the climate change policy

Policy Response

To address these challenges, the GoU will pursue the following priority:

- To strengthen efforts to promote integrated fisheries resource management and improve aquaculture in order to ensure sustainable fisheries production

Specific strategies for tackling these sectoral policy priorities will include the following:

- Promote and encourage the adaptive management of fishing capacity based on climate and environmental forecasts, to protect against extreme events
- Promote sustainable fish farming as a means of economic diversification and to reduce over-fishing in natural water bodies
- Promote and encourage collaborative and participatory management of aquatic ecosystems

- Promote awareness of the climate change–related impacts on fisheries amongst the various stakeholders, such as local communities, resource managers and policy makers
- Provide economic incentives to diversify livelihood options in order to reduce dependence on climate-sensitive fisheries resources
- Promote biological engineering and restoration of stress-tolerant organisms
- Improve and strengthen trans-boundary cooperation regarding fisheries and aquatic ecosystems

TRANSPORT AND WORKS

Sectoral Context and Challenges

- Uganda's transport systems and other infrastructure continue to be built without taking predicted climate change patterns into account
- Climate-related hazards and predicted impacts of climate change threaten vital transport infrastructure such as roads, bridges and rail networks
- The economic cost of the impacts of climate change on infrastructure damage, repairs and reconstructions, though difficult to estimate, is very high.
- Uganda's transport policy aims to promote cheaper, more efficient and more reliable transport services as a means of providing effective support to increased agricultural and industrial production, trade, tourism, and social and administrative services. For all transport projects, Environmental Impact Assessments (EIAs) are prepared in accordance with the Ugandan Guidelines and the latest international standards and environmental criteria, and submitted to the National Environment Management Authority (NEMA) for approval. Although not much has been done to integrate climate change in transport policy, the Ministry of Works and Transport (MoWT) is currently developing a Climate Change Risk Management Strategy for the transport sector

Policy Response

To address these challenges, the GoU will pursue the following priority:

- To strengthen efforts to promote integrated fisheries resource management and improve aquaculture in order to ensure sustainable fisheries production

Specific strategies for tackling these sectoral policy priorities will include the following:

- Integrate climate change into the existing infrastructure risk assessment guidelines and methodology
- Building on work already underway, establish and enforce climate change–resilient standards for transport and infrastructure planning and development through monitoring and reporting systems
- Encourage the integration of climate change into transport and infrastructure development strategies
- Promote and encourage water catchment protection in transport infrastructure development and maintenance
- Climate-proof existing and future infrastructure by conducting geotechnical site investigations (GSIs) to determine whether areas are appropriate or inappropriate for infrastructural development

FORESTRY

Sectoral Context and Challenges

- Uganda is endowed with abundant forest resources, which contribute significantly to environmental sustainability, the economy, community livelihoods and carbon sequestration
- Uganda forestry policy (the 2001 National Forestry Policy and the 2001 National Forestry and Tree Planting Act) makes reference to climate change issues on the commercial forest plantation, forest products processing industries, collaborative forest management, farm forest conservation of forest biodiversity, watershed management, soil conservation and urban forest
- However, the country's forest cover is disappearing at an alarming rate. Major causes of deforestation include clearing for settlements and agriculture, overgrazing, wildfires, charcoal burning, over-exploitation of wood resources for commercial purposes.
- Climate change and intensified land use will exacerbate degradation and desertification, as tree mortality increases with reduced rainfall and the incidences of pest, diseases and forest fires rise
- This will increase the rate of interventions needed in this sector to ensure sustainable forest management

Policy Response

To address these challenges, the GoU will pursue the following priority:

- To ensure the sustainable management of forestry resources so that they can continue to provide global services, including mitigating climate change, while supporting the sustainable development needs of communities and the country

Specific strategies for tackling these sectoral policy priorities will include the following:

- Strengthen the existing national forestry policy to prevent forest degradation.
- Promote intensified and sustained afforestation and reforestation programmes implemented by the government, institutions, households and individuals, the private sector, civil society and multilateral organisations
- Promote alternative energy sources, energy conservation initiatives and efficient biomass energy production and utilisation technologies to reduce biomass consumption
- Encourage agro-forestry, which will enable poor rural households to meet their subsistence and energy needs
- Strengthen existing forestry research and encourage conservation and restoration of forest ecosystems critically threatened by climate change

WETLANDS

Sectoral Context and Challenges

- Uganda is endowed with wetland resources that contribute significantly to environmental sustainability, community livelihoods and carbon sequestration
- The Uganda government has put in place legislation to manage all its natural resources, including wetlands. The Wetland Policy is in line with efforts to address climate change, as it aims to establish principles by which wetland resources can be optimally used now and in the future, to end practices that reduce wetland productivity, to maintain the biological diversity of natural or semi-natural wetlands and to maintain wetland functions and values
- However, the country's wetlands are disappearing at an alarming rate. In 1964, the total area

of wetlands was estimated at 32,000 km2 but by 1999, it had decreased to 30,000 km2, about 13% of the total area of Uganda. As of 2005, the wetland cover had been further reduced to 26,308 km2, only 11% of the total land area

- Major drivers of wetland degradation include draining of wetlands for agriculture, urban and industrial expansion, over-harvesting of wetland resources (mainly for construction and handicraft), over-fishing and poor use of wetland catchments leading to siltation of wetlands and rivers
- Climate change and intensified land use will exacerbate wetland degradation, as wetlands will be encroached upon further for farming, and the incidence of wetland fires is likely to rise
- This will increase the rate of interventions needed in this sector to ensure sustainable wetland conservation and restoration

Policy Response

To address these challenges, the GoU will pursue the following priority:

- To promote long-term wetland conservation and restoration of degraded wetlands so that they can continue to provide global services, including mitigating climate change, while supporting the sustainable development needs of communities and the country

Specific strategies for tackling these sectoral policy priorities will include the following:

- Strengthen the existing national wetland policy to prevent wetland degradation and encroachment
- Promote and intensify wetland protection and restoration of degraded wetlands
- Strengthen collaborative and participatory management of wetland resources
- Strengthen existing wetland research and encourage conservation and restoration of ecosystems critically threatened by climate change

BIODIVERSITY AND ECOSYSTEM SERVICES

Sectoral Context and Challenges

- The GoU promotes the conservation and sustainable utilisation of the country's biodiversity, as well as the effective management of its ecosystems
- There are currently a number of initiatives in Uganda to mainstream climate change biodiversity and ecosystem management, including sustainable land management
- The government also promotes equitable sharing of the benefits arising thereof for the wellbeing of the nation
- However, with climate change and increasing human pressure, biodiversity and ecosystems are being rapidly degraded

Policy Response

To address these challenges, the GoU will pursue the following priority:

- To effectively address the challenges posed by climate change impacts on biodiversity and ecosystems, so as to ensure ecosystem health and provision of ecosystem services that are crucial to sustainable and resilient development

Specific strategies for tackling these sectoral policy priorities will include the following:

- Identify biodiversity hotspots where only restricted development should be allowed
- Encourage collaborative management and sustainable use of biodiversity and ecosystems
- Promote valuation and payment for ecosystem services, and streamline other ecosystem benefit-sharing schemes

- Ensure that any human activity within the vicinity of protected areas does not compromise the integrity of the ecosystem
- Strengthen the capacity for monitoring the impacts of climate change on biodiversity, ecosystems and ecosystem services

C: Checklist for building Climate Change in the CMP Process

This checklist is aimed at providing those responsible for, or involved in catchment management planning to ensure that they have taken into account all the recommended climate change mainstreaming requirements. In this way resilience to climate change can already be built in at an early stage in the project planning cycle.

Checklist for building Climate Change in the CMP Process

Subject Area		Action for Climate Change Mainstreaming	Check
1. Project preparation		▪ Consult existing (e.g. Uganda Climate Change Policy, 2012) and latest documentation on climate change in Uganda. ▪ Consult Climate Change Department (CCD) website and meet with CCD officials to brief them on the project and obtain their support.	
2. Building the knowledge base (STEP 1 of catchment planning process)			
2.1	Observed Climate Change trend data	▪ Collect all historic climate data that can be obtained for points in and around the catchment. The most important aim is to have long and as unbroken as possible records. Sometimes the best records may lie outside the catchment boundary but may still be useful. Rainfall records are the most important.	
		▪ Collect global historic (observed and patched) data sets for precipitation. (See Annex E of these Catchment Management Planning Guidelines for sources)	
		▪ Carry out data quality checks (mass duration and statistical tests etc.) on observed sets and correlation analysis with global data sets	
2.2	Future climate datasets	▪ Obtain datasets reflecting climate under conditions of future climate change (see Annex E of these Catchment Management Planning Guidelines for sources)	
2.3	Identify future data collection needs	▪ Based on the analysis of collected data and gaps (spatial and temporal), identify data collection needs for the future that should be incorporated into the CMP	
3. Water resources planning analysis (STEP 2.1. of catchment planning process)			
3.1	Generation of "under climate change conditions" hydrology	▪ The approach and methodology is described in Paragraph 40 of these guidelines, with further details provided in Annex C.	
3.2	Water demand/use under climate change conditions	▪ Make estimates on the impact of climate change on project water demands. These estimates should be used in the "with climate change modelling runs". In addition to temperature increase, and likely increases in evapotranspiration. It is worth looking carefully at potential shifts of agro-ecological zones and hence in crop choices. (See Paragraph 63 of these guidelines)	

4. Catchment Stakeholder participation framework (STEP 2.2 of the catchment planning process)			
4.1	Common understanding of the climate change concept	▪ It is important that stakeholders have a good understanding of what climate change is and also of the change that has resulted from anthropogenic pressures on natural resources. These points are underlined in Table 3 (Stakeholder engagement in integrated catchment planning) under Paragraph 67 of the Revised Catchment Management Planning Guidelines	
4.2	Localised action as a part of strategic thinking	▪ Even if the planning process is strategic in nature, it is important that proposed interventions include localised action as a part of the strategic thinking. Micro-level IWRM-based interventions aimed at a sustainable approach to water resources and related natural resources management are essential and the overall plan should include clear strategies aimed taking these initiatives to scale. This is covered in Paragraph 118 of the Revised Catchment Management Planning Guidelines.	

Annex D - Example of the use of a multi- objective evaluation framework

Example of the use of a multi- objective evaluation framework

The table below represents the application of a "Consequence Table" to evaluate alternative scenarios with respect to a set of planning objectives, criteria and measures similar to those shown in Section 2.5.

The DSS is used to determine the value for each measure for each scenario and the resulting value placed in the corresponding cell as shown in the Table. To use the Table, a base case or focus scenario must be chosen. Any scenario may be chosen, and one can easily cycle through the entire set of scenarios one after the other comparing each scenario to all the others. In the Table below Scenario D has been chosen as the Focus Scenario against which all the other scenarios are compared. The underlying model colours the cells for each of the non-focus scenarios according to the scheme shown at the bottom of the Table:

- Red if the value in the cell is significantly worse than the value for the Focus Scenario
- Yellow if the value in the cell is not significantly different than the value for the Focus Scenario, and
- Green if the value in the cell is not significantly different than the value for the Focus Scenario

It is evident from the results shown in the Table that the selected Focus Scenario (D) is superior to all other scenarios in nearly by nearly all measures. The exception is Scenario C.

Scenarios D & C are not significantly different in many respects including agricultural benefits, employment generation, and poverty, public health and food security impact as well as impacts on navigation and biodiversity. They also represent about the same qualities in regard to regional negotiation and political impact (instability). The differences are displayed in the table below:

Results in more of	But less of
▪Fewer resettled people ▪Greater protection of cultural sites Lower financial risk ▪Lower technical risk	▪ Power generation ▪ Flood benefits ▪ Water supply benefits ▪ Watershed management ▪ Greenhouse gases credits ▪ Regional interdependence ▪ Regional trade ▪ Growth pole potential

We can now see that the difference between these two scenarios is that one has less risk (C) while the other (D) has larger economic benefits. The trade-off is thus whether to accept more risk for the extra economic benefits. From the Table, these incremental benefits are, something greater than roughly $2+ billion per year. However, note that C involves one dam, and D 4 dams. This suggests, given the long gestation time of these large infrastructure projects, that the incremental benefits from Scenario D may start coming much later than those from C, in which the present worth of these incremental benefits may be smaller than they appear to be and for some stakeholders, particularly those who are risk averse, this might tip the balance in favour of C.

It is fortunate that in this example the differences between the two most favourable Scenarios involved a relatively simple (though not easy) comparison based on similar sets of objectives. It may not always be the case that the arguments can be expressed in such clear and simple terms. Nevertheless, with such a tool, it is much better and much more transparent to carry out the evaluation with all objectives in view rather than to look at indices constructed by weights where the metric becomes quite abstrac

Focus Scenario--> D (B+4 Dams)

Illustrative Template for **Consequence Table** to Evaluate Scenarios

Type	Criteria	Indicator	Preference (H=Higher is better; L=Lower is Better)	Units	Alternative Scenarios A (Base Case)	B (Low Level Dev)	C (B+1Dam)	D (B+4 Dams)	E (B+Basin2)
Economic	Agriculture	Agricultural benefits	H	billion $/year	4.93	5.50	9.00	11.00	7.00
	Power	Power benefits	H	billion $/year	0.50	0.70	0.98	1.36	0.72
	Flood Protection	Expected flood damages	L	billion $/year	0.30	0.28	0.18	0.05	0.26
	Employment	Total new F/T jobs	H	million # jobs	-	0.30	0.50	0.65	0.31
Social	Low Income Effect	Change in no. people above $1/day	H	million # people	-	0.60	1.00	1.30	0.50
	Public Health	Incidence of water related disease	L	billion DALYs	10.00	10.00	9.00	8.00	10.00
	Resettlement	People relocated	L	thousands# people	-	25.00	26.00	125.00	150.00
	Drinking Water	New people with adequate access to safe water	H	additional million # people	-	2.00	3.00	4.00	2.20
	Food Security	Percent of pop with cereal needs met	H	%	0.75	0.77	0.82	0.90	0.78
	Navigation	Navigable river reaches	H	km-months	25,000	25,000	40,000	50,000	30,000
Environmental	Aquatic/wetland biodiv	Area of aquatic habitat	H	thousand sq km	10.00	9.90	9.90	9.90	4.00
	Watershed management	Area of well managed watershed	H	thousand hectares	20.00	50.00	350.00	500.00	60.00
	Water Quality	Water quality index	H	unitless	0.80	0.75	0.85	0.90	0.75
	Saline water intrusion	Flow to Med Sea	H	bcm	13.00	10.00	13.00	14.00	11.00
	Greenhouse gases	GHG emission offset	H	million tonnes/year	-	0.70	7.50	22.00	2.00
	Cultural sites	Sites impacted	L	# sites	-	-	-	2.00	1.00
Regional/ Implementation	Regional Interdependence	Degree of joint ownership and management	H	scale	1.00	1.00	3.00	4.00	1.00
	Regional Trade	Value of bilateral trade	H	billion $/year	1.00	1.00	1.50	3.00	1.00
	Growth Pole Potential	Number of equivalent centres	H	# equiv centres	-	-	1.00	4.00	0.50
	Negotation Space	Total system losses	L	bcm	40.00	43.00	38.00	36.00	42.00
	Financing Risk	Financing Risk Scale	L	scale	1.00	1.00	3.00	4.00	4.00
	Technical Risk	Technical Complexity Scale	L	scale	1.00	1.00	2.00	3.00	3.00
	Political Instability	Conflict Potential/Instability Scale	L	scale	1.00	1.00	1.00	1.00	3.00

Focus Alternative
Significantly Worse Than Focus Alternative
Not Significantly Different to Focus Alternative
Significantly Better Than Focus Alternative

Annex E- Generic Measures Used for Micro - and Sub- catchment Management

Generic Measures Used for Micro- and Sub- catchment Management

Divert / drain runoff & run-on.	Where there is excess water in humid environments, or at the height of the wet seasons in sub- humid conditions, the soil and ground water can become saturated, or the soil's infiltration capacity can be exceeded. Thus safe discharge of surplus water is necessary. This helps avoid leaching of nutrients, soil erosion, or landslides. It can be achieved through the use of graded terraces, cut-off drains and diversion ditches etc.
Impede runoff (slow down runoff).	Uncontrolled runoff causes erosion - and represents a net loss of moisture to plants where rainfall limits. The strategy here is to slow runoff, allowing more time for the water to infiltrate into the soil and reducing the damaging impact of runoff through soil erosion. It is applicable to all climates. This can be accomplished through the use of vegetative strips, earth and stone bunds, terraces etc.
Retain runoff (avoid runoff).	In situations where rainfall limits plant growth, the strategy is to avoid any movement of water on the land in order to encourage rainfall infiltration. Thus water storage is improved within the rooting depth of plants, and groundwater tables are recharged. This is crucial in sub-humid to semi-arid areas. The technologies involved are cross-slope barriers, mulching, vegetative cover, minimum / no tillage etc.
Trap runoff (harvest runoff).	Harvesting runoff water is appropriate where rainfall is insufficient and runoff needs to be concentrated to improve plant performance. Planting pits, half moons etc. can be used. This can also be applied in environments with excess water during wet seasons, followed by water shortage: dams and ponds can further be used for irrigation, flood control or even hydropower generation.
Reduce soil evaporation loss.	Water loss from the soil surface can be reduced through soil cover by mulch and vegetation, windbreaks, shade etc. This is mainly appropriate in drier conditions where evaporation losses can be more than half of the rainfall.
Increased water use efficiency	In conveying and distributing irrigation water as well as applying it in the field. Conveyance and distribution can be improved through well maintained, lined canals and piping systems – and above all avoiding leakages. In the field, reducing evaporation losses can be achieved by using low pressure sprinkler irrigation during the night or early morning, and avoiding irrigation when windy. Additionally, deep seepage of water beyond rooting depth needs to be avoided.
Spread of limited irrigation water over a larger area	Not fully satisfying the crop water requirements i.e. deficit irrigation. It allows achieving considerably higher total crop yields and water use efficiency compared to using water for full irrigation on a smaller area.
Supplementary irrigation	Complement the lack of rain during periods of water deficits, at water-stress sensitivity stages in plant growth. Supplementary irrigation is a key strategy, still underused, for unlocking rainfed yield potential and water productivity / water use efficiency
Water harvesting and improved water storage	Provide for irrigation during times of surplus and using the water for (supplementary) irrigation during times of water stress. Small dams and other storage facilities, which are combined with community level water management, need to be explored as alternatives to large-scale irrigation projects.
Integrated irrigation management	Focus on a broader set of dimensions of irrigated agriculture such as including sustainability. For example, coordinated water management, maximized economic and social welfare, assured equitable access to water and water services, without compromising the sustainability of ecosystems
Improved fallow- systems	The deliberate planting of fast-growing species - usually leguminous - into a fallow for rapid replenishment of soil fertility. These can range from forest to bush, savannas, grass and legume fallows. There are numerous cases showing the importance of nutrient fixing plants planted either in sequence, intercropped or in rotation.

Residue management	A practice that ideally leaves 30 percent or more of the soil surface covered with crop residues after harvest. It requires residue from the previous crop as the main resource (thus burning is discouraged) – it also helps reducing erosion, improving water infiltration and therefore moisture conservation. There are positive impacts also on soil structure and surface water quality.

Application of improved compost and manure	Compost (mainly from plant residues) and manure (from domestic livestock) help to close the nutrient cycle by ensuring that these do not become losses to the system. By building up soil organic material, they help maintain soil structure and health, as well as fertility. Furthermore they are within the reach of the poorest farmers.
Tapping nutrients	This takes place through the roots of trees and other perennial plants when mixed with annual crops (e.g. in agro-forestry systems). Trees act as nutrient pumps: that is they take up nutrients from the deep subsoil below the rooting depth of annual crops and return them to the topsoil in the form of mulch and litter. This enhances the availability of nutrients for annual crops.
Application of inorganic fertilizer	Without a combination of organic matter application and inorganic fertilizer, soil fertility is unlikely to meet production demands: thus the concept of 'Integrated Soil Fertility Management' should be supported. It is possible to substantially increase millet and sorghum yields and profitability by using micro-doses of inorganic fertilizer in combination with techniques that conserve and concentrate soil moisture and organic matter.
Minimum soil disturbance	Manage systems with minimum soil disturbance such as reduced or zero tillage systems leave more biological surface residues, provide environments for enhanced soil biotic activity, and maintain more interconnected pores and better soil aggregates, which are able to withstand raindrop impact (and thus reduce splash erosion). Water can infiltrate more readily and rapidly into the soil with reduced tillage, and this also helps protect the soil from erosion. In addition, organic matter decomposes less rapidly under these systems. Carbon dioxide emissions are thus reduced. No tillage has proven especially useful for maintaining and increasing soil organic matter.

Annex F - Generic Source Protection Measures

Generic Source Protection Measures

Water quality- biological	▪ Ability to close intakes (time of travel information) if pollution or flood event occurs, or is predicted ▪ CLTS Programme to improve sanitation in catchment and reduced open defecation. ▪ Long detention times in reservoirs to allow for natural treatment. ▪ Long detention times in reservoirs to allow for natural treatment. ▪ Regular catchment patrols ▪ Research program to determine types of pathogens present in wild and domesticated animals ▪ Routine plankton monitoring for all reservoirs. ▪ Signage and education ▪ Stock fencing ▪ Stormwater detention measures: overflow detention ponds, swales, improved soil water retention. ▪ Sustainable drainage systems ▪ Water Protection Zone (Exclude public access to land within supply catchment)
Water quality – chemical	▪ Ability to close intakes (time of travel information) if pollution or flood event occurs, or is predicted ▪ Capacity building of farmers on agricultural chemical use and slurry spreading
Water quality - physical	▪ Ability to close intakes (time of travel information) if pollution or flood event occurs, or is predicted ▪ Ensure intake is set at an appropriate depth by changing depth setting ('floating intake'). ▪ Fire management and protection procedures. Bushfire management policy ▪ Reforestation with native species ▪ Regular catchment patrols ▪ Regular cleaning of area close to intake. ▪ Regular cleaning of screens to reduce clogging and maintain pumping rate ▪ Water Protection Zone (Exclude public access to land within supply catchment)
Water quantity – water flow or level	▪ Eradicate *Eucalyptus* from the sensitive locations in the catchment ▪ Sustainable drainage systems

Annex G- Typical Investment Option

Typical Investment Options

Indicative Catchment Plan Investment Options Typically Considered in Integrated Catchment action plans		
Option	**Description**	**Indicators**
Valley Tanks	Small water storages used primarily for livestock, groundwater recharge for drinking water and limited irrigation (kitchen gardens)	Volume of water stored (m^3) Estimated livestock served Ha of land irrigated
Dam & reservoir	Generally small dams with limited water storage, but larger than traditional valley tanks able to support a wider range of uses and provide more water in the dry season; possible purposes include water for agriculture, urban and industrial water supply, energy production (micro-hydro, and possibly flood risk reduction.	
Rainwater harvesting (off-farm)	Small dams, ponds and tanks that harvest rainwater runoff used for small scale (decentralized) irrigation, fisheries, and flood management	
Gravity diversion of water (from river or water body) for bulk water supply for multiple purposes (agriculture, drinking, industry, etc.)	Generally low weirs used to divert water bulk water supply) into farmer (group) constructed canals and distribution ditches. These are developed in collaboration with District extension and agriculture development officers who are responsible for agriculture development.	Ha of land Volume of water delivered (m^3)
Pump delivery of water for bulk supply for multiple purposes (agriculture, drinking, industry, etc.)	Pump delivery of bulk irrigation water supplies by as above; includes treadle or similar pumps (shallow groundwater) or small pumps (dug wells, water bodies)	
Water saving irrigation technology	Introduction of low pressure pipe water distribution especially for horticulture or cash crops where water shortages can reduce yields and reduce returns; also introduction of small scale drip (especially for orchard crops) and sprinkler irrigation on a selected basis with private sector participation	
Mini- & micro-hydropower		KWh of energy generated
Solar power for pumps, mills and other village prime mover needs; refrigeration (fisheries)		
New or increased village or settlement drinking water supply (GW)		m^3 per year Number of people provided with access to improved water sources and sanitation serves and hours per day of increased sevice delivery
New or improved (reliability, volume) bulk water supply for towns or cities		
Protection of village, town and urban water sources		
Flood risk management and preparedness	Flood proofing, measures flood warning and communications, relocation of activities from flood risk zones	Ha of land with reduced flood risk or protected
Drain and waterway improvements	Reconstruction and stabilization of degraded waterways	Ha of land (e.g. forested, area of increased groundwater levels, area sustainably managed or improved)
River bank stabilization	A combination of revetments (stone, gabions) and vegetative planting (trees, shrubs) to stabilize degrading river banks	
Contour bunds	Small raised bunds aligned with the contour to slow or stop surface runoff of rainfall and stop erosion of top soil	
Gulley control	Systems of small structures to stop small stream and gully formation and progressive erosion	
Check dams to manage hill torrents		
Reforestation and afforestation	Tree planting to re-establish forest cover, reduce soil exposure to erosion, reduce runoff rates and increase groundwater recharge	
Wetland restoration	Restoration and improvement of environmental services	

Annex H - Example of Logical Framework and Project management framework for Monitoring and Evaluation

Example of a logical framework taken from the Baro-Akobo-Sobat Integrated Water Resources development and Management Plan (BRLi, 2017)

Achievement of the vision for the basin "A sustainably managed and developed BAS river sub-basin with prosperous, connected, peacefully and mutually co-existing societies."

Strategic objective 1: to contribute to food security, livelihood enhancement, poverty reduction and the protection and conservation of biological resources through stakeholder-driven management of wetlands, watersheds and other important natural resources

Medium-term outcome	**Indicators**	**Assumptions and risks**
Poverty is reduced at the local level, with wider impacts following taking to scale	- Average daily income of subsistence/small-holder farmers **(USD/day)** - Undernourished people **(% of children and adults)** - Attendance of children at school **(% with gender disaggregation)**	- Availability of resources (human and financial) - Political stability - Support from government structures and transboundary cooperation
Biological resources (biodiversity and eco services) are protected and conserved at the local level;	- Number of livelihood-based watershed management projects & wetlands protection projects implemented within the sub-basin **(Number of projects)** - Increase in forest surface area in the basin **(ha/annum)** - Increase in wetlands surface area in the basin **(ha/annum)** - Compliance of development projects with Environmental and Social safeguards **(% of projects compliant)**	- Availability of resources (human and financial) - Political stability - Support from government structures and transboundary cooperation
Project planning, implementation, operation and management is led by stakeholders / beneficiaries	- Level of stakeholders and beneficiaries' involvement into projects planning, implementation, operation and management **(qualitative assessment using standardised questionnaire)** - Number (and %) of projects successfully implemented **(number of projects)** - Extent of gender mainstreaming into project planning **(Number of initiatives led by women)**	- Availability of resources (human and financial) - Political stability - Support from government structures and transboundary cooperation

Strategic objective 2: Taking into account the comparative advantages of the different parts of the sub-basin to sustainably develop water resources for hydropower, irrigation, water supply and sanitation and other sectors with the dual aims of reducing poverty within the sub-basin and generating revenue;

Medium-term outcome	**Indicators**	**Assumptions and risks**
Large-scale hydropower developed and affordable electricity supplied within the basin and at the national levels	- Hydropower production within the basin and at national level **(GWHrs/annum)** - Population with access to electricity **(% in rural and urban areas, disaggregated by administrative area)**	- Availability of resources (human and financial) - Political stability - Support from government structures and transboundary cooperation
Large-scale irrigation developed and contributing to both food self-sufficiency within the basin and revenue generation	- Large scale irrigation schemes under cultivation in the basin **(ha of land irrigated)** - Share of the production for local consumption and revenue generation **(% for local consumption and % for revenue generation)** - Number of local people employed in large scale irrigation schemes **(Number of people, disaggregated by administrative area)**	- Availability of resources (human and financial) - Political stability - Support from government structures and transboundary cooperation

Example of a Project Management Framework (MPMF) taken from the Baro-Akobo-Sobat Integrated Water Resources Development and Management Plan (BRLi, 2017)

Achievement of the vision for the basin "A sustainably managed and developed BAS river sub-basin with prosperous, connected, peacefully and mutually co-existing societies."

Strategic objective 1: to contribute to food security, livelihood enhancement, poverty reduction and the protection and conservation of biological resources through stakeholder-driven management of wetlands, watersheds and other important natural resources

Medium-term outcome	Indicators	Data source	Data collection methodology	Frequency of data collection	Respon-sibility	Baseline information	Target (25 years - year 2042)	Uses of information
Poverty is reduced at the local level, with wider impacts following taking to scale	Average daily income of small-holder farmers (USD/day) Undernourished people (% of children and adults) Attendance of children to school (% with gender disaggregation)	- Central Statistic Agency of Ethiopia - South Sudan National Bureau of Statistics -Administrative units: Zones, Woredas, Kebeles (Ethiopia); Counties, Bomas, Payams (South Sudan) - Implementing Agencies* ** "Implementing Agencies" refers to the organisations implementing development projects in the sub-basin.*	- Document review - Data collection - Consultation of the implementing agencies - National census	Annually less frequently for national census (5-10 years)	ENTRO	To be established during the implementation of the ST and MT/LT projects for the smallest unit of analysis available for each project.	100% greater improvement than average of no-project areas or average for the Zone/County	- Assess the relevance of the projects - Reframe the projects if necessary: adaptive management to keep the projects on track to reach the desired outcomes
Biological resources (biodiversity and eco services) are protected and conserved at the local level	Number of livelihood based watershed management projects & wetlands protection projects implemented within the sub-basin (Number of projects)	- Ministry of Water, Irrigation and Electricity (Ethiopia) - Ministry of Electricity, Dams, Irrigation and Water Resources (South Sudan) - Ethiopian Environmental Protection Authority - Ministry of Environment (South Sudan) - ENTRO	- Document review - Data collection - Consultation of the Ministries	Annually	ENTRO	No baseline information	No target	Assess the adequacy between the needs in the sub-basin and the projects implemented
	Increase in the forest surface area in the project area (ha/annum)	-Administrative units: Zones, Woreda, Kebeles (Ethiopia); counties, Bomas, Payams (South Sudan) - Implementing Agencies	- Document review - Data collection - Consultation of the implementing agencies	Annually	ENTRO	Ha of forest in the project area: to be established during the implementation of the ST, MT/LT projects for the smallest unit of analysis available for each project.	> 0%	Reframe the projects if necessary: adaptive management to make sure that there are no further losses of forests in the selected areas