Member of the Surbana Jurong Group

PREPARATION of CATCHMENT MANAGEMENT PLANS in the WATERSHED AREAS of WADELAI, TOCHI, MUBUKU II, DOHO II and NGENGE IRRIGATION SCHEMES

CATCHMENT MANAGEMENT PLAN for TOCHI IRRIGATION SCHEME - DRAFT

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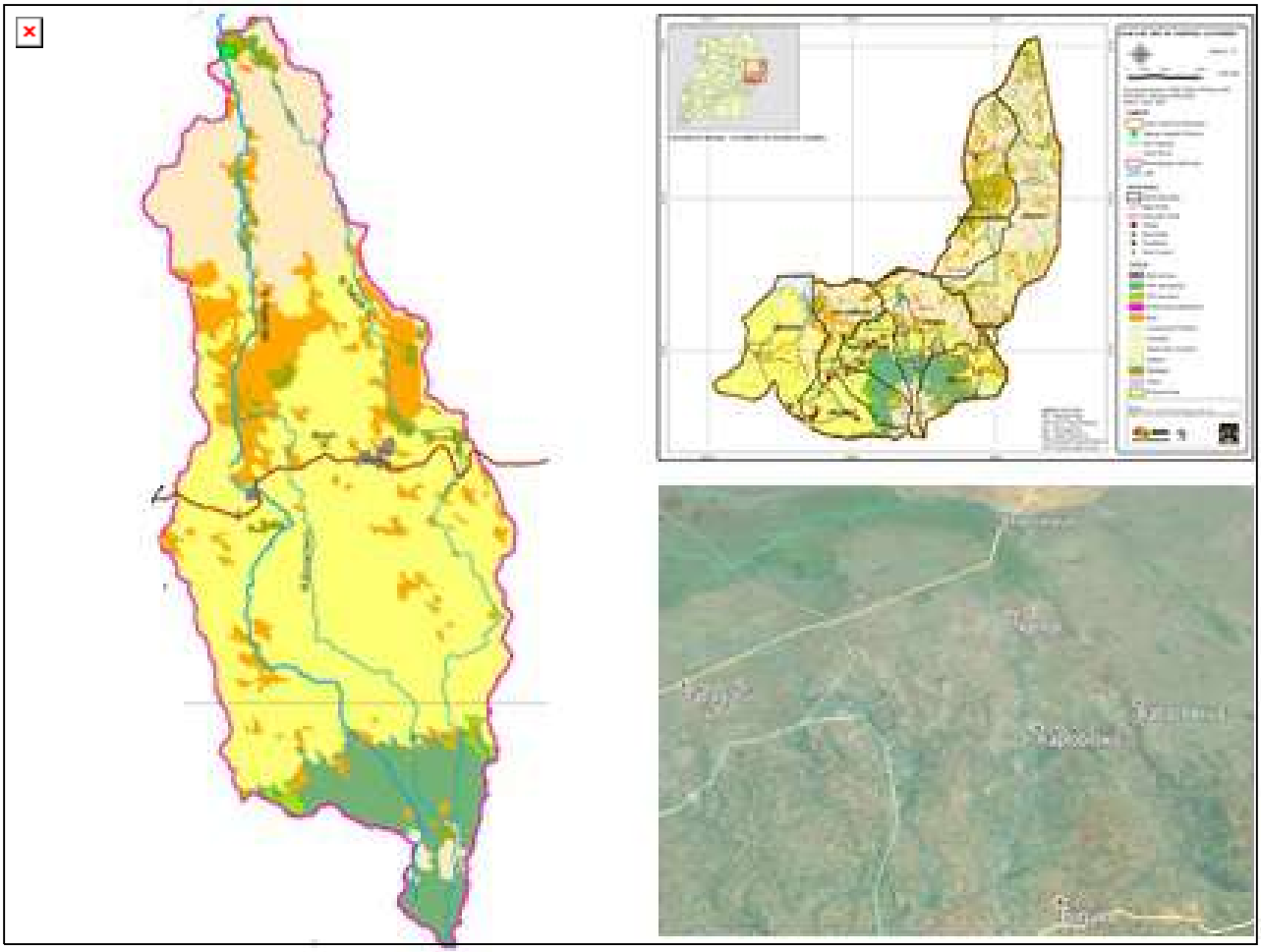

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Table of Contents

Tables

Figures

Appendices

Tables of Appendices

Figures of Appendices

SUMMARY

This report covers the Catchment Management Plan for the Tochi irrigation scheme (CMP or Plan). The scheme is located in the northern part of Uganda. The surrounding catchment is part of the Victoria Nile river basin under the Albert Water Management Zone of MoWE and located within the Oyam, Omoro, Nwoya, Kole, Gulu and Amuru Districts.

Background

The Government of Uganda with support from the Nordic Development Fund, through the Forestry Sector Support Department under the Ministry of Water and Environment, is currently implementing the Farm Income Enhancement and Forest Conservation Programme - Project 2 (FIEFOC-2) which is designed to improve farm incomes, rural livelihoods, food security and climate resilience, sustainable Natural Resources management and agricultural enterprise development. The Programme represents an investment of approximately USD 82 million over a five years Project Period (2016 - 2021) in an integrated development of five new, small and medium scale agricultural irrigation schemes in the Pakwach, Oyam, Kasese, Butaleja and Kween Districts.

FIEFOC-2 aims at building on the achievements of the first phase of the program, FIEFOC-1, which was implemented between 2006 and 2012 with the rehabilitation of existing irrigation schemes.

The programme is implemented through three components:

- Component 1 - Agricultural Infrastructural Development;
- Component 2 - Agribusiness Development;
- Component 3 - Integrated Natural Resources Development and Management.

One of the activities under Component 3 is the preparation of a Catchment Management Plan for the surrounding watershed of the new Tochi irrigation scheme (still under construction by FIEFOC-2 at time of CMP completion). For this task the consultancy firm SMEC Uganda Ltd was commissioned the assignment in March 2018 to preparing the CMP.

The Tochi catchment is environmentally heavily degraded and the focus of the CMP is therefore on environmental protection of the catchment, in general and on the protection of the scheme against sedimentation and floods, in specific.

Within the broader context of National and District strategies and plans[1], and based on the environmental and socio-economic assessments that were carried out under the assignment, site specific strategies and action points were drafted. This has resulted in the identification, prioritization, costing and scheduling of a number of catchment protection works and activities for implementation during the short (2020), medium (2025) and long term (2040).

The implementation of the Plan will sooner or later lead to improved management of the catchment and, as a result, to achieving the overall objective of FIEFOC-2, i.e. improved farm incomes, rural livelihoods and sustainable Natural Resources management in the area.

[1] National Sector Development Plans 2015/16-2019/20 of MoWE, MoAAIF and MoEMD; District Development Plans of Districts located within the Tochi catchment, i.e. Oyam, Nwoya, Kole, Gulu and Amuru.

The draft Plan (this report) was developed in the period April 2018 up to date of completion. The final version of the Plan will be discussed and agreed upon during the last round of stakeholder consultations which are planned for November 2018, to be followed by finalizing the Plan with comments from the stakeholders addressed.

The Plan

The development of the CMP was guided by four principles:

1) CMP process follows the Guidelines for Catchment Based Water Resources Planning for Uganda, MoWE, revision 2016 (the Guidelines);
2) CMP has been developed within the context of the Water Management Zoning set-up of MoWE, and National and District strategies / plans;
3) CMP has been developed taken into account the consultations and feedback from the stakeholders at different levels throughout the planning process (National, Regional, and Local level Government; Catchment Management Organizations under the Albert WMZ and other CMOs / Groups / Forums); and
4) CMP is partly based on information gathered, processed and recorded in a number of key reports that have preceded this CMP. These are:
    a) Stakeholder Engagement report - Final of 10 September 2018, two Volumes;
    b) Natural Resources Assessment report - Final of 14 September 2018, three volumes;
    c) Strategic Social and Environmental Assessment report - Final of 20 September 2018;
    d) Report on Evaluation of Options - Draft of 10 October 2018.

The CMP's methodology applied comprises of the following elements:

- Description of study area;
- Policy, strategy and legislative framework related to catchment planning;
- Institutional setting of institutions that have a stake in the Tochi catchment planning and management;
- Knowledge Base based on the catchment's situation analysis of physical, social-economical and environmental features, GIS data/maps and analytical tools;
- Outcomes of Water Balance study based on the hydrological and water allocation modelling for the catchment with estimated current/ future (projected) water demands for the different water use sectors (including Climate Change scenarios);
- Strategic Planning Framework with overall objective, issues/challenges, planning strategies and action points;
- Summary of proposed Catchment Protection Works;
- Outcomes of the Multi-Criteria, Economic Viability and Sensitivity analyses for the investment options;
- Implementing plan for the prioritized investment options;
- Environmental and Social Management Plan for monitoring the implementation of the investments.

The environmental and social challenges of the Tochi catchment are related to deforestation, soil erosion, river bank cultivation, wetland encroachment and floods, drought and effects of Climate Change (environmental challenges) as well as poor farming methods, bush burning, high population pressure on land, land tenure, education, gender and some cultural practises (social challenges).

The outcomes of the Multi-Criteria and Economic Viability analyses reveal that the highest priority for the works is assigned to:

1) Soil and Water Conservation;
2) Stabilisation of River banks with Vegetation;
3) Agro-Forestry.

The implementation plan is designed for implementing the works along three planning horizons, i.e. short term (by 2020), medium term (by 2025) and long term (by 2040) with costing, indication of lead and supporting agencies in implementation as well as funding sources.

Highest costs of 24.2 million USD occur in the first year (mainly investment) to be followed by 4.7-6.8 million USD annually on operational costs for the next 20 years or so to come.

Implementation Plan for the Investments on Environmental Protection of the Tochi catchment

Investment Options for Tochi	Implem en-tation Priority	Ranking			Period taken for Impact to start	Funding Option	Implementing Agency		Funding Requirements for Investment and Operational Costs (USD '000)		
		MCA ranking	Economic Benefit ranking (EIRR)	MCA, EIRR combined ranking			Lead	Support	Short term (0-2 yrs; 2019-2021)	Medium term (3-7 yrs; 2022-2026)	Long term (8+ yrs; 2027 >)
Soil and Water Conservation	high	high	high	high - high	Medium term	Consolidated Gov Funds / Loan	farmers	FSSD, DLG (Oyam, Omoro, Nwoya, Kole, Gulu, Amuru)	3,039	4,134	11,763
Stabilisation of River Banks with vegetation	medium to high	high	medium	high - medium	Medium term	Consolidated Gov Funds / Loan	DLG (Oyam, Omoro, Nwoya, Kole, Gulu, Amuru)	Catchment Mng Committees	1,238	280	790
Agro-Forestry	medium to high	medium	high	medium - high	Long term	Consolidated Gov Funds / Loan	DLG (Oyam, Omoro, Nwoya, Kole, Gulu, Amuru)	farmers, NGOs, CBOs	2,114	1,654	4,705
Civil Works	medium	high	low	high - low	Short term	Consolidated Gov Funds / Loan	FSSD	DLG (Oyam, Omoro, Nwoya, Kole, Gulu, Amuru) , MoWE, MoWT	2,107	965	2,745
Woodlot Establishment	medium	medium	medium	medium - medium	Long term	Private Investor / PPP	farmers	FSSD, NFA, DLG (Oyam, Omoro, Nwoya, Kole, Gulu, Amuru)	23,945	18,505	47,720
Replanting of Trees in CFRs, LFRs	medium	medium	medium	medium - medium	Long term	Consolidated Gov Funds / Loan	NFA		1,133	875	2,256
Restoration and Enrichment Planting	low	medium	low	medium - low	Long term	Consolidated Gov Funds / Loan	NFA		265	50	141
Buffer Zone Demarcation and Protection	low	low	medium	low - medium	Short term	Consolidated Gov Funds / Loan	DLG (Oyam, Omoro, Nwoya, Kole, Gulu, Amuru)	Catchment Mng Committees	133	107	276

ABBREVIATIONS

AfDB	African Development Bank
ASSP	Agriculture Sector Strategic Plan
BAT	British American Tobacco
CAO	Chief Administrative Officer
CBO	Community Based Organization
CBD	Convention on Biological Diversity
CBR	Cost-Benefit Ratio
CF	Community Forest
CFR	Central Forest Reserve
CIDA	Canadian International Development Agency
CMC	Catchment Management Committee
CMO	Catchment Management Organization
CMP	Catchment Management Plan
CTC	Catchment Technical Committee
DEM	Digital Elevation Model
DEO	District Environmental Officer
DFS	District Forestry Services
DFO	District Forestry Officer
DLG	District Local Government
DNRO	District Natural Resources Officer
DoEA	Directorate of Environmental Affairs
DoWMD	Directorate of Water Management Development
DoWRM	Directorate of Water Resources Management
DPO	District Production Officer
EC	European Commission
EIA	Environmental Impact Assessment
ENPV	Economic Net Present Value
ENPV/C	Economic Net Present Value by Investment Cost Ratio
ERR	Economic Rate of Return
ERT	Energy for Rural Transformation
EVA	Economic Viability Analysis
FAO	Food and Agriculture Organization of the United Nations
FMA	Forest Management Area
FIEFOC-1	Farm Income Enhancement and Forestry Conservation Program I
FIEFOC-2	Farm Income Enhancement and Forestry Conservation Program II
FNCMP	Forest Nature Conservation Master Plan
FR	Forest Reserve
FRA	Forest Resources Assessment
FSSD	Forestry Sector Support Department
FY	Fiscal Year
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GNP	Gross National Product

GO	Governmental Organization
GoU	Government of Uganda
GTZ	German Technical Cooperation
ha	Hectare
ICEDA	Iceland Development Agency
IDA	International Development Association
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
JICA	Japan International Cooperation Agency
LFR	Local Forest Reserve
LG	Local Government
LSSP	Land Sector Strategic Plan
MCA	Multi-Criteria Analysis
MDG	Millennium Development Goal
MIRR	Modified Internal Rate of Return
MEIRR	Modified Economic International Rate of Return
MoAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MoEMD	Ministry of Energy and Mineral Development
MoFPED	Ministry of Finance, Planning and Economic Development
MoGLSD	Ministry of Gender, Labour and Social Development
MoH	Ministry of Health
MoLG	Ministry of Local Government
MoLHUD	Ministry of Lands, Housing & Urban Development
MoTWA	Ministry of Tourism, Wildlife and Antiquities
MoWE	Ministry of Water and Environment
MSL	Mean Sea Level
NAP	National Agriculture Policy
NARO	National Agricultural Research Organization
NDF	Nordic Development Fund
NDP	National Development Plan
NEMA	National Environment Management Authority
NFA	National Forestry Authority
NFP	National Forest Plan
NGO	None Government Organization
NORAD	Norwegian Agency for Development Cooperation
NPHC	National Population and Housing Census
NPV	Net Present Value
NR	Natural Resources
NRA	Natural Resources Assessment
O&M	Operation and Maintenance
PEAP	Poverty Eradication Action Plan
PMA	Plan for Modernization of Agriculture
PNF	Private Natural Forest
SACCO	Savings and Credit Cooperative Organisation
SDG	Sustainable Development Goal
SDIP	Social Development Sector Strategic Plan

SSEA	Strategic Social and Environmental Assessment
SFM	Sustainable Forest Management
spp	several species
SPF	Strategic Planning Framework
SPR	Sector Performance Report
SWC	Soil and Water Conservation
SSIP	Sector Strategic Sector Investment Plan
TC	Town Council
ToR	Terms of Reference
UBOS	Uganda Bureau of Statistics
UGX	Uganda Shilling
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNRA	Uganda National Roads Authority
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USD	American Dollar
WAC	WMZ Advisory Committee
WB	World Bank
WESDP	Water and Environment Sector Development Plan
WESWG	Water and Environment Sector Working Group
WMZ	Water Management Zone
WPC	Water Policy Committee
WR	Water Resources
WRM	Water Resources Management
WWF	World Wildlife Fund

1 INTRODUCTION

1.1 Project Background

The need for sustainable Natural Resources management is well addressed in the Country's National Development Plan (NDP) and the long term development strategy, the Vision 2040. The Farm Income Enhancement and Forest Conservation Programme - Project 2 (FIEFOC-2) is designed within the context of the NDP and contributes to the improvement of farm incomes, rural livelihoods, food security and climate resilience, sustainable Natural Resources management and agricultural enterprise development.

FIEFOC-2

The overall objectives of FIEFOC-2 are improved farm incomes, rural livelihoods, food security and climate resilience. This Project represents an investment of approximately USD 82 million over a 5 years Project Period (2016 - 2021) in an integrated development of five new, small and medium scale agricultural irrigation schemes with a total size of 4,038 ha in the Nebbi, Oyam, Kasese, Butaleja and Kween Districts.

FIEFOC-2 aims at building on the achievements of the first phase of the program, FIEFOC-1 which was implemented between 2006 and 2012, with the rehabilitation of three existing irrigation schemes. FIEFOC-2 will improve on the sustainability from the first phase with a more targeted approach, complementing installation of physical infrastructure with extensive training and capacity development in agribusiness development, Natural Resources management and climate smart agriculture.

FIEFOC-2 is by design a strategic response to the impacts of climate change as evidenced by the increasing variability of rainfall, droughts and flooding in the vulnerable areas of Uganda. The introduction of the five new irrigation schemes will enable the Project beneficiaries and communities to transition from predominantly rain-fed and climate-vulnerable, subsistence agriculture to more sustainable, productive and profitable agricultural models (NDF, Pipeline Proposal, 2015).

The FIEFOC-2 program will be implemented through the following three components:

- Component 1 - Agricultural Infrastructural Development;
- Component 2 - Agribusiness Development;
- Component 3 - Integrated Natural Resources Development and Management.

Component 3 - Integrated Natural Resources Development and Management

The objective of this FIEFOC-2 Component is the establishment of a viable basis for irrigated agriculture and Natural Resources management in five irrigation schemes with improved farming. The schemes are Wadelai, Tochi, Mubuku II, Ngenge and Doho II. The watersheds of the schemes are currently subject to environmental degradation with high erosion and sediment loads in the rivers.

1.2 Objective of Catchment Management Plan

One of the objectives under this Component 3 is the preparation of a Catchment Management Plan for the watershed of the Tochi irrigation scheme (the CMP or the Plan) with identification and implementation plan for prioritized catchment improvement works. The implementation of the Plan will sooner or later lead to improved management of the watershed and, as a result, improved protection of the irrigation scheme against sedimentation and floods.

The focus of the Plan is on the 1) identification, 2) prioritization, 3) costing and on 3) the planning for implementing the catchment improvement works. For this task the consultancy firm SMEC Uganda Ltd was commissioned the assignment to preparing the Plan in March 2018.

The draft Plan (this report) was developed in the period April 2018 up to date of completion. The final version of the Plan will be discussed and agreed upon during the last round of stakeholder consultations which are planned for November 2018 and then to be followed by the completion of the Plan.

1.3 Context of Catchment Management Plan

The overall strategies of the Tochi CMP (Chapter 10) were identified within the broader context of the:

- National Sector Development Plans 2015/16-2019/20 of MoWE, MoAAIF and MoEMD; and
- District Development Plans of the Districts located within the Tochi catchment, i.e. Oyam, Nwoya, Kole, Gulu and Amuru.

The strategies extracted from these plans are directly related to environmental improvements, in general and to soil erosion/flood mitigation, in particular.

1.4 Structure of Catchment Management Plan

The Plan is structured as follows:

Chapter 2 provides the approach and methodology for the Catchment Management Planning process within the context of the de-concentrated management of Water Resources country wide through the Water Management Zones (WMZs).

Section 3 describes the study area.

Section 4 provides the policy, strategy and legislative framework related to catchment planning.

Section 5 presents the present institutional setting of institutions that have a stake in the Tochi catchment planning as well as the roles of these institutions in the planning.

Chapters 6, 7 and 8 capture a synopsis of the knowledge base of the catchment's physical (Chapter 6), social-economical (Chapter 7) and environmental features (Chapter 8).

Chapter 9 presents the outcomes of the Water Balance study based on the hydrological and water allocation modelling for the catchment taken into account the outcomes of a Water Resources assessment and the estimated current/ future (projected) water demands for the different water use sectors (including Climate Change scenarios).

Chapter 10 captures the Framework for Strategic Catchment Planning for Tochi with the overall objective, issues/challenges, planning strategies and action points.

Chapter 11 describes the identified catchment protection works with reference to Volume 3 of the NRA report of 14 September 2018.

Chapter 12 describes the outputs of the Multi-Criteria Analysis (MCA) and the Economic Viability Analysis (EVA) of the investment options (the selected protection works). The analyses have taken into account the economic, social and environmental benefits as well as the economic rate of returns and costs. The analytical process developed is user-friendly and pragmatic with prioritized options using weighted criteria.

Chapter 13 provides the planning for implementing the prioritized investment options with costing, roles and responsibilities of the implementing agencies, and the different planning horizons for implementation. It also presents an environmental and social management plan for monitoring the implementation of the investments. This draft implementation plan needs to be confirmed by the catchment stakeholders (see also Section 1.2).

The Plan is illustrated with tables, figures. More detailed, additional information is provided in the Appendixes.

2 APPROACH and METHODOLOGY

The Plan is in essence a "road map" to guiding the developer, the MoWE, from where the Tochi catchment is and to where it should go. The development is guided by four principles:

1) the CMP process follows the Guidelines for Catchment Based Water Resources Planning for Uganda, MoWE, revision 2016 (the Guidelines);
2) the CMP was developed within the context of the Albert WMZ (Lake Victoria Nile river basin, see Section 3.1) and the District Development plans of the Districts located in the catchment (see also Section 1.3);
3) the CMP was developed by taken into account the consultations and feedback from the stakeholders at different levels throughout the planning process (National, Regional, and Local level Government; Catchment Management Organizations under the Albert WMZ and other CMOs / Groups / Forums); and
4) the CMP is partly based on information gathered, processed and recorded in a number of key reports that have preceded this CMP. These reports are listed in Section 2.1.4 and were generated under this consultancy assignment.

2.1 Approach for Developing the Catchment Management Plan

2.1.1 CMP process follows Guidelines

For developing the CMP for Tochi the consultant was guided by the five methodological steps of the Guidelines. The Guidelines stipulate that the CMP identifies the key hotspot sites for restoration. The Plan should include a review of the current institutional arrangements, the identification of policy and legal gaps as well as capacity building needs, and recommendations on what actions the FSSD, the FIEFOC-2 project team and the Ministry should take to ensure a smooth and timely implementation of the Plan. This CMP also includes a review of potential financing for the fully costed prioritized and sequenced investments for the short, medium and long term, up to the year 2040, as well as a preliminary strategy for sourcing financing. All elements of the Guidelines are clearly reflected in this CMP. Table 2.1 explains.

Table 2.1 - CMP Guidelines references

CMP Guidelines	Corresponding Report Section
Step 1	Section 3-8
Step 2	Section 8-9 + Project reports[2]
Step 3	Section 10-11
Step 4	Section 12 + Project report[3]
Step 5	Section 13

[2] Stakeholder Engagement report - Final of 10 September 2018, two Volumes; Natural Resources Assessment report - Final of 14 September 2018, three volumes; Strategic Social and Environmental Assessment report - Final of 20 September 2018.
[3] Report on Evaluation of Options - Draft of 10 October 2018.

2.1.2 CMP developed within context of Albert WMZ, Victoria Nile River Basin

The CMP for Tochi has been developed within the context of the Albert WMZ - Victoria Nile River Basin. Also information was taken from the District Development Plans of Oyam, Nwoya, Kole, Gulu and Amuru. The plans entail the planning of socio-economic and environmental interventions in the Districts regarding Natural and Water Resources management works to help resolve conflicts, conserve and protect the areas and its resources, and ensure equitable access. The information has guided the consultants in drafting the environmental protection works for Tochi.

Section 3.1 further elaborates on the Albert WMZ and the division in three river basins (of which Victoria Nile is one) following the classification of MoWE.

2.1.3 Stakeholders' feedback throughout CMP development process

This CMP was developed applying a participatory approach with ample feedback from the stakeholders whereby valuable information and ideas were collected and addressed in the Plan. Reference is made to the Project Stakeholder Engagement report of 10 September 2018.

The proposed investment options will be discussed in a Workshop to be held in November 2018 with the key stakeholders whereby consensus will be sought on the selection and implementation of the proposed works.

2.1.4 Documents that contributed to CMP development

A number of Project reports were developed during the consultancy assignment. They have preceded this CMP and are related to previous steps in the CMP development. These reports have largely contributed to developing this CMP:

1) Stakeholder Engagement report - Final of 10 September 2018, two Volumes;
2) Natural Resources Assessment report - Final of 14 September 2018, three volumes;
3) Strategic Social and Environmental Assessment report - Final of 20 September 2018;
4) Report on Evaluation of Options - Draft of 10 October 2018.

A complete list of supporting documents and information as prepared under the consultancy assignment is presented in Appendix 2.1.

2.2 Methodology for Developing the Catchment Management Plan

Based on the Guidelines, the following five methodological steps were applied in developing the CMP for Tochi:

1) The *establishment of a KNOWLEDGE BASE* on which the remainder of the planning process rests based on the following assessments:
   a) Natural Resources Assessment;
   b) Water Resources Assessment;
   c) Socio-Economic Assessment;
   d) Environmental Assessment;
   e) Institutional Assessment;
   f) Policy/ Strategy, Legislation Assessment.

2) The *formulation of a FRAMEWORK for STRATEGIC CATCHMENT PLANNING* with an overall Objective, key issues and challenges, planning strategies and key areas for action based on literature review, assessments and inputs received from the stakeholders.
3) The *identification and evaluation of the CATCHMENT PROTECTION WORKS*, the *application of a MULTI-CRITERIA ANALYSIS with SCENARIO ANALYSES,* and an *ECONOMIC VIABILITY ANALYSIS* with costing and prioritization of works.
4) The *drafting of an IMPLEMENTATION PLAN* with special attention to the prioritized works with a phased implementation over three planning horizons, i.e. short (2020), medium (2025) and long term (2040).
5) The *formulation of an ENVIRONMENTAL and SOCIAL MANAGEMENT MONITORING PLAN*.

These steps are indicated in a methodology diagram and presented in Figure 2.2.

Stakeholder Consultations and Feedback

Much attention was given to consulting the Government stakeholders at the National (Section 5.1), Regional (Section 5.2) and Local level (Districts, Sub-Counties and Parishes, Section 5.3), Catchment Management Organisation, Groups and Forums (Section 5.4 and 5.5). These consultations were conducted during meetings, field visits and Workshops. The stakeholders were involved throughout the CMP development process (reflected in the diagram as a cross-cutting activity) and have significantly contributed to reaching an understanding of the catchment challenges and opportunities.

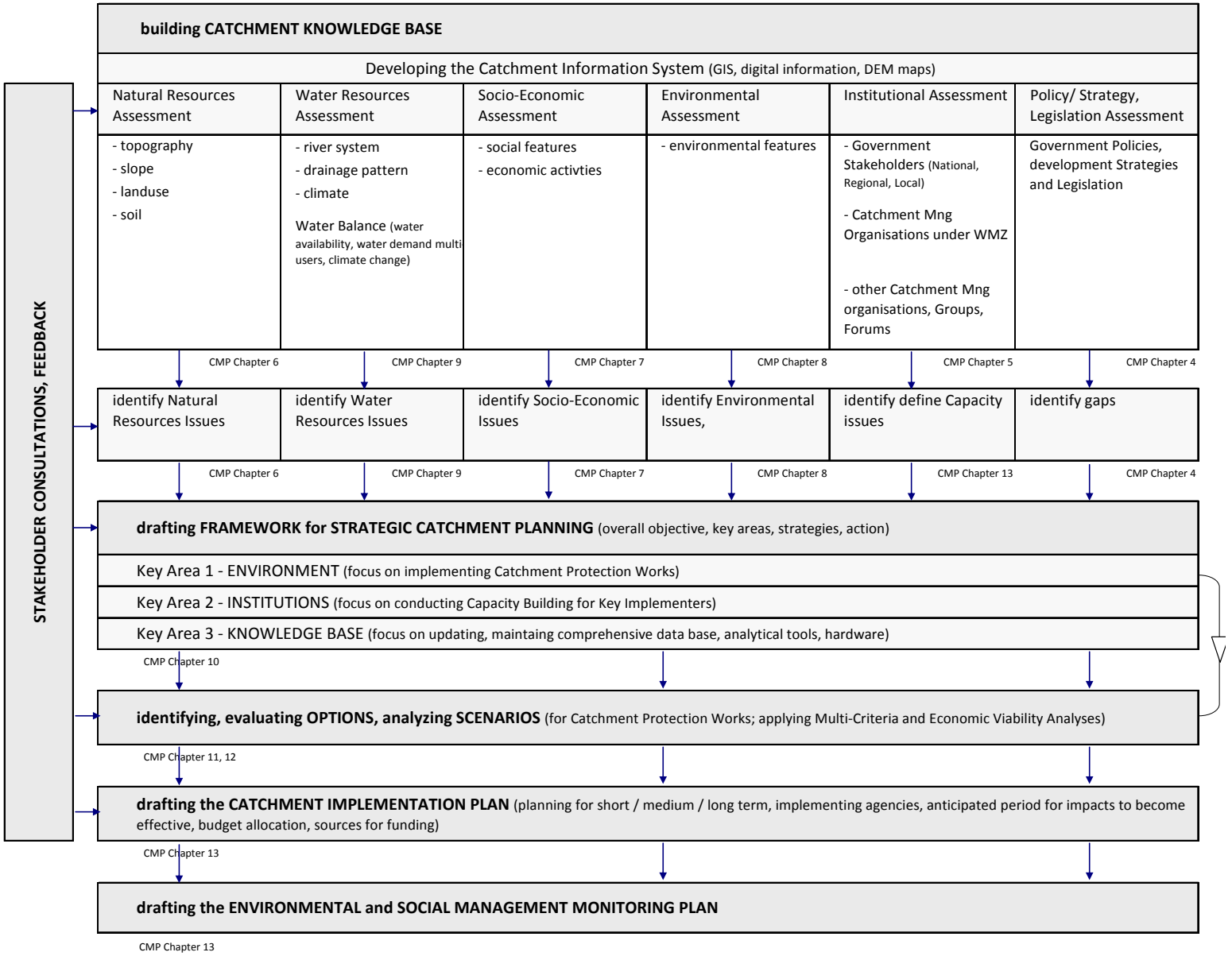

Figure 2.1 - Methodology Diagram for developing the Tochi CMP

3 KNOWLEDGE BASE - STUDY AREA

The Tochi catchment is located in the northern part of Uganda (Figure 3.1). It is part of the Nile River Basin. The Nile River Basin is arguably the most important water catchment area on the African continent. Its headwaters are situated in the Great Equatorial Lakes region and include almost all of the countries of Rwanda, Burundi and Uganda and portions of the Democratic Republic of Congo, Kenya and Tanzania as illustrated in Figure 3.2.

Figure 3.1 - Location of Tochi Catchment

3.1 Water Management Zoning

The creation of Water Management Zones (WMZs) was initiated by the Directorate of Water Resources Management (DoWRM) out of the need to take IWRM functions closer to stakeholders (farmers, townspeople, local government officials, businessmen, etc). This was intended to increase the focus onto the real problems, to improve the analytical underpinnings (for example, hydrologic analysis and water resource assessment, multi-sector water balance) of programs and projects and to provide an opportunity for stakeholders to participate in the formulation of plans and to develop new water infrastructure.

In order to enact the Water Sector Reform that started in 2006, Uganda was divided into four WMZs (Figure 3.3) based on the eight River Basins (Figure 3.4) in the country *(http: //www.mwe.go.ug/llibrary/watermanagement-zones-wmz)*. Each region covers a WMZ. Each WMZ comprises of a number of catchments. The Tochi catchment falls within the Victoria Nile river basin which is part of the Albert WMZ that is managed by the Western Region WMZ of MoWE with its regional office in Fort Portal (Figure 3.4).

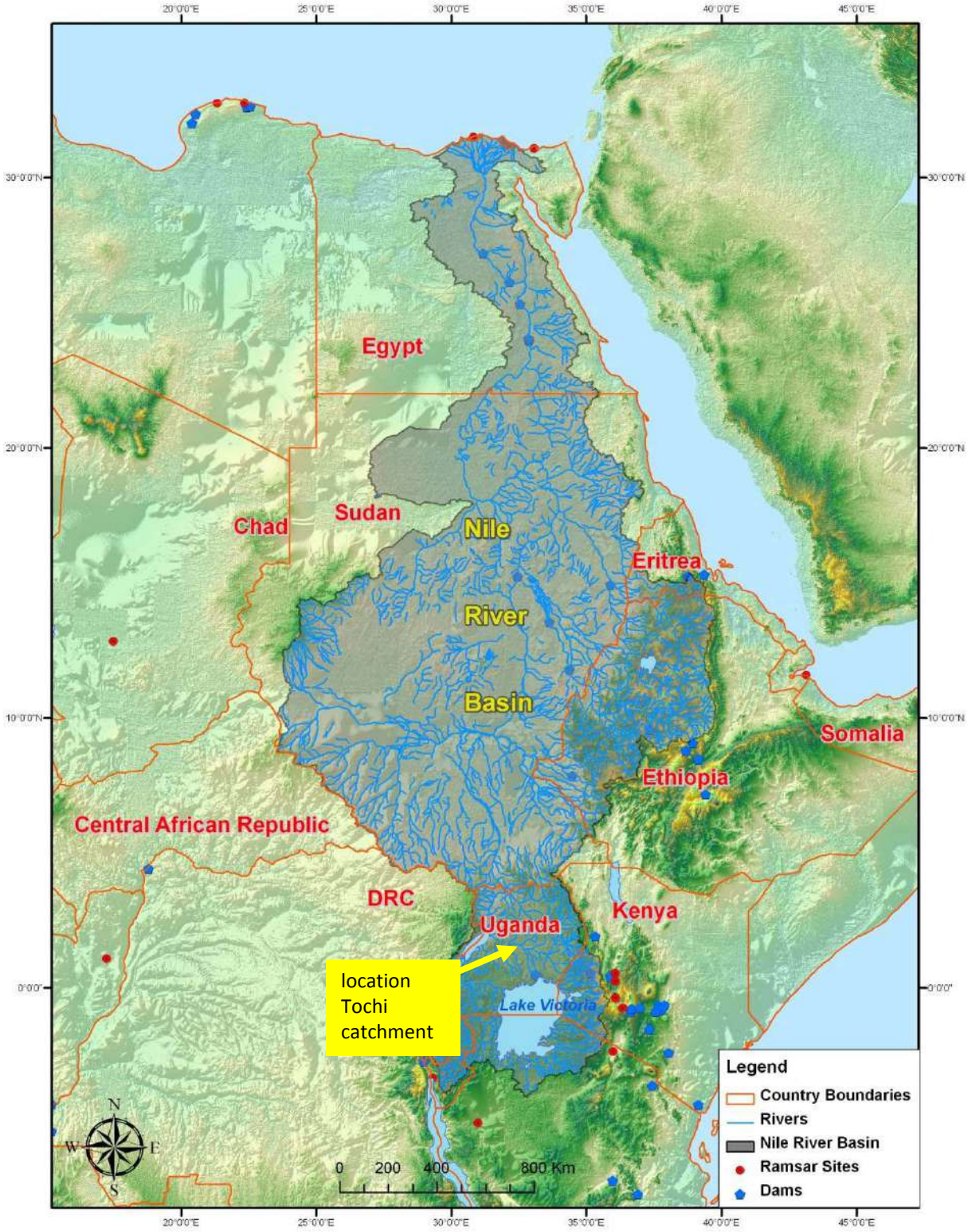

Figure 3.2 - Greater Nile Basin (source: Catchment Management Plan for Awoja Catchment, MoWE/AURECON, December 2013)

Figure 3.3 - Water Management Zones (source: Uganda National Water Development Report, 2015)

Figure 3.4 - River Basins (source: Uganda National Water Development Report, 2015)

3.2 River System Characteristics

The Tochi river catchment (1,611 km^2) has its headwaters near Kilak and Bar-Dege in the Amuru District. The water supply for the Tochi irrigation scheme comes exclusively from the river Tochi, at the intake near Achaba. This river flows mainly through the Gulu and Oyam Districts before joining the river Kyoga Nile upstream of the Karuma Falls near Jaber, through relatively flat terrain.

The catchment elevation varies between 1,240 m +MSL in the upstream hills and 1,035 m +MSL at the intersection with the river Nile with an average elevation of 1,076 m +MSL.

3.3 Administration, Population

There are six Districts, 25 Sub-Counties and 77 Parishes in the catchment. The names of the Districts, Sub-Counties and Parishes are listed in Table 3.1. Figure 3.5 shows the map with the Districts, District capitals, and Sub-Counties.

Current and projected population figures of the Districts and of those parts of the Districts that fall with the Tochi catchment are presented in Table 3.2. Data are taken from the Census 2002, 2014 (2014 NPHC - Main Report), Worldometers Uganda Population 2018 and Worldometers Uganda Population 2050.

Table 3.1 - Districts, Sub-Counties and Parishes in Tochi catchment

District OYAM

SUB-COUNTY	PARISH
ABOK	ARIBA
	AJERIJERI
	BAR-RIO
	ITUBARA
	BAR
ACABA	ABANYA
	OBANGANGEO
	ANYEKE
ALEKA	AGWAR
ICEME	ORUPU
	AUNGU
	OMOLO
	ALONI
	AWIO
MINAKULU	ADEL
	KULUABURA
	ATEGO
	OPUK
	ACENO
MYENE	OYORO
NGAI	OKOMO
	KULAKULA
	AKUCA
	OMACH
	ACUT
	ARAMITA
OTWAL	AMUKUGUNGU
	ADER
	ACOKARA
	OKII
OYAM TC	WESTERN
	EASTERN

District OMORO

SUB-COUNTY	PARISH
BOBI	PATEK
	PALWO
	PALENGA
	PAIDONGO
	PAIDWE
KORO	PAGEYA
	LABWOC
	ACOYO
	IBAKARA
	LAPAINAT WEST
LAKWANA	LANENOBER
	LUJORONGOLE
	PARAK
LALOGI	LUKWIR
	JAKA
OMORO TC	GEM
	PARWECH
	TE-GOT
ONGAKO	KAL
	ALOKOLUM
	PATUDA
	ONYONA
	ABWOCH

District NWOYA

SUB-COUNTY	PARISH
ALERO	PANGUR
KOCH GOMA	LII
	GOMA KAL
	ORUM

District KOLE

SUB-COUNTY	PARISH
ABOKE	AKWIRIDIDI
	OPETA

District GULU

SUB-COUNTY	PARISH
BAR-DEGE	KANYAGOGA
BUNGATIRA	LAROO
LAROO	QUEEN'S
	PECE PRISON
	AGWEE
LAYIBI	KIROMBE
	TECHO
	LIBRARY
	PATUDA
PECE	PAWEL
	LABOUR LINE
	TEGWANA
	VANGUARD
UNYAMA	UNYAMA

District AMURU

SUB-COUNTY	PARISH
LAMOGI	PALEMA
	LACOR

Figure 3.5 - Map with Districts, District capitals, and Sub-Counties in Tochi catchment

Table 3.2 - Current and Projected Population

Irrigation Scheme	District	Population District (10^3)						
		Yr 2002 [1]	Yr 2007 [1]	Yr 2014 [1]	Yr 2018 [2]	Year 2020	Yr 2025 [3]	Yr 2040 [3]
TOCHI	Oyam	276.5	320.9	396.5	452.0	481.7	563.2	873.0
	Gulu (since 07/2016)	166.9	195.6	244.4	278.6	297.0	347.2	538.2
	Amuru	139.4	159.2	193.0	220.0	234.5	274.1	424.9
	Nwoya	45.1	72.2	131.6	150.0	159.8	186.9	289.7
	Omoro [3]	141.1	165.2	206.5	235.5	250.9	293.4	454.8
Total Tochi		**769**	**913**	**1,172**	**1,336**	**1,424**	**1,665**	**2,581**

Irrigation Scheme	District	Population for part of District located in Catchment Irrigation Scheme (10^3)						
		Yr 2002 [1]	Yr 2007 [1]	Yr 2014 [1]	Yr 2018 [2]	Yr 2020	Yr 2025 [3]	Yr 2040 [3]
TOCHI	Oyam	87.1	101.1	124.9	142.4	144.5	177.5	275.1
	Gulu (since 07/2016)	3.3	3.9	4.8	5.5	5.9	6.9	10.7
	Amuru	0.7	0.7	0.9	1.0	1.1	1.3	2.0
	Nwoya	1.4	2.3	4.2	4.8	4.8	6.0	9.2
	Omoro [3]	64.9	76.0	95.0	108.3	115.4	134.9	209.2
Total Tochi		**157**	**184**	**230**	**262**	**272**	**327**	**506**

Note:
[1] Census 2002, 2014 (2014 NPHC - Main Report);
[2] Worldometers Uganda Population 2018;
[3] Worldometers Uganda Population 2050.

4 KNOWLEDGE BASE - POLICY, STRATEGY and LEGISLATIVE FRAMEWORK

The Government of Uganda has put considerable efforts in ensuring that policies reflected in the Poverty Eradication Action Plan (PEAP) and its planned successor, the National Development Plan (NDP), the Plan for Modernization of Agriculture (PMA), the Social Development Sector Strategic Plan (SDIP) and the decentralization and good governance programmes have taken into account environmental sustainability as a priority. These laws and policies aim at sustainable socio-economic development without affecting the Country's Natural Resources.

Similarly, a number of interventions, key among which are the multi-institutional Water Policy Committee (WPC) and the Water and Environment Sector Working Group (WESWG), that provide policy and technical guidance for all sector development activities, have been established to achieve this objective.

Moreover, a number of Governmental and None-Governmental Organizations are working on the various coordination, research, and implementation elements of these laws.

Context
Although an exhaustive detailing of the Country's policy, strategy and legislative framework is beyond the scope of this Plan, this Chapter summarizes some of the most relevant Environment and Natural Resources planning and management related policies, strategies and legislation currently in force that have linkages with catchment planning and management. It is within this context of the Plan that the relevant Policies, Strategies and Legislation were identified.

4.1 Policies

The Government of Uganda has a number of policies that wholly or partly enforce the protection of the environment and its Natural Resources. The major policies relating to the planning and management of the Tochi catchment are:

1) National Water Policy (1999);
2) National Environment Management Policy (2014);
3) Uganda National Forestry Policy (2004);
4) National Policy for Conservation and Management of Wetland Resources (1995);
5) National Land Policy (2013);
6) National Irrigation Policy (2017).

Other policies that indirectly affect the planning and management of catchments include:

7) National Fisheries Policy (2004);
8) National Climate Change Policy (2015);
9) Energy Policy for Uganda (2002);
10) National Agricultural Policy (2013);
11) National Gender Policy (2007);
12) National Health Policy (2010);
13) National Population Policy (2008).

These Policies provide guidance in planning and management of catchments in general, in the ways summarized in Table 4.1.

Table 4.1 - National Policy Framework related to the catchment Planning and Management

NATIONAL POLICY FRAMEWORK

Policy Name	Level	Responsible Entity	Relevance to Catchment Planning and Management
Major Policies			
National Water Policy (1999)	National	MoWE	It provides policy framework, guideline and strategic directions in Water Resources Development, Planning, Management and Utilization.
National Environment Management Policy (2014)	National	NEMA	It provides policy framework, guideline and strategic direction for integration of environmental concerns in all development Planning process, implementation, Monitoring and Evaluation as well as inter-sectoral cooperation and coordination during its implementation.
National Land Policy (2013)	National	MoLHUD	It provides the policy framework for land resources Planning, Development, Management, utilization, tenure management as well as land governance regime.
National Irrigation Policy (2017)	National	MoAAIF	Provides policy framework, guideline and strategic directions in irrigation development planning and management.
National Forestry Policy (2001)	National	NFA	It provides policy framework and strategic directions for Planning, development, management and sustainable utilization of trees and forest resources.
National Policy for the Management & Conservation of Wetland Resources (1995)	National	MoWE	It provides policy framework, guidelines and strategic directions for Planning, Development, Management, and Conservation, of wetland resources for sustainable use.

Policy Name	Level	Responsible Entity	Relevance to Catchment Planning and Management
other Policies			
National Energy Policy (2002)	National	MoEMD	It provides policy framework and strategic directions for Energy Sector development, planning and management, particularly on optimum use of biomass energy sources (firewood, charcoal and crop residues) as important renewable source of energy.
National Climate Change Policy (2015)	National	MoWE	It provides policy framework, guidelines and strategic directions on climate change adaptation and mitigation measures, while planning for sustainable development and uses of Water, Environmental and natural resources.
Mining and Mineral Policy for Uganda (2016)	National	MoEMD	It provides policy framework, guidelines and strategic directions for mineral resources Planning, Development, Exploitation and Management, including its adverse impacts on environment and natural resources.
National Gender Policy (2007)	National	MoGLSD	It provides policy framework, guideline and strategic direction to all stakeholders in planning, resource allocation, implementation, monitoring and evaluation of programmes with a gender perspective (Gender Mainstreaming).
National Health Policy (2010)	National	MoH	It provides policy framework, guidelines and strategic direction for the Health Sector Planning, Development, and Management, particularly on Sanitation and Hygiene program planning and management.
National Population Policy (2008)	National	MoFPED	It provides a policy framework, guidelines and strategic directions that integrate population factors in development planning at all levels.

Policy Name	Level	Responsible Entity	Relevance to Catchment Planning and Management
National Agricultural Policy (2013)	National	MoAAIF	It provides policy frameworks, guidelines and strategic directions for all agriculture and agriculture related sub-sector Planning, Development, and Management.
National Fisheries Policy (2000)	National	MoAAIF	It provides policy framework, guideline and strategic direction on Aquaculture Development, Planning, sustainable management and exploitation of fisheries resources.

4.2 Development Strategies and Plans

Uganda has a number of development strategies and plans that affect the management of the environment and the prevailing natural resources. The key strategies and plans being implemented by the Government of Uganda and other development partners include the following:

1) Green Growth Development Strategy 2017/18-2030/31;
2) Millennium Development Goals (MDGs);
3) Sustainable Development Goals (SDGs);
4) National Biodiversity Strategy and Action Plan II (2015-2025);
5) Environment, Natural Resources Sub-Sector Gender Mainstreaming Strategy (2016-2021);
6) Water and Environment Sector Strategic Investment Plan (2018-2030);
7) Water and Environment Sector Development Plan (2015/16-2019/20);

Other development strategies and plans that indirectly affect the planning and management of catchments include:

9) The Uganda Vision 2040;
10) Second National Development Plan (NDPII) (2015/16-2019/20);
11) Energy and Mineral Sector Development Plan 2015/16 – 2019/20;
12) Land Sector Strategic Plan (LSSP-II) (2013 – 2023);
13) Agriculture Sector Strategic Plan (ASSP) (2015/16-2019/20).

These Development Strategies and Plans provide guidance in the planning and management of catchments in general in the ways summarized Table 4.2.

Table 4.2 - National Strategy and Planning Framework related to Catchment Planning and Management

NATIONAL STRATEGY and PLANNING FRAMEWORK

National Strategy / Plan	Imple-mentation Period	Imple-menting Entity	Relevance to Catchment Planning and Management
Major Development Strategies and Plans			
Green Growth Development Strategy (2000)	2018 - 2031	GoU	It is the National Development Strategy that provides guidance, strategies and governance frameworks for implementing the green growth principles within the existing development frameworks towards the sustainable development of the Country.
Sustainable Development Goals		GoU	It is a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. It has 17 development goals that build on the successes of MDGs , while including new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities
National Biodiversity Strategy and Action Plan II (2016)	2015-2025	NEMA	It is the National Strategy that provides the Government with a framework for implementing its obligations under the Convention on Biological Diversity (CBD) at country level as well as the setting of conservation priorities, channelling of investments and building of the necessary capacity for the conservation and sustainable use of biodiversity in the Country.
Environment and Natural Resources Sub-Sector Gender Mainstreaming Strategy (2016)	2016-2021	MoWE	It is the sub-sector Development Strategy that guides gender mainstreaming in Water, Environment and Natural Resources sub-sectors development, planning and management.
Water and Environment Sector Strategic Investment Plan	2018-2030	MoWE	It is the Water and Environment Sector Strategic Sector Investment Plan (SSIP) to guide annual investments in the sector up to 2030.
Water and Environment Sector Development Plan (2015)	2015-2020	MoWE	It is the Water and Environment Sector Development Plan that indicates the sector`s investment priorities areas amid to be achieve the national goal during the plan period. For instance, the WESDP prioritized restoration of

National Strategy / Plan	Imple-mentation Period	Imple-menting Entity	Relevance to Catchment Planning and Management
			degraded ecosystems and protection of productive ecosystems, management of forest reserves and wetlands to support economic growth that uses Natural Resources in a sustainable manner, or so-called green growth.
other Development Strategies and Plans			
Energy & Mineral Sector Development Plan(2015)	2015-2020	MoEMD	It provides the sector`s development agenda for the stated planning period, which is to meet the energy needs of Uganda's population for social and economic development in an environmentally sustainable manner. One of the primary agenda is to ensure wide distribution of electricity through rural electrification. This indirectly affects the use of fuel wood for cooking with electricity being a better option.
Agriculture Sector Strategic Plan	2015-2020	MoAAIF	It articulates the National agricultural development priorities documented in the National Development Plan (NDP) II and the National Agriculture Policy (NAP) 2013.
Ugandan Vision (2013)	2013 - 2040	GoU	It is a Nation Vision that provides development paths and strategies to realize Uganda's National Vision statement which is "a Transformed Ugandan Society from a Peasant to a Modern and Prosperous Country by 2040" This is to be done through modernisation of agriculture among others.
Second National Development Plan (2015)	2015-2020	GoU	It is the National Development Plan of the country that sets priority investment areas of the country with greatest multiplier effect on the overall National economic development during the plan period (2015-2020). Accordingly, agriculture, Tourism, Minerals, Oil and Gas, Infrastructure development and human capital development are highly emphasized.
Land Sector Strategic Plan	2013-2023	MoLHUD	It is the land sector strategic plan that provides the operational framework for advancing land sector reforms necessary to frame and safeguard Uganda's land tenure system, rights for land users; streamline, modernize land delivery; encourage optimal use of land, NRs.

4.3 Legislation

The major legislation in Uganda that affects the management of catchments and its Natural Resources (with relevance to the Tochi catchment) include the following:

1) Water Act (1997), Cap 152;
2) National Environment Act (1995), Cap 153;
3) National Forestry and Tree Planting Act (2003).

Other legislation that has an influence on the management of the Tochi catchment and its Natural Resources include:

5) Land Act (1988);
6) Constitution of the Republic of Uganda (1995);
7) Agricultural Seeds and Plants Act No. 10/94;
8) Local Government Act (1997).

The major legislation concerned with the protection of the environment is the Water Act of 1997 and the National Environment Act, 1995.

Water Act, 1997

The core legislation for WRM development and use in Uganda is the Water Act (1997) Cap 152, which clearly states the framework for development and management of Water Resources in a sustainable way. Through the Act, clean, safe and sufficient amounts of water can be provided and water pollution, which is detrimental to the health and to the environment controlled though waste discharge. The long title of the Act clearly explains its purpose, which is to provide for the use, protection and management of Water Resources and supply; to provide for the constitution of, and facilitate the devolution of water supply and sewerage undertakings. Therefore, the objectives of the Act include the promotion of the rational management and use of the waters of Uganda through application of appropriate standards and techniques; and the co-ordination of all public and private activities which may influence the quality, quantity, distribution, use or management of Water Resources.

The Act vests all rights to manage all Water Resources related issues in the Government. That these vested rights of the Government are to be exercised by the Minister in charge of water and its lead agency Directorate of Water Resources Management (DoWRM). According to the Act, the occupier of the land is given rights to use water that naturally exists on the land for domestic use, firefighting or irrigating a subsistence garden.

The basic foundation of most of the Act's provisions is the reconciliation between protecting the environment and ensuring the availability to the population of water of sufficient quality and quantity.

The Water Act (1997) promotes the rational management and use of the waters of Uganda, minimizing harmful environmental impacts. It aims to achieve orderly development and use of Water Resources for purposes other than domestic use, such as water for livestock, irrigation, agriculture, industrial, commercial and mining purposes, energy, navigation, fishing, and preservation of flora.

National Environment Act, 1995

The National Environment Act Cap 153 which is the main environmental legal instrument was enacted in 1995 by the legislature (Parliament) of Uganda upon the presentation of the National Environment Bill. This represented a key milestone in the implementation of the Rio Declaration commitments and in environmental management in Uganda. One of its important outcomes was to provide for the establishment of a specialized competent authority in environmental matters the National Environment Management Authority (NEMA) whose key roles are coordination, monitoring and supervision.

Overall, the Act transformed the legal and institutional framework for environment management. Subsequent supplementary statutory instruments to the National Environment Act includes 1) the National Environment Regulations 1999 (on waste management), 2) the National Environment Regulations, 2000 (on wetlands, river banks and lake shore management) and 3) the National Environment Regulations 2005 (access to genetic resources and benefit sharing).

The general principles of the Act are to:

1) assure all people living in the country the fundamental right to an environment adequate for their health and well-being;
2) encourage the maximum participation by the people of Uganda in the development of policies, plans, and processes for the management of the environment;
3) use and conserve the environment and Natural Resources of Uganda equitably and for the benefit of both present and future generations, taking into account the rate of population growth and the productivity of the available resources;
4) conserve the cultural heritage and use the environment and Natural Resources of Uganda for the benefit of both present and future generations;
5) maintain stable functioning relations between the living and nonliving parts of the environment, through preserving biological diversity and respecting the principle of optimum sustainable yield in the use of natural resources;
6) reclaim lost ecosystems where possible and reverse the degradation of Natural Resources;
7) establish adequate environmental protection standards and monitor changes in environmental quality;
8) publish relevant data on environmental quality and resource use;
9) require prior environmental assessments of proposed projects that may significantly affect the environment or use of Natural Resources;
10) ensure that environmental awareness is treated as an integral part of education at all levels;
11) ensure that the true and total costs of environmental pollution are borne by the polluter and
12) promote international cooperation between Uganda and other states in the field of the environment.

Table 4.3 - Legislative Framework related to Catchment Planning and Management

LEGISLATIVE FRAMEWORK

Legislation	Context	Enforcing Entity	Relevance to Catchment Planning and Management
Major Legislation			
Water Act, 1997	National	MoWE	It provides legislative and institutional frameworks for the Development, Management and Utilization of WR.
Environmental Management Act,1995	National	NEMA	It provides the legislative and institutional Framework for Environmental Management
Forestry and Tree Planting Act, 2003	National	MoWE, NFA	It provides the legal framework for Development, Management and Utilization of Forest Resources. The Act distinguishes between CFRs, LFRs, community forests, and private forests and the respective responsible bodies for these forests categories.
other Legislation			
Mining Act, 2003	National	MoEMD	It provides the legislative Framework for Development, Management and Utilization of Mineral Resources.
Land Act, 1998	National	MoLHUD	It provides the legislative framework for the Tenure, Ownership and Management of land
Petroleum Exploration, Development and Act, 2013	National	MoEMD	It provides the regulatory and institutional frameworks for petroleum exploration, development and production.
Public Health Act, 1935	National	MoH	It is an Act to consolidate the law regarding the preservation of public health.
Surface and Marine Transport Act, 2001	National	MoWT	It is an Act to establish a regulatory authority in relation to the surface and marine transport sectors, and to provide for its operation in place of former authorities and for related matters.
Agricultural Seeds and Plants Act, 2006	National		It provides legislative framework for the promotion, regulation and control of plant breeding and variety release, multiplication, conditioning, marketing, importing and quality assurance of seeds and other planting materials.

Legislation	Context	Enforcing Entity	Relevance to Catchment Planning and Management
The Cattle Grazing Act, 1945	National	MoAAIF	An Act to regulate and control cattle grazing.
The Water (Waste Discharge) Regulations, No. 32 / 1998	National	MoWE	It provides regulation for the water abstraction and waste water discharge through the use of permits.
Local Government Act, 1997	National	MoLG	The Act provides for the decentralization of functions, powers, responsibilities and services to Local Governments.

5 KNOWLEDGE BASE - INSTITUTIONAL FRAMEWORK

The Tochi catchment is not only a natural system of land, water, and ecosystems, but it is also a unique social and economic system dependent upon the exploitation of the land, water, environment, and the Natural Resources. Thus, catchment management planning requires an integrated and multi-sectoral management approach, which calls for a comprehensive institutional framework that ensures wide and active participation of stakeholders at all levels. This requires the involvement of all institutions from individual resources users and traditional resources management structures to Districts and Ministries in an integrated and coordinated way. Accordingly, this Chapter discusses the existing Institutions that have relevance to Water, Environment and Natural Resources Development, Planning and Management, in general and catchment management planning, in particular. For ease of reference, stakeholders have been identified and tabulated in the following five categories:

1) Government - National Level Stakeholders;
2) Government - Regional Level Stakeholders;
3) Government - Local Level Stakeholders;
4) Catchment Management Organizations under the WMZ;
5) other CMOs / Groups / Forums.

5.1 Government - National Level Stakeholders

The National level stakeholders of GoU are presented in Table 5.1 with roles and responsibilities related to catchment, environmental management.

Table 5.1 - National Level stakeholders

Ministry	Department / Agency relevant to Catchment Management	Roles and Responsibilities
Ministry of Water and Environment	Directorate of Water Resources Management	1. Setting National policies and standards, managing and regulating Water Resources determining priorities for water development and management. 2. Has a National mandate to ensure provision of quality water and environmental protection services in the Country and the sustainable management and utilization of water and environment resources for the population of Uganda.
	National Forest Authority.	1. To manage the Central Forest Reserves on a sustainable basis. 2. To supply high quality forestry-related products and services to government, local communities and the private sector.

Ministry	Department / Agency relevant to Catchment Management	Roles and Responsibilities
		3. Contributing to a sufficiently forested, ecologically stable and economically prosperous Uganda.
	National Environment Management Authority	1. Coordination, monitoring, supervising and regulating environmental management matters in Uganda. 2. Promoting sustainable utilization of Water and Environmental Resources and ensuring a clean, healthy and productive environment in Uganda. 3. Internal/self-regulation and control in compliance to the existing policy and legal frameworks. 4. Advocacy and lobbying for environmental quality and sustainability in Uganda.
	Wetlands Department	1. To manage wetland resources. 2. To maintain a sustainable biophysical and socio-economic values of the wetlands in Uganda for present and future generations.
	National Water and Sewage Corporation	1. To manage the Water Resources in ways which are most beneficial to the people of Uganda. 2. To provide water supply services for domestic stock, horticultural, industrial, commercial environmental and other beneficial uses. 3. To provide sewerage services and to develop the water and sewerage systems in urban centers and big National institutions throughout the Country.
Ministry of Agriculture Animal Industry and Fisheries		1. Technical advice on Irrigation schemes. 2. Provision of technical assistance in the design and construction of on-farm irrigation systems. 3. Provision of extension services and advice to farmers on irrigation systems and promotion of efficient water use. 4. Provision of support in the supervision and monitoring of water use and management

Ministry	Department / Agency relevant to Catchment Management	Roles and Responsibilities
Ministry of Energy and Mineral Development	National Hydro Power Projects	Establishment, Licensing and Monitoring of Mini-Hydro power stations.
Ministry of Lands Housing and Urban Development	Department of Land Registry and Issuance of Titles	Management of land ownership through issuance of land titles and survey of protected areas.
	Office of Chief Government Valuer	Management of compensation.
Ministry of Works and Transport	Uganda National Roads Authority	1. Abstraction of water for road construction. 2. Mining of river sand for road construction. 3. Mining of local materials for road construction.
Ministry of Internal Affairs	NGO Forum	1. Network and plan for allocation of resources. 2. Licensing of NGOs.

5.2 Government - Regional Level Stakeholders

The creation of the Water Management Zones was initiated by the Directorate of Water Resources Management out of the need to take IWRM functions closer to stakeholders (farmers, townspeople, local government officials, businessmen, etc). This was intended to increase the focus onto the real problems, to improve the analytical underpinnings (for example, hydrologic analysis and water resource assessment, multi-sector water balance) of programs and projects and provides an opportunity for stakeholders to participate in the formulation of plans and the develop new water infrastructure.

The four WMZs are part of DoWRM and are headquartered at the four regional offices located country wide. For the Tochi catchment, the Albert WMZ office is located in Fort Portal (see also Section 3.1), however for the day-to-day operation, this catchment falls under the management of the Upper Nile WMZ office in Lira.

The main roles and responsibilities of the Upper Nile WMZ related to Tochi catchment management are summarized in Appendix 5.1.

5.3 Government - Local Level Stakeholders

At the District level, the key players in the development and implementation of the CMP catchment plan are:

1) Department of Natural Resources (Forestry, Environment, Physical Planning and Lands);
2) Production Department; and
3) Community Based Services Department.

At the Sub-County level, these roles are carried out by similar line Departments as is the case at the District level. However, where the Department does not have a line representation at the Sub-County level a focal person is usually designated to perform those roles. Table 5.2 lists the local stakeholders at the District and Sub-County level.

Roles

Local governments are expected to play the following roles in the catchment management:

- Develop a framework defining its operations;
- Constitute a catchment technical committee and a secretariat;
- Interpret the catchment management Plan for purposes of implementation;
- Co-ordinate the implementation of the Plan;
- Mobilize resources for the Plan implementation;
- Co-ordinate research;
- Evaluate the progress of activities within the Plan area in collaboration with other stakeholders, develop a code of conduct, regulation guidelines or by-laws;
- Identify constraints in the processes of plan implementation;
- Identifying and integrating IWRM issues in Development plans;
- Produce annual work plans and budgets based on the management Plan;
- Implementation of IWRM interventions;
- Supervision and monitoring;
- Documentation and information exchange; and
- Form an arbitration committee to resolve conflicts.

Effectiveness

One of the strengths of the local government in catchment management is that they have the structures in place with the required competences in place, especially at the District level.

At the political wing, there are leaders who are directly elected by their communities at various levels to represent their interests. These are very instrumental in carrying out the mobilization of their respective communities to embrace the project objectives and the underlying activities.

Challenges

Despite the knowledge base , competencies and well spelt out roles that they are expected to play, the local governments have challenges that need to be attended to if the catchment management plans are to yield any fruits. Among those that came up during the consultation process as challenges are:

- Inadequate staffing level for the positions in the Departments mentioned earlier for the management of the catchment plans. It was not uncommon to find one officer holding more than one portfolio especially in the Natural Resources Departments.

- The issue of limited funds to operationalize the work plans came up in almost all the local governments visited. The available resources at the local governments are usually unable to satisfy the demand, for example, of the seedling requirements of the communities. The staffs are also unable to undertake or oversee the implementation and close monitoring of the projects initiated for the conservation of the catchment areas due to limitation in facilitation for transport and other required logistics.
- The top-bottom approach to the management of the catchment plans is seen as a big challenge where the ministry does not involve both the communities and the local governments in determining any intervention deemed beneficial to the local governments. Most times, the local governments are recipients of decision that have already been taken at the ministry level. This was more emphasized by the local governments when it comes to the procurement of the tree and fruit seedlings delivered to the local governments for distribution to the communities. The seedlings supplied are procured from the Centre and delivered to the Districts without due regard to their suitability to the local environmental conditions and interests of the recipients. In addition, the time of delivery is usually mismatched with the prevailing weather conditions of the locality at the time of delivery. The Centre usually supplies the seedling when the dry season is either starting or is in the middle.

Table 5.2 - Local Level Stakeholders of the Tochi catchment

Irrigation Scheme	Local Government
Tochi	Local Government of Oyam (Minakulu, Myene, Kamdini, Aber, Loro, Acaba, Iceme, Oyam TC, Ngai Abok, Lakwana and Bobi Sub-Counties), Gulu (Layibi and Pece Divisions), Omoro (Ongako and Koro Sub-Counties) and Nwoya (Koch Goma Sub-Counties) Districts

5.4 Catchment Management Organizations under WMZ

The WMZ works through an established institutional framework at the catchment level known as the Catchment Management Organization (CMOs) structure that builds on and utilizes to the maximum practicable extent existing structures and relationships.

The CMO constitutes of two connected and complimentary committees that include the Catchment Management Committee (CMC) and the Catchment Technical Committee (CTC),

Table 5.3 presents the CMOs under the WMZ structure with roles and composition of its members. Table 5.4 summarizes the status of the existing WMZ catchment management structures for the Tochi Catchment.

Table 5.3 - WMZ Structures, Roles and Composition

Structures Under WMZ	Roles	Composition
Catchment Management Organization (CMO)	▪ Coordination of planning of WRM issues within the catchment area; ▪ Coordination of preparation and implementation of IWRM plan in the catchment in liaison with Local Governments (LGs), relevant District officers, water-user associations and other stakeholders; ▪ Coordinate implementation, monitoring and enforcement of relevant acts, bye-laws, guidelines, regulations, permits, plans, standards, etc; ▪ Advocacy, Lobbying, resource mobilization, Joint planning, activity coordination.	Made up of staff specifically engaged to support the CMO, Representatives from Water User Groups, NGOs, Catchment Management Committee, key actors in Water and other Natural Resources.
Catchment Management Committee (CMC) *(This is the most important stakeholder group and the WMZ will need to take considerable care including wide consultations to select and mobilize candidates some of whom will have to be motivated.* *The CMC would meet frequently, perhaps every month, during the latter stages of the planning process)*	▪ Represent all stakeholders in collaborating with the WMZ team at each step of the planning process, and development of catchment vision; ▪ Decide on the planning objectives and key issues; ▪ Identify options and considering alternative scenarios; ▪ Review the draft final catchment plan and agreed with the CMC; ▪ Play steering role for the implementation of the catchment plan; ▪ Develop a framework defining its operations; ▪ Constitute a catchment technical committee and a secretariat; ▪ Interpret the sub catchment management plan for purposes of implementation; ▪ Co-ordinate the implementation of the plan; ▪ Mobilize resources for the plan implementation; ▪ Co-ordinate research; ▪ Evaluate the progress of activities within the plan area; ▪ In collaboration with other stakeholders, develop a code of conduct, regulation guidelines or by laws of the forum; ▪ Identify constraints in the processes of plan implementation; ▪ Identifying and integrating IWRM issues in Development plans; ▪ Produce annual work plans based on the management plan; ▪ Implementation of IWRM interventions;	Representatives of all key stakeholder groups in the catchment including the political and technical leadership of the various administrative units in the catchment (District Top Political leaders, CAOs, Technical Officers at District level Representatives of NGOs, of Private Sector, Youth Platforms, Academic Institutions, Media, Cultural Leaders, Religious leaders, Grass Root Women groups, Water User Groups)

Structures Under WMZ	Roles	Composition
	▪ Supervision and monitoring; ▪ Documentation and information exchange; ▪ Recommend review of CMP plans; ▪ Form an arbitration committee to resolve conflicts.	
Catchment Technical Committee (CTC) *(de-facto the technical arm of the CMO)*	▪ to bring technical experience and knowledge of the sector programs and projects in the catchment to the planning process; ▪ to take responsibility for operationalizing and in some cases implementing programs and projects in the agreed plan; ▪ to oversee and foster inter-District cooperation during the implementation phase.	▪ WMZ team; ▪ Representatives of the line Departments at District (or zonal level) and ▪ Heads of the District service Departments (there are typically multiple Districts in a catchment).
Stakeholder Forum	▪ Policy Initiation; ▪ Represent interests of major stakeholders in the CMO; ▪ Advise and provide information to CMC and CMO; Secretariat; ▪ Review relevant proposals, plans, projects, etc. and initiate proposals; ▪ Review relevant proposals, plans, projects, etc. and initiate proposals, petitions, & other actions;	Representation of District Councils, Farmers Groups, Sub-county representation, Women groups, Relevant Local Government Technical Staff (Environment Committee, Natural resources Committee), NGOs, CBOs and other lead agencies, Registered Water User Associations operators in the CMO.
The Inter-District Steering Forum (*This is an important group since it is essential for the WMZ planning team to ensure that key issues within and across Districts is addressed. Local government is likely to play a major role in implementing the catchment plan*	▪ Enact and enforce, in the context of local government laws and regulations, policies, ordinances and bye-laws related to IWRM and wise use and sustainable management of water and environmental resources; ▪ Participate actively in the development and implementation of catchment management plans for the river/lake basins; ▪ Promote integrated planning in management of land, water and environmental resources; promote and facilitate the mainstreaming of IWRM into District and town development plans, District environmental action plans, poverty	▪ All the chairpersons of District and urban councils; ▪ All the Districts' water and sanitation committees; ▪ All the Districts' environment committees, ▪ All the respective chief administrative officers, ▪ All important

Structures Under WMZ	Roles	Composition
including and beyond the provision of water and sanitation services. Hence, the Inter-District Steering Forum has both an important political and substantive role in the preparation and implementation of the catchment plan)	eradication action plans, District water development plans and other relevant plans; ▪ Carry out monitoring and evaluation of IWRM activities in their respective areas ▪ Raise public awareness within their jurisdictions on water and environmental issues; ▪ Encourage and increase stakeholder participation in the integrated management of water resources; ▪ In collaboration with the WMZ team and DoWRM, resolve conflicts related to use of the water resources.	leaders of business and private sector groups including farmer organizations, fisherman and livestock associations.
The WMZ Advisory Committee (WAC) (*brings together the regional and national partners)*	▪ to ensure that the catchment planning process internalizes the plans, projects and priorities of the various line Departments and their regional units, and ▪ to provide guidance to the WMZ team on sector policy, strategies and priorities.	The NGOs with experience working at catchment and sub-catchment level on a wide range of programs and the aim is to facilitate the integration of this experience into the catchment planning process.
Water Users Association	▪ Coordinate implementation of activities decided in the stakeholder forum and CMC ▪ Make and implement bye laws ▪ Assist the CMC in information dissemination, planning, regulation and enforcement of water resources management activities	Representatives of water user groups
Water Users Group	▪ Responsible for proper use, management and protection of water and related resources ▪ Make and implement bye laws for water resources protection ▪ Make and implement bye laws	Individual water user
other Water related Stakeholders	▪ Responsible for proper use, management and protection of water and related resources ▪ Make and implement bye-laws for water resources protection	Farmers, builders, project developers, brick makers, sand miners, industries, hydro power producers, etc

Table 5.4 - Status of existing WMZ catchment management structures for the Tochi catchment

Irrigation Scheme	Water Management Zone	Catchment Management Organization	Catchment Management Committee	Catchment Technical Committee	Catchment Stakeholder Forum
Tochi	Upper Nile Water Management Zone	not yet constituted	not yet constituted	not yet constituted	not yet constituted

5.5 Other Catchment Management Organizations, Groups and Forums

This Section comes up with a list of additional Catchment Management Organizations relevant for the Tochi catchment (not under the WMZs), Groups and Forums. These are presented in Table 5.5 with roles, effectiveness and challenges these organizations are currently facing.

Table 5.5 - Catchment Management Organizations, Groups and Forums for Tochi, served by river Tochi in Gulu, Omoro, Oyam and Nwoya District

CBO, CMO or CMG	Roles	Effectiveness	Challenges
Cultural/ Traditional and Religious Leaders	• Mobilization and • Sensitization of communities	• Have the respect of their subjects	• Strict adherence to tradition as opposed to adaption of new approaches to development
Agricultural Produce buyers e.g. Mukwano Mt. Meru, Agri EXIM, Ngetta Tropical Holdings Ltd	• Provide ease in accessing farmers • Support farmers in seeds and other inputs in their interest areas • Provide markets for produce	• Can easily mobilize farmer as part of their business partners • Can give support in the distribution of seedlings when carrying out their normal input distribution activities	• Do not directly do conservation as their core business • Engaging them in seedling distribution may because a conflict of interest
PRELNOR Project	• Has component of a community based natural resources management in the area of energy saving technology • Supports the District with the	• Have structures that can be used to mobilize and sensitize the community for environment conservation by working through	• It is just a project which has a defined time frame

CBO, CMO or CMG	Roles	Effectiveness	Challenges
	construction of climate resilient access roads from the run-off rain water and • Identification of reservoirs for water collection	established government structures	
ACOT Cooperative	• Training for agricultural activities and have small irrigation component	• Provide a means of accessing water to farmers during times of scarcity hence • Impart skills to that benefit farmers directly through training Programmes	• Poor attitude on the part of some members to trees planting
AID Africa	• Construction of environmental stoves.	• Give alternatives to destruction of trees for wood fuels. • Give energy efficient cook stoves. • Alternative tree project for trees that are fast growing. • Have nursery beds for trees that are given to communities.	• Communities do not give them he required attention like do not plant, do not attend or care for them. • Slow adaptation with others still stuck to the old three stones
World Vision	• Support development of community disaster risk • (FMNR)- Farmer Managed Natural Regeneration. • promote Soil and water conservation • Promote the use of Energy saving	• Has a community approach of participation in its activities	• Activities are moved by provision of a fee • Adoption is low but when you attach a fee they adopt

CBO, CMO or CMG	Roles	Effectiveness	Challenges
	stoves.		
Refugee Law Project	• Support enforcement (fuel, police allowances) to check illegal dealers in the community • Distribution of trees to institutions for planting	• Works with other stakeholders who have expertise in the area of conservation to achieve their main objectives	• Attitude of the community as new entrants with other established players • Not sure of the future- other funders

6 KNOWLEDGE BASE - PHYSICAL CHARACTERISTICS

This Chapter captures part of the knowledge base of the Tochi catchment, i.e. information on the catchment's physical features. These features are 1) topography, 2) slopes, 3) land use and 4) soils. Wetlands, river banks and open water bodies are described in Section 8.1.2. Data are illustrated with maps, distribution tables and pie diagrams.

The information was formalised in the final version of Volume 1 of the Natural Resources Assessment report of 13 September 2018.

6.1 GIS Data Processing, Mapping

The Landsat Imagery of a spatial resolution of 30m x 30m for the Tochi catchment was downloaded from the website earthexplorer.usgs.gov. In addition, the Aster Digital elevation model of spatial resolution 30m x 30 m of the entire Uganda was also downloaded from the website earthexplorer.usgs.gov.

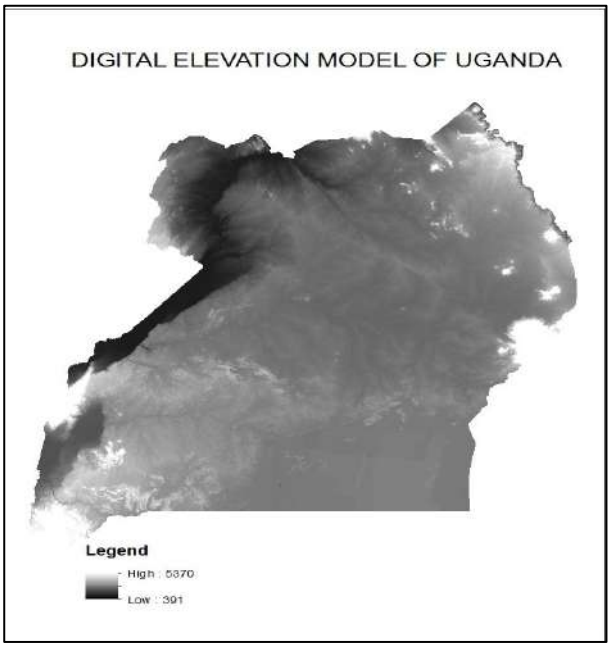

Figure 6.1 - Digital Elevation Model of Uganda

Geographical data information (shapefiles) was collected from various sources as listed in Table 6.1. Data were also collected from the FAO website:

http://www.fao.org/uganda/fao-in-uganda/en/

Other sites for GIS data visited included:

- http://197.254.113.174/layers/geonode%3Aug_act_sep15 (Uganda land degradation data 2015)
- https://freegisdata.rtwilson.com
- http://www.naturalearthdata.com

Table 6.1 - GIS Data

Type of Data	Source of Data
Uganda District Boundaries, 2017	UBOS
Uganda County Boundaries, 2017	UBOS
Uganda Sub-County Boundaries, 2017	UBOS
Uganda Sub-County Boundaries, 2017	UBOS
Uganda Towns, 2017	UBOS
Population, 2014 census	UBOS
Uganda Rivers, Lakes, Wetlands	NEMA
Land Use	NFA
Protected Areas	NFA
Roads	UNRA

The Digital Elevation model was used to delineate the watershed boundary of the Tochi irrigation scheme whereby the drainage area of the Tochi river (which feeds the scheme with irrigation water) was mapped out, including the river network upstream of the scheme intake point. This method is summarized in Appendix 6.1.

6.2 Topography and Slopes

The Tochi catchment covers 1,611 $km^{2.}$ Its topography ranges from around 1,200 m^{+} MSL in the north western corner where the Tochi river has its origin to up to around 1,040 m^{+} MSL near the intake point of the irrigation scheme. The catchment has largely flat slopes of < 7% (92% of the area) with somewhat steeper slopes of up to 15% at the outcrops[4] that appear all over the catchment (8% of the area).

The distribution of the topo and slope classes is shown in Tables 6.2 and 6.3 and Figures 6.2 and 6.3, respectively. The topography and slope maps for the catchment are presented in Figures 6.4 and 6.5, respectively.

[4] Exposures of bedrock or ancient superficial deposits

Table 6.2 - Distribution of Topography Classes

Catchment	Catchment Area (km^2)	Topography (m^+ MSL)	Area in Catchment	
			(km^2)	(% of area)
TOCHI	1,611	1,040 - 1,060	185	11.5
		1,060 - 1,075	394	24.5
		1,075 - 1,085	312	19.4
		1,085 - 1,095	308	19.1
		1,095 - 1,105	226	14.1
		1,105 - 1,120	152	9.5
		1,120 - 1,140	30	1.8
		1,140 - 1,240	4	0.2
Total Tochi			*1,611*	*100*

Table 6.3 - Distribution of Slope Classes

Catchment	Slope Class	Area in Catchment	
		(km^2)	(% of area)
TOCHI	0-7 %	1,479.8	91.8
	7-15 %	129.3	8.0
	15-25 %	1.5	0.1
	25-30 %	0.2	0.0
	>30 %	0.4	0.0
Total Tochi		*1,611*	*100*

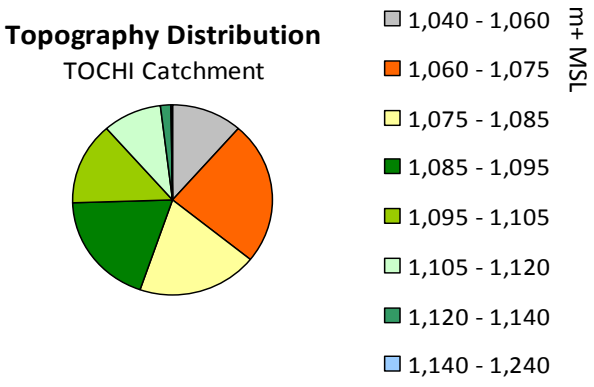

Figure 6.2 - Distribution of Topography Classes

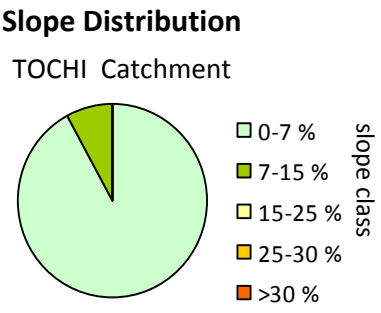

Figure 6.3 - Distribution of Slope Classes

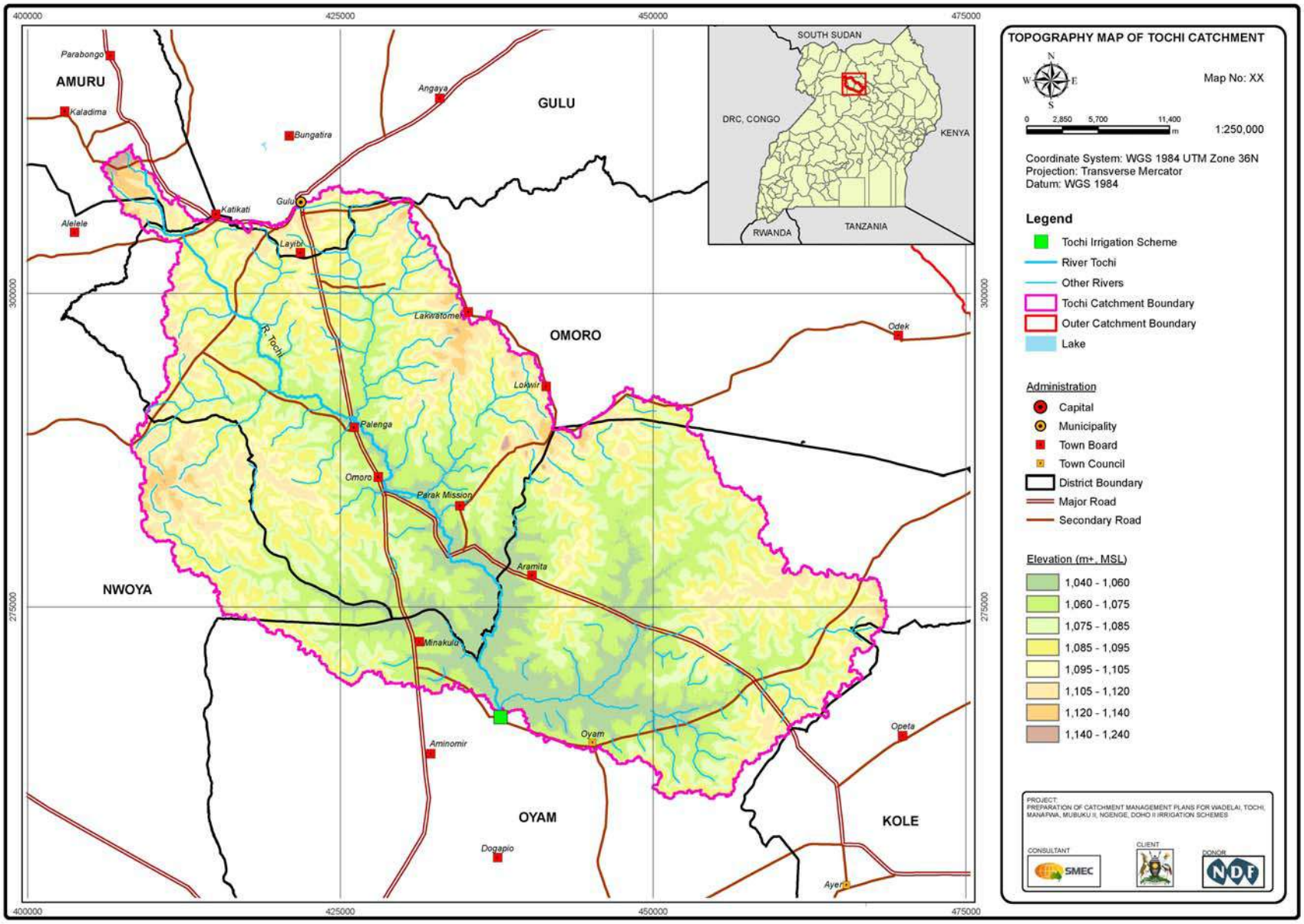

Figure 6.4 - Topography Map

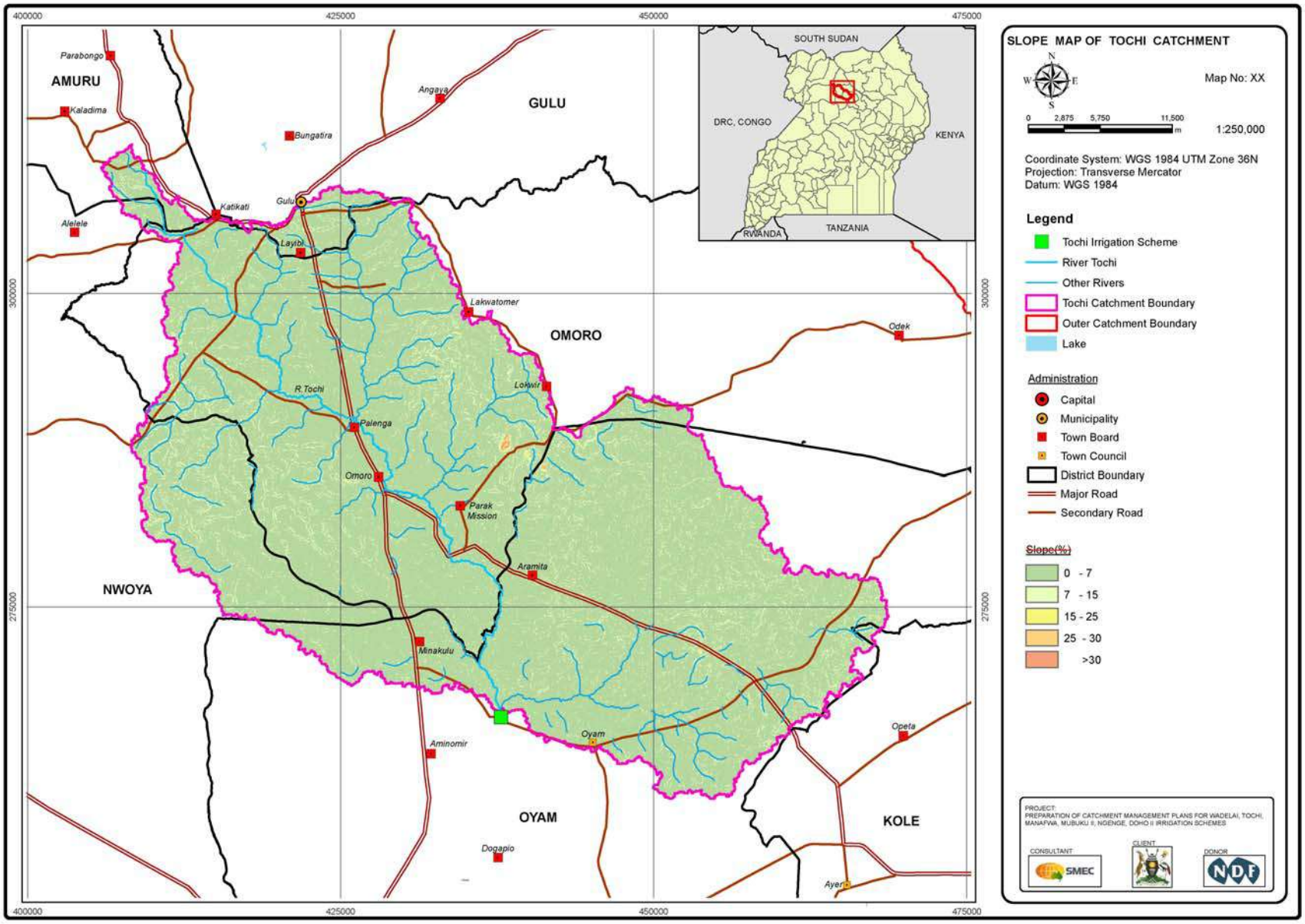

Figure 6.5 - Slope Map

6.3 Land Use

The vast majority of the land, almost 80%, is used as small scale farmland where the population is engaged in subsistence farming alongside livestock. Most grown crops are cassava, beans, maize, *sim sim*, sweet potatoes, sunflower, soya beans, sorghum, and ground nuts. Mostly grown in the first season are soya, maize, beans, cassava, ground nuts, sweet potatoes, sunflower and millet. Wetlands cover 95 km^2 (6% coverage catchment). Forest coverage is negligible whereas woodlands cover 50 km^2. 28 km^2 of the catchment is covered with residential area. A more detailed description of land use is presented in Section 8.1.

The distribution of the land use classes is shown Tables 6.4 and Figure 6.6. The land use map for the catchment is shown in Figure 6.7.

Table 6.4 - Distribution of Land Use Classes

Catchment	Catchment Area (km^2)	Land Use	Area in Catchment	
			(km^2)	(% of area)
TOCHI	1,611	Broad leaved plantations	3.7	0.2
		Built Up Area	27.8	1.7
		Bush	62.9	3.9
		Commercial Farmland	1.9	0.1
		Grassland	84.9	5.3
		Small scale Farmland	1,276.8	79.2
		Tropical high forest low stock	0.9	0.1
		Wetland	95.3	5.9
		Woodland	50.2	3.1
		Others	7.2	0.4
Total Tochi			*1,611*	*100*

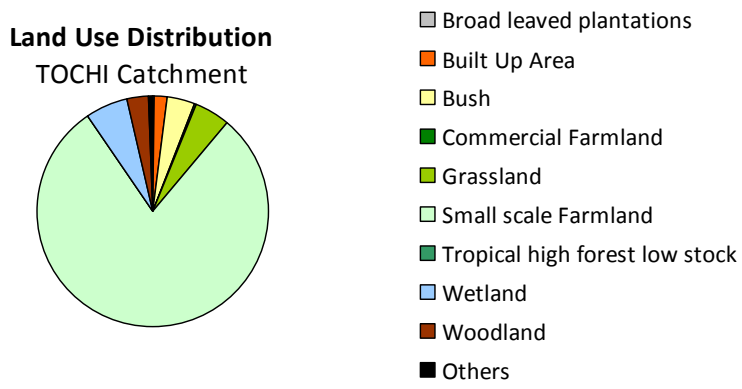

Figure 6.6 - Distribution of Land Use

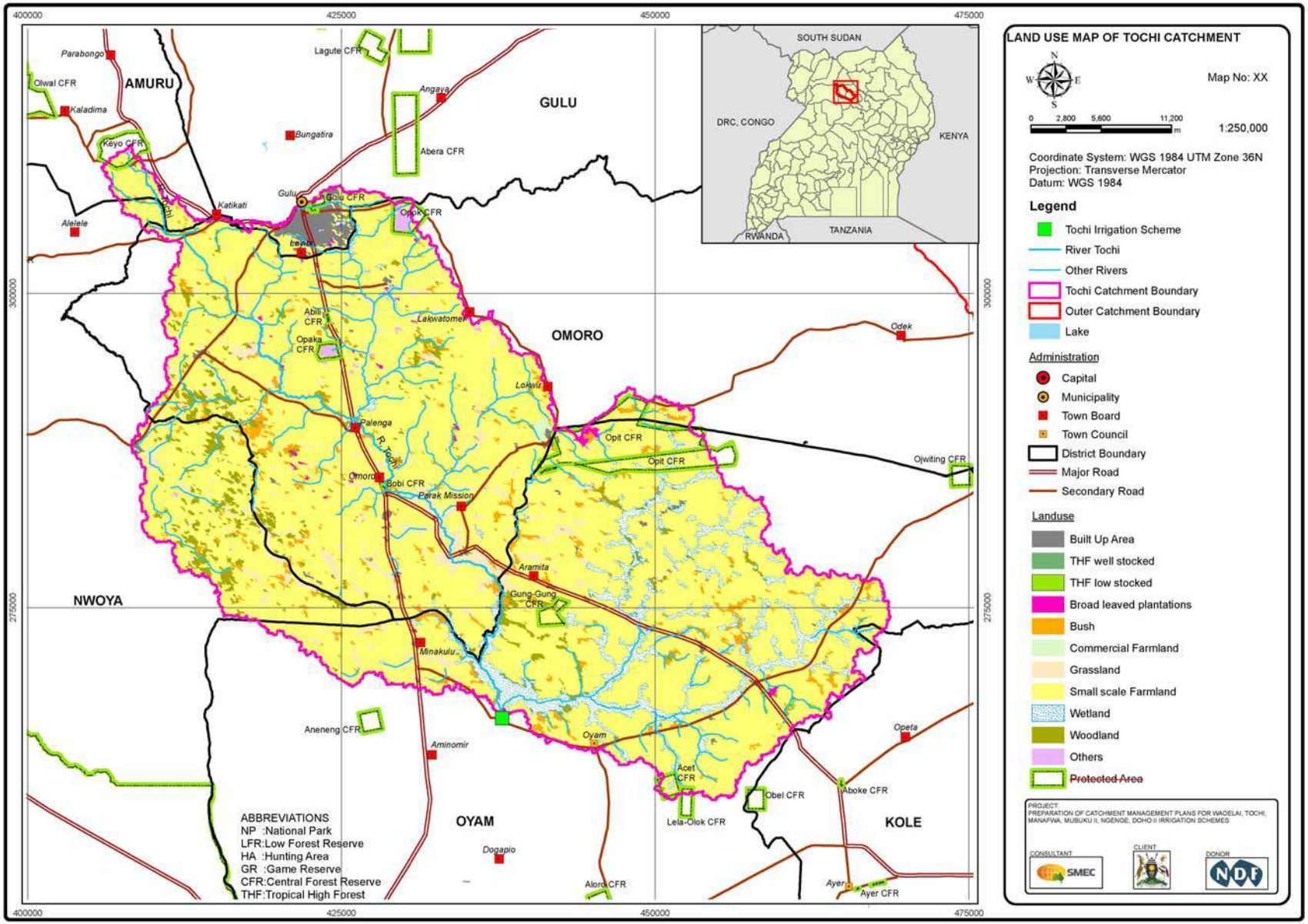

Figure 6.7 - Land Use Map

6.4 Soils

The prevailing soil type in the Tochi catchment belongs to the group of the *Ferrallitic (Lateritic* or *Ferrisols*) soils. The prevailing soil texture is a mixture of sandy loams and sands.

Ferrallitic (Lateritic or *Ferrisols)*
Well drained soils, intensely weathered rock, rich in iron and aluminium. During dry spells the soils become droughty because of the low water storage capacity. Soils are low in pH, low in phosphorous and low in natural fertility. The soil profile is primarily red and patchy yellow-red.

The bulk of all cycling plant nutrients is contained in the upper 10 to 50 cm soil layer. If the process of `nutrient cycling' is interrupted, e.g. after introduction of low input sedentary subsistence farming, the root zone will rapidly become depleted of plant nutrients.

Maintaining soil fertility by manuring, mulching and/or adequate (i.e. long enough) fallow periods and prevention of surface soil erosion are important management requirements (*source: FAO soil map of Uganda (http://www.fao.org/docrep*).

The distribution of the soil classes is shown Table 6.5 and Figure 6.8. The soil map for the catchment is shown in Figure 6.9.

Table 6.5 - Distribution of Soil Classes

Catchment	Soil Type	Soil Structure and other features	Area in Catchment	
			(km^2)	(% of area)
TOCHI	FERRALLITIC SOILS	mainly sandy loams - red	469.2	29
		mainly sandy loams - yellowish	911.2	57
		on sandy sediments - yellowish	230.8	14
Total Tochi			*1,611*	*100*

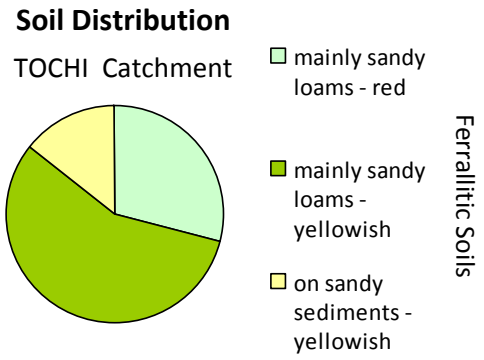

Figure 6.8 - Distribution of Soil Classes

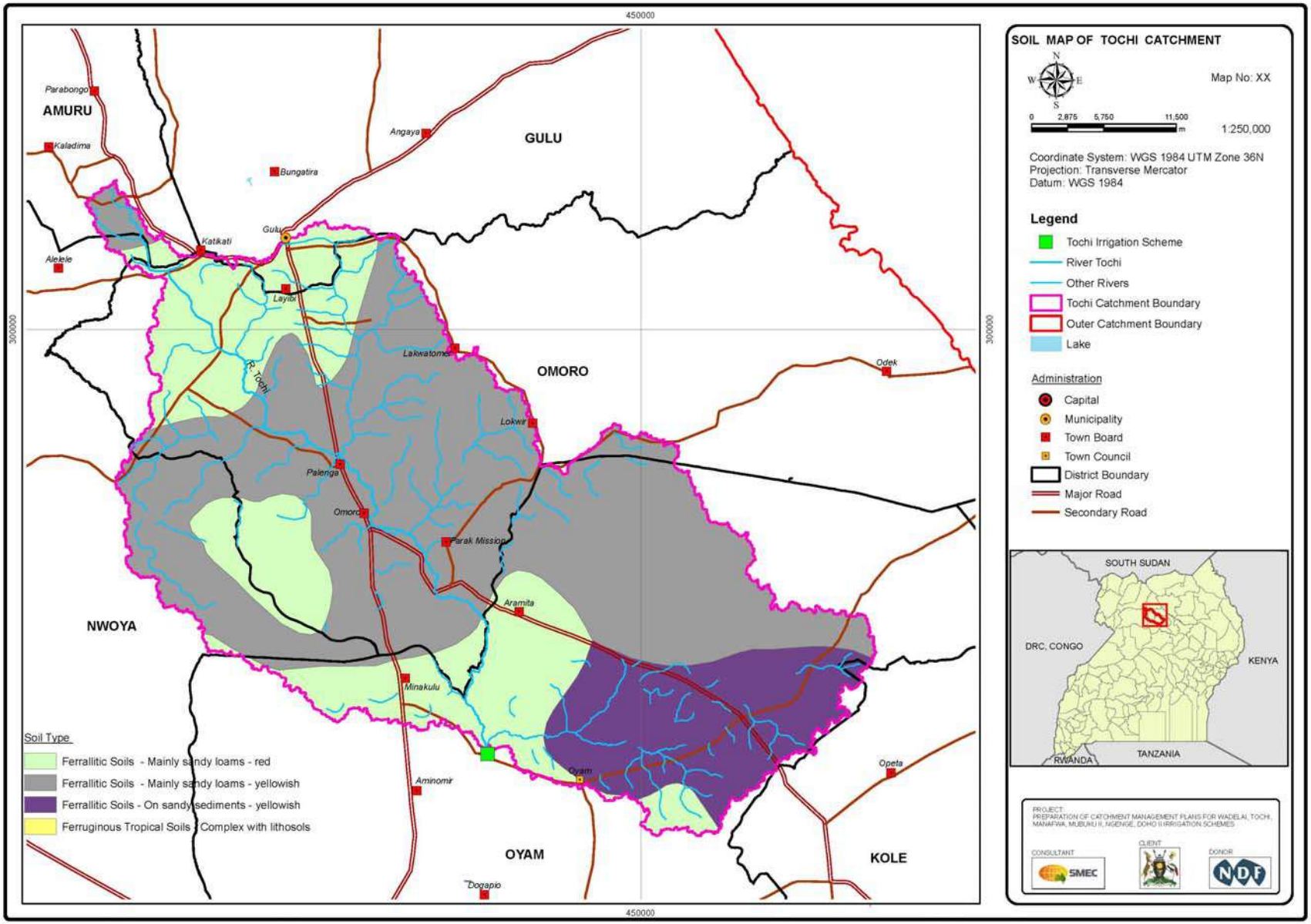

Figure 6.9 - Soil Map

7 KNOWLEDGE BASE - SOCIO-ECONOMICAL CHARACTERISTICS

This Chapter captures a synopsis of the catchment's Knowledge Base where it concerns the data base on social and economical features including an analysis of the challenges and mitigation measures.

The information was formalised in the Strategic Social and Environmental Assessment report of 20 September and in Volume 1 of the Natural Resources Assessment report of 13 September 2018.

7.1 Social Challenges and Mitigation Measures

The social challenges for the Tochi catchment were identified during literature review, stakeholder meetings and field visits. Most of these are related to poor farming methods, bush burning, population pressure, land tenure, education, gender, cultural practises, refugees and transboundary issues. Many of these challenges are directly linked to the on-going environmental degradation in the catchment. As such additional information is included in Chapter 8 where the environmental challenges are discussed.

7.1.1 Poor Farming Methods

More than 60% of the private land in the Tochi catchment is under substance farming where farmers use rudimentary tools to cultivate various types of crops. In most of the farms, farmers practice mono-cropping cultivation season after season and this results in soil exhaustion. In the long run, the farmlands are rendered unproductive with the population increasing.

Possible future impact of poor farming methods if not mitigated

- Reduction in production and productivity as a result of nutrients being depleted and being washed downstream;
- Food insecurity;
- Risk of less healthy citizens who may be susceptible to diseases (as a result of deteriorating food security situation);
- Sedimentation of streams and rivers in the catchment which, in turn, will degrade the water quality and eventually may fail the scheme to function due to high silt deposition in the canals;
- Risk of eutrophication of water sources downstream; this reduces the potential of these sources to sustain fish and other aquatic organisms.

Proposed mitigation measures

- Government to sensitize farmers for promoting Soil and Water Conservation measures on private and Government farmlands. Such measures include careful tillage, crop rotation, contour ploughing, terracing, strip cropping, mulching and others as defined in Volume 3 of the final version of the Natural Resources Assessment report of 13 September 2018 (see also Section 11.10);
- Government to train MoAAIF, DLG extension staff in Soil and Water Conservation (SWC) at the Sub-County level who will in turn train trainers;

- Ministry to roll out sensitization of population about dangers of poor farming and the need to conserve soil structure;
- Government to roll out agro-forestry and support woodlot establishment for landholdings with a capacity of more than five acres;
- Government to establish Catchment Management Committees at village level that will be used to channel the SWC training packages and information to the communities at the village level;
- Government to identify and support other livelihood activities (other than over reliance on subsistence agriculture) in accordance with the preferences and needs of the benefiting communities.

7.1.2 Bush Burning

Bush burning is commonly done by cattle grazers in the hills and savannah grasslands and woodlands along the Tochi catchment area and is severe during the dry season. It is normally intended to burn mature grass to rejuvenate fresh pasture for animals. Bush burning was noted to be severe in the catchments. It was also observed that people occasionally set up fires to burn large chunks of land without having any goal to do so. Uncontrolled and indiscriminate bush burning was mentioned as one of the major environmental challenges especially in the Omoro, Oyam and Nwoya Districts. The fires go wild and destroy cassava gardens and planting materials for the next season. On several cases, these fires destroy young forest plantations especially pine trees. This results in immense losses to farmers and other investors. Uncontrolled bush burning can also destroy the ecosystems through the killing of the biodiversity and preventing the natural regeneration.

Future impact of indiscriminate bush burning if not mitigated

- Destroying property, homes and lives;
- Promoting soil erosion with adverse effects on the catchment;
- Altering biodiversity in the catchment, risking some species to disappear or to go into extinction;
- Reducing the water holding/retaining capacity of soil and, as a result, reducing the base flows of streams;
- Increasing soil temperature which affects the activity of micro-organisms and hence reducing soil productivity;
- Affecting soil structure and nutrients availability;
- Prolonging droughts due to loss of ground cover;
- Releasing large amounts of smoke into the air, causing air pollution; ash and smoke can cause serious health problems to humans who suffer from allergies and other medical problems.

Proposed mitigation measures

- Government to put in place ordinances and by-laws on bush burning with clear punitive measures to those who set uncontrolled fires. In this regard, the community should be advised to carry out bush burning only in their areas of jurisdiction beyond which penalties should be affected to the offenders regardless of the impact of the fire;
- Communities should be continuously sensitized on the dangers of bush burning by setting up public (prevention) bush fire programs;

- Public awareness on risks of bush fires by issuing warnings in the event of weather conditions favouring bush fires;
- Continuously sensitizing communities on improved farming methods.

7.1.3 Population Pressure on Land

Population pressure on land is one of the leading environmental issues in the Tochi catchment. According to the National Population and Housing Census of 2014, the annual population growth rate was 3.0% and the total fertility rate was 5.8 children per woman. These rates explain the high population pressure exerted on land especially in the rural areas of the catchment. This has been exacerbated by high poverty levels which have pushed communities to encroach on the available Natural Resources. This in turn has led to massive forest degradation, encroachment of protected areas as the Forest Reserves, wetlands and swamps and river banks in search of more land for cultivation.

Secondly, communities in search for alternative livelihood sources have invaded Natural Resources in activities such as sand mining along the river banks causing indiscriminate tree cutting for brick baking, charcoal and fuel wood. Other activities include the operation of washing bays inside and along rivers, the direct utilization of rivers for domestic activities like washing, bathing and water for domestic use. Discussions with stakeholders reveal that these activities are far from being regulated or controlled due to the weak implementation of laws that have been worsened by political interference.

The population growth rate, if not controlled, will lead to continued pressure on land and Natural Resources for survival. With 80% of the population in Uganda still depending on agriculture as the main source of income and livelihood, land degradation and continuous encroachment on the Natural Resources (including the river banks) will reach a worse off level. This situation applies now to the Tochi catchment and will lead to continued siltation of streams and irrigation channels of the Tochi scheme as well as to flooding of the scheme and the lower lying areas surrounding it.

Proposed mitigation measures

- In the short term, communities to be encouraged to adopting modern farming practices that maximize productivity including integrated land and soil management systems such as the construction of contours along hilly slopes and the planting of grass bunds and hedge rows;
- Communities to be encouraged and guided to starting other livelihood options such as: agro-forestry, apiary farming (honey beekeeping), passion fruits growing, dairy cows, poultry, piggery and goat and other options that do not necessarily result in extensive land clearing.
- Government to be encouraged promoting block farming where a group of farmers are guided to produce and market a single commodity;
- Government to formulate a policy that should discourage land fragmentation. Such policy would be hinged on the notion that off-springs would inherit land from their parents in shares rather than physical land. This principle would curb land fragmentation and promote commercial farming;
- Government to continue investing heavily in educating all children. Now the majority of people who went to school tend to produce fewer children compared to those who have not. Generally educated people tend to plan their families better. Also the school

system tends to delay people from involving in early marriages which in turn reduce the potential in producing many children;

- Government to continue sensitizing population on family planning;
- In the long run, there is need to develop a holistic approach of comprehensively understanding the land availability and degradation issues in order to come up with the right policies. As a country Uganda should strive to move away from entirely depending on land/agriculture by encouraging communities starting seriously looking at other sources of livelihood. Communities should gradually start moving away from peasantry to commercial farming. The revival of cooperatives shall help in marketing of produces and by doing so, the gradual elimination of middlemen who usually take advantage of poor farmers.

7.1.4 Land Tenure Systems

The main land tenure system in the Tochi catchment is customary. Customary land tenure is a system that places emphasis on use rather than ownership and the rights to control and use are derived from being a member of a given community and are retained by performance of certain obligations in the community. Most of the users of such land do not own titles but are legally recognized as the owners. In this system, land is owned communally and is passed on to the next generation through sub-divisions among the sons leading which generally leads to land fragmentation. This practice is largely responsible for subsistence farming and hence low agricultural outputs resulting in continue people living in a vicious circle of poverty. This kind of system has kept communities clinging onto land as the main source of livelihood. This in turn has led to land and river bank degradation, soil erosion etc.

The Ministry of Lands, Housing and Urban Development is implementing a systematic demarcation of customary land through the Land Sector Strategic Plan (LSSP) 2001-2011, aiming at improving land availability, accessibility, affordability and the effective use of land information for planning and implementing of new development programs. Once successfully implemented, people owning land under the customary tenure will be able to get a Certificate of Customary Land Ownership that will enable them to utilize their land in a more profitable manner including being able to access loans for development.

7.1.5 Education

Educational attainment is an important indicator of the society's stock of human capital and level of socio-economic development. The multi-dimensionality of poverty implies that non-literate people become harder to reach; they get isolated from rapid information and communication advances and become marginalized in powerful modernizing processes.

Literacy can act as a mechanism of social inclusion, as a tool for empowerment and direction for participation. Illiteracy as a dimension of poverty, inequality and exclusion needs to be tackled in its own right. This is because illiteracy has a negative impact on the distribution aspects of opportunities, scale of economic, social and political growth eradication measures.

It is well known fact that when girls stay at school up to a higher level, they automatically delay the time of starting to produce children leading to automatic family planning. However, in the rural areas of the Tochi catchment, only 20% or less of the girls finish

primary level education due to the high levels of school drop outs caused by early marriages and unwanted pregnancies.

Mitigation

As the saying goes "Education is the Key" a lot more emphasis should be put in narrowing the school drop-out rates now associated with Universal Primary Education especially for the girl child. During consultations in the Tochi catchment, most stakeholders echoed that the adaptation rate of new interventions is low due to the low education levels of communities. Education of the girl child up to the tertiary level delays the conception time for girls. In addition, it also leads to a higher uptake of contraceptives hence controlling the number of children per woman to less than 5.8 children according to the National statistics.

7.1.6 Gender Analysis

Women are important stakeholders in agriculture and water management; they play a key role in water and land conservation, rainwater harvesting, and watershed management. Women also play an important role in both irrigated and non-irrigated agriculture. A larger number of women than men are engaged in rain-fed agriculture meanwhile producing two thirds of the food. According to the latest FAO estimates, women account for an average of 43% of the agricultural labour force in developing countries but in spite of this, water policies related to agriculture continue to wrongly assume that farmers are men, thus marginalizing women in Water Resource management.

Women play a major role in productive pursuits, including crop and livestock production processing and small enterprise operation, as well as in domestic and social activities. Rural women are the predominant target group due to their responsibilities in interventions related to health welfare, household nutrition and conservation. They will also play a leading part in the District Development activities of Oyam, Nwoya, Kole, Gulu and Amuru which aim at increasing the opportunities of the rural population to start up new businesses, diversify and expand the household level economic base.

Women have proved themselves interested in and capable of taking on an entrepreneurial role that enhances family income and well-being thereby diverting some attention away from land. Their principle involvement to date has been in small agricultural and livestock ventures and in businesses trading of farm produce and inputs and household requisites. With encouragement, it is foreseen that they will be able to expand this involvement and start to contribute in a more formal way to community and village planning and development.

7.1.7 Cultural Practices

Uganda has a diverse culture. It encompasses various religions, tribes, traditions and beliefs, value systems and languages among others. Uganda's population is made up of different ethnic groups with unique customs and norms. These play a major role in shaping the behaviour and ways of life of the people in the country. Lately, some of the traditional values have changed due to the integration of the people as a result of migration and/or inter marriages. Some cultural groupings are headed by traditional kings or chiefs who are not politically elected but have an indirect role in community governance and moral build up. Language is one of the uniting factors in any society. In Uganda, while English is the official language, there are a number of other languages spoken. However, Swahili is being

promoted in the spirit of regional integration within the East African Community (EAC). Uganda's constitution allows freedom of worship. There are various religious groupings in the Country. The catchment Districts Oyam, Nwoya, Kole, Gulu and Amuru have legally recognized cultural instructions and leaders. For example, the Acholi have a cultural leader known as the Paramount Chief 'Rwoth".

During consultations with several stakeholders it was noted that strong beliefs have greatly impacted on how communities perceive and absorb some of the new interventions brought on board regarding the Natural Resources conservation. Cultural practices such as land inheritance where people believe that since their ancestors used to own and farm the same land therefore Government has no authority to regulate any activity on that land. The continued use of traditional methods and tools of land cultivation and hence maintaining these in a subsistence way of farming leads to a low uptake of new interventions.

Some communities have a strong believe that they should be buried among their ancestors making it difficult to resettle them away from the fragile ecosystems.

Mitigation

It is recommended to conduct sensitizations on catchment interventions starting with the cultural leaders (heads of cultural institutions) and use them for mobilization communities during the introduction of the new interventions. This would produce better results rather than using the technical, Government staff since communities tend to believe more in their cultural leaders.

7.2 Economic Activities and Road Infrastructure

Most economic activities in the Tochi catchment are related to agriculture as discussed before in Section 6.3 under Land Use.

Industry, Trade

Processing of agricultural produce, especially grain milling and hulling dominates the industrial sub-sector. Retail trade leads in the trade sub-sector. Almost all enterprises are located in trading centres, markets and play an important role in the development of the Districts in the catchment.

Road Infrastructure

The roads in the Tochi catchment are at the National, District and feeder road level. The National and District roads are under the management of the Uganda National Roads Authority and the feeder roads are under the management of the Districts and the corresponding Sub-Counties.

Most of the unpaved roads are dry weather earth roads with minimal maintenance. The only paved roads passing through the catchment are the Kamudini - Gulu road and sections of the Kamudini - lira road. The District roads in the area include the Bobi - Omor road and the Gulu - Omor road.

8 KNOWLEDGE BASE - ENVIRONMENTAL CHARACTERISTICS

This Chapter captures a synopsis of the catchment's Knowledge Base where it concerns information on the environmental features and challenges of the catchment. Information was gathered through a:
1) situation analysis of the catchment's environmental features; and
2) analysis of the environmental challenges with proposed mitigation measures.

This information was formalised in the Strategic Social and Environmental Assessment report of 20 September 2018 and in Volume 1 of the Natural Resources Assessment report of 13 September 2018.

8.1 Situation Analysis of Environmental Characteristics

8.1.1 Land Cover/Use of Private Land

Private land within the catchment of Tochi covers approximately 142,500 hectares (352,100 acres) accounting to 88.4% of the total land in the catchment. Land use on private land is further divided into subsistence farmland (agricultural fields & private forestry), grassland and bush & woodland.

Farmland and Forestry

On the private land, agricultural fields and patches of private wood lots account for about 76.3% of the land used in the Tochi catchment. Cultivation is by means of hand hoes and small areas (about 1-5 acres) are being tilled. In the Gulu, Oyam and Nwoya sections of the catchment, farmers cultivate annual crops such as maize, beans, cassava, millet, groundnuts, sunflower and rice among others. Block farming is being encouraged in the Omoro District with farmers tilling more than 50 acres of land to cultivate and market a single crop as a group. For example, 100 acres of maize is being grown in the Bobi Sub-County, 120 acres is being planned for soya beans in the Lalogi Sub-County and 50 acres of cassava in the Lakwana Sub-County.

In the Omoro District, land holdings in the Sub-Counties, close to Gulu town such as Ongako and Koro, are about 2-5 acres per household. However, landholdings in the rest of the Sub-Counties such as Lalogi, Lakwana and Bobi are estimated at 10-15 acres per household. In the Nwoya District, the landholdings in the Koch Goma Sub-County were estimated at 10 acres per household. In the Oyam District, the average land holding was estimated at 6-7 acres. Generally, the average landholding in the entire Tochi catchment is at least 6 acres or more.

Forest plantations on private land have been estimated at 5% in the whole of the Tochi catchment. The general tree cover for the entire catchment has been estimated at 30%. Patches of plantation forests are observed in private farmlands ranging from less than 1 to 8 acres in some areas. Tree species planted include *Tectona gradis, Eucalyptus spp, Grevelia robasta, Terminalia Spp, Pinus spp and Azadrachita indica among others.*

Bush and Woodland Savannah

Bush and woodlands account for 6.8% of private land. Patches of woodland savannah are scattered in several areas of the Nwoya and Omoro Districts, especially in the Sub-Counties of Koch Goma and Ongako, respectively. In the Oyam District, woodlands are concentrated in some areas of the Ngai Sub-County, especially in the Omach and Aramita Parishes and parts of the Myene Sub-County in the Zuma and Myene Parishes. Woodlands are continuously exploited by the local communities as sources of firewood, charcoal, timber and poles. These are also grazing areas especially for goats. Some of the common tree species that were observed in the private woodlands including those scattered in the farmlands around homesteads are presented in Appendix 8.1.

Grassland Savannah

Grasslands constitute of 5.2% of the entire private land in the catchment. The grassland savannah vegetation is characterized by open canopy of trees 10-12 meters high and underlying grasses of 80 centimeters high. The common tree Genus/species include; *Acacia, Ficus natalensis, Combretum boanasus, Aethicupum* (fan palm) while the common grasses include *Imperatus cylidrnia, Hypenaria fufa, Digitria scalarum, Themeda triandra,* lemon grass, Bermuda grass, Common finger grass (*Digitaria eriantha)*, purple plume grass (*B. bladhii*), pinhole grass (*B. insculpta*) and stinking grass (*B. radicans*). There are also some herbs like *Bidens pilosa, Ageratum conizoids, Amarunthus species* Eucalyptus, *Jacaranda, Cipressus, Theruvian, Pines, Hibiscus, Eougainvillae, Plamthoyant, combretum* and *Lantaraa camara*. One of the key environmental challenges with grasslands is continuous bush burning to rejuvenate pasture for animals. This practice interferes with natural succession of the ecosystem and exposes the ground to soil erosion. In some area, the vegetation may change or even fail to recover after severe fires. Bush burning was raised as one of the key environmental challenges in the Omoro District because these wild and indiscriminate fires burn substantial chunks of land, thus destroying gardens, forest plantations and cassava planting material for the next season. Grasslands are exploited as key grazing areas in addition to being used as sources of raw materials for thatching houses, stove construction, broom making and mulching.

8.1.2 Land Cover of Protected Areas

Protected areas in the Tochi catchment include the Central Forest Reserves, Local Forest Reserves, wetlands, river banks and open water bodies. The total area under protection was estimated at 18,750 ha constituting of 11.6% of the Tochi catchment.

Forest Reserves

The Tochi catchment comprises of 18 protected forest ecosystems of which 10 are under the NFA (Central Forest Reserves only) and eight are Local Forest Reservess under the District Forest services. The total percentage of protected forest ecosystems in the catchment is 5.9%. Table 8.1 presents sizes and locations.

Table 8.1 - Forest Reserves in the Tochi catchment

S. No	Name of forest reserve	Area (ha)	Sub-County	District
Central Forest Reserves				
1	Acet	256	Acaba	Oyam
2	Lela-Olok	215	Acaba	Oyam
3	Gung Gung	303	Ngai	Oyam
4	Bobi	5	Bobi	Omoro
6	Opit	1,593	Ngai, Abok & Lalogi	Oyam & Omoro
5	Opaka	208	Koro	Omoro
7	Opok	536	Koro	Omoro
8	Abilli	5	Koro	Omoro
9	Gulu	94	Laro Division	Gulu
10	Keyo	781	Lamogi	Nwoya
Local Forest Reserves				
11	Aber	10	Aber	Oyam
12	Achaba	6	Acaba	Oyam
13	Atura	8	Aber	Oyam
14	Iceme	16	Iceme	Oyam
15	Ngai	3	Ngai	Oyam
16	Otwal	5	Otwal	Oyam
17	Anyeke	5	Acaba	Oyam
18	Ngunyboke	3	Loro	Oyam

Specific land cover for each of the Forest Reserves

Most of the government forests in the Tochi catchment are being managed as plantations. Some have been leased to private tree planters while others are being planted and managed by NFA. Majority of them have unclear boundaries and have been encroached for agricultural activities by the surrounding communities. Appendix 8.2 presents the status of each forest reserve and proposed future management option to improve or restore its integrity. It presents the level of degradation in percentages per forest. Therefore, the higher the degradation, the higher the priority attached to that forest in terms of restoration needs.

Wetlands, River Banks and Open Water Bodies

The major wetland in the catchment is the Tochi river wetland system which spreads widely in the Oyam and Omoro Districts. Other wetlands and open water bodies in the Tochi catchment are strips of wet vegetation along river Tochi and its tributaries. The total area under wetland and open water body is about 9,240 hectares which is approximately 5.7% of the entire area.

The biodiversity in these wetlands consists of various species of fish, mammals, dragon flies, birds, molluscs, reptiles and macrophytes. Papyrus and other wetland plants have commercial value and many other plants are used for medicinal purposes. Other vegetation types (macrophytes) include phragmites, typha and sedges. The wetlands are important as a breeding ground for some species of fish. Mud fish is especially found in the wetlands and is a delicacy for the local population.

However, a lot of illegal human activities such as over-cultivation, burning, overharvesting of the wetlands resources, brick making, settlements and urbanization is degrading the wetlands. There is need, therefore, to have strategies to restore and conserve the degraded wetlands before they are lost to unsustainable developments. This degradation is excarcabated by the effects of climate change that induces the drying up. Stream sedimentation is very high during the rainy seasons due to cultivation up to the river banks.

Figure 8.1 - Local fishing activities in the river Tochi wetland system (source: SMEC, 2018)

8.1.3 Trading Centre and Rural Growth Centres

Trading centres here refer to planned and non-planned commercial areas in the catchment with sizable and congested settlements to the level of a Town Council or Municipal Council. Rural growth centres are upcoming town ships that have the potential to become Town Councils by 2025. Therefore, the following towns (about 4.2% of the total catchment area) whose size was estimated using Google earth constitute the actual area of the Tochi catchment under trading centres and rural growth centres.

Unless appropriate interventions or investment options are put in place, future expansion of existing towns and growth of new ones will impact negatively on the integrity and capacity of the catchment to sustainably supply water for the irrigation scheme.

Expansion for townships is usually associated with vegetation clearing, poor waste management practices and pollution from various sources which may eventually affect the quality and quantity of water in the catchment. Table 8.2 presents the area occupied by towns and trading centres in the Tochi catchment. None of the towns listed below has a gazetted and centralised waste management system.

Table 8.2 - Major towns and trading centres in the Tochi catchment

No	Name of Town or Trading Centre	Size (ha)	% size catchment	District
1	Gulu Municipal Council	4,244	2.634	Gulu
2	Palenga Town Council	71	0.044	Omoro
3	Abili Trading Centre	195	0.121	Omoro
4	Lalogi Trading Centre	56	0.035	Omoro
5	Oyam Town Council	293	0.182	Omoro
6	Minakulu Town Council	737	0.457	Oyam
7	Iceme Trading Council	722	0.448	Oyam
8	Ngai Trading Centre	413	0.256	Oyam
Total area under trading centres		**6,731**	**4.2**	

Figure 8.2 - A burrow pit near a wetland being used as a final solid waste disposal site for Gulu Municipality (source: SMEC, 2018)

8.2 Analysis of Environmental Issues and Proposed Mitigation Measures

Several environmental challenges were identified in the Tochi catchment. These are:

- Deforestation;
- Soil Erosion;
- River Bank Cultivation and Wetland Encroachment;
- Floods;
- Invasive Species;
- Pests and Diseases
- Pollution from Agrochemicals (fertilizers, pesticides, insecticides, etc);
- Poor Waste Management; and
- Drought and Climate Change.

8.2.1 Deforestation

According the report on The State of Uganda Forestry 2016, Uganda's vegetation cover (trees, forests and woodlands) significantly has reduced from 45% in 1890 to about 9% in 2015, due to the ever-increasing pressure and demand exerted by the rapid population growth and economic activities. Fuel wood supplies have been rapidly decreasing due to population growth and agricultural expansion which has in turn led to increased deforestation. According to NEMA 2011, 58.9 % of the firewood used for cooking is obtained from natural forests and trees growing naturally on farm, and 34.6 % is collected from plantation/planted forests. This shows that households rely on natural systems for fuel wood rather than plantations. This scenario is not sustainable and has resulted in rapid degradation of woodlands and other patches of natural forests in both government and private land. Deforestation is mainly due to intensive charcoal burning and land clearing for agriculture and settlements.

Future impact of deforestation if not mitigated

- Deforestation will result further into acute deforestation in the catchments.
- The cost of maintaining the irrigation schemes will be unsustainable due to high silt & solid waste levels in the canals. This would eventually result in the closure of the irrigation schemes;
- The pressure on protected areas by 2040 is likely to result in a full-scale conflict with the communities surrounding protected areas and this will affect the tourism industry severely;
- The cost of protecting the Central and Local Forest Reserves will be inevitably high and NFA may eventually end up leasing most of the Central Forest Reserves to private tree planters. This will further accelerate complete depletion of Central Forest Reserves;
- Acute deforestation will result in excessive soil erosion, floods but after, streams will dry up and drought will set in sparking several environmental, economic and social problems associated with lack of adequate water to run human and environmental systems;
- Scarcity of fuel wood and acute environmental degradations is likely to result in high crime rates and high levels of lawlessness due to scarcity of resources to meet basic needs.

Proposed mitigation measures

- Government needs to support & increase fuel wood supply to a sustainable level on private land. This can be achieved by formulating a policy that should discourage land fragmentation. Such a policy would be hinged on the notion that off-springs would inherit land from their parents in shares rather than physical land. This principle would curb land fragmentation and promote commercial farming. Secondly, government needs to support & monitor massive tree planting activities per Sub-County by availing adequate and quality seedlings to the communities as well as seedlings to be procured locally in the host Sub-Counties;
- Government needs to increase efficiency of fuel wood utilization along the supply and consumption chain. This can be done by investing in training the population on energy saving kilns and stoves;
- Reducing the fuel wood consumption rate per household by investing and sponsoring other energy sources such as gas, biogas, solar and electricity;
- Government needs to support & improve other livelihoods options with less impact on vegetation clearance. These may include Value addition on agricultural products by increasing shelf life, bee keeping, zero grazing & poultry, supporting village SACCOs with credit, extending electricity to rural areas, supporting irrigation schemes, tea farming and others following the needs of the community;
- Enforcing the law by evicting all encroachers out of the protected areas. This can be achieved by facilitating the NFA field staff to do their work, seeking political support at all levels. It is also recommended that NFA stops further the leasing of CFRs to private tree planters;
- Government to invest in education and family planning.

8.2.2 Soil Erosion

Soil erosion is the washing away of top soil either by running water, wind or poor tillage practices. One of the main causes of soil erosion is water erosion, which is the loss of topsoil due to rainfall. Raindrops fall directly on topsoil. The impact of the raindrops loosens the material bonding it together, allowing small fragments to detach. If the rainfall continues, water gathers on the ground, causing water flow on the land surface, known as surface water runoff. This runoff carries the detached soil materials away and deposits them elsewhere. Soil erosion is one of the biggest threats to the Tochi irrigation scheme because it will result in the sedimentation of irrigation canals and hence in high maintenance costs.

There are different types of soil erosion caused by water. These are:

Sheet Erosion

Sheet erosion is erosion that occurs fairly evenly over an area. As raindrops loosen the soil, the surface water runoff transports topsoil in a uniform fashion, almost like a bed sheet sliding off of a bed. This can be so elusive that it might not even be noticed until much of the valuable, nutrient-rich topsoil has already been washed away.

Rill Erosion

Rill erosion is erosion that results in small, short-lived and well-defined streams. When rainfall does not soak into the soil, it can gather on the surface and run downhill, forming small channels of water called rills. A rill will dry up after the rainfall, but you may still see the stream bed that was created by the temporary stream.

Gully Erosion

Gully erosion can be thought of as advanced rill erosion. In fact, if rills are not addressed, they will grow into larger gullies. Gully erosion can spell big problems for farmers because the affected land is not able to be used for growing crops, and the big ditches create a hazard for the farmer driving his farm machinery over the fields.

River Bank Erosion

Bank erosion is another type of water erosion and is defined as erosion of the bank of a stream or waterway. Surface water runoff always moves toward the lowest level due to gravity. Therefore, low-lying streams, rivers and even constructed drainage channels collect water runoff. However, over time, this water activity and other forces naturally wear down the banks lining the waterways.

Future impact of erosion if not mitigated

- Reduction in production and productivity as a result of nutrient being washed downstream;
- It will result into sedimentation of streams and rivers in the catchment which in turn degrades the water quality and eventually may fail the scheme due to high deposition of silt in the canals;
- There is potential for causing eutrophication of water sources downstream and this reduces the potential of the source to sustain fish and other aquatic organisms;
- Pollution of streams is likely for example with residues of pesticides and herbicides used on farmland;
- It may accelerate mudslides if not mitigated.

Proposed mitigation measures

- Government is advised to sensitize farmers to promote soil and water conservation measures on private and government farmlands. Such measures include careful tillage, crop rotation, contour ploughing, terraces, strip cropping, mulching and others as defined in the interventions report;
- Ministry to roll out massive sensitization of the population on the dangers of soil erosion and the need to conserve soil structure;
- Government to roll out massive Agro-Forestry in the catchment and supports woodlot establishment for catchment zones that have a landholding capacity of more than five acres;
- Government to establish catchment management committees at village level that will be used to channel training packages and information to the communities at village level;
- All river banks to be marked and protected with appropriate vegetation cover;
- Government to identify and support other livelihood activities other than over reliance on subsistence agriculture in accordance with the preferences and needs of the benefiting community;
- Hotspots along rivers to be protected using civil measures such as check dams, gabions, and stone pitching;
- Formulation of more bylaws on river bank protection and enforcing the existing ones;
- Rain water harvesting at homestead level to minimize water that goes into the fields;
- Improved and well directed drainage system in the townships can greatly reduce surface water and eventually control soil erosion.

8.2.3 River Bank Cultivation and Wetland Encroachment

Despite the fact that wetlands and river banks are supposed to be no go zones for farming and other non-permissible activities, the general observations on the status of wetlands in the Tochi catchment was that most of these are heavily degraded and encroached by farming activities up the nearest water mark. Other degrading activities include brick making, sand mining and extraction of wetland flora such as papyrus. This has affected the capacity of the wetlands and river banks to perform their functions.

Possible future impact of river banks and wetland encroachment if not mitigated

- It will result into sedimentation of streams and rivers in the catchment which in turn degrades the water quality and eventually may fail the scheme due to high deposition of silt in the canals;
- It results in floods;
- Stream bank cultivation accelerates stream bank erosion which further threatens the survival of irrigation scheme downstream;
- Degradation of wetlands results in drying of streams over time;
- It results in loss of biological diversity.

Proposed mitigation measures

- Remove all encroachers out of wetlands and river bank buffer zones;
- Demarcate all wetlands and river bank boundaries with appropriate tree species;
- Stabilize all buffer zones with vegetative measures using appropriate plant/grass species such as bamboo, elephant grasses and phragmites;
- Sensitize the population to appreciate the importance of conserving wetlands and river banks;
- Put in place bylaws that should deter the population from cultivating in the wetlands and river banks;
- Government to support and promote other livelihood programs;
- Ensure catchment management committees at village level are functional.

8.2.4 Floods

Floods are natural occurrences where an area or land that is normally dry abruptly becomes submerged in water. Floods can be defined as an overflow of large quantities of water onto a normally dry land. Flooding happens in many ways due to overflow of streams, rivers, lakes or oceans or as a result of excessive rain.

Floods impact both individuals and communities, and have social, economic, and environmental consequences. Floods are one of the most expensive natural disasters. Floods can traumatise victims and their families for long periods of time. The loss of loved ones has deep impacts, especially on children. Displacement from one's home, loss of property and disruption to business and social affairs can cause continuing stress. For some people the psychological impacts can be long lasting.

Future impact of flooding if not mitigated

- Damage of infrastructure such as roads and bridges, schools and health facilities;
- Death and destruction of homesteads;
- People may be forced to leave their homes and normal life may be disrupted cause serious psychological effects, and economical and social losses;

- Continuous washing away of gardens hence recurrent famine;
- Loss of biodiversity;
- Deterioration of health conditions owing to waterborne diseases.

Proposed mitigation measures

- Restoration of heavily degraded areas through massive tree planting in the catchments;
- Consistent sensitization of communities on appropriate land/soil utilization technologies;
- Periodically desilting and dredging of the river channels;
- Installation of early warning systems in the rivers to alert the communities of the pending catastrophes;
- Strengthening of the flood hotspots by installation of gabions, stone pitching and planting of appropriate plant species along the river bank like bamboo and reeds;
- Sensitizing the communities to preserve river banks;
- Sustainable financing for sustainability of the already existing interventions is key.

8.2.5 Invasive Species

Invasive species in this context are plants that are intentionally or accidentally introduced by humans into areas outside of their natural habitat. These species can spread rapidly with negative consequences for native species. Invasive plant species have an impact on the diversity of local species. They affect water availability and damage the quality of soil nutrients. Once an alien plant has invaded a habitat, it changes the conditions of that environment. It does so by changing the light, solar radiation and temperature levels in the invaded patches. The quality and availability of food, shelter, nest sites, basking sites and perches are changed for a number of animals. They can also inflict big changes on native vegetation, altering the frequency of fires, nutrient cycling, water availability and soil erosion.

Several invasive species exist but notably is *Striga spp* and *Lantana camara* which affects cereals and grazing land respectively. *Striga spp* is said to grow quickly in maize gardens resulting in stunting of maize plants and causing substantial reduction in yields. *Lantana camara* when consumed by cows is said to result in reduction in milk yields and also affects the digestive system of browsers resulting in illness. Invasive plants can result in native biodiversity loss. Invasive plant species spread quickly and can displace native plants, prevent native plant growth, and create monocultures. A healthy plant community has a variety of herbs, shrubs, and trees. Invasive plants cause biological pollution by reducing plant species diversity. Changes in plant community diversity reduce the quality and quantity of fish and wildlife habitat.

Future impact of invasive species if not mitigated

- Results in reduced agricultural production and productivity;
- Some invasive species such as *Lantana camara* displaces grazing pasture wherever it grows;
- Some species such as *Lantana camara* if fed on by animals have direct negative impact on animals' health hence affecting agriculture;
- Invasive species can result in substantial losses in biological diversity of the native species;
- The cost of eliminating invasive species is extremely high if the species has gone beyond containable levels.

Proposed mitigation measures

- Planting herbicide treated (*Imazapyr*-resistant) maize seed;
- Use of striga resistant maize varieties;
- Sensitization and encouragement of farmers to adopt good agricultural practices like, crop rotation, mulching, intercropping (For example intercropping maize and Desmodium controls striga) among others;
- Physical removal of the invasive species;
- Spraying of the invasive species using permissible herbicides;
- Government to fund and or conduct research on management of various invasive species.

8.2.6 Pests and Diseases

A swarm of pests could ruin a whole season's worth of planting and careful cultivation, leading to financial loss. Pests also destroy the habitat of other organisms as well as natural resources, leading to reduction in water quality, increase in soil erosion and degradation of land, and destruction of native plants that provide food and shelter to native species or those endemic to the catchment.

Another way that pests can harm the ecology is through their competition with native animals for food and shelter. To a certain extent, pests can even poison native animals and pass on diseases, leading to the decline of certain animal and plant species. The worst ecological scenario that can be imagined with regards to pests is the decreased number of native species, the degradation of their natural habitats and food, and their extinction. In general, it is of no doubt that pests are nuisances in their own right, and should not be taken lightly or else the havoc they wreak would be unprecedented.

Future impact of pests and diseases are not mitigated

- Plant pests and diseases can wipe out farmers' hard work and cause significant losses to yields and incomes, posing a major threat to food security. Outbreaks and upsurges can cause huge losses to crops and pastures, threatening the livelihoods of farmers and the food and nutrition security of millions at a time;
- Famine;
- Reduced agricultural productivity;
- Affects livelihoods due to reduced household income.

Proposed mitigation measures

- Through extension services, government to support farmers through Introduction of resistant crop varieties;
- Supporting farmers in multiplication of the resistant varieties;
- Sensitization of farmers on farming methods that reduce pest and disease prevalence like rotational cropping which breaks the cycle of pests and diseases
- Crop diversification;
- Spraying if all other methods fail or are not applicable;
- More research by NARO and knowledge dissemination to the farmers is key;
- Availing farmers with clean/certified seeds;
- Government identify and support other livelihood options.

8.2.7 Pollution from Agrochemicals (fertilizers, pesticides, insecticides, etc)

The usage of agrochemicals is increasingly becoming more pronounced in the catchment. However, several parts of the Tochi catchment have been earmarked for several commercial agricultural farms due to the availability of large chunks of land. The environmental impacts of agrochemical usage on existing farms is not well studied and there are concerns that pollution of streams and other community water sources is taking place.

Excessive use of fertilizers, for example, can lead to the contamination of groundwater with nitrate, rendering it unfit for consumption by humans or livestock. Water containing large concentrations of nitrate can poison animals by immobilizing some of the haemoglobin in blood, reducing the ability to transport oxygen. In addition, the run-off of agricultural fertilizer into streams, lakes, and other surface waters can cause an increased productivity of those aquatic ecosystems, a problem known as eutrophication. The ecological effects of eutrophication can include an extensive mortality of fish and other aquatic animals, along with excessive growth of nuisance algae, and an off-taste of drinking water. The use of pesticides can also result in environmental problems such as poisoning non-target organisms in the ecosystem.

Possible future impact of agrochemicals if not mitigated

Effect on soil:

- The chemicals may kill helpful bacteria;
- Increase nitrate content in soil;
- Alter pH levels;
- Kill soil organisms;
- Unnatural growth effects;
- Residual effects.

Effect on water:

- Make water unfit for consumption;
- Agrochemicals in water diffusing with larger water bodies promote the growth of algae;
- Excess chemicals lead to Eutrophication;
- Lead to water pollution thereby affecting aquatic animals;
- Alter the chemical properties of water.

Effect on air:

- Pesticide particles diffuse with air altering their nature;
- Wind drifts carry polluted air to other parts thereby spreading their ill effects;
- Depending on weather conditions, more amount of spray may evaporate;
- Air polluted in this way is inhaled by surrounding living organisms having drastic effects on their health.

Proposed mitigation measures

Mitigating the impact of pesticides on large agricultural firms is a complex task and requires to be handled on a case by case basis following recommendations from a detailed environmental and social impact assessment study conducted on a farm to farm base.

8.2.8 Poor Waste Management

Tochi is facing a challenge of solid and liquid waste management at all levels including household, Municipal/Town Council and all other trading centres. In all the major and upcoming rural growth canters, waste is disposed haphazardly in the surrounding environments and in non-gazetted waste disposal sites. None of the towns has a proper and functional centralized waste disposal facility and this puts the health and several systems at risk. Waste segregation is similarly unpopular in all the catchments. This scenario puts the entire environment at risk of being contaminated. Other concerns are that there is insufficient capacity to handle all wastes i.e. in terms of funds, trucks, skips and the attitude of the people towards waste is still poor leading to littering.

Future impact of poor waste management if not mitigated

Environmental effects:

- Surface water contamination: Waste that ends up in water bodies negatively change the chemical composition of the water. Technically, this is called water pollution. This will affect all ecosystems existing in the water. It can also cause harm to animals that drink from such polluted water;
- Soil contamination: Hazardous chemicals that get into the soil (contaminants) can harm plants when they take up the contamination through their roots. If humans eat plants and animals that have been in contact with such polluted soils, there can be negative impact on their health;
- Pollution: Bad waste management practices can result in land and air pollution and can cause respiratory problems and other adverse health effects as contaminants are absorbed from the lungs into other parts of the body;
- Leachate: Liquid that forms as water trickles through contaminated areas is called Leachate. It forms very harmful mixture of chemicals that may result in hazardous substances entering surface water, groundwater or soil.

Social Economic effects:

- Municipal wellbeing: Everyone wants to live and visit places that are clean, fresh and healthy. An urban area with poor sanitation, smelly and with waste matter does not attract investors and tourists. Such cities tend to have poor living standards;
- Recycling revenue: Urban areas that do not invest in recycling and proper waste control miss out on revenue from recycling. They also miss out on job opportunities that come from recycling, composting and businesses that work with them;
- Spreading of diseases: Poor disposal of waste has the potential to spark off several non-communicable diseases such as cholera, dysentery and others resulting loss of lives, loss of income and livelihoods.

Proposed mitigation measures

- Implement sustainable waste minimisation, separation at source, reuse, recycling and recovery programmes;
- Promote and ensure effective delivery of waste services to all waste generators within the Municipalities and Town councils;
- Safely handle and dispose off solid waste through best practices;
- Integrate physical planning in all solid waste management activities and decisions;
- Promote public participation and inclusion in the solid waste management system;

- Promoting the participation and involvement of the private and informal sectors in the municipal solid waste management system;
- Develop solid waste management byelaws of for each of the catchment and enforce them;
- Institute sound budgeting and financial management for waste services;
- Ensure adequate staffing, remuneration and capacity for solid waste management;
- Establish and implement a Waste Information System and effectively report on status and progress.

8.2.9 Drought and Climate Change

A drought is a period of below-average precipitation in a given region, resulting in prolonged shortages in the water supply, whether atmospheric, surface water or ground water. Due to climate change effects, droughts can occur anywhere in the Country and have even become difficult to predict. Droughts occur at different periods of the year and of recent there have been several shifts in the weather patterns. The recent worst drought in Uganda occurred in 2016.

Future impact of drought if not mitigated

The effects of drought and water shortage can be divided into three groups: environmental, economic and social:

- In the case of environmental effects: lower surface and subterranean water-levels, lower flow-levels (with a decrease below the minimum leading to direct danger for amphibian life), increased pollution of surface water, the drying out of wetlands, more and larger fires, higher deflation intensity, loss of biodiversity, worse health of trees and the appearance of pests and dendroid diseases;
- Economic losses include lower agricultural, forests, game and fishing output, higher food-production costs, lower energy-production levels in hydro plants, losses caused by depleted water tourism and transport revenue, disruption of water supplies for municipal economies;
- Social costs include the negative effect on the health of people directly exposed to this phenomenon (excessive heat waves), possible limitation of water supplies, increased pollution levels, high food-costs, stress caused by failed harvests and others.

Generally, the consequences of drought include:

- Diminished crop growth or yield productions and carrying capacity for livestock;
- Excessive dust accumulation which triggers erosion and further eroding the landscape;
- Famine and hunger due to lack of water for irrigation and too little water to support food crops;
- Habitat damage, affecting both terrestrial and aquatic wildlife;
- Malnutrition, dehydration and related diseases;
- Reduced electricity production due to reduced water-flow through hydroelectric dams;
- General social unrest;
- Wildfires, which normally become more common during times of drought and may cause human deaths and substantial damage to property.

Proposed mitigation measures

- Government to support more mini and major irrigation schemes;
- Long term re-vegetation of bare hills to be undertaken;
- Encouraging environmentally clean farming methods that conserve soil and water;
- Households to be encouraged and supported in establishment of household woodlots for energy and other wood requirements;
- Introduction of drought tolerant crop varieties;
- Improved rangeland practices;
- Improved water management practices like rain water harvesting;
- Government should consider constructing multipurpose dams & water reservoirs to supply water in terms of drought;
- Government to set aside funds to counteract the effects of drought related disasters in case they occur.

9 WATER RESOURCES PLANNING - WATER BALANCE STUDY

9.1 Introduction

This Chapter covers the Water Balance study for the Tochi catchment with and analysis of present and projected water demands through modelling whereby a comparison is made between water availability and different water demand scenarios for multiple users, for three time horizons, i.e. 2020, 2025 and 2040. Reference is made to the final version of Volume 2 of the Natural Resources Assessment report of 13 September 2018.

The objectives of the Water Balance study are:

- to review data availability for the Tochi catchment;
- to carry out hydrological modelling to establish available water resources using current and future scenarios;
- to prepare water resources models for allocation water to different users (including the environment);
- use the water resources model to assessing and prioritizing different water resources development and management interventions.

The study is carried out using the following iterative processes:

a) Review of existing documents, designs, national statutes and guidelines and any other related information;
b) Data collection including climate datasets, hydrological data, terrain models, synthesis of collected technical data. Compilation of all data in a project database;
c) Identification of water use sectors, estimation of water demands and determination of key drivers and trends in water demands for the Tochi catchment;
d) Modelling of the hydrology and water resources. Determination of key drivers and trends in water resources of the area;
e) Water resources allocation modelling; assessment and prioritization of water resources development and management scenarios.

The Chapter is structured as follows:
Section 9.2 - Outcomes of the Water Balance modelling;
Section 9.3 - Conclusions

Reference is made to Volume 2 of the Natural Resources Assessment report of 14 September 2018 for information on the:

1) Methodology applied;
2) Outcomes of the hydrological modelling (water availability); and
3) Discussion on Water Resources risks and mitigation measures;

These three topics of the Water Balance study are not included in this CMP as been discussed extensively in the NRA report.

9.2 Water Balance Modelling

The water balance modelling for the river Tochi catchment was aimed at comparing the current and future available water resources against the demands from the multi users such as domestic demand, environmental flow demand, industrial demand and irrigation demand.

9.2.1 Water Demand

Water demand for drinking and other uses

The estimated current and projected population of the Districts located in the river Tochi catchment is shown in Table 9.1. Gulu has large urban centres while urban centres in the remaining Districts are small with insignificant industrial demand. Therefore, per capita water demands for Arua was set to 70 l/day and the rest of the Districts were set to 20 l/c/day. The total domestic and industrial demand rises from 2.0 Mm3 in 2020 to 3.9 Mm3 in 2040 (Figure 9.1 and Table 9.2)

Table 9.1 - Population in river Tochi catchment (rounded 10^2)

Year	Oyam	Gulu	Amuru	Nwoya	Omoro
2002	87,100	3,300	700	1,400	64,900
2007	101,100	3,900	800	2,300	76,000
2014	124,900	4,800	900	4,200	95,000
2018	142,400	5,500	1,000	4,800	108,300
2020	144,500	5,900	1,100	4,900	115,400
2025	177,500	6,900	1,300	6,000	134,900
2040	275,100	10,700	2,000	9,200	209,200

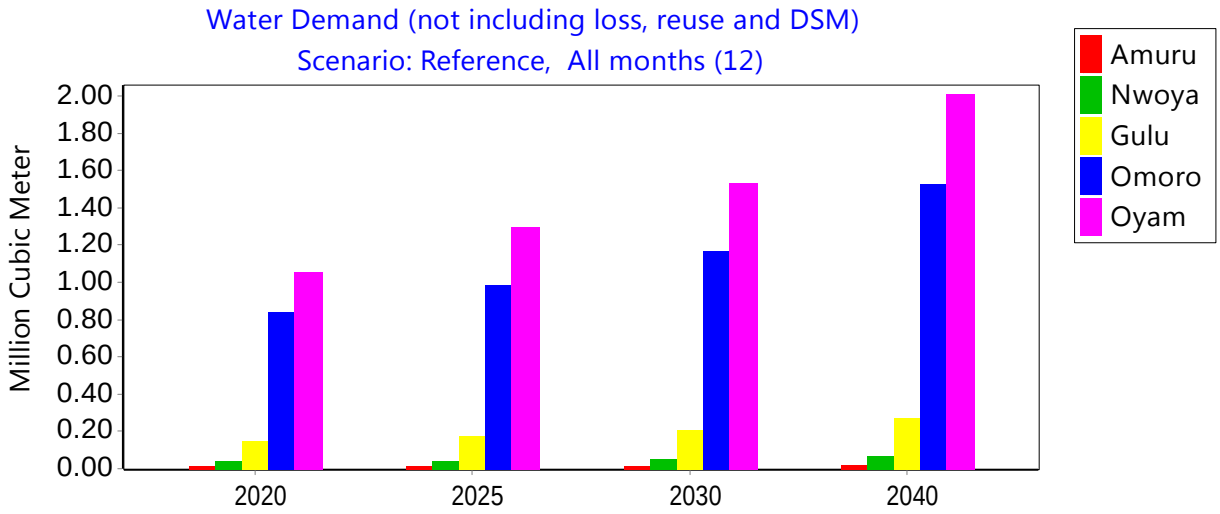

Figure 9.1 - Growth in domestic and industrial demand

Table 9.2 - Domestic and Industrial demand (thousand M3)

Node	2020	2025	2030	2040
Amuru	8	9	11	15
Gulu	152	176	208	273
Nwoya	35	43	51	67
Omoro	842	985	1,166	1,527
Oyam	1,055	1,296	1,533	2,008
Sum	*2,091*	*2,509*	*2,970*	*3,890*

Water demand for irrigation

A total of 1,064 ha are planned for development in the short term. On the assumption that the command area will be levelled, the irrigation system will be established and the crops to be cultivated include maize, millet, cassava, beans, groundnut, cotton and sesame. The irrigation water demand was estimated as shown in Table 9.3. The annual irrigation requirement per hectare was therefore estimated as 21,419 m3/ha but it varies from nil in January and February to 4,470 m3/ha in April. For future projections, it was assumed that further expansion of up to 1,500 ha will be carried out in the medium to long term. Figure 9.2 shows the irrigation demand projections for the two scenarios.

Table 9.3 - Monthly irrigation water requirement

Month	Monthly Requirement (Mm3)	Monthly Requirement (m3/s)	Irrigation requirement (m3/ha)
Jan	0.0	0.0	0
Feb	0.0	0.0	0
Mar	1.5	0.6	2,014
Apr	3.4	1.3	4,470
May	1.1	0.4	1,449
Jun	1.1	0.4	1,411
Jul	0.2	0.1	303
Aug	1.3	0.5	1,685
Sep	3.2	1.2	4,311
Oct	1.2	0.5	1,628
Nov	2.0	0.7	2,604
Dec	1.2	0.4	1,543
Annual Requirement			*21,418*

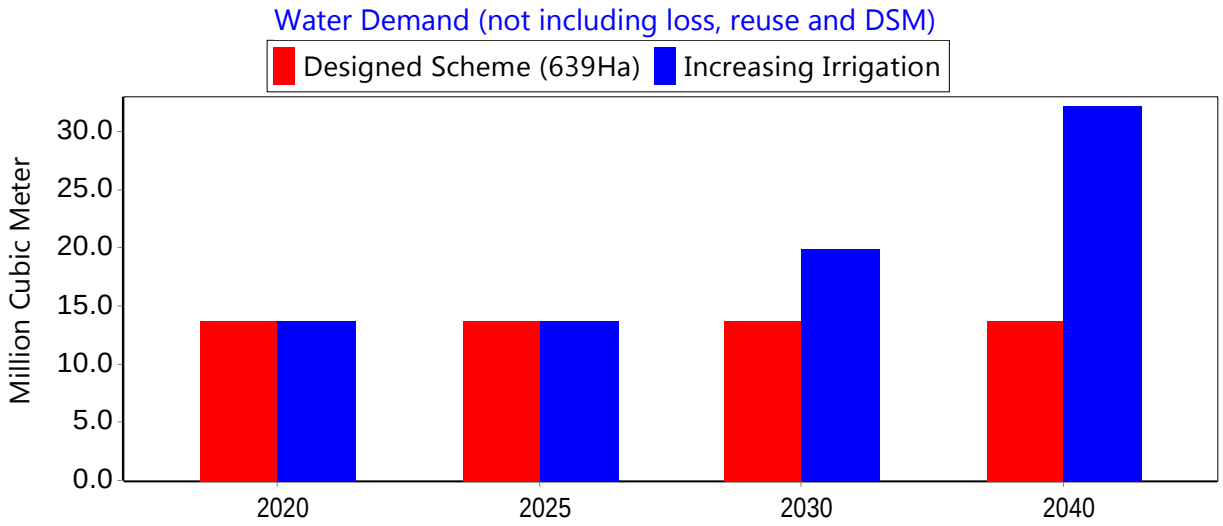

Figure 9.2 - Irrigation demand projections

Water demand for the environment

The annual average of the mean annual flow is 6.7 m3/s. As explained in Volume 2 of the NRA report, the environmental flow requirement for dry months was set to be 10% of mean annual flow and that for wet months was set to 20% of the mean annual flow. Therefore the annual minimum flow requirement is as shown in Figure 9.3 and Figure 9.4.

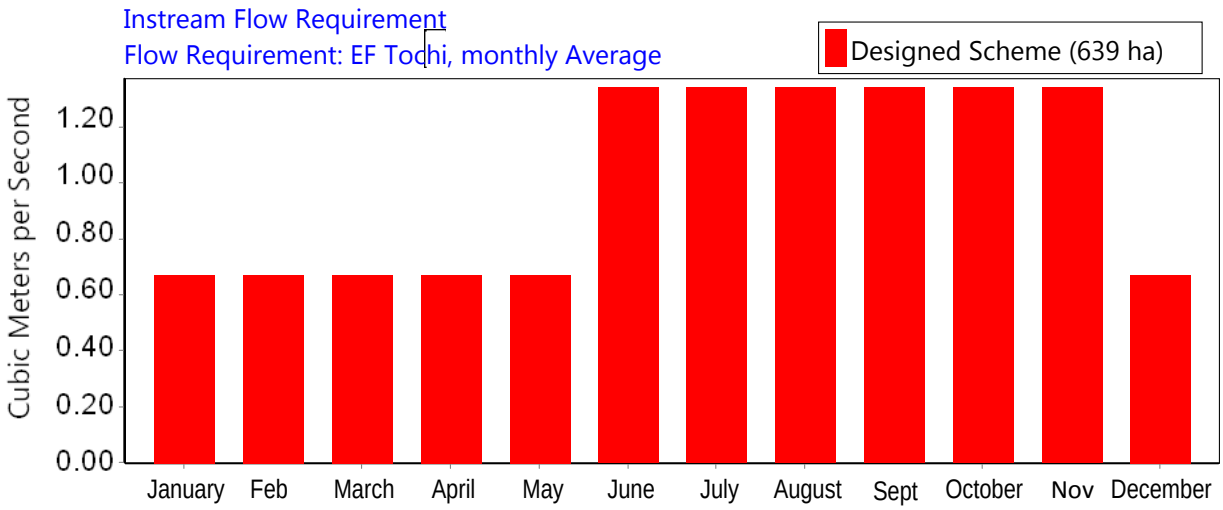

Figure 9.3 - Monthly environmental flow requirement (m3/s)

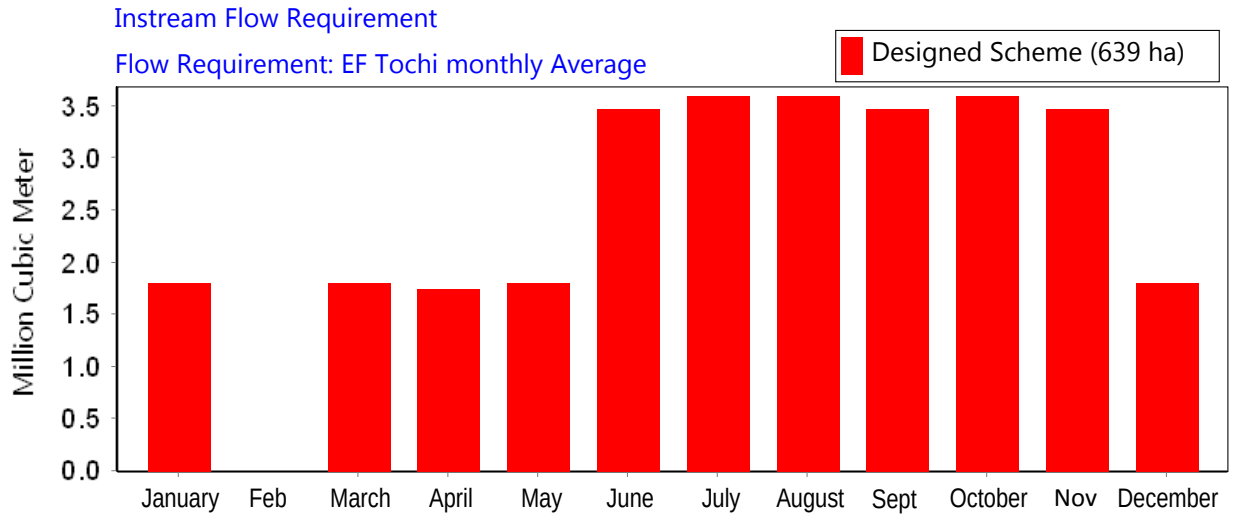

Figure 9.4 - Total monthly environmental flow requirement (Mm3)

Total water requirement

The projected total water requirements are shown in Figure 9.5. The total requirement rises from 15.8 Mm3 in 2020 to 16.2 Mm3 in 2025, primarily driven by increases in domestic and industrial requirements. If no further expansion of the irrigated area is undertaken, the water requirements will increase to 17.6 Mm3 by 2040. If further expansion of irrigated area is undertaken the water requirement will increase to 36.1 Mm3 by 2040.

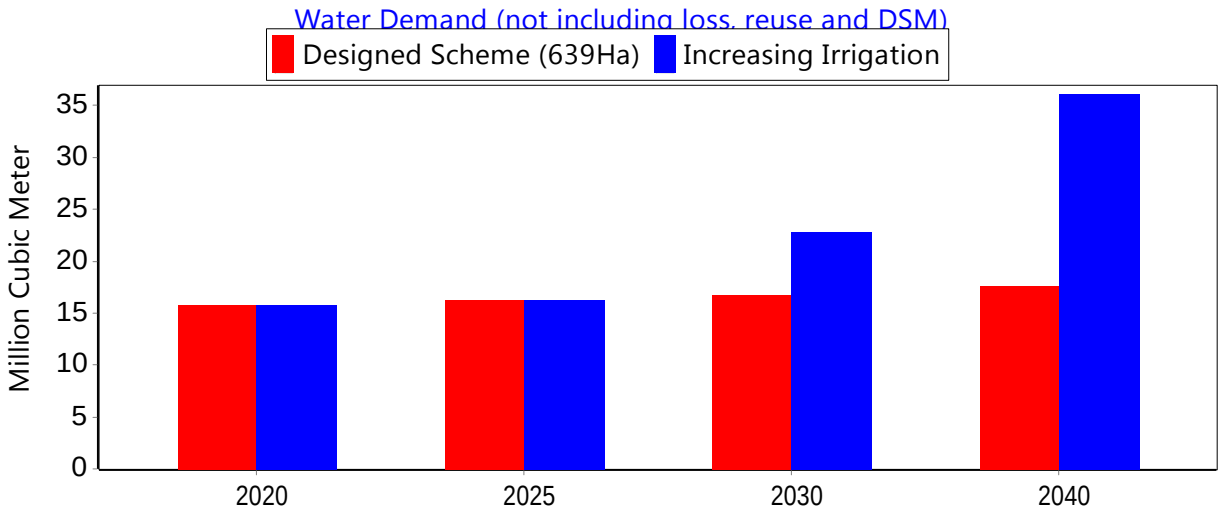

Figure 9.5 - Projections of total water requirement

9.2.2 Water Balance

No climate change scenario

For the no climate change case, available supply meets demand most of the demand apart from a few years (Figure 9.6). If no expansion on the designed scheme is carried out, the demand deficit occurs in most years and averages 1.9 Mm3/year but can be as high as 6 Mm3/year. If further expansion of the scheme is carried out, demand deficit increases to an average of 5.9 Mm3/year but can be as high as 13.9 Mm3/year. Most of the demand deficit is registered in the dry months of January to June (Figure 9.7). August and September also register some demand deficits. However, the supply reliability is very low at 86%% and drops just marginally to 83% if the irrigated area is expanded (Table 9.4).

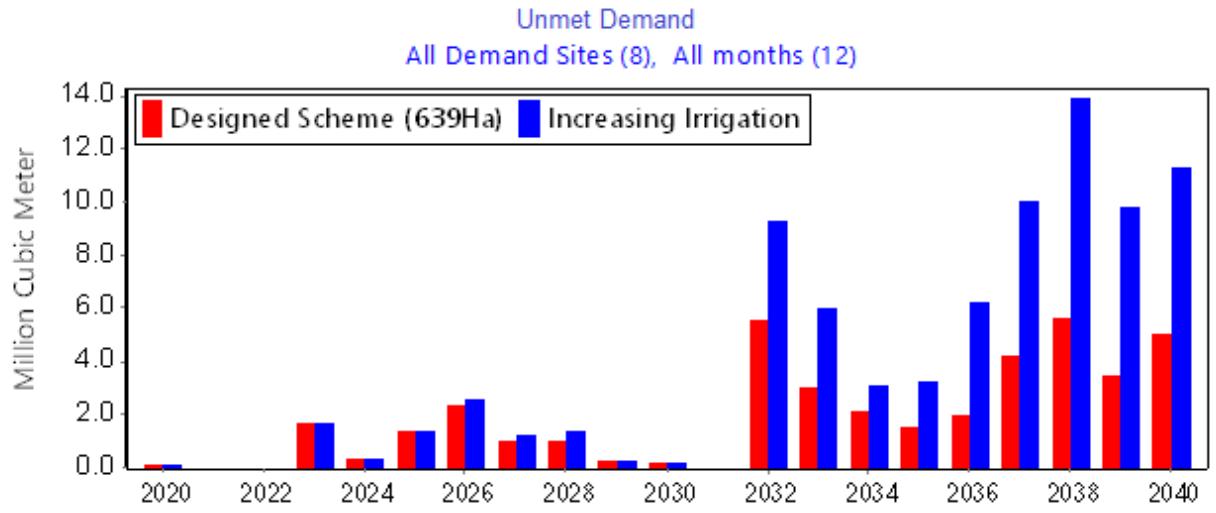

Figure 9.6 - Annual demand deficit

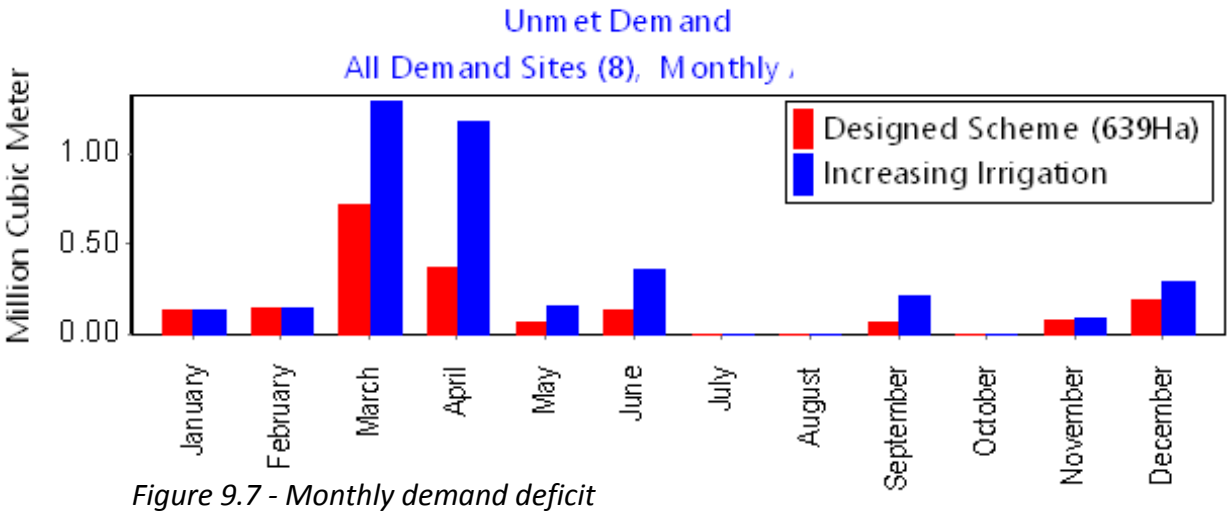

Figure 9.7 - Monthly demand deficit

Table 9.4 - Water supply reliability (%)

Scenario	Amuru	Gulu	Nwoya	Omoro	Oyam	Irrigation
Designed Scheme (639 ha)	85.7	85.7	85.7	85.7	85.7	86.5
Increasing Irrigation	85.7	85.7	85.7	85.7	85.7	83.7

Storage reservoir

The analysis above shows that the water supply deficit for the Tochi scheme is too high. Therefore, a storage reservoir will be required improve water supply reliability and boost the viability of the scheme. The scheme design proposes a storage reservoir having a total volume of 10,721 Mm3 at elevation of 1,042 m MSL. The reservoir curve of elevation and storage capacity is shown in Figure 9.8.

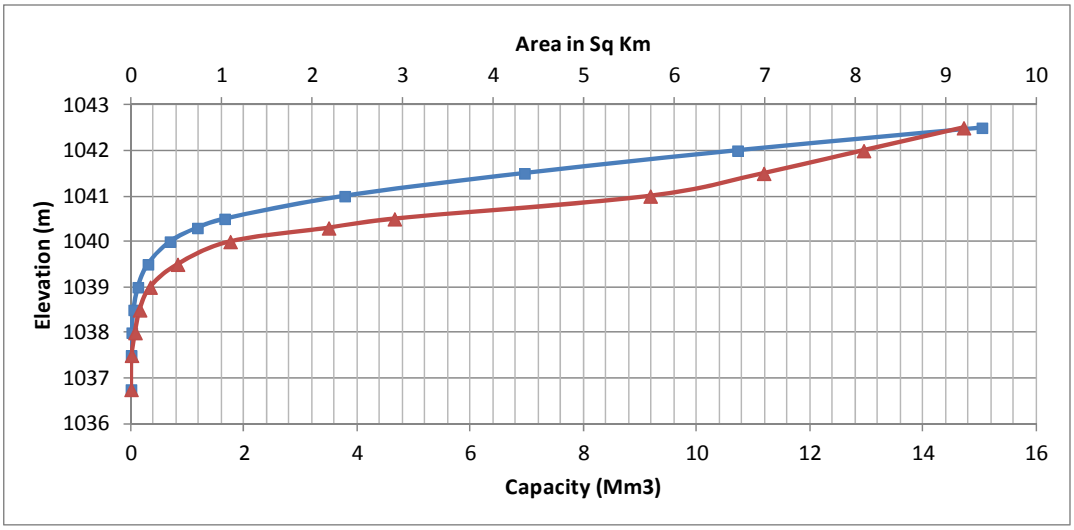

Figure 9.8 - Elevation versus area and Capacity Curve for river Tochi

A simulation was carried out of the flow requirements including the proposed reservoir. Figure 9.9 shows the variation in storage volume over time and Figure 9.10 shows is a curve showing how frequently the reservoir is at different storage levels. Overall, supply reliability increases to 100% when a reservoir is included in the scheme (Table 9.5). Even when irrigated area is increased, the reliability of supply is still very high at 99.6%.

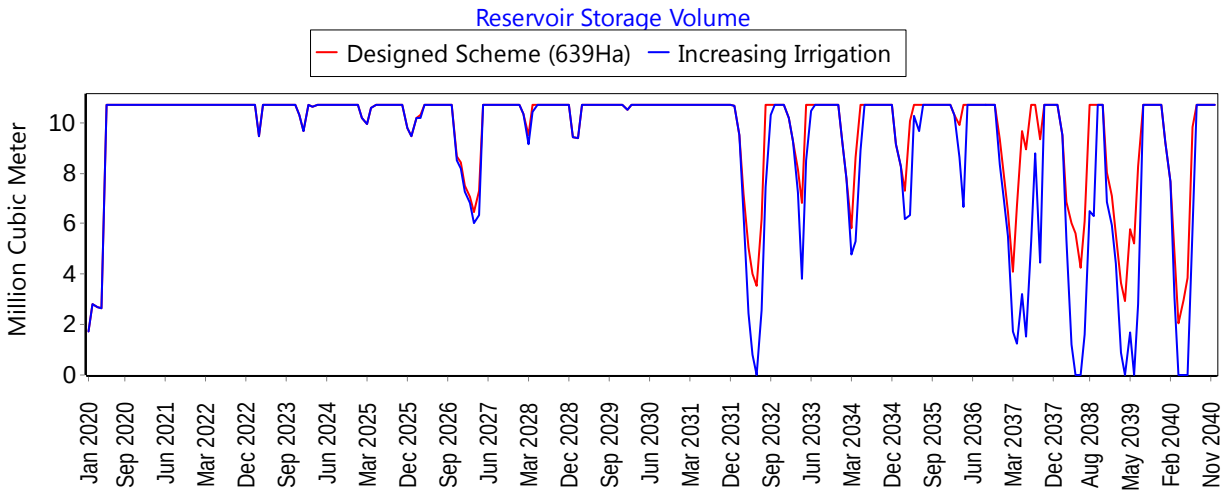

Figure 9.9 - Variation of reservoir storage volume

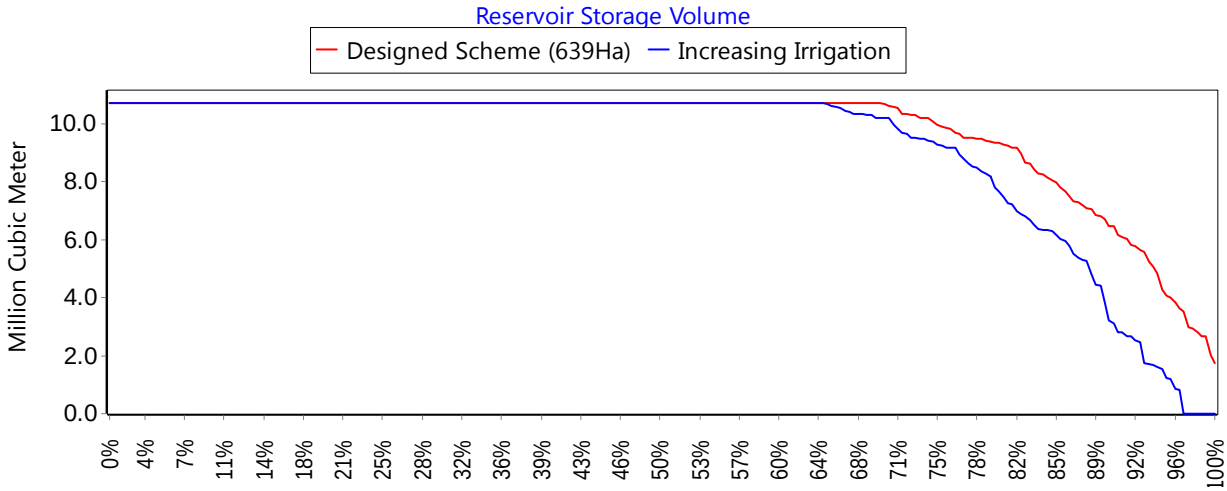

Figure 9.10 - Variation of storage volume (% of time)

Table 9.5 - Water supply reliability (%) with reservoir

Scenario	Amuru	Gulu	Irrigation	Nwoya	Omoro	Oyam
Designed Scheme (639 ha)	100	100	100	100	100	100
Increasing Irrigation	99.6	99.6	96.8	99.6	99.6	99.6

With climate change scenario

As explained before, sensitivity assessment was carried out to assess the impact of climate change on water resources availability in the various irrigation schemes by setting various thresholds for changes in temperature and rainfall and analysing the resultant effect on ability of the scheme to meet to water requirements for the various time horizons. The assessment was then carried out on the reliability of the resultant water supply to meet water supply requirements under the changed conditions. In particular, the following thresholds were considered:

- Temperature change - changes of +2°C and +4°C;
- Rainfall change - reductions in basin rainfall of 10% and 20%.

Table 9.6 shows that, as expected, there would be a reduction in water supply reliability with climate change. The resultant reductions due to reduced rainfall are higher than reductions due to increased temperature (Figure 9.11 and Figure 9.12). This implies that it is possible to address some of the vulnerability to climate change through taking robust water catchment protection measures like protection of remaining forest coverage and prevention of wetland degradation.

Table 9.6 - Water supply reliability with and without climate change (%)

Development option	Scenarios	Demand nodes					
		Amuru	Gulu	Nwoya	Omoro	Oyam	Irrigation
Designed Scheme (639 ha)	No climate change	100	100	100	100	100	100
	Rainfall 10% lower	100	100	100	100	100	98.8
	Rainfall 20% lower	90.9	90.9	90.9	90.9	90.9	87.3
	Temp 2deg higher	100	100	100	100	100	100
	Temp 4deg higher	100	100	100	100	100	100
Increasing Irrigation (to 1,500 ha)	No climate change	99.6	99.6	99.6	99.6	99.6	96.8
	Rainfall 10% lower	96.8	96.8	96.8	96.8	96.8	92.9
	Rainfall 20% lower	88.1	88.1	88.1	88.1	88.1	81
	Temp 2deg higher	99.6	99.6	99.6	99.6	99.6	96.8
	Temp 4deg higher	99.2	99.2	99.2	99.2	99.2	95.6

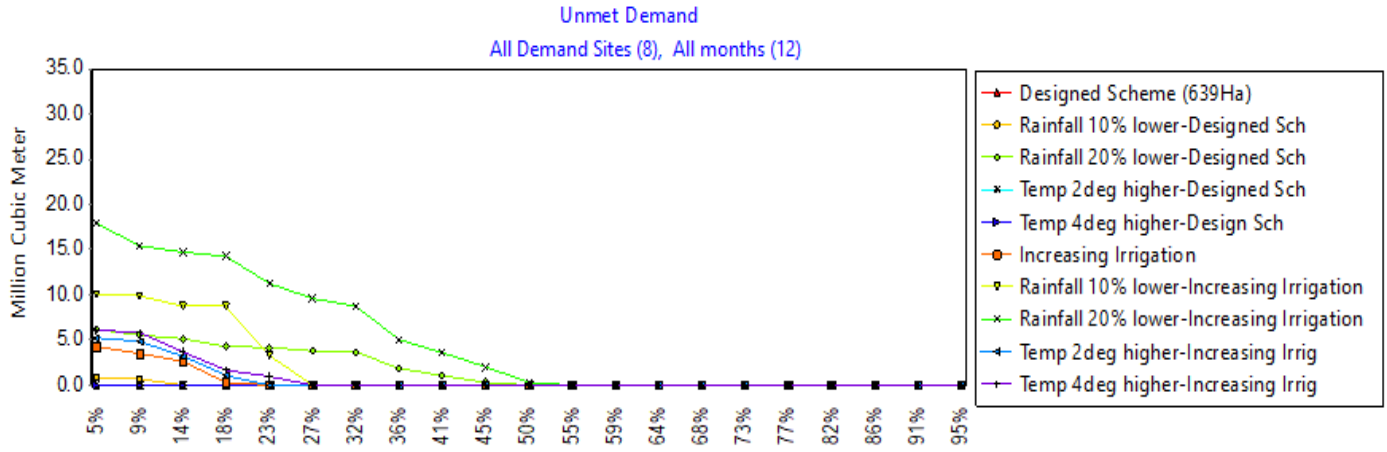

Figure 9.11 - Demand deficit frequency with climate change (annual)

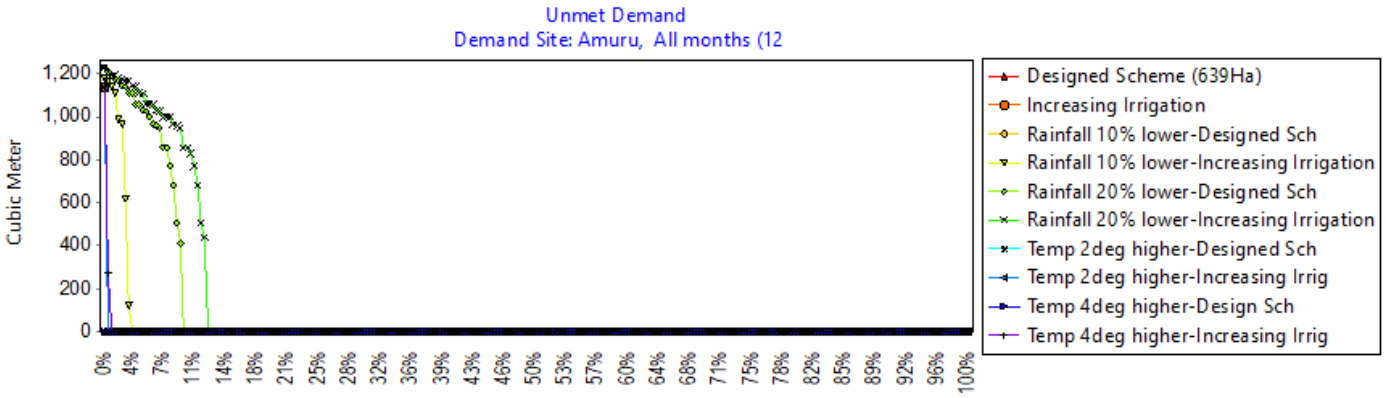

Figure 9.12 - Demand deficit frequency with climate change (monthly)

9.3 Summary and Conclusions

The new Tochi irrigation scheme will be fed by the Tochi river that exhibit significant daily, seasonal and annual flow fluctuation. To derive the stream flow series, a combination of measured climate data and global datasets, which are more complete and have been error controlled, were used. The Princeton historical climate dataset (Sheffield et all, 2008) blends reanalysis data with observations to create global daily and monthly data of temperature, precipitation and wind speed for 1948-2010, at a 0.25 degree spatial resolution. Catchment delineation was carried out using the HydroSHEDS digital elevation data having a resolution of 3 arc seconds (90 m) during the Space Shuttle flight for NASA's Shuttle Radar Topography Mission (SRTM). The hydrological model was calibrated using river flow data for gauged rivers and flow data from nearby rivers for ungauged catchments.

The water demands considered included domestic, industrial (only for the larger urban centres), irrigation (existing and expanded) and environmental flow requirement. The environmental flow was taken as a seasonally varying value of 10% for dry months and 20% for wet months. Balancing water supply and demand was carried out by considering the ability of the river system to continue meeting water demands in the short term (by 2020), medium term (by 2025) and the long term (by 2040) with the inclusion of the planned

irrigation command area. Potential impacts of climate change were considered. Where major shortcomings in supply were observed, i.e. in cases of low water supply reliabilities, water storage reservoirs are proposed. The available river water supply was also checked for sufficiency to satisfy demand in cases where further expansion of the irrigated area over the design area was carried out in the medium to long term.

A sensitivity assessment was carried out to assess the impact of climate change on water resources availability in the Tochi irrigation scheme by setting various thresholds for changes in temperature and rainfall and analysing the resultant effect on ability of the scheme to meet to water requirements for the various time horizons. In particular, the following thresholds were considered; (a) temperature change - changes of +2°C and +4°C; and (b) rainfall change - reductions in basin rainfall of 10% and 20%. The assessment was then carried out on the reliability of the resultant water supply to meet water supply requirements under the changed conditions.

Based on the above water resources modelling and assessment results, the following conclusions were made:

Conclusions

The Tochi river has a mean flow of 6.7 m3/s which is equivalent to an annual yield of 213 Mm3/year.

In addition to the water demand for irrigation, water demands for nearby towns of Oyam, Gulu, Amuru, Nwoya and Omoro were considered. The total water demand for the designed irrigation area of 639 ha increases from 15.8 Mm3/year in 2020 to 16.2 Mm3/year in 2025 and to 17.6 Mm3/year in 2040 if no further expansion of the irrigated area is carried out, mainly driven by population growth.

With further expansion of the irrigated area to double the designed area, the water demand increases to 36.1 Mm3/year. For the no-climate change case the river is unable to meet the water demand especially in the dry periods. Supply reliabilities are then low, at around 85%. The demand deficits are high with an average of 1.9 Mm3/year (13% of demand in 2020) but can be as high as 6 Mm3/year (38% of the 2020 total demand).

A storage reservoir is proposed to address the demand deficit. The scheme design proposes a storage reservoir with a total volume of 10,721 Mm3 at an elevation of 1,042 m+ MSL which would increase the supply reliability to 100% for the designed scheme and to 99.6% with further expansion of the scheme in the medium term to long term scenario. Climate change would result in a reduction in the water supply reliability. The resultant reductions due to reduced rainfall are higher than the reductions due to increased temperature. However, water supply reliabilities are still 80% or more.

10 FRAMEWORK for STRATEGIC CATCHMENT PLANNING

10.1 Approach

This Chapter discusses the Framework for Strategic Catchment Planning (or referred to as the Strategic Planning Framework or SPF) for the Tochi catchment.

The SPF captures the *Overall Objective* of the CMP on how to develop the catchment in the future by addressing a number of *Key Areas* with *Issues/Challenges* (identified during the Natural Resources assessment as discussed before), *Planning Strategies* and an *Action Plan* with prioritized interventions, costing and a plan for implementation. A "vision-oriented" approach has been taken – that is, the strategies have been identified such that they will lead to the achievement of the overall objective.

The principles underpinning the CMP are based on the environmental sustainability of the catchment with a bias towards the protection of the Natural Resources, in general and the protection of the Tochi irrigation scheme against excessive sedimentation, in particular.

10.2 Structure of Framework for Strategic Catchment Planning

The framework for Tochi comprises of seven elements. These are:

1) Overall Objective that reflects the vision on how to develop the catchment in the future (Section 10.3);
2) Key Areas that are broad categories of issues, reflecting the priority challenges. These can be thought of as things that need to be done to achieve the overall objective for the Tochi catchment. The following three Key Areas were identified:

Key Areas of the Strategic Planning Framework of the Tochi CMP

1) ENVIRONMENT
2) INSTITUTIONS
3) KNOWLEDGE BASE

For each Key Area the issues, challenges, strategies and action points were identified. These are discussed in Sections 10.4-10.6:

3) Issues and Challenges. These were identified during the stakeholder meetings, the field surveys and the Natural Resources assessment;
4) Strategies. These are formulated based on the issues and challenges identified and are required to achieve the overall objective.
5) Action and Interventions. These are formulated based on the strategies identified and are to be implemented for tackling the environmental challenges. They are elaborated and evaluated in Chapter 11 and 12.
6) Implementation Plan. This plan captures the planning of the prioritized interventions, costing of investment packages and funding sources with budget allocation over three

time horizons, i.e. the short term (by 2020), medium term (by 2025) and the long term (by 2040). This plan presented in Chapter 13.

7) Environmental and Social Management Monitoring Plan. In order to check progress on implementing the interventions and on the resulting effects of the investments, an environmental and social management monitoring plan has been drafted for usage by the implementers of the interventions. This will allow them to make regular edits and updates of the CMP so to improve the future management of the catchment (Chapter 13).The SPF flow diagram is shown in Figure 10.1.

10.3 Overall Objective of the Catchment Management Plan

The overall objective of the CMP has been defined as

> *"Ensure equitable access to and use of the Natural Resources, protect the Tochi catchment and its Natural Resources against environmental degradation, and protect the Tochi irrigation scheme against excessive sedimentation and floods".*

The base for formulating this objective lies in the FIEFOC-2 Project Appraisal report, AfDB, August, 2015 and the ToR of the consultancy assignment, MoWE, June 2017. The objective fits within the Farm Income Enhancement and Forest Conservation Programme - Project 2 (FIEFOC-2) that was designed within the context of the GoU's National Development Plan (NDP) and the National long term development strategy, Vision 2040, of which both promote *agricultural infrastructure* and *income enhancement*.

These FIEFOC and NDP strategies are reflected in Chapter 13 whereby the implementation of the proposed catchment protection works will sooner or later:

1) safeguard the new irrigation infrastructure against degradation (potential high risk of high sedimentation and floods) by means of erosion mitigation measures and improved catchment management (this is within the context of the NDP/Vision 2014's strategy on agricultural infrastructure enhancement); and
2) enhance farmers' incomes in the rainfed areas by increased crop yields due to the application of improved Soil and Water Conservation techniques (this is within the context of the NDP/Vision 2014's strategy on income enhancement); and
3) enhance farmers' incomes in the irrigation scheme by increased irrigated crop yields due to reduced siltation in the irrigation channels, higher water availability and a reduced risk of floods (this is within the context of the NDP/Vision 2014's strategy on income enhancement).

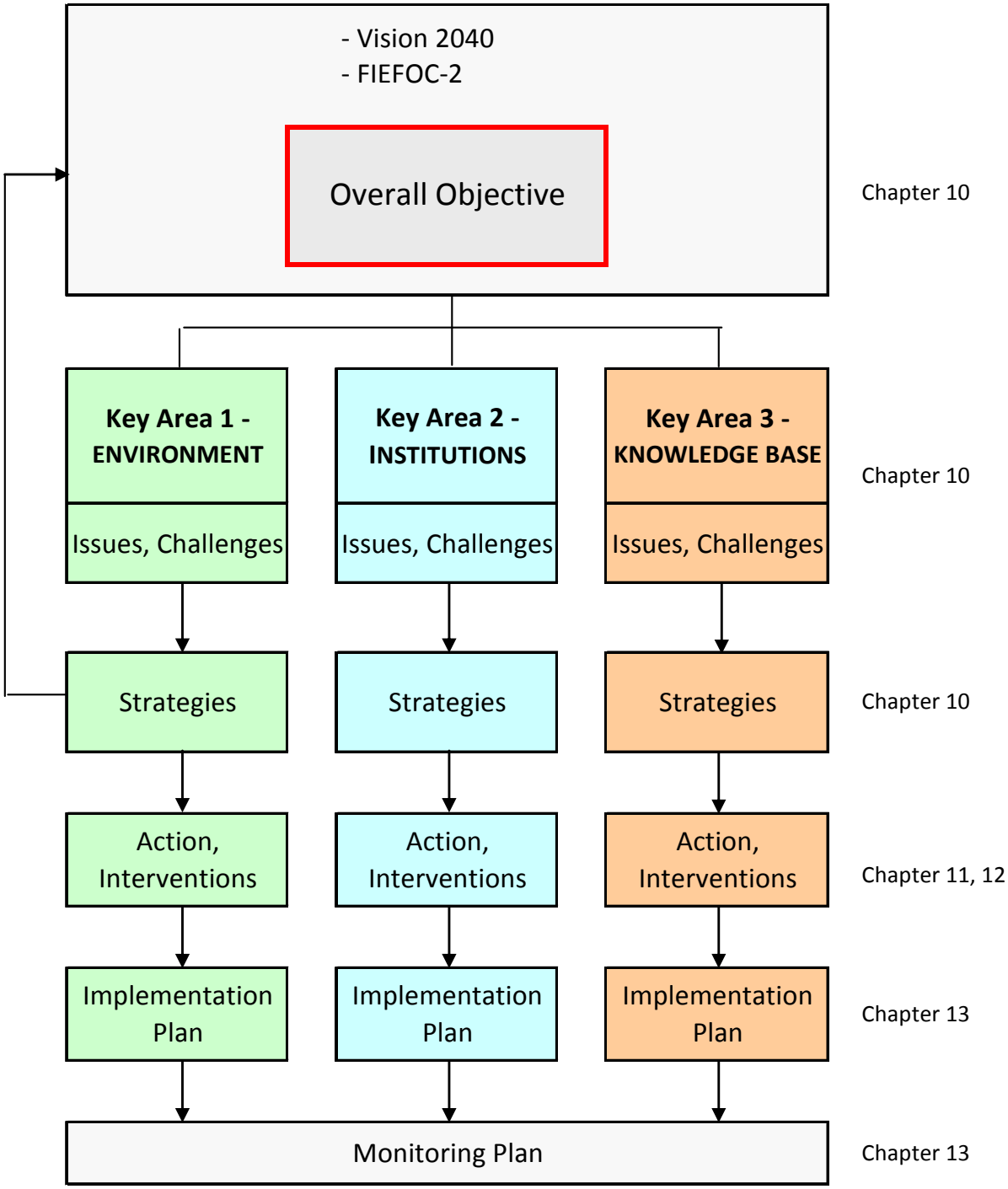

Figure 10.1 - Flow Diagram of the Strategic Planning Framework

10.4 Key Area 1 - Environment

A total of nine major issues and challenges related to environmental degradation in the Tochi catchment were identified during the Natural Resources Assessment. These are:

1) Deforestation;
2) Soil Erosion;
3) River Bank Cultivation and Wetland Encroachment;
4) Floods;
5) Invasive Species;
6) Pests and Diseases;
7) Pollution from Agrochemicals (fertilizers, pesticides, insecticides, etc);
8) Poor Waste Management; and
9) Drought and Climate Change.

The issues and challenges were discussed in more detail in Section 8.2 and are summarized in Table 10.1. To address these challenges, strategies and action points were formulated with physical and non-physical interventions. The latter are directly or indirectly related to environmental protection of the catchment. These are presented in Table 10.2. Eight of the physical, catchment protection works are further discussed, evaluated and prioritized for implementation for the short, medium and long term (see Chapter 11, 12 and 13).

Table 10.1 - Key Area 1 - Environment - Issues and Challenges

Issues	Challenges
Deforestation	Fuel wood supplies have been rapidly decreasing due to population growth and agricultural expansion which has in turn led to increased deforestation. has resulted in rapid degradation of woodlands and other patches of natural forests in both government and private land. Deforestation is mainly due to intensive charcoal burning and land clearing for agriculture and settlements.
Soil Erosion	One of the main causes of soil erosion is water erosion, which is the loss of topsoil due to rainfall. The runoff carries the detached soil materials away and deposits them elsewhere. Soil erosion is one of the biggest threats to the irrigation scheme because it results in the sedimentation of irrigation canals resulting in high maintenance costs.
River Bank Cultivation and Wetland Encroachment	Despite the fact that wetlands and river banks are supposed to be no go zones for farming and other non-permissible activities, the general observation on the status of wetlands in the catchments was that most of these are heavily degraded and encroached by farming activities up the nearest water mark. Other degrading activities include brick making, sand mining and extraction of wetland flora such as papyrus.
Floods	The consequences of floods, both negative and positive, vary greatly depending on their location, duration, depth and speed, as well as the vulnerability and value of the affected natural and constructed environments. Floods impact both individuals and communities, and have social, economic, and environmental consequences.
Invasive Species	Invasive species in this context are plants that are intentionally or accidentally introduced by humans into areas outside of their natural habitat. These species can spread rapidly with negative consequences for native species. Invasive plant species have an impact on the diversity of local species. They affect water availability and damage the quality of soil nutrients. Once an alien plant has invaded a habitat, it changes the conditions of that environment.

Issues	Challenges
Pests and Diseases	In the catchment area, the main pests/diseases farmers are affected by are coffee leaf rust, coffee die back, cassava mosaic, banana wilt, cassava brown strike and fall army warm which affects maize, locusts which affect cotton, avian influenza which affects pigs. A swarm of pests could ruin a whole season's worth of planting and careful cultivation, leading to financial loss. Pests also destroy the habitat of other organisms as well as natural resources, leading to reduction in water quality, increase in soil erosion and degradation of land, and destruction of native plants that provide food and shelter to native species or those endemic to the catchment.
Pollution from Agrochemicals	Excessive use of fertilizers can lead to the contamination of groundwater with nitrate, rendering it unfit for consumption by humans or livestock. Water containing large concentrations of nitrate can poison animals by immobilizing some of the haemoglobin in blood, reducing the ability to transport oxygen.
Poor Waste Management	In all the major and upcoming rural growth centres, waste is disposed haphazardly in the surrounding environments and in non-gazetted waste disposal sites. None of the towns in the catchment has a proper and functional centralized waste disposal facility. This puts the health and several systems at risk. Waste segregation is similarly unpopular in the catchment.
Drought and Climate Change	Due to climate change effects, droughts can occur anywhere in the country and have even become difficult to predict. In the catchment, droughts occur at different periods of the year and of recent there have been several shifts in the weather patterns. The recent worst drought in Uganda occurred in 2016.

Table 10.2 - Key Area 1 - Environment - Strategies and Action

Issues	Strategies	Action - Non Physical	Action - Physical (Chapter 11 elaborates on the catchment protection works)
Deforestation	Promotion use of alternative energy sources.	Train population on energy saving kilns and stoves.	Restoration and Enrichment Planting in CFRs and LFRs.
	Government to discourage land fragmentation.	Invest, sponsor other energy sources such as gas, biogas, solar and electricity.	Replanting of Trees in CFRs and LFRs
	Government supports & improves livelihood options with less impact on vegetation clearance.	Set-up op bylaws on Ordinances on Bush Burning	Forest Boundary Marking of CFRs and LFRs
	Government to enforce the law on evicting encroachers out of the protected areas.	Invest in bee keeping, zero grazing & poultry, supporting village SACCOs with credit, extending electricity to rural areas, tea farming and others following the needs of the community.	
		Facilitate NFA field staff to do their work.	
		Seek political support at all levels.	
Soil Erosion	Government to sensitize farmers to promote SWC measures on private, Government lands.	Identify, support other livelihood activities other than over reliance on subsistence agriculture.	Farmers apply improved SWC techniques: improved land preparation, contour farming with

Issues	Strategies	Action - Non Physical	Action - Physical (Chapter 11 elaborates on the catchment protection works)
	Ministry to roll out sensitization of catchment population on dangers of soil erosion and need to conserve soil structure.	Extension to farmers by DLG on improved SWC techniques.	hedgerows and rock/soil bunds, cultivation with cover crops, mulching, multi-cropping, composting and nutrient cycling, rainwater harvesting, adjusted farming techniques on steep upland areas
	Government to roll out agro-forestry and to support woodlot establishment for land with landholding capacity > 5 acres.		Farmers allocate land and use for agro-forestry and woodlots.
River Bank Cultivation and Wetland Encroachment	Government to support DLGs in implementing action program on river bank and wetland protection	Formulation of more bylaws on river bank protection.	Demarcate wetlands, river banks with tree species.
		Put in place some bylaws that should deter the population from cultivating in the wetlands and river banks.	Stabilize buffer zones with plant/grass species.
	Government to sensitize population to appreciate the importance of conserving wetlands and river banks.	Government to support and promote other livelihood programs.	Stabilize river beds with gabions, stone pitching
		Ensure catchment management committees at village level are functional.	Reduce river peak flows with check dams.
		Remove encroachers out of wetlands and river bank buffer zones.	

Issues	Strategies	Action - Non Physical	**Action - Physical** (Chapter 11 elaborates on the catchment protection works)
	Sustainable financing for sustainability of the already existing interventions.	Installation of early warning systems in the rivers to alert the communities of the pending catastrophes.	Restoration of heavily degraded areas through tree planting.
		Extension to farmers on cultivation flood resistant crop and related farming practises.	Periodically desilting and dredging of the river channels.
	Sensitizing the communities to preserve river banks by appropriate land/soil utilization technologies.		Strengthening of flood hotspots by installation of flood protection dykes, gabions, stone pitching and planting of appropriate plant species.
Invasive Species	Government to sensitize, encourage farmers to adopt good agricultural practices.	Government to fund and/or conduct research on management of invasive species.	Physical removal of invasive species.
			Spraying of invasive species using permissible herbicides.
			Planting of herbicide treated (*Imazapyr*-resistant) maize seed.
			Use of striga resistant maize varieties.
Pests and Diseases	Government to sensitize farmers on farming methods that reduce pest and disease prevalence.	Through extension services, introducing resistant crop varieties to farmers.	Farmers apply crop diversification and rotational cropping which breaks the cycle of pests and diseases.
		Support to farmers in multiplication of resistant varieties.	Availing farmers with clean/certified seeds.

Issues	Strategies	Action - Non Physical	Action - Physical (Chapter 11 elaborates on the catchment protection works)
Pollution from Agrochemicals	Mitigating the impact of pesticides on large agricultural firms is a complex task and requires to be handled on a case by case basis following recommendations from detailed environmental and social impact assessment studies.		
Poor Waste Management	Government to promote, ensure effective delivery of waste services to all waste generators within the Municipalities and Town councils.	Integrate physical planning in all solid waste management activities and decisions.	Implement sustainable waste minimisation, separation at source, reuse, recycling and recovery.
		Develop solid waste management byelaws of for the catchment and enforce these.	Safely handle and dispose off solid waste through best practices.
	Government to promote public participation and inclusion in the solid waste management system.	Institute sound budgeting and financial management for waste services.	
		Ensure adequate staffing, remuneration and capacity for solid waste management.	
		Establish and implement a Waste Information System and effectively report on status and progress.	
Drought and Climate Change	Government to set aside funds to counteract the effects of drought related disasters.	Encouraging environmentally clean farming methods that conserve soil and water.	Government to support development of more mini and major irrigation schemes.
		Households to be encouraged and supported in establishment of household woodlots for energy and other wood requirements.	Long term re-vegetation of bare hills to be undertaken.
			Introduction of drought tolerant crop varieties.
			Improved rangeland practices.

Issues	Strategies	Action - Non Physical	**Action - Physical** (Chapter 11 elaborates on the catchment protection works)
			Improved water management practices like rain water harvesting.
			Government to consider constructing multipurpose dams & water reservoirs to supply water in terms of drought.

10.5 Key Area 2 - Institutions

Since it is not always possible to "force" the various stakeholders to adopt a coordinated planning and implementation approach and that the transition to a more coordinated approach will see both success and failure, much depends on the *capacity of the key implementers* to influencing on how the various stakeholders (particularly Government) plan their future activities.

For the two key institutions that are considered to have a major stake in the management of the environment of the Tochi catchment, the capacity issues and challenges were indentified. These institutions are the National Forestry Authority, and the District Forestry Services of the Oyam, Omoro, Nwoya, Kole, Gulu and Amuru Districts. The outcomes of the capacity need assessment are discussed in Section 13.2.

The challenges were identified during the Strategic Social Assessment that was conducted under the consultancy assignment. The challenges are discussed in the Strategic Social and Environmental Assessment report of 20 September 2018 (SSEA report) in more detail. A summary of these challenges is presented in Table 10.3. A number of strategies with action points were identified and formulated based on the mitigation measures as discussed in the SSEA report. These are also presented in Table 10.3.

Table 10.3 - Key Area 2 - Institutions - Issues / Challenges, Strategies and Action

Institution	Issues and Challenges	Strategies	Action
National Forestry Authority	Management problems have resulted in encroachment of CFRs for agriculture, settlements and deforestation for charcoal and timber.	Government to secure sufficient funding	NFA to seek political support at all levels.
	Non-availability of funds to conduct manage forest management activities Unclear forest boundaries.		NFA to mobilize funds from Government or Development Partners to address the management issues.
	Delayed payment of contractors.		Increase funding to replant or restore the degraded forest reserves.
	Dilapidated staff offices & residences.	Capacity Building for NFA	Secure funding for capacity building activities and implement.
	Delayed payment of staff.	CFR protection	Strengthen forest law enforcement and governance program to curb illegal activities in CFRs.
	Understaffing.		Develop a management plan for each Forest Reserve.
	Dubious sale of forest land.		Sensitize all forest encroachers to leave.
	Poor facilitation of staff (transport & fuel).		Effective coordination of all relevant Departments to ensure that policies and programs enhance forest conservation and protection.
	Unclear forest boundaries.		Open and demarcate all forest reserve boundaries with live and permanent markers.

Institution	Issues and Challenges	Strategies	Action
			Encourage tree planting by communities on their own lands.
			Promote non-consumptive use of forests e.g ecotourism, bee keeping and others.
District Natural Resources Services for Oyam, Omoro, Nwoya, Kole, Gulu and Amuru Districts.	The Natural Resource Departments at the Districts are underfunded. This incapacitates the Departments to undertake conservation and tree planting activities in the catchment. The Departments are understaffed with no forestry extension agents at the Sub-Counties.	Government to secure sufficient funding	NRD to mobilize funds from Government or Development Partners to address the management issues.
			NRD to seek political support at all levels.
			Increase funding to replant or restore the forest reserves.
		Capacity Building NRD	NRD should consider recruiting more NR staff in the District Local Government including forestry extension staff at the Sub-Counties.
		LFR protection	Develop a management plan for each forest reserve.
			Open and demarcate all forest reserve boundaries with live and permanent markers.
			Sensitize forest encroachers to leave peacefully.
			Supporting massive tree planting on private land.
			Beef up forest protection.
			Promote non-consumptive use of forests e.g ecotourism, bee keeping and others.

10.6 Key Area 3 - Knowledge Base

The Knowledge Base for the Tochi catchment, as designed under the consultancy assignment, comprises of information stored in a comprehensive data base, links to web sites (source information) and software for GIS processing, hydrological modelling and water allocation modelling.

This base has gradually developed with data gathered during the catchment's situation and diagnostic analyses with information on:

- physical features of the Tochi catchment;
- environmental features (including hot spots of erosion and sedimentation);
- socio-economic information

as well as with processed GIS data, maps and the outcomes from the analytical tools such as the WEAP model with the water balance (including climate change and different water availability, water demand scenarios).

The importance of maintaining this Knowledge Base lies in the future usage of it so to enable regular updating of the Tochi CMP by its implementers.

Likewise with the previous two key areas, a number of challenges, strategies with action points were identified and formulated (Table 10.4). The action points focus on creating and sustaining an enabling environment for the key stakeholders to maintain and use the Knowledge Base effectively for future planning and updating of the CMP.

Table 10.4 - Key Area 3 - Knowledge Base - Issues, Challenges, Strategies and Action

Issues and Challenges	Strategies	Action
Shortage of specialists in Natural Resources management (forestry, environment, soil, hydrology, GIS etc).	Capacity Building of key stakeholder institutions with extra attention to IT and Knowledge Base development	Recruitment of specialists
Staff less informed about latest technology software (software relevant for use by specialist such GIS applications, land use planning, hydrological and water allocation models, data base management etc).		Exposure specialists to latest software packages related to environmental management. Conduct exchange visits, participate in seminars/ workshops/fairs.
Staff insuffiently trained in data processing and data base management.		Staff participates in data processing and data base management training.
Poor accessibility of specialized data.		Coordinated efforts to make data available free of charge.
Data gaps in GIS data base, hydrological data (river flows, river levels), meteo records, land use data etc.		Use of specialized software to filling data gaps for long term time series.
High costs involved for extending licensing for hydrological, water allocation, water balance models.		Use of open source software.
Poor internet connections at DLG or lower level.		Apply mobile devices with modems when internet connection is poor.
Shortage in computers and other hardware.		Avail new hardware, computers.

11 PROPOSED CATCHMENT PROTECTION WORKS

11.1 Introduction

Based on the previous assessments and the Strategic Planning Framework, this Chapter comes up with a list of catchment protection works for the Tochi catchment. These are summarized as follows:

- Protection of the River Banks and Wetlands through buffer Zone demarcation and protection, and stabilization of the river banks through check dams, gabions and stone pitching;
- Protection of the Local and Central Forest Reserves through restoration and enrichment planting, replanting of trees and forest boundary marking;
- Agro-Forestry on private land;
- Woodlot establishment;
- Soil and Water Conservation.

In addition to these physical works, a number of complimentary and cross cutting activities were identified such as developing new policies, bylaws, sensitization of local communities, training, other physical works etc. These are in support of the main works (Table 11.1)

The works have been discussed extensively with the stakeholders during consultations at the National level, Regional level and at the District level during formal and informal meetings, and Workshops. Reference is made to Volume 3 of the final version of the Natural Resources Assessment report of 13 September 2018.

Table 11.1 - Main Works and Complimentary / Cross Cutting Activities for Tochi catchment

	Main Works
1	Buffer zone demarcation
2	Stabilization river banks
3	Civil Works (check dams, gabions, stone pitching)
4	Restoration and enrichment planting
5	Replanting of trees
6	Forest boundary marking
7	Agro-Forestry
8	Woodlot establishment
9	Soil and Water conservation
10	Urban Forestry
11	Set-up of waste management systems in towns
12	Set-up of drainage systems in towns
13	Identification and support to other livelihood programs
	Complimentary / Cross Cutting Activities
14	Set-up of Bylaws on River Bank Protection and Waste Sorting
15	Set-up of Policy and Ordinance on Fuel Wood Farming
16	Set-up op Bylaws on Ordinances on Bush Burning
17	Training of MoAAIF, DLG extension Staff in SWC
18	Sensitization of Population on Catchment Protection
19	Set-up of Catchment Management Committees at Village Level
20	Procurement of Tree Seedlings
21	Collaboration with NGOs, CBOs and other Organisations
22	Mobilise Funds to Address Management Issues in CFRs
23	Eviction of Forest Encroachers

This chapter presents for each work or activity a summary. It is structured as follows:

Section 11.2 - Protection of River Banks and Wetlands
Section 11.3 - Stabilization River Banks by Vegetation
Section 11.4 - Stabilization River Banks by Civil Works
Section 11.5 - Restoration and Enrichment Planting in Forest Reserves
Section 11.6 - Replanting of Trees in Forest Reserves
Section 11.7 - Forest Boundary Marking
Section 11.8 - Agro-Forestry
Section 11.9 - Woodlot Establishment
Section 11.10 - Soil and Water Conservation
Section 11.11 - Set-up of Bylaws on River Bank Protection and Waste Sorting
Section 11.12 - Set-up of Policy and Ordinance on Fuel Wood Farming
Section 11.13 - Set-up op Bylaws on Ordinances on Bush Burning
Section 11.14 - Training of MoAAIF / DLG extension staff in SWC
Section 11.15 - Sensitization of Population on Catchment Protection
Section 11.16 - Set-up of Catchment Management Committees at Village Level
Section 11.17 - Procurement of Tree Seedlings
Section 11.18 - Urban Forestry
Section 11.19 - Set-up of Waste Management Systems in Towns
Section 11.20 - Set-up of Drainage Systems in Towns

Section 11.21 - Collaboration with NGOs, CBOs and Other Organisations
Section 11.22 - Mobilise Funds to Address Management Issues in CFRs
Section 11.23 - Eviction of Forest Encroachers
Section 11.24 - Identification and Support to other Livelihood Programs

11.2 Protection of River Banks and Wetlands

Riparian areas are very vulnerable to erosion due to high stream velocities. To minimize erosion/sedimentation, it is very important to protect this portion of the catchment. Buffer zones are vegetative areas that separate field boundaries from rivers. These protected areas are effective at stabilizing stream banks with their extensive root system. They are also efficient at preventing soil and contaminants from entering watercourses by providing an area for field runoff to collect. These areas allow soil particles to settle out of the runoff water.

Although the Wetlands, River Banks and Lakeshores Regulations provide for the observance and protection of a 30-meter buffer zone from the nearest water mark for the wetlands, field surveys in all the five catchments have shown that the above regulation is not effective in all wetlands and streams. On the contrary, river bank cultivation is the practice and this has resulted in sedimentation of these rivers. Farmers were observed to cultivate up to the river bank subjecting the rivers to high levels of sediments. In several cases the river banks were observed to be unstable and susceptible to being washed away. It is therefore recommended that the 30 meter buffer zone around all wetlands and rivers/streams in each of the catchment be demarcated and marked.

11.3 Stabilization River Banks by Vegetation

The buffer zone would then be restored and stabilised with appropriate vegetation covers. Bamboo, *phragmites*[5] and Elephant grass are recommended grasses with the ability to hold the soil together. Other tree species that can be planted to stabilize the buffer zone include *Ficus spp, Bathdavia spp* and any other tree species that is seen locally to perform naturally well in the river bank being considered for restoration and protection.

11.4 Stabilization River Banks by Civil Works

Stream bank degradation is one of the major causes for the high sediment loads in the rivers, in particular after heavy rainfall. This phenomenon was widely observed during the field visits and confirmed by the DLG staff and local communities.

There are a number of Civil Works that can be used to prevent soil erosion in stream beds and embankments. These range from temporary to permanent measures and from low cost to high cost measures. Some of these are listed below.

- Check dams reduce river flow velocity;
- Gabions (or other structures) in river embankments with high erosion, at places of high economic value (house, schools, markets, bridges etc);
- Stone pitching slope protection at places of high economic value;
- River groins along unprotected river reaches (meanders);
- Gully control with check dams.

[5] genus of four species of large perennial grasses

Given the nature of the streams in catchments, required investments and complexity of installation, and based on SMEC's experience with similar conditions in other developing conditions, the consultant recommends three types of civil works which include:

- Gabion walls;
- Stone pitching; and
- Check dams.

These measures are easy to implement and not highly capital intensive. They will be put in selected places in the streams where there is excessive soil erosion and need to protect places or structures of high economic value. Standard designs are presented in Appendix 11.1.

Check Dams

Check dams are small low drop structures built across a gully or channel to prevent it from deepening further. These small dams decrease the slope gradient and reduce the velocity of water flow and the erosive power of the runoff. They also promote the deposition of eroded materials to further stabilise the gully or channel.

Gully plugging using check dams, accompanied by planting between the dams to stabilize the channel, can be one of the most effective ways to conserve soil and water and rehabilitate land degraded by gullies (Guedel, 2008). The effectiveness of different check dams depends upon the design, location, and construction materials.

Check dams can be constructed from a wide range of materials including rock, wood, bamboo, gravel bags, sand bags, concrete, masonry, and fibre rolls. They are a highly effective to reducing flow velocities in channels and waterways. Contrasting big dams, check dams have a faster implementation timeline, are cost effective, and are smaller in scope. Because of this, their implementation will not typically displace people or communities nor will they destroy natural resources if careful design considerations are undertaken.

Gabions

A gabion is a heavy duty basket-like structure made in the shape of a box from welded or twisted galvanized iron wire mesh, divided by wire diaphragms into cells, and filled with heavy material (typically rocks or broken concrete) that cannot escape through the mesh openings. Gabions are generally used as construction blocks, and are tied together with galvanized iron binding wire to form larger structures. Gabion walls are constructed using gabion boxes of various sizes stacked next to and on top of each other before tying. Good quality stone should be used to fill the boxes, with dimensions preferably not less than 10 cm, or at least great than the mesh size. Stones should be packed as tight as possible to increase the density of the gabion wall. The gabion structures are flexible and provide good drainage due to the dry stone packing.

The base layer of gabions should be placed below the expected maximum scour depth, or the toe can be protected with gabion mattresses.

Gabions can flex to ground movement, dissipate energy from flowing water, and drain freely. Their strength and effectiveness may increase with time, as silt and vegetation fill the voids, and reinforce the structure. In locations where high flood water velocities are expected, carrying woody debris and gravels in suspension, the stronger welded gabions are the preferred choice, to resist damage to the gabion structures during floods.

Damage to the baskets should be repaired immediately. Missing stones should also be replaced from time to time to maintain a tightly packed basket. This will minimize stone movement which can cause abrasion damage to the basket wires.

Stone Pitching

Stone pitching is constructed using good quality stones with cement sand mortar. These walls are rigid and designed as gravity structures with a base width varying from 0.5–0.75 times the wall height. The foundation must be on firm, risk-free ground. Weep holes of at least 75 mm diameter should be included every 2 x 2 m^2 in a staggered pattern for drainage. Stone Pitching can be in a trapezoidal form or rectangular section. The trapezoidal section is more preferable due to its soil stabilising ability and ease for construction because it requires no formwork at all.

11.5 Restoration and Enrichment Planting in Forest Reserves

Both enrichment and restoration planting are terminologies usually applied in protected areas being managed as natural forests and they are undertaken to increase/improve the stocking of the indigenous tree species in the forest. Restoration planting is a type of re-afforestation practice undertaken in certain sections of a heavily degraded forest to restore its former tree cover and integrity. In restoration planting, the assumption is that the degraded area has hardly any tree cover left and hence the intensity of tree planting is uniform throughout the degraded area. On the other hand, enrichment planting is a term used to restore patches of a degraded forest where tree cover in the degraded part has not been entirely depleted. Therefore, while conducting enrichment planting, the intensity of tree planting is not uniform and the trees planted per hectare are fewer. For example, in restoration planting a spacing of 4 m x 4 m or 5 m x 5 m can be used but in enrichment planting, a spacing of 10 m x 10 m or more can be used.

Basing on information obtained from the National Forest Authority, restoration planting will be undertaken in some CFRs in the Tochi catchment. Opit CFR in Omoro & Oyam Districts, Keyo CFR in Amuru District and several others. The tree species that will be considered for restoration and enrichment planting will differ in each forest reserve but generally species such as *Milicia excelsa, Terminalia spp,* Mahogany, *Albizia spp, Bathdavia spp, Antiaris toxicaria, Cordia spp, Melia volkense, Tectona grandis, Spathodia spp, Prunus africana, Croton megalocapus, Olea spp* among others will be considered. The extent of re-afforestation to be undertaken in each forest will be presented in the investment options /catchment management plan report.

11.6 Replanting of Trees in Forest Reserve

Replanting is a terminology used to refer to re-afforestation activities in protected areas being managed as plantation forests.

According to NFA, some of the protected areas that had been managed as natural forests previous had been converted into plantation forests and allocated to private tree planters. However, other plantations forests are managed by NFA. Consultations with NFA and DFOs staff indicated that several plantation forests in the Tochi catchment were due for replanting although it is not known whether NFA or private tree planters will fulfil their obligations in this respect.

Some of the forest reserves that need to be replanted include Opaka CFR in Omoro District, Gulu Forest Reserve in Gulu District, Awang, Lendu, Okavu-reru & Usi CFRs in Zombo District and several others.

Generally, all Local Forest Reserves managed as plantation forests are degraded and are due for replanting. Most of the tree species considered for replanting in plantation forests include *Eucalyptus spp, Pinus spp, Cupressus lustanica, Terminalia spp, Tectona grandis, Maesopsis eminii, Bathdavia spp* and a few others.

11.7 Forest Boundary Marking

Consultations with NFA and DSF staff indicate that one of the causes of forest encroachment is unclear forest boundaries. The local communities take advantage of unclear forest boundaries to enter and cultivate in forest reserves. In some cases, people have even constructed settlements in the protected areas.

Most of the reserves have unclear boundaries. It is therefore recommended that all forest reserves with unclear boundaries should undergo boundary re-opening after which boundary marking with permanent concrete pillars and live markers (appropriate tree species) should be undertaken.

11.8 Agro-Forestry

Agro-forestry has been recommended as one of the most viable interventions for the Tochi catchment and shall be used to improve and stabilise the integrity of the catchment in subsistence farmlands. In the Tochi catchment, subsistence farmlands contribute more than 50% of the total land cover.

Agro-forestry is the growing of trees on farms and this practice contributes to a wide range of products and services. Trees can be grown to provide food, shelter, energy, medicine, cash income, raw materials for crafts, fodder and forage and resources to meet social obligations. Trees used in agro-forestry systems can also provide a variety of services such as being a form of saving and investment and contributing to the improvement of soil fertility for crop production.

The type of tree species that can be planted on farms will vary depending on the farm size, farming objectives and other social and physiographic factors. In addition to fruit trees, other tree species include *Albizia spp., Cassia siamea, Commiphora eminii subsp. zimmermanni, Grevellea robusta, Sesbania sesban, Ficus sycomorus, Bridelia micrantha, Croton macrostachyus, Cordia abyssinica, Jacaranda mimosifolia (*only in high-rainfall areas*), Spathodea campanulata, Markhamia lutea, Acacia spp., Combretum spp., Terminalia spp., Piliostigma thonningii, Erythrina abyssinica, Entada abyssinica, Balanites aegyptiaca, Morus spp., Faurea saligna, Ficus natalensis, Grewia spp., Melia volkensii, Moringa oleifera, Psidium guajava, Calliandra calothyrsus, Flemingia macrophylla, Gliricidia sepium.*

In terms of spacing and establishment, a population of up to 100 trees per hectare, corresponding to a spacing of 10 m x 10 m, is appropriate in high-potential areas if the crop is light demanding, e.g. maize. If trees are to be planted, a better option than square spacing may be to plant trees in lines (alleys) with close spacing within the rows and a wider spacing between the rows which resulting in a similar overall density. A spacing of 5 m within the

rows and 20 m between rows can be suggested. Tree and crop species and management methods chosen are factors that will influence the selected spacing.

11.9 Woodlot Establishment

Woodlot establishment is the planting of a pure stand forest either for timber, fuel wood, medicine and other forestry benefits as determined by the farmers' objectives. The area planted as a pure stand forest will depend on the land owned by each household but even half an acre planted with trees will be considered as a forest.

Unlike agro-forestry where trees are grown on farms, woodlots as an intervention can be recommended for parts of the Tochi catchment where the average landholdings are more than 5 acres per household. Basing on the discussions held with various stakeholders, especially the District and Sub-County extension workers, households are willing to allocate 5 acres of their land for crop farming activities and any other extra land for converting into a stand forest for exploiting fuel wood, poles and timber. The more land a household has beyond 5 acres, the greater the willingness and desire to establish woodlots. Families with less land are advised to go for agro-forestry so to realise the similar benefits.

Tree species recommended depend on the household objectives but generally, *Eucalyptus spp, Maesopsis eminii and Terminalia spp* are chosen.

The environmental benefits of establishing woodlots will result in the conservation of soil, water and plant resources. When a household has a defined, reliable and sustainable source of fuelwood, over dependency on woodland for fuel wood and charcoal will reduce steadily hence resulting in a more suitable consumption of forest resources. This intervention will also reduce the rate of forest reserves' degradation for charcoal and fuel wood.

11.10 Soil and Water Conservation

To mitigate some of the environmental problems in the Tochi catchment, general Soil and Water conservation measures are recommended for the Tochi farmers and residents. Most of these measures concern conservation agriculture measures, while others are general practices that encourage rainwater storage and infiltration and minimize stormwater runoff. The ultimate objective is to slow down the flow of rainwater runoff, maximize the retention of moisture and nutrient in the soil, and to reduce soil erosion throughout the catchment.

In general, soil and water conservation measures aim at maintaining vegetation on the land. Tree roots promote soil conservation which also leads to water conservation. Thick topsoil stores more water than shallow topsoil. In large part of the catchment, the water-holding capacity has gradually decreased due to logging, slash & burn activities and agricultural land preparation.

The main Soil and Water Conservation measures include: the protection of the riparian buffer zones along the streams, the protection of upland areas, land preparation, contour/strip farming, application of cover crops/mulching, multiple cropping and water harvesting. Although it is best to integrate these measures when planting crops on arable land, all measures are meaningful individually and can be implemented independently. Some of these measures are simple and low-cost whereas others require more input (seeds/seedlings, labour).

Land Preparation

Tillage is practiced by most farmers to prepare the soil before planting. It is generally accepted that tillage loosens the soil and makes it more susceptible to erosion. Ploughing is not advisable on slopes greater than 18% and along river banks.

Conservation tillage is generally recommended for the Tochi farmers. This form of tillage involves leaving the previous year's crop residue (such as corn stalks) on the field before and after planting the next crop to reduce soil erosion and runoff. Conservation tillage also encourages carbon sequestration and soil enrichment.

The following tillage practices are recommended:

- Incorporate previous crops residue in tillage;
- Ploughing in between the stubbles of the previous crop;
- Only ploughing where crops will be planted;
- Reduce number of tillage operations (one pass instead of two);
- Plough short before planting of new crop;
- After ploughing, cover soil with mulch before new crop has established;
- Tillage is strongly discouraged in slopes greater than 18%.

Contour Farming

Contour farming (or cross-slope farming) is a combination of contour ploughing and contour planting. Ploughing and planting should be done along the contours, or pathways of equal elevation. Ploughing/planting should not be done down slope so as to minimize runoff flowing downhill along a straight path and prevent water loss and soil erosion. Contour farming enhances the retention of water and nutrients into the soil and makes these available for crops or other plants.

Hedgerows and Rock / Soil Bunds

Sloped areas can be stabilized using hedgerows, soil bunds or other types of manmade barriers. Planted at various spacings, hedgerows prevent soil erosion and assist to flatten sloped areas into terraces over time. This measure can be implemented in both cropped and non-cropped areas. The main advantage of live hedgerows over rock bunds is that trees/bushes can be planted that provide some benefits to the people. Hedgerows have multiple advantages:

- Plant cuttings from hedgerows can be used as mulch (cropped areas) or fodder;
- Economic trees/bushes can be planted such as fruit trees and medicinal plants;
- Leguminous plants can be planted that enrich the soil;
- Hedgerow seeds can be sold.

Some of the hedgerow plants that can be utilised to stabilise sloped areas in the catchment are listed below. Depending on the location, it may be good to choose a hardy plant which can survive several months without water.

- Fruit trees;
- Vetiver grass;
- Sisal or other cacti;
- Vetiver grass or bamboo shoots;
- Moringa or other small trees / bushes;
- Medicinal plants/shrubs.

The hedgerows / rock bunds should follow the contour lines. The horizontal spacing can be based on a 1.5 m vertical drop over the hill. If done well, the main advantages of the rock heaps are that they can be cheaper and require less maintenance than the hedgerows.

Cover Crops and Mulching

Cover crops and mulching provide additional protection to the soil layer against the impacts of the rainfall. Temporary or permanent covers can be fast growing annual or perennial plants. Some of the advantages of cover crops are:

- minimizes erosion and soil loss;
- organic fertilizer for topsoil, such as nitrogen or phosphate;
- temperature control (favorable for seed germination, root/microorganisms' growth);
- limits weed growth;
- protection of the soil against the sun heat;
- can use economic value plants such as beans, peas, peanuts;
- fodder plants in pastures;
- can be used as traps for pest attacks.

Some good cover crops include:

- Leguminous plants such as alfalfa, peas, beans, chickpeas, lentils, cowpeas, soybeans, and peanuts. These plants improve the soil quality for other crops;
- Squashes (*Cucurbita pepo*): plants such as pumpkin and zucchini have large leaves which can protect the soil against splashes;
- Melons (*Citrullus, Cucumis, Benincasa*): similar vine plants such as watermelon and melon make good cover crops around and at the base of the main crop;
- Locally used fodder plants.

Mulching is adding organic residues (straw, corn, stalks, leaves) at the surface of the soil. Similar to cover crops, mulching can help with both splash erosion protection and soil enrichment. Some of the advantages are listed above. Disadvantages include creating conditions favorable for pests to develop. It is recommended to do mulching before the on-set of the rainy season and to incorporate mulch in the soil during soil preparation.

Multiple Cropping

It is recommended that farmers follow several cropping practices, including crop rotation, relay planting and intercropping. Important advantages of multi-cropping are to maximize the use of land, increase production and manage pest management.

Crop rotation follows a system of alternating grain crops with legumes. Legumes enrich the soil with nutrients which become available to other crops. Crop rotation allows farmers to increase soil organic matter content, soil structure and rooting depth. This is accomplished by growing secondary crops which enhance soil health.

Relay planting is planting / sowing a second crop before the harvest of the first one. A good example is corn with a legume crop such as peanut or cowpea. The land can be left to fallow at a later stage. Relay planting helps to reduce the need for weeding.

Intercropping is a form of multiple cropping whereby several crops are grown in proximity. Apart from maximizing the use of the land, intercropping allows synergies of resources or ecological processes that would not occur if only a single crop was planted. One way is to intercrop cereal crops or vegetables with legumes or forage crops.

Another strategy is to integrate perennial trees/bushes with annual crops. For example, rows of fruit trees or coffee plants can be planted on land where other crops are typically planted. This provides the advantage of more long-term protection against erosion, diversification of income sources, and weed control. The choice of tree/bush depends on preference, availability of seedlings, rainfall, elevation, the amount shade created on other crops and the maintenance requirements.

Composting and Nutrient Cycling

The practices of composting and others which encourage nutrient cycling at the soil layer are recommended throughout the Tochi irrigation scheme catchment. Composting is the process of decomposing organic waste and producing nutrient rich material which can be used as organic fertilizer. All organic waste from plants, crops, and animal waste may be composted. Composting is not only good to enhance the fertility of farmlands, it also increases the organic matter content in the soil, which in term increases the soil structure and retention capacity.

Rainwater Harvesting

Rainwater harvesting treats water as a valuable resource to be maintained onsite and not as a waste to be removed from the land. The objective of rainwater harvesting is to capture rainfall or runoff as close as possible to its source, and to re-use it onsite for various purposes.

Before implementing water harvesting on private land, it is first recommended to take time to observe the drainage patterns onsite. Some of the features to study include the preferred runoff flow paths, the pooling areas, the parts being eroded away and the zones where sedimentation occurs. Having a good understanding of these dynamics enables to prescribe the right type of earth work.

Some of the general water harvesting principles are to start from the top of the watershed and to implement measures along the rainwater flow path. Runoff is to be directed to follow a more zig-zag pathway to increase the time of flow, the distance travelled and ground infiltration from source to sink. Sunken basins should be dug around perennial plants with overflow directed to next basin downstream.

Water harvesting theory encourages synergistic practices on land to not only slow down water flow on land and reduce erosion but also provide other benefits such as for farming.

Some of these practices include planting vegetative groundcover, spreading organic mulch and providing water to crops, cattle and wildlife and protect soil against erosion. Water harvesting requires the residents to continually reassess and monitor drainage patterns on their sites and intervene where and when needed.

In the Tochi catchment, water harvesting can be undertaken through a variety of ways, including:

- Capturing runoff from rooftops and re-using the water around the building for various purposes;
- Capturing runoff through
  - ✓ a series of stepped basins around perennial trees/bushes;
  - ✓ earthen drainage channels zigzagging downhill and flowing along hedgerows;

- Capturing seasonal floodwaters through check dams along small streams.

If practiced to a large scale by watershed residents on their rooftops, through sunken basins and other small earth works on farmlands or through check dams along streams, rainwater harvesting has the potential to significantly reduce runoff generated throughout the catchment and to prevent drainage and erosion problems. Government programs may be implemented to build capacity and encourage catchment residents to practice rainwater harvesting.

11.11 Set-up of By-Law on River Bank Protection and Waste Sorting

There is need for developing By-laws on river usage to protect it from activities that are potentially harmful in the long run if not mitigated or regulated. Some of the activities that need regulation include limit issuing of licenses for sand/gravel mining in and along river beds, farming within the river banks, failure to mark and protect the 30-meter buffer zone, farming within the buffer zone, dumping waste into the rivers and others.

The Government also needs to embark on sensitizing the population on the dangers of unsorted waste and using the catchment management committees at village level. It should become mandatory for every household to provide for waste sorting. The By-laws should be well communicated to the village members and stipulate the penalty for non-compliance to the offenders.

11.12 Set-up of Policy and Ordinance on Fuel Wood Farming

According to the National Forest Plan of 2013, fuel wood and charcoal accounted for the lion's share of 94% of the round wood produced in 2017. The remaining 6% was attached to timber and poles. Without considering farming activities, these statistics indicate that people mainly cut trees to use it as fire wood or charcoal. Despite the fact that fire wood is used daily up by more than 95% of the population nation wise, most households hardly have any deliberate plan to plant fuel wood or woodlots. The mindset that fuel wood and charcoal will always be obtained from the natural woodlands, bushes and forest reserves has accelerated deforestation and general environmental degradation in the Tochi catchment. By 2040 when the population of Uganda is expected to have reached 83 million, the demand for fuel wood by then will have more than doubled. Therefore, if there is no deliberate plan to cause people to plant their own sources of fire wood, the Country is likely to get into a fuel wood crisis soon.

The crisis will be demonstrated by excessive deforestation of all trees in range lands, protected areas and farmlands. This scenario will accelerate conflicts on resource usage among communities, law enforcers and will eventually affect the tourism potential of the Uganda.

It is therefore recommended that GoU puts in place a policy or ordinance where every household is obliged to plant and own a deliberate and sustainable source of firewood by 2025.

11.13 Set-up of By-Law and Ordinances on Bush Burning

Uncontrolled and indiscriminate bush burning was mentioned as one of the major environmental challenges especially in the Omoro, Oyam and Nwoya Districts. The community set several chunks of land on fire even without any objectives and in most cases, the fires go wild and destroy cassava gardens and planting materials for the next season. On several cases, these fires destroy young forest plantations especially pine trees and results in immense losses to farmers and other investors. Uncontrolled bush burning can destroy the ecosystems through killing the biodiversity and preventing natural regeneration. It is therefore recommended that GoU puts in place ordinances and By-laws on bush burning with clear punitive measures to those who set uncontrolled fires.

11.14 Training in Soil & Water Conservation

GoU through the Ministry of Agriculture, Animal Industry and Fisheries, and the DLGs with the Tochi catchment should invest in training the extensions workers at the Sub-County level who will in turn conduct training of trainers at the village level. The extension workers should be trained in Soil and Water Conservation, Agro-Forestry techniques, energy saving technologies and waste management.

11.15 Sensitization of Population on Catchment Protection

GoU through the Ministry of Water and Environment should roll out sensitization of the Tochi catchment population on key environmental issues. Through radio stations, television and print media, the population should be alerted of the need to re-vegetate the catchment, mark and protect the river banks, and establish household sources of fuel wood.

Other areas for sensitization include the need to sort solid waste at the household level, protect wetlands, evacuate from the forest reserves and adopt energy saving technologies.

These sensitization messages should be presented in such a way that the population will perceive the need to protect the environment as a matter of urgency.

11.16 Set-up of Catchment Management Committees at Village Level

The message of catchment protection can effectively be communicated to the population if the Ministry has an established catchment/environment management committee at the village level. The committee should be trained and equipped with basic knowledge and the legislation on environment. It should constitute the focal persons that will monitor non-compliance on a weekly basis at the village level and advise the offenders on corrective actions or report directly to the existing Sub-County environmental committees.

11.17 Procurement of Tree Seedlings

The current system being implemented under FIEFOC 1 & 2 where seedlings are procured from the centre (Wakiso, Mukono, Kampala & other non-catchment Districts) was observed to be less efficient. Also the system demotivates the local Government staff and the local community from participating in environmental protection programs. It is less participatory and does not promote local people that would wish to venture in environmental protection businesses. Generally, the whole idea of tree planting and environmental protection has been criticized by several stakeholders as not being implemented with sustainable

objectives. It was stated that on several occasions the seedlings arrive late at the destination when the rainy season was almost ending. In some cases, it was stated that the seedlings are not normally hardened off to adapt to the climate onsite and these factors eventually affect the overall survival of the seedlings in the main gardens. This scenario also creates uncertainty among the farmers and the local Government staff because they cannot predict whether the seedlings will come or not.

Eventually, most of the stakeholders and beneficiaries either get detached from the project or give it less priority. It is therefore recommended that all contractors that will be involved in supplying seedlings for the Tochi catchment protection should own nurseries in the host Districts. This arrangement will motivate the local community to engage in the tree nursery operations with a large multiplier effect. The District staff will then be able to supervise the nurseries and ensure quality seedlings are supplied on time.

11.18 Urban Forestry

Urban forestry is the care and management of tree populations in urban settings for physiological, sociological, economic and aesthetic benefits. Urban forestry comprises all green elements under urban influence such as;

- Street trees and road plantations;
- Public green areas, such as parks, gardens & cemeteries;
- Semi-private space, such as green space in residential areas and in industrial or specially designated parks;
- Public and private tree plantations on vacant lots, green belts, woodlands, rangelands, and forests close to urban areas;
- Natural forests under urban influence, such as nature reserves, national parks and forests for eco-tourism;
- Urban agricultural land, such as orchards, allotments and others.

However, selections of trees are important for urban forestry because trees in the urban of the Tochi catchment areas face more stress than those in rural areas. Some of the common stresses faced by urban trees are the restrictive soil volume and crown space, soil pollution, air pollution, wind and drought.

In addition to the tangible benefits of urban forestry such as fuel wood, food, fodder and building materials, trees in urban areas reduce topsoil erosion, prevent harmful land pollutants contained in the soil from getting into waterways, slow down water run-off, and ensure that groundwater supplies are continually being replenished. For every 5% of tree cover added to a community, storm water runoff is reduced by approximately 2% (Grants Pass Oregon, 2018). Trees reduce air pollution, mitigate greenhouse gas emissions, conserve water and energy, reduce noise pollution and lower urban air temperature. Trees act as natural pollution filters. Their canopies, trunks, roots, and associated soil and other natural elements of the landscape filter polluted particulate matter out of the flow toward the storm sewers. Reducing the flow of storm water reduces the amount of pollution that is washed into a drainage area. Trees use nutrients like nitrogen, phosphorus, and potassium which are by products of urban living and yet they can pollute streams.

According to Climate TechWiki 2018, over half of the world's population lived in urban areas in 2008 and by 2050 this will rise to 70 per cent and more than 90 percent of total

population growth will be in cities in developing countries (UNHABITAT, 2009). Hence, in this context urban forestry plays a key role in developing countries. Currently, the percentage of urban population in Uganda was at 16.4% in 2016. By 2040, Uganda's urban population will have hit more than 24%.

Therefore, this concept of urban forestry is recommended for all urban areas in the catchment. As such it has been zoned out on the Tochi map for proposed interventions, indicated in the report on Evaluation of Options of 10 October 2018.

11.19 Set-up of Waste Management Systems in Towns

The ongoing, poor disposal of waste in the existing and upcoming urban areas in Tochi has the potential to cumulatively contaminate and pollute the catchment. Consultations with various stakeholders and field surveys indicated none of the urban areas has a gazetted and/or appropriate landfill to manage solid waste. Unsorted solid waste is dumped haphazardly in private places and, if it is not contained now, will eventually become a burden and an environmental hazard. When solid waste in the form of polyethylene bags, plastics and other materials find their way into the drainage channels and rivers, they will eventually end in the irrigation canals and may become difficult to manage.

It is recommended that all towns and rural growth centres prepare to gazette and operate appropriate waste disposal facilities/sites. In this regard, waste sorting should be initiated at the source (household) and followed consistently up to its final destination.

11.20 Set-up of Drainage Systems in Towns

Although most of the Districts have physical plans that designate certain areas as Agricultural, Commercial, Residential, Industrial and/or Buffer zones, the actual implementation of these plans is virtually non-existent. The growth of most of the towns continues to be haphazard while the population growth rate of Uganda continues to be one of the highest in the world. This ongoing and rapid growth comes along with land clearing which further exposes the ground to soil erosion. It is therefore recommended that all towns are properly planned, paved and drainage systems directed in the right places to avert the danger of further sedimentation of streams.

11.21 Collaboration with NGOs, CBOs and other Organisations

The Stakeholder Engagement Report of 18 September 2018 has identified a number of organisations together with the role they play in catchment management for Tochi and its protection. It is recommended that the Government collaborates with them through knowledge sharing, funding of certain activities, sensitizations and trainings especially in Soil and Water Conservation techniques, tree planting, energy saving techniques and others to accelerate the rate of adoption of certain technologies and the general impact of Governments efforts to promote environmental protection.

11.22 Mobilise Funds to Address Management Issues in Central Forest Reserves

Consultations with NFA field staff revealed several management issues within NFA. Most of the challenges identified are attributed to inadequate funding to undertake the forest management programs. Several Forest Supervisors are not well facilitated in terms of transport and fuel to carry out their duties. It was also stated that field staff make budgets for annual forest management activities but hardly is anything implemented.

This is also one of the reasons why forest boundary demarcation and replanting has not been undertaken for several forest reserves. In some cases, field staff offices and residences need to be renovated. Generally, this scenario demotivates field staff and has resulted in further forest degradation and encroachment. It is therefore recommended that NFA mobilises funds from Government and other development partners to undertake all the pending management activities and restore the integrity of CFRs.

11.23 Eviction of Forest Encroachers

A number of forests reserves in the Tochi catchment are either encroached with gardens or settlements or both. It is therefore recommended that all encroachers be sensitized and advised to leave the forest reserve peacefully but if they do not comply, then NFA should evict them forcefully. The degraded areas should be restored by replanting, enrichment or restoration planting.

11.24 Identification and Support to other Livelihood Programs

Some of the suggestions for investment options that contribute to the livelihoods of local communities in Tochi (with less impact on vegetation clearance) are linked to bee keeping, poultry farming, value addition on agricultural products by increasing shelf life, supporting zero grazing, goat rearing, building village savings SACCOs and extension of electricity to the villages. Training farmers on energy saving technologies is also recommended to reduce fuel wood wastage.

12 EVALUATION of OPTIONS and SCENARIO ANALYSIS

The Chapter is a synopsis of the final version of the report on Evaluation of Options of 10 October 2018. The focus is on the prioritization of the proposed catchment improvement works by conducting:

1) a Multi Criteria Analysis (MCA)based on the assessment and scoring of different economic, social and environmental scenarios with benefits of the identified works. The methodology applied has been successfully used by SMEC (and well accepted) during similar projects on catchment protection (Section 12.1);
2) an Economic Viability Analysis (EVA) of the benefits of the investment options (Section 12.2).

The methodologies for both analyses with ranking were discussed in detail in the evaluation report and will therefore not be repeated here. The final ranking of the works is based on a combination of results from both the MCA and the EVA with a dominant role of the MEIRR (Section 13.1).

12.1 Multi Criteria Analysis of Investment Options

As discussed in Chapter 11, a total of 23 interventions were identified for the Tochi catchment. These comprise of 13 main works and 10 complementary (or cross-cutting) activities (Table 11.1). The outcomes of the analysis are presented in Appendix 5.3 and 5.4 of the report on Evaluation of Options. The level scores and weighting factors were applied for the main works[6] as well as the estimated time for interventions to start becoming effective.

Conclusions

The MCA analysis reveals that the following four interventions can be given a **high priority** for implementation (see Table 12.1)[7]**:**

1) Soil and Water Conservation;
2) Identification, Support to Livelihood Programs;
3) Stabilization River Banks by Civil Works;
4) Stabilization River Banks by Vegetation.

[6] Note: The 10 complementary activities are part of and supportive to the main works. The benefits of these complimentary activities are indirect of nature as opposed to the direct benefits of the main works. For defining the investment packages, the complimentary activities are therefore not considered as separate interventions but considered being an integrated part of the main works.

[7] A comparison of the ranked interventions between the benefit groups reveal that different prioritized classes are assigned for the same intervention which one would normally expect. E.g. river bank stabilization by vegetation scores relatively low for the social benefits due a number of foreseen negative impacts when it comes to implementation such as reduced land availability for current land users and a high potential risk of conflicts that may arise between farmers and authorities. However, the assessed high economic as well as the environmental benefits outweigh the low social scores and by combining the scores for all three benefit groups the interventions can still be earmarked as an intervention with high priority.

The interventions with a **medium priority** are:

5) Set-up of Drainage Systems in Towns;
6) Set-up of Waste Management Systems in Towns;
7) Agro-Forestry;
8) Woodlot Establishment;
9) Restoration and Enrichment Planting;
10) Replanting of Trees.

Apart from the economic viability and budget requirement that will be discussed in Chapter 13, another consideration that was taken into account is the duration for each intervention to become effective. This is also discussed in Chapter 13.

Table 12.1 - Prioritization of the main investment options for the Tochi catchment based on the summarized MCA ranking of benefits (source: report on Evaluation of Options, 10 October 2018)

Ranked Interventions	Summarized Rankings	Quartile Ranking (see also Appendix 5.1)		Priority Class	Adjusted Priority Class
1 Buffer Zone Demarcation	7	0.00	Q1 →	Low Priority	Low Priority
2 Forest Boundary Marking	9	0.08			
3 Urban Forestry	9	0.17			
4 Replanting of Trees	11	***0.25***			Medium Priority
5 Restoration and Enrichment Planting	15	0.33	← Q2 →	Medium Priority	
6 Woodlot Establishment	20	0.42			
7 Agro-Forestry	23	0.50			
8 Set-up of Waste Management Systems in Towns	24	0.58			
9 Set-up of Drainage Systems in Towns	25	0.67			
10 Stabilization River Banks by Vegetation	**27**	***0.75***			**High Priority**
11 Stabilization River Banks by Civil Works	**30**	**0.83**	← Q3	High Priority	
12 Identification, Support to Livelihood Programs	**34**	**0.92**			
13 Soil and Water Conservation	**39**	**1.00**			

12.2 Economic Viability Analysis of Investment Options

The economic analysis is aimed at establishing the economic viability (EVA) of the proposed investments in the Tochi catchment. The analysis is pre-feasibility of nature and full feasibility studies will be required. Given the pre-feasibility nature of the assessment, the *general principle of considering higher costs* and *modest benefits* is followed.

The appraisal entailed developing an economic model in Microsoft Excel spread sheets. The modelling focused on economic as opposed to financial modelling. The economic analysis focused on the benefits of different interventions to the economy as a whole. Additionally, some of the benefits accrue to the economy and not individual investors. The modelling entailed the specification of parameters, estimation of costs and benefits, conversion of the financial values into economic values and computation of economic indicators. Reference is made to the report of Evaluation of Options.

Selection of Catchment Works

After ample consideration and thought it was decided that the EVA would focus on eight potential investment works (out of the 13 preliminary identified main works). These investment works include:

1) Soil and Water Conservation;
2) Agro-Forestry;
3) Woodlot establishment;
4) Buffer zone demarcation and protection;
5) Stabilization of river banks with cover crops;
6) Civil Works (check dams, gabions, stone pitching);
7) Restoration and enrichment planting in the Forest Reserves
8) Replanting of trees in Forest Reserves.

The other initially proposed works such as forest boundary marking, urban forestry, the set-up of drainage systems in towns, setting-up of waste management systems in towns and the identification and support to other livelihood programs were not examined under the EVA due to limited availability of information on design and investment costs, and the quantification of benefits.

Conclusions

The economic viability results for the proposed investments are presented in Table 12.2.

Investments:
Woodlots establishment require the highest investment funds, followed by Agro-Forestry, Civil Works, and Soil and Water Conservation.

Economy:
Soil and Water Conservation generates the highest wealth to the economy as one USD generates as much as USD 22.8 whereas Restoration and Enrichment Planting in forest reserves generates the lowest dollars to the economy as one USD generates only USD 1.2.

Economic Viability, most attractive investment options:
The most attractive investment option as measured by MEIRR is Soil and Water Conservation while the least attractive is Restoration and Enrichment Planting. Accordingly, within the Tochi catchment, Soil and Water Conservation is therefore the most economically viable

investment option from an economic viability point of view, followed by agro-forestry, replanting of trees in forest reserves and woodlot establishment for Tochi.

Table 12.2 - Economic Viability Results for Investments in Tochi Catchment

Investment	Investment cost (USD, rounded in 10^3)	ENPV (USD, rounded in 10^3)	ENPV/C	MEIRR (%)	Ran-king*
Soil and water conservation	1,228,000	27,989,000	22.8	31.2	1
Agro-Forestry	1,497,000	28,630,000	19.1	30.0	2
Replanting of Trees in Forest Reserves	870,000	9,736,000	11.2	23.8	3
Woodlot Establishment	18,395,000	205,451,000	11.2	23.7	4
Buffer Zone Demarcation and Protection	103,000	934,000	9.1	25.7	5
Stabilisation of River Banks with cover plants	1,064,000	7,859,000	7.4	24.5	6
Civil Works	1,433,000	2,042,000	1.4	18.0	7
Restoration and Enrichment Planting in Forest Reserves	197,000	242,000	1.2	13.0	8

*ENPV/C

12.3 Sensitivity Analysis

The economic costs and benefits were subjected to a sensitivity analysis under different scenarios. The scenarios included (i) increase or decrease in total economic costs (investment and maintenance costs) by 10% and 20% while benefits remain constant, and (ii) decrease or increase in economic benefits by 10% and 20% while economic costs remained constant. ENPV and MIRR were computed for the above scenarios for each project in all attachments. The purpose of sensitivity analysis was to identify risk factors for investments.

Overall, the increase or decrease in economic costs or benefits did not have impact on the economic viability of proposed investments in the Tochi catchment.

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13 IMPLEMENTATION

13.1 Key Area 1 - Environment

As presented in Sections 12.1 the investments options were classified in three ranking groups, i.e. high, medium and low priority. A similar ranking was applied for the results of the EVA. Both rankings were then merged in a combined ranking with ranking groups such as high-high, medium-high, low-medium etc.

For most works the ranking based on the MCA follows more or less the ranking from the EVA (e.g. high versus high or medium versus medium) or differ with one ranking group (e.g. high versus medium or low versus medium).

An exception is the Civil Works where the priority ranking based on the assessed benefits derived from the MCA turns out to be much higher than the priority ranking based on the EIRR of the EVA. The underlying reason for this is that the economic benefits of the Civil Works are assessed as relatively low (an ENPV/C of less than 2) in comparison with the other main works.

As shown in the implementation plan (Table 13.1) for the investment options, the highest priorities (high or medium-high) for implementing the works for the Tochi catchment are assigned to:

- **Soil and Water Conservation;**
- **Stabilisation of River banks with Vegetation**;
- **Agro-Forestry**.

The implementation plan is designed to guiding the implementation of the works along three planning horizons, i.e. short term (by 2020), medium term (by 2025) and long term (by 2040) with indication of lead and supporting agencies in implementation as well as the funding sources.

Table 13.2 presents the annual investment and operational costs up to 2038. Highest costs of 24.2 million USD occur in the first year (mainly investment) to be followed by 4.7-6.8 million USD annually on operational costs for the next 20 or so to come.

Table 13.1 - Implementation Plan for Investments Tochi catchment

Investment Options for Tochi	Implem en-tation Priority	Ranking			Period taken for Impact to start	Funding Option	Implementing Agency		Funding Requirements for Investment and Operational Costs (accumulated) (USD '000)		
		MCA ranking	Economic Benefit ranking (EIRR)	MCA, EIRR combined ranking			Lead	Support	Short term (0-2 yrs; 2019-2021)	Medium term (3-7 yrs; 2022-2026)	Long term (8+ yrs; 2027 >)
Soil and Water Conservation	high	high	high	high - high	Medium term	Consolidated Gov Funds / Loan	farmers	FSSD, DLG (Oyam, Omoro, Nwoya, Kole, Gulu, Amuru)	3,039	4,134	11,763
Stabilisation of River Banks with vegetation	medium to high	high	medium	high - medium	Medium term	Consolidated Gov Funds / Loan	DLG (Oyam, Omoro, Nwoya, Kole, Gulu, Amuru)	Catchment Mng Committees	1,238	280	790
Agro-Forestry	medium to high	medium	high	medium - high	Long term	Consolidated Gov Funds / Loan	DLG (Oyam, Omoro, Nwoya, Kole, Gulu, Amuru)	farmers, NGOs, CBOs	2,114	1,654	4,705
Civil Works	medium	high	low	high - low	Short term	Consolidated Gov Funds / Loan	FSSD	DLG , MoWE, MoWT	2,107	965	2,745
Woodlot Establishment	medium	medium	medium	medium - medium	Long term	Private Investor / PPP	farmers	FSSD, NFA, DLG	23,945	18,505	47,720
Replanting of Trees in CFRs, LFRs	medium	medium	medium	medium - medium	Long term	Consolidated Gov Funds / Loan	NFA		1,133	875	2,256
Restoration and Enrichment Planting	low	medium	low	medium - low	Long term	Consolidated Gov Funds / Loan	NFA		265	50	141
Buffer Zone Demarcation and Protection	low	low	medium	low - medium	Short term	Consolidated Gov Funds / Loan	DLG (Oyam, Omoro, Nwoya, Kole, Gulu, Amuru)	Catchment Mng Committees	133	107	276

Table 13.2 - Investment and Operational Costs for the Environmental Protection Works in the Tochi catchment (USD '000, Nominal, (Key Area 1)

	Short term			Medium term				
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
1 Soil and Water Conservation	1,497	764	779	794	810	826	843	860
2 Agro-Forestry	1,497	305	312	318	324	331	337	344
3 Replanting of Trees in Forest Reserves	820	148	165	168	172	175	178	182
4 Woodlot Establishment	17,324	3,132	3,490	3,558	3,628	3,700	3,772	3,847
5 Buffer Zone Demarcation and Protection	101	12	20	21	21	21	22	22
6 Stabilisation of River Banks with vegetation	1,004	181	53	54	55	56	57	58
7 Civil Works	1,747	178	182	185	189	193	197	201
8 Restoration and Enrichment Planting in Forest Reserves	203	53	10	10	10	10	10	10
Total	*24,193*	*4,773*	*5,009*	*5,108*	*5,209*	*5,312*	*5,417*	*5,524*

	Long term											
	2027	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**
1 Soil and Water Conservation	877	895	912	931	949	968	988	1,007	1,028	1,048	1,069	1,091
2 Agro-Forestry	351	358	365	372	380	387	395	403	411	419	428	436
3 Replanting of Trees in Forest Reserves	185	189	193	197	200	204	208	213	217	221	225	3
4 Woodlot Establishment	3,922	4,000	4,078	4,159	4,241	4,325	4,410	4,497	4,586	4,676	4,769	59
5 Buffer Zone Demarcation and Protection	23	23	24	24	25	25	26	26	27	27	28	0
6 Stabilisation of River Banks with vegetation	59	60	62	63	64	65	66	68	69	70	72	73
7 Civil Works	205	209	213	217	222	226	231	235	240	245	250	255
8 Restoration and Enrichment Planting in Forest Reserves	11	11	11	11	11	12	12	12	12	13	13	13
Total	*5,633*	*5,744*	*5,858*	*5,974*	*6,092*	*6,212*	*6,335*	*6,461*	*6,589*	*6,719*	*6,852*	*1,929*

13.2 Key Area 2 - Institutions

13.2.1 Key Institutions involved in management of Tochi catchment

This Section lists the key institutions that are involved in the management of the Tochi catchment with roles and responsibilities in the implementation of the CMP (Table 13.3).

Table 13.3 - Key Institutions involved in management of the Tochi catchment

No	Institution	Role in the implementation of the management plan
1	All Local Governments in the watersheds of river Tochi and its tributaries and these include; - Gulu District - Oyam District - Omoro District - Nwoya District	These Districts shall be at the forefront of working with several stakeholders in the catchment including farmers to ensure all interventions are implemented effectively. They shall monitor effectiveness of the various mitigation measures recommended in the SSEA report and enforce compliance especially on private land and Local Forest Reserves.
2	National Forestry Authority	In accordance with its mandate, NFA will be responsible for restoration and management of all CFRs in the Tochi catchment as listed in the Natural Resource Assessment report. NFA will manage and coordinate sustainable management and utilization of all forestry resources in the catchment.
3	Ministry of Agriculture, Animal Industry and Fisheries (MoAAIF)	MoAAIF is a key stakeholder in the sense that catchment restoration & management in the Tochi catchment will necessitate soil & water conservation measures/ interventions of which some are best implemented under MoAAIF through agricultural extension staff at District & sub-counties. MoAAIF will work with farmers to implement the mitigation measures presented in the SSEA report and will monitor and improve efficiency of such measures in accordance with the Environmental and Social Management & Monitoring Plan presented under Table 6.1 of the SSEA report.
4	Albert Water Management Zones	The implementation of Tochi Catchment Management Plan shall be undertaken in the context of the wider management plans undertaken by the Albert Management Zone on other major rivers. Therefore, FSSD will have to work with the Albert Water Management Zone in the implementation of certain interventions

No	Institution	Role in the implementation of the management plan
		especially proposed civil works along rivers and streams.
5	NGOs and CBOs	Certain NGOs and CBOs will indirectly and or directly participate in the implementation of the Tochi Catchment Management Plan especially those with activities that complement the proposed management interventions in the Natural Resource Assessment Report Volume II and the Evaluation of Options Report.
6	Forestry Section Support Division (FSSD)	FSSD is a key stakeholder because overall supervision and management of all catchment management interventions will be its duty. FSSD will coordinate all five institutions that are listed as key players in the implementation of the management plan and shall provide the necessary resources and logistics for effective implementation of the proposed catchment management interventions that are presented in the Natural Resource Assessment Report Volume 3 and the Evaluation of Options Report.

13.2.2 Capacity Building Needs Assessment

This Section summarizes the outcomes of a capacity building needs assessment that was conducted among the National Forestry Authority, Albert Water Management Zone and the Natural Resources Departments of the Gulu, Oyam, Omoro and Nwoya Districts. This assessment was conducted in October 2018.

The assessment identified five major areas for funding. These include infrastructure, tools and equipment, human resource, transport and communication and training needs. Details of the capacity building needs assessment for each institution are presented in Appendix 13.1. Below is the discussion on the capacity needs for the institutions.

Human Resources and Expertise

According to the LG structure, the Natural Resource Department is supposed to comprise of at least 10-12 staff which includes a Natural Resource Officer, Senior Environment Officer, Environment Officer, Forest Officer, Assistant Forest Officer, Senior Lands Officer, Lands Officer, Physical Planner, Staff Surveyor, Cartographer and two Forest Rangers. However, none of the Districts have a fully constituted structure. The human resources gaps for each District are presented in Appendix 13.1.

Transport and Communication

Almost all of the Natural Resources Departments of Gulu, Oyam, Omoro and Nwoya lack basic transport means to conduct field-based activities. For all four Districts the only transport means available are motorcycles which were provided under FIEFOC. Based on the nature and magnitude of work each District has to undertake regarding the implementation of the CMP and other duties, it is recommended that each Department gets at least one vehicle and three motorcycles and one motorcycle for each Sub-County.

Tools and Equipment

The Gulu, Oyam, Omoro and Nwoya Districts all lack basic office tools and equipment to function effectively and efficiently. Some of the tools and equipment that are urgently needed are computers, cadastral maps for the LFRs, GPSs, cameras, photocopiers, scanners, projectors, survey equipment (Total Station and RTK), internet services, water testing kits, mensuration equipment (such as campuses, Relascope, diameter tapes, Calipers, Suntos, hypsometers and linear tapes) and a generator.

Infrastructure

Other than Gulu and Nwoya Districts which have an office building for the Departments, the rest of the Districts lack office space for their Departments. Most of these are temporarily being housed under other Departments and are generally scattered. It is highly recommended that the Natural Resources Departments of Oyam and Omoro secure funds to construct an office building of their own in order to function effectively. The building should be furnished with a resource centre/library, a board room and a storage facility for the land documents among others. The NFA section in the Tochi catchment is currently not in need of an office building.

Training Needs

The District Departments have competent staff but need refresher training in some of the emerging fields to increase their knowledge base and be able to integrate work with new development strategies. When the training needs assessment was undertaken at each

District's NR Department as well as the NFA, the following training needs were identified, generally applicable for each District:

Training Topics for the Districts

- Training in Monitoring and Evaluation;
- Training in Environmental Impact Assessment;
- Training in GIS and availability of the GIS software;
- NEMA to train and gazette the Environment Officer, Physical Planner and CDO as Environmental Inspectors so that they are protected by the law while conducting their work;
- Human Resource Management;
- Economic valuation of Natural Resources;
- Extern exposure trips to best practices & case studies in and outside Uganda;
- Soil and Water Conservation skills;
- Project Planning and Management;
- Monitoring and Evaluation;
- Financial Management;
- Training in Natural Resources Management at Masters & Diploma level;
- Training in Energy Saving Technologies;
- Training in Wetland Management including demarcation;
- Water testing skills and kits;
- Information Management System in Natural Resource Management;
- Gender mainstreaming in Natural Resource Management;
- Climate change modelling;
- Tree nursery management;
- Silviculture;
- Extension methods.

Training Topics for the National Forestry Authority

- Collaborative Forest Management;
- Conflict management/Stakeholder engagement;
- Paramilitary training to effectively enforce protection;
- Nursery activities;
- GPS usage and mapping;
- Collaborative Forest Management;
- Human resource management;
- Forest Boundary opening.

Training Topics for the Albert Water Management Zone

- Water modelling;
- Courses in Climate Change interventions and remediation;
- Stakeholder engagement and management;
- Tailored made courses;
- Soil and Land Management.

The Capacity Building needs requirements for the District LGs and NFA identified in this report should be met in the short term for an effective implementation of the CMP. It is recommended that at least 94,000 USD be set aside for Capacity Building for each District without an office building and at least 64,000 USD for each District with an office building and that I can be used to purchase of a departmental vehicle, 3 motor cycles, computer hardware and software, knowledge base enrichment and conducting refresher trainings for the staff.

The NFA unit under the Tochi catchment would also need at least 60,000 USD to set aside for Capacity Building.

Additionally, FSSD would need to set aside some funds to build capacity of some NGOs and CBOs whose activities contribute directly or indirectly to the management of the Tochi catchment. In this regard, it is suggested that at least 60,000 USD be set aside for building capacity.

All action points as indicated in the text before and in the Appendix 13.1 are considered as equally important and are to be implemented at soonest. The leading agencies responsible for implementing the proposed Capacity Building action are the key institutions themselves that were assessed. The action points can be implemented as stand alone activities but better as an integrated part of the Capacity Building activities. Funding sources should come from the consolidated Government budgets preferably, and not from loans due to the recurrent nature of the activities.

3.3 Key Area 3 - Knowledge Base

The Capacity Building (Key Area 2) aims at enhancing the knowledge and skills of the key implementers of the Tochi CMP so to sustain the management of the Natural Resources in the catchment. Within this context, important is the so-called Knowledge Base that has been set up under the consultancy assignment. The transfer of this Knowledge Base will guide and assist the key stakeholders engaged in managing the Tochi catchment to more effectively implement the Plan.

Based on the field reconnaissance, information compiled from previous studies and the outcomes of the Natural Resources assessment a comprehensive Knowledge Base has been developed comprising of:

- physical features of the catchment;
- climatic data;
- environmental features (including hot spots of erosion and sedimentation);
- socio-economic information;
- processed GIS data, maps;
- analytical tools such as the WEAP model with water balance and climate change water availability scenarios etc.

The importance of maintaining the Knowledge Base for the Tochi catchment (including the analytical tools) for future usage to updating the CMP is evident.

The Capacity Building assessment has revealed that there are a number of challenges related to developing this Knowledge Base. In Table 13.4 a number of action points are listed for implementation. All nine action points as indicated in the Table can be considered as equally important and are to be implemented as soon as possible. Costs are included in the costs for

Capacity Building. The leading agencies responsible for implementing the proposed action are the key institutions involved in implementing the CMP. The action points can be implemented as stand alone activities but better as an integrated part of the Capacity Building activities.

Table 13.4 - Implementation Plan for developing Knowledge Base (Key Area 3)

Strategy	**Implementation**		
	Short term (2020)	**Medium term** (2025)	**Long term** (2040)
Capacity Building of key specialist on IT, GIS, data base management, M&E	Recruitment of specialists.		
	Exposure specialists to latest software packages related to environmental management. Conduct exchange visits, participate in seminars/ workshops/fairs.		
	Staff participates in data processing and data base management training.		
	Coordinated efforts to make data available free of charge.		
	Use of specialized software to filling data gaps for long term time series.		
	Use of open source software.		
	Apply mobile devices with modems when internet connection is poor.		
	Avail new hardware, computers.		
Secure funding for procurement and maintenance, updating of models, equipment.	Procurement of laptops, printers , scanners, digitizing equipment, data storage devices, internet connections, cameras, GPS, photocopiers, projectors, survey equipment mensuration equipment etc.		

13.4 Source of Funding

An analysis of the potential funding sources for financing the catchment and capacity building works was carried out.

The analysis assumes grants as the main source of funding. Bilateral or multi-lateral donors are preferred to private sector lenders as the main benefits of investment are economic in nature. Some investments will be implemented through grants solicited by GoU while others with some potential financial returns can be implemented through public private partnerships. In this partnership, the Government shall provide funds through grants or consolidated funds while the private sector shall provide land and undertake activities as per conditions of the partnership. An elaboration on different forms and sources of funds is presented hereunder:

Government Funding

Funds from the consolidated fund could be a potential source for financing the proposed investments. This is justified by the fact that the planned investments in the Tochi catchment mainly yield economic benefits with limited financial investments. The investments on public land could be taken with Government funds in partnership with the private sector under the public-private partnership arrangement.

Major International Development Partners

The major international development partners could be a good source of financial grants to undertaking investments in the catchment. These partners are bilateral and multilateral agencies.

Key bilateral agencies include the Canadian International Development Agency (CIDA), Iceland Development Agency (ICEDA), NORAD, German Technical Cooperation (GTZ), United States Agency for International Development (USAID) and Japan International Cooperation Agency (JICA).

Multi-lateral development agencies which are considered potential sources for funding include International Development Association (IDA), The World Bank, African Development Bank (AfDB), European Commission (EC), European Investment Bank, United Nations Development Programme (UNDP) and Global Environmental Facility (GEF). In sourcing for funding, the lead Government agencies will have to initiate contacts and develop concepts for sharing with the potential partners before developing full project proposals for funding.

Environmental Trust Fund

GoU in partnership with development partners could set-up a multi-source fund. This fund would be a facility that provides funds to undertake the interventions. The fund could be set-up with the help of development partners and managed in accordance with agreed frameworks and conditions. An Environmental Trust Fund encompasses conservation trust funds, wildlife trusts, climate and forest funds, and other funds established to deliver environmental, social and economic benefits. The funds can be built through contributions from multi-lateral, bilateral and international NGO institutions.

Private Investment

Private investment projects are usually implemented if these would enhance the commercial operations of private companies or as social responsibility projects. Establishment of woodlots on private land could be undertaken by the private sector actors within the framework of public-private partnerships. Large scale replanting of CFRs can be undertaken by private investors interested in forests for an agreed period of time in line with investment periods. Such investments will have to participate in carbon credit trading programme to guarantee a constant inflow of financial resources to private investors.

13.5 Environmental and Social Management Monitoring Plan

A periodic performance review and evaluation of implementing the investment packages is considered essential to evaluate the merit of having the Tochi CMP in place and how its full potential will be realised in future. If the CMP fails to show, in real terms, it will fail to attract the support of key stakeholders.

Table 13.5 presents the environmental and social monitoring actions with time frames, specific responsibilities assigned for monitoring and the follow-up actions defined in order to check progress and resulting effects of the works on the environment in Tochi.

Monitoring shall begin right away and continue through the planning, mobilization of funds and implementation phases.

One important aspect of the monitoring is to assess the effectiveness of the mitigation measures on the environment and how it affects the communities. Where they are found lacking, appropriate new actions to mitigate any adverse effects must be undertaken to ensure the integrity of the Tochi catchment, in general and the Tochi irrigation scheme, in specific.

Table 13.5 - Environmental and Social Management Monitoring Plan

S/N	Issues and concerns	Impact	Mitigation Measures	Monitoring indicators	Monitoring Frequency	Means of verification	Responsible Institution(s)
ENVIRONMENTAL ISSUES							
1	**Soil Erosion**	As presented in Section 8.2.2	As presented in Section 8.2.2	• No of farmers undertaking soil & water conservation measures including Agro-Forestry. • Level & extent of sensitization undertaken to address the dangers of soil erosion. • Presence of well facilitated and trained environmental committees at village level. • Measures undertaken to protect river banks. • Evidence of written and well enforced bylaws in river bank protection at village level. • Nature of drainage systems in urban centers listed in the Natural Resources Report.	Every 6 months Every 4 months Every 6 months Every 3 months Annually Every 6 months	-Physical observation of phenomena in the catchments. -Reports available & level of mass media engagement. -Attitude of the local community towards soil erosion prevention and management	-Ministry of Water & Environment. -Ministry of Agriculture, Animal Industries and Fisheries.
2	**Floods**	As presented in Section 8.2.4	As presented in Section 8.2.4	• Extent of tree planting undertaken and the general percentage of tree cover in the catchments. • Measures undertaken to protect river banks. • Level of sensitization undertaken among the population to protect river banks. • Extent to which desilting of rivers	Every 6 months Every 6 months Every 4 months Every 6 months	-Physical observation of phenomena in the catchments. -Reports available & level of mass media engagement. -Frequency of flood occurrences	-Ministry of Water & Environment. -Ministry of Agriculture, Animal Industries and Fisheries. Ministry of Disaster Preparedness

S/N	Issues and concerns	Impact	Mitigation Measures	Monitoring indicators	Monitoring Frequency	Means of verification	Responsible Institution(s)
				is undertaken. • Measures used to communicate or alert the communities on possibility of floods.	When ever need arises but especially during the onset of rainy season.		
3	**Drought and Climate Change**	As presented in Section 8.2.9	As presented in Section 8.2.9	• Number of other irrigation schemes being undertaken by government in the catchments. • Extent of tree planting undertaken and the general percentage of tree cover in the catchments. • Nature of farming practices undertaken by farmers in the catchments. • Governments effort in supporting farmers on cultivation of drought resistant crop varieties. • Extent to which water harvesting is embraced in households. • Number of multipurpose reservoirs constructed by government in the catchments. • Extent to which households conserve fuel wood energy.	Annually Every 6 months Every 6 months Every 6 months Every 6 months Annually Every after 3 months	-Physical observation of phenomena in the catchments. -Testimonies from the public and the local communities. -Documented evidence.	-Ministry of Water & Environment. -Ministry of Agriculture, Animal Industries and Fisheries.

S/N	Issues and concerns	Impact	Mitigation Measures	Monitoring indicators	Monitoring Frequency	Means of verification	Responsible Institution(s)
4	**Poor waste management**	As presented in Section 8.2.8	As presented in Section 8.2.8	• Evidence that waste is sorted, recycled and re-used at source. • Presence of centralized waste disposal systems for all towns and trading centers in the catchments. • Presence of written and implemented bylaws on waste sorting, disposal and management in the catchments.	Monthly. Every 3 months. Every 3 months	-Physical observation of phenomena in the catchments. -Attitude of the population on waste management.	- Ministry of Lands and Urban Planning. -Ministry of Water and Environment.
5	**Invasive Species**	As presented in Section 8.2.5	As presented in Section 8.2.5	• Concerns from farmers on invasive species. • Extent to which invasive species have colonized the catchments. • Government's effort to eliminate invasive species.	Every 6 months. Annually. Annually.	-Physical observation of phenomena in the catchments. -Testimonies from the community.	-Ministry of Water and Environment. -Agriculture, Animal Industries and Fisheries. - Ministry of Disaster Preparedness.
6	**Pests and Diseases**	As presented in Section 8.2.6	As presented in Section 8.2.6	• Concerns from farmers on pests and diseases. • Nature of farming practices undertaken by farmers. • Extent to which pests and diseases have affected farmers. • Government's effort to eliminate pests and diseases.	Every 3 months. Ever 6 months. Every 6 months. Every 6 months.	-Physical observation of phenomena in the catchments. -Testimonies from the community.	-Ministry of Water and Environment. -Agriculture, Animal Industries and Fisheries.
7	**Deforestation**	As presented in Section 8.2.1	As presented in Section 8.2.1	• Government policy on fuel wood farming per household. • Extent of tree planting undertaken and the general	Every 6 months. Every 6 months.	-Physical observation of phenomena in the catchments.	-Ministry of Water and Environment. -Ministry of Energy

S/N	Issues and concerns	Impact	Mitigation Measures	Monitoring indicators	Monitoring Frequency	Means of verification	Responsible Institution(s)
				percentage of tree cover in the catchments. • Government's policy on land fragmentation. • Governments effort to promote fuel wood utilization efficiency. • Governments effort to provide alternative sources of fuel. • Governments effort to support other livelihood options that do impact on vegetation clearance. • Governments effort to eliminate all forms of encroachments in Central and Local Forest Reserves.	Annually. Every 6 months. Annually Every 3 months. Every 3 months.	-Documented evidence. -Testimonies from the community. - Level of mass media engagement.	and Mineral Development.
8	**Pollution from Agro-chemicals**	As presented in Section 8.2.7	As presented in Section 8.2.7	• Evidence that both local and commercial farms are not polluting streams and other community water sources.	Every 3 months	-Water quality tests. -Testimonies from the community. -Physical observations of phenomena.	-Ministry of Water and Environment. -Ministry of Agriculture, Animal Industry and Fisheries.
9	**River Bank Cultiva-tion & Wetland Encroach-ment**	As presented in Section 8.2.3	As presented in Section 8.2.3	• Number of encroachments and settlements in river banks and wetlands. • Measures undertaken to protect river banks and wetlands. • Presence of written and implemented bylaws on wetland and river bank protection.	Every 3 months. Every 3 months Annually.	-Physical observations of phenomena. -Attitude of the local community towards wetland protection.	-Ministry of Water and Environment. -Ministry of Agriculture, Animal Industry and Fisheries.

S/N	Issues and concerns	Impact	Mitigation Measures	Monitoring indicators	Monitoring Frequency	Means of verification	Responsible Institution(s)
				• Governments effort to promote and support other livelihood options. • Extent to which catchment management committees have been constituted, organized and supported at village level.	Every 3 months. Every 6 months.	- Level of mass media engagement.	
SOCIAL ISSUES							
10	**Poor Farming Methods**	As presented in Section 7.1.1	As presented in Section 7.1.1	• Nature of farming practices undertaken by farmers in the catchments. • Number of Agricultural and Forestry extension staff at Sub-County level. • Effort rendered by government through extension staff and other means to train farmers on appropriate farming methods. • Extent of tree planting undertaken and the general percentage of tree cover in the catchments.	Every 3 months. Every 6 months. Every 6 months. Every 6 months.	-Physical observations of phenomena. -Attitude of the local community towards wetland protection. - Level of mass media engagement.	-Ministry of Water and Environment. -Ministry of Agriculture, Animal Industry and Fisheries.
11	**Popula-tion Pressure on Land**	As presented in Section 7.1.3	As presented in Section 7.1.3	• Nature of farming practices undertaken by farmers in the catchments. • Government's effort to promote and support other livelihood options.	Every 6 months. Every 3 months.	- Level of mass media engagement. -Physical observations of phenomena.	-Ministry of Water and Environment. -Ministry of Agriculture, Animal Industry and Fisheries.

S/N	Issues and concerns	Impact	Mitigation Measures	Monitoring indicators	Monitoring Frequency	Means of verification	Responsible Institution(s)
				• Governments effort to discourage land fragmentation. • Governments effort to promote education for all children. • Governments effort to promote and support family planning.	Annually. Every 3 months. Every 2 months.	-Documented evidence.	-Ministry of Health. -Ministry of Education. -Ministry of Disaster preparedness.
12	**Bush Burning**	As presented in Section 7.1.2	As presented in Section 7.1.2	• Evidence that bylaws were created to discourage bush burning. • Extent to which government has gone in sensitizing the community on the dangers of bush burning.	Every 6 months. Every 6 months.	-Physical observations of phenomena. - Level of mass media engagement. -Documented evidence.	-Ministry of Disaster preparedness. -Ministry of Water and Environment.
INSTITUTIONAL CHALLENGES							
13	**National Forestry Authority**	As presented in Section 5.1	As presented in Section 5.1	• Evidence that all management issues in Central Forest Reserves have been addressed.	Every 4 months.	-Physical observations of phenomena. - Level of mass media engagement. -Documented evidence.	-Ministry of Water and Environment.
14	**District Forestry Services**	As presented in Section 5.3	As presented in Section 5.3	Evidence that all management issues in Local Forest Reserves have been addressed.	Every 4 months.	-Physical observations of phenomena. - Level of mass media engagement.	-Ministry of Water and Environment.

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80) Water and Environment Sector Performance Report (SPR), MoWE, Uganda, 2017
81) Water and Environment Sector Strategic Investment Plan, MoWE, 2018
82) Water Permit Systems, Policy Reforms and Implications for Equity in Uganda, Project Country Report, Nicholas Kiggundu, 2017
83) Water Resources Management, Environmental Degradation and Human Welfare: Lessons Learned from the Lake Kyoga Catchment in Uganda, UNDP-UNEP Poverty-Environment Initiative, Policy Brief, 2009
84) Water Source Protection Guidelines, MoWE
85) Wetland Atlas for Uganda, DoWMD, MoWE

Site Specific

1) DDP Oyam 2010 - 2014
2) District Development Plans of Oyam, Nwoya, Kole, Gulu and Amuru 2015 - 2021
3) Overview of Oyam District State of Environment and its Implications (no date)
4) Environmental and Social Assessment for the Tochi Irrigation Scheme, Aarvee, July 201
5) Feasibility Study and Detailed Engineering Design of the Tochi Irrigation Scheme, Aarvee, July 2015 (agronomy, water resources, socio-economics, environmental, design, financial and economical analysis)

APPENDICES

Appendix 2.1 - Project Documents

The following documents were generated during the development of the draft CMP for Tochi:

1) Inception report of 11 May 2018
2) Inception Workshop report of 03 July 2018
3) Draft Natural Resources Assessment (NRA) report of 30 July 2018.
   - Volume 1 - Main report
   - Volume 2 - Water Balance study report
   - Volume 3 - Catchment Protection Works report
4) Final Natural Resources Assessment (NRA) report of 14 September 2018.
   - Volume 1 - Main report
   - Volume 2 - Water Balance study report
   - Volume 3 - Catchment Protection Works report
5) Draft Stakeholder Engagement of 30 July 2018
   - Volume 1 - Main report
   - Volume 2 - Appendices
6) Final Stakeholder Engagement report of 18 September 2018
   - Volume 1 - Main report
   - Volume 2 - Appendices
7) Stakeholder and NRA Workshop report of 29 August 2018
8) Training Workshop report of 03 September 2018
9) Draft Strategic Social and Environmental Assessment (SSEA) report of 29 August 2018
10) Final Strategic Social and Environmental Assessment (SSEA) report of 20 September 2018
11) Draft report on Evaluation of Options of 10 October 2018.

Appendix 5.1 - Main roles and responsibilities of WMZ related to CMP

Note: for the day-to-day catchment management, Tochi falls under the Upper Nile WMZ and not under the Albert WMZ

- Prepare zonal and catchment water development and management strategies and plans;
- Develop, maintain and expand the zonal and catchment knowledge database and information system, prepare knowledge products, and disseminate data and information including maps to support Catchment Management Organization (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 analyze 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, storage and analysis 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 plan.

Appendix 6.1 - Methodology for delineation catchment boundary with Digital Elevation model

- DEM Reconditioning: The fill tool of the hydrology toolset in ArcMap to fill up any gaps in the DEM;
- Computation of Flow Direction Raster: The reconditioned DEM was then used to compute the Flow Accumulation Raster showing the direction of water flow at each pixel located on the DEM;
- Computation of the Flow Accumulation Raster: This raster derived from the Flow direction raster shows the pixels which the highest water amounts of water on the DEM;
- Selection of Pour Point: A shapefile was created and the lowest point along the river was digitized as the pour point of the river;
- Watershed tool: The watershed tool under hydrology toolset of ArcMap was run to generate the catchment, with input parameters as Flow direction raster and pour point;
- Conversion of Raster Catchment Boundary to vector: The raster catchment boundary was converted to polygon. The area of the polygon was then calculated to determine the size of the catchment.

Appendix 8.1 - Tree Species in Tochi catchment

SN	Biological Name	Common name	Common use value	Other remarks
1	*Azadrachta indica*	Neem	Herbal remedy for malaria, mouth / skin ulcers, anti hyperglycemic agent, tooth brush, common animal de-wormer etc	Highly planted in majority of homes within the catchment area
2	*Gmelina arborrhea*	White oak	ornamental	Planted in some homesteads
3	*Eucalyptus camaldulensis*	Eucalyptus	Sold as seedlings, small poles, big poles and firewood	Most common Eucalyptus species in areas of the catchment zone
4	*Grevelia robusta*	Australia silk oak	Firewood, Agroforestry systems	Not so much embraced by majority of small scale farmers
5	*Sena siamea*	cassia	Firewood, bee forage, timber	Commonly planted
6	*Mellia volcansii*	Giant lira	Timber, has anti termite effects	Planted in many homesteads
7	*Afzellia africana*	African mahogany	Timber (precious), back used as fish poison	Has poisonous seed
8	*Tectona grandis*	Teak	Bee forage, logs for sale	
9	*Albizia zygia*	Nongo	Precious timber	
10	*Citrus sinensis*	Orange	Juice flavor	
11	*Mellia azadrach*	mellia	Has anti termite effects	
12	*Mangifera indica*	Mango	Mango fruits, bark is an important ingredient in the anti cough herbal formulations	
13	*Zizyphus abyssinica*	Mukwatango	Charcoal , firewood	
14	*Harizonia abyssinica*			Thorny creeper
15	*Tamarindus indica*	Mukooge	Edible fruits, charcoal	Found planted in most homes of the catchment area
16	*Vernonia amygdalina*	Mululuuza	Malaria cure	Naturally growing
17	*Albizia coriaria*	mugavu	- Bark effective against cough when mixed with that of mango, bottlebrush and Eucalyptus - Very precious timber	

SN	Biological Name	Common name	Common use value	Other remarks
18	*Stagnotaenia alariacea*	kinyoolangombe		
19	*Euphorbia candelebrum*	Nkukuulu	Highly poisonous white latex	
20	*Antiaris toxicaria*	Kirundu	Timber for construction and carpentry	
21	*Acacia sieberiana*	Muwawa	Firewood	
22	*Ficus natalensis*	Mutuba	Food for browsers, excellent agroforestry tree	
23	*Ficus sur*		Timber for shuttering, fruits for birds and other wild life	
24	*Makhamia lutea*	Musambya	Precious timber	
25	*Croton megalocarpus*		ornamental	
26	*Kigeria africana*			
27	*Thevetia peruviana*	Kasenene	Ornamental, hedge shrub	
28	*Stereospermum kunthianum*			
29	*Combretum collinum*	Lukoola	Charcoal	
30	*Combretum molle*	Ndagi	charcoal	
31	*Phoenix reclinata*	kisansa	mats	
32	*Grewia bicolor*			
33	*Cedrella odorata*		Timber	
34	Vitellaria paradoxa	Shear butter tree	Fruits are squeezed to produce edible oil	

Appendix 8.2 - Land Cover of Forest Reserves in Tochi catchment

CENTRAL FOREST RESERVES (CFRs)

No	Name of Protected area & location	Physical description of the land cover feature	Proposed future management option to improve or restore its integrity
1	Bobi CFR (Omoro District)	It is a plantation forest which was leased to private tree planters. It is entirely planted with eucalyptus. It is not encroached although the boundaries need to be opened and marked.	• The forest boundary should be opened and marked with permanent markers.
2	Abilli CFR (Omoro District)	This forest reserves is completely encroached with settlements, gardens and a telecommunication mast. Its boundaries are known but need to be re-opened. A section of the forest is under contention because some individuals are claiming it's their land.	• All encroachers should be sensitized and advised to leave the forest reserve peacefully but if they do not comply, then NFA should evict them forcefully. • The boundaries should be opened and marked with permanent and live markers.
3	Opaka CFR (Omoro District)	This forest reserve was leased to private tree planters and is currently planted with pine and teak. A few sections are not planted but NFA believes the remaining sections will be fully planted. Boundaries are almost known except a few corners.	• The forest boundaries should be fully opened and marked with permanent and live markers.
4	Opok CFR (Omoro District)	Opok was leased to private tree planters. It is currently planted with teak, pine & Eucalyptus. About 70 hectares were left unplanted and these were re allocated to other private tree planters in the recent allocations by NFA. It is anticipated that the unplanted area will be planted in the first planting season of 2019. Its boundaries are known and there is no encroachment.	• No further action is required.
5	Opit CFR (Omoro & Oyam Districts)	Opit was formerly planted with teak and Aborea but has been harvested. The forest is encroached by cultivation activities to about 2%. Currently, the forest comprises 25 ha of Teak and 11 ha of Pine under NFA. Half of the	• About 40% need to be replanted by NFA. • The forest boundary needs to be opened and marked. • The encroachers need to

No	Name of Protected area & location	Physical description of the land cover feature	Proposed future management option to improve or restore its integrity
		empty areas will be given to private tree planters and the remaining area needs to be planted by NFA. Its boundary is not opened although the community know the status of the ecosystems as a CFR.	sensitize to leave the forest.
6	Gulu Forest Reserve Gulu District	The forest reserve was encroached by people who came during the Kony insurgency but according to NFA, they have been ordered to leave by the end of 2018. Other encroachers are cultivators who come from the surrounding areas. About 80% is encroached and generally the entire forest is being threatened by urban development. NFA is planning to develop it into recreation park and have the boundary opened.	• About 80% of the forest needs to be planted in accordance with its management plan of converting it into a recreation park. • The boundary needs to be opened in consultation with Gulu Municipal Council. • The intensity of evicting the encroachers should be increased. • Further cultivation in the forest reserve should be stopped.
7	Keyo CFR (Amuru District)	Keyo is a woodland natural forest which is heavily degraded with settlements and cultivation and charcoal burning. The encroachers are communities who were chased from Apaa village bordering Adjuman District . NFA tried to open its boundaries but politicians interfered and the exercise was put on halt. It is a natural forest comprising tree species such *as Ficus spp, Albizia spp, Combretum spp, Acassia spp* , Mahogany species and others.	• About 75% of the forest needs to be restored through enrichment planting.
10	Acet CFR (Oyam Distrct)	It is fully planted with eucalyptus (100%) which is over mature and needs to be harvested after which replanting should be undertaken. Initially it had been leased to BAT but has been returned to NFA. The boundaries are not clear and need to be re-opened.	• The boundary should be opened and marked.
11	Gung Gung CFR (Oyam	The entire forest is encroached with gardens up to 100%. Efforts were made by NFA together with tree talk and Nature Uganda in 2013 & 2014 to	• All encroachers should be sensitized and advised to leave the forest reserve peacefully but if they do not comply, then NFA

No	Name of Protected area & location	Physical description of the land cover feature	Proposed future management option to improve or restore its integrity
	Distrct)	restore the forest but the encroachers became hostile and the process was put on halt. Its boundaries are also not clear.	should evict them forcefully • The boundaries need to be opened and marked. • The entire reserve (100%) needs to be reforestated.
13	Lela-Olok	It is partly encroached up to 50% and its boundaries are not clear. The entre forest has been leased to private tree planters.	• The forest boundaries should be opened and marked.

Local Forest Reserves (LFRs)

14	Aber	This forest has been fairly protected from encroachment. It is a natural forest comprising several tree species including *Milicia spp*, *Cidrella spp*, *Albizia* among others. Under NUSAF III, enrichment planting was done and 10 Ha were planted with *Milicia spp*, *Maesopsis spp*. Its boundary is known and is mainly defined by community roads.	• At least 30% of the forest needs to be restored / replanted through enrichment planting.
15	Achaba	Although there are a few scattered trees of eucalyptus and *Cidrella spp* remaining, the forest is said to be encroached up to 100%. It has been converted into agricultural fields and needs to be replanted afresh.	• The entire forest (100%) should be reforestated. • The boundaries need to be opened and marked. • All encroachers need to be evicted.
16	Atura	The forest is 100% encroached although the encroachers are aware that they are cultivating in a forest reserve. Encroachment is in form of gardens. The boundaries are not clear and need to be opened and marked.	• The entire forest (100%) should be reforestated • The boundaries need to be opened and marked. • All encroachers need to be evicted.
17	Iceme	The forest is encroached up to 75%. About 25% of the forest was replanted by the district forest services with funding from Tree Talk. Its boundaries are not clear.	• About 75% of the forest should be replanted. • The boundaries need to be opened and marked. • All encroachers need to be evicted.
18	Ngai	The forest is encroached with gardens	• About 75% of the forest should

No	Name of Protected area & location	Physical description of the land cover feature	Proposed future management option to improve or restore its integrity
		and settlements including a police post. About 75% of the forest needs to be re-forestated and boundary reopened.	be replanted. • The boundaries need to be opened and marked. • All encroachers need to be evicted.
19	Otwal	The forest is encroached with gardens with only 30% forest cover planted with Teak species. Its boundary needs to be opened.	• About 70% of the forest should be replanted. • The boundaries need to be opened and marked. • All encroachers need to be evicted.
20	Anyeke	The forest is 100% encroached with gardens and settlements. The boundaries are also not clear. A school has been built in the reserve (known as Ben Wacha Primary School).	• The entire forest (100%) should be reforestated • The boundaries need to be opened and marked. • All encroachers need to be evicted.
21	Ngunyboke	The forest is 100% encroached with gardens and settlements. The boundaries are also not clear	• The entire forest (100%) should be reforested • The boundaries need to be opened and marked. • All encroachers need to be evicted.

Appendix 11.1 - Design and Quantities of Civil Works for River Bank Stabilization

A Stream Bank Erosion

Erosion is the removal of soil particles from a site due to the forces of water. Over time, these forces will slowly wear away or disintegrate the soil. In the case of a stream, erosion may occur in several ways, identified below.

Erosion of streams in agricultural areas normally occurs as a result of one of three factors:

1) Change in stream flow;
2) Water flowing over or through the stream bank;
3) Discharge of concentrated runoff from other sources.

Streams are subject to wide fluctuations in both flow depth and velocity over a period of years, due to normal seasonal changes in rainfall and large single-storm events. As flow depths and velocities increase, the force of the water flowing against the streambank removes soil particles from the banks, and in many cases erosion causes banks to slump and fall into the flowing water.

In extreme situations where high flows persist over long periods, banks may erode several feet annually. Rain falling on stream banks or runoff from adjacent fields that enters a stream by flowing over the stream banks can also erode soil from stream banks, particularly if banks are inadequately protected. Finally, water discharged into a stream from tributary drainage systems (such as waterways or tile lines) can also erode stream banks, particularly if the water is discharged in an area where the bank is unstable and highly erodible. In many cases, moving the outlet to a point where the steam is less erodible or stabilizing the outlet area with rock can alleviate this problem.

Although a stream channel may appear to be stable, when viewed over a period of decades or centuries most streams exhibit a tendency to adjust or shift location, these changes are due to differences in soil type and structure within the stream channel or are the result of erosion occurring from catastrophic storm events. Any straight stream channel will eventually erode on portions of each bank and begin to bend or meander. As the stream bends become longer and more sharply curved, more soil is eroded from one side of the channel and deposited on the other side of the channel.

B Types of Civil Works for River Embankment and Bed Protection

There are a number of civil works that can be used to prevent soil erosion in stream bed and embankments. These range from temporary to permanent measure and from low cost to high cost measures. Some of them are listed below.

1) Check dams in tributaries of main rivers in upper watershed to reduce river flow velocity;
2) Gabions (or other structures) in river embankments with high erosion, at places of high economic value (house, schools, markets, bridges etc);
3) Stone pitching slope protection along roads and structures of economic importance;
4) River groins along unprotected reaches (meanders) being eroded away;
5) Gully control with check dams;

6) Retaining walls at places with steep slopes and risk of landslides;
7) Wooden pole barriers along contours;
8) Benched terraces on very steep slopes;

Important factors for designing and selecting the suitable protection structure types are:

1) Eroded bank length.
2) Proper alignment (to avoid flow disturbance).
3) Proper land use (especially upland the protected area).
4) Design should be friendly with the environment.
5) Availability of the suitable construction materials such as stone size, quality and thickness.
6) Suitable filter layer/geo-textile separator to prevent migration of base materials through revetment.
7) Back fill (fine sand, silt and clay with proper compaction).
8) Water elevation (the protection should be at least one meter above maximum water level).
9) Slope should not be steeper than 3 horizontal and 2 vertical (34^0) for better stability purposes.

Given the nature of the streams in catchments, required investment and complexity of installation, the consultant recommends three types of civil works innervations which include Check dams, Gabion walls and Stone pitching. These measures are easy to implement and not highly capital intensive. They will be put in selected places in the streams where there are excessive soil erosion and need to protect places or structures of high economic value.

C Gabions

A gabion is a heavy duty basket-like structure made in the shape of a box from welded or twisted galvanized iron wire mesh, divided by wire diaphragms into cells, and filled with heavy material (typically rocks or broken concrete) that cannot escape through the mesh openings. Gabions are generally used as construction blocks, and are tied together with galvanized iron binding wire to form larger structures. Gabion walls are constructed using gabion boxes of various sizes stacked next to and on top of each other before tying. Good quality stone should be used to fill the boxes, with dimensions preferably not less than 10 cm, or at least great than the mesh size. Stones should be packed as tight as possible to increase the density of the gabion wall. The gabion structures are flexible and provide good drainage due to the dry stone packing.

The base layer of gabions should be placed below the expected maximum scour depth, or the toe can be protected with gabion mattresses.

Gabions can flex to ground movement, dissipate energy from flowing water, and drain freely. Their strength and effectiveness may increase with time, as silt and vegetation fill the voids, and reinforce the structure. In locations where high flood water velocities are expected, carrying woody debris and gravels in suspension, the stronger 4.5 mm welded gabions are the preferred choice, to resist damage to the gabion structures during floods. Some of the design considerations for the gabions are given in Table 1 and Figure 1.

Table 1 - Design considerations for Gabions

Type	Gabion	
	Low	High
Top width	1.0 m	1–2 m
Base width	0.6–0.75 H	0.55–0.65 H
Front batter	6:1	6:1
Back batter	varies	varies
Inward dip of foundation	1:6	1:6
Foundation depth below drain	0.5 m	1 m
Height range (H)	1–6 m	6–10 m
Hill slope	35–60°	35–60°

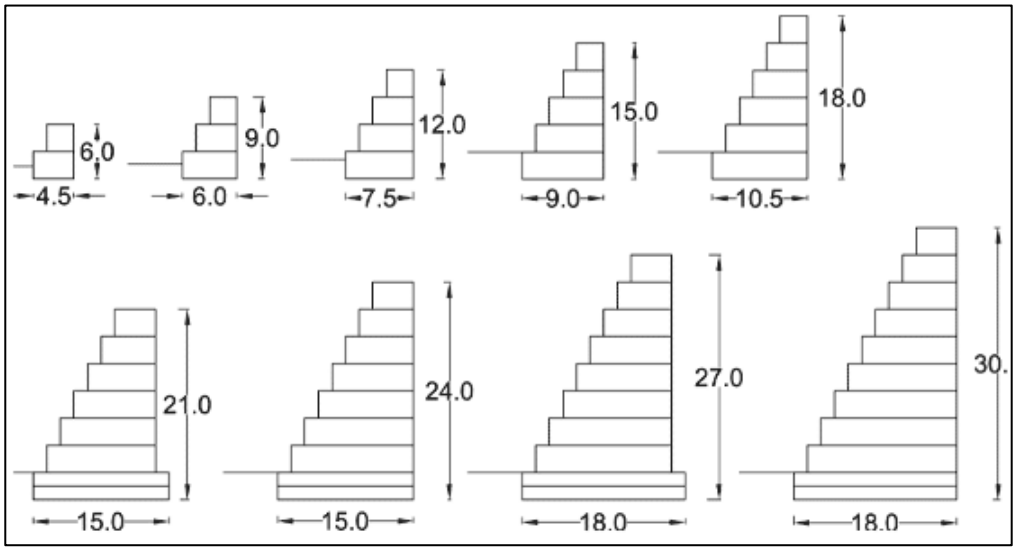

Figure 1 - Sample design dimensions and arrangement for Gabion walls

Installation / Construction

There are different types of gabions such as mattresses and upper level baskets. Mattresses are baskets which are usually 9 to 12 inches thick and provide a foundation for the upper level baskets. Upper level baskets should be about 6, 9, and 12 feet in lengths and 1, 1.5, and 3 feet in heights.

At the construction site, gabion baskets are unfolded and assembled by lacing the basket edges together with wire. Individual baskets are then laced together, stretched, and filled with stone. The lids are closed and then wired to other baskets. The result is a large heavy mass that is not as easily moved by waves or current as single stones might be. Generally, gabion walls are suitable on sites where bulkheads or revetments are acceptable.

Gabions are suggested for use in brackish and freshwater environments, where corrosion of the wire will be minimal. The baskets should be staggered and joined, much like the courses of a brick wall, in order to form a stronger structure (Figure 2). It is also recommended that the end of the mattresses be anchored with large stones or anchor screws.

Figure 2 - Sample of Gabion layout

Maintenance

Damage to the baskets should be repaired immediately. Missing stones should also be replaced from time to time to maintain a tightly packed basket. This will minimize stone movement which can cause abrasion damage to the basket wires

Advantages of Gabion structures over stone and concrete retaining walls

1) Rapid Construction with immediate use;
2) Dissipate flowing water energy;
3) Semi-flexible building blocks for channel stabilization;
4) Have an irregular surface to diffuse and reduce river bank scouring;
5) Gabions use of smaller rock for river bank protection. When large rip rap is unavailable;
6) Much cheaper, more flexible and greener than concrete;
7) Can be installed in dry or wet conditions;
8) Free draining, with no hydrostatic pressure issues.

Estimation of Quantities

Gabions are proposed in main river channels near infrastructures like roads and buildings and in places of high embankment and meandering. The figures are estimated by using Arial photography and in comparison with other similar projects (Table 2). This estimate should be verified by specialized personnel by carrying out physical inspection of the rivers during advanced planning for implementation. The cross-section of Gabion walls vary for each location where they are to be implemented depending on the height of the embankment. A detailed engineering design will have to be generated before execution of gabion wall construction. The estimated Volumes of gabions required for each catchment is estimated as shown in the table below.

Table 2 - Estimation of quantities for Gabions

Catchment	Required Volume of stone filled Gabions (m^3)
Tochi	6.000
Wadelai	7.000
Doho II	4,500
Mobuku II	3,500
Ngenge	2,000

D Stone Pitching

Stone pitching is constructed using good quality stones with cement sand mortar. These walls are rigid and designed as gravity structures with a base width varying from 0.5–0.75 times the wall height. The foundation must be on firm, risk-free ground. Weep holes of at least 75 mm diameter should be included every 2 x 2 m^2 in a staggered pattern for drainage. Stone Pitching can be in a trapezoidal form or rectangular section. The trapezoidal section is more preferable due to its soil stabilising ability and ease for construction because it requires no formwork at all. A typical sample of a trapezoidal section of stone pitching is given in Figure 3.

The following precautions in the design and construction of stone pitching will increase the chances for a successful installation:

1) Use a paved lining only in soil conditions where settlement or lateral movement of the foundation soil is not likely to occur;
2) Use a channel grade not steeper than 10%;
3) Do not use a channel grade flatter than 0.35% in order to avoid deposition of sediment;
4) Compact loose foundation soils;
5) Provide an underdrain system for major channels where hydrostatic uplift forces are anticipated. Do not use weep holes unless foundation is rock or compact till, or provisions are made to prevent the washing out of the supporting soil;
6) Depress channel so that the top of the lining is below the surrounding ground surface;
7) Do not use contraction or expansion joints;
8) Use continuous reinforcement extending through all construction joints;
9) Increase the height of lining on the outside of bends and opposite connecting channels;
10) Collect and control flow at the upstream end of the lining in order to prevent under mining by water flowing adjacent to the channel;
11) Provide cut-offs below ground surface at upstream and downstream ends of lining.

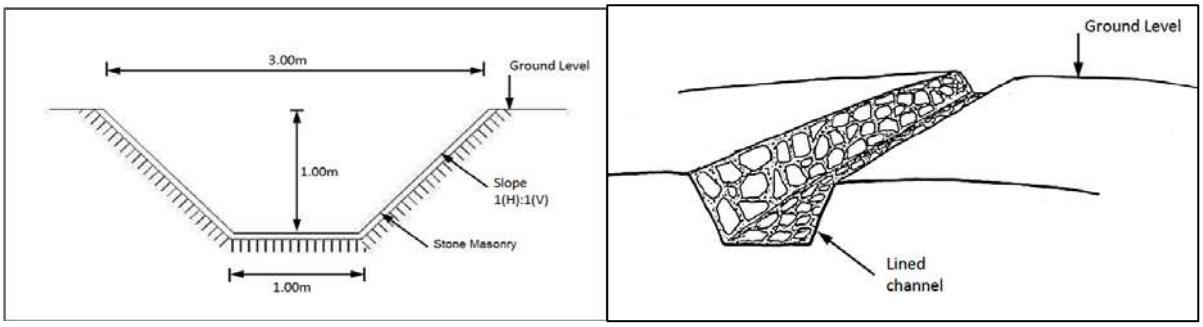

Figure 3 - Sample section of a trapezoidal Stone Pitching

Construction Steps

1) Prepare a sound slope before constructing the stone pitching; it must be free of loose debris and topsoil, and trimmed to an even surface;
2) Bed the stones down well into the slope surface. Excavate as necessary to ensure an even upper surface to the stone pitching;
3) Build the stone pitching carefully, with the stones fitted together firmly, as if it is a dry masonry wall. Stones should be perpendicular to the slope, with the main point or narrow side down;
4) In drains and gullies, a rough surface can be left to retard water flow.

Application for the Assignment

Stone pitching is proposed on the side drains of the roads which are usually prone to excessive soil erosion that pours into larger rivers that eventually drain into the rivers feeding the irrigation schemes. Requirement for stone pitching will mainly depend on the terrain where the road passes and also the nature of road side drainage pattern. The lining may also be on one side of the road or both.

The following stone pitching requirement estimate for the various terrain of the road has been determined to be relatively fair from previous experience on similar projects around the world (Table 3 and 4).

Table 3 - Estimation of Stone Pitching length relative to road length

Terrain	Stone pitching length requirement relative to the total road length (%)
Hilly	8
Moderate	5
Flat	3

The roads under consideration include National roads, District road and motorable community access roads in the catchments. Paved roads are eliminated from the estimates.

Table 4 - Estimation of quantities for Stone Pitching

Catchment	Terrain	Total Road length (Km)	Length of stone pitching Required (Km)	Stone Pitching Requirement (m^2)
Tochi	Flat	1,480	44	48,400
Wadelai	Flat	759	23	25,300
Mobuku II	Hilly	285	23	25,300
Ngenge	Hilly	40	3	3,300
Doho II	Hilly	560	45	49,500

E Check Dams

Check dams are small low drop structures built across a gully or channel to prevent it from deepening further. These small dams decrease the slope gradient and reduce the velocity of water flow and the erosive power of the runoff. They also promote the deposition of eroded materials to further stabilise the gully or channel.

Gully plugging using check dams, accompanied by planting between the dams to stabilize the channel, can be one of the most effective ways to conserve soil and water and rehabilitate land degraded by gullies (Guedel 2008). The effectiveness of different check dams depends upon the design, location, and construction materials.

Check dams can be constructed from a wide range of materials including rock, wood, bamboo, gravel bags, sand bags, concrete, masonry, and fibre rolls. The characteristics, advantages, and disadvantages of some major different types of check dams are summarized in Table 5.

Table 5 - Characteristics, advantages and disadvantages of various types of Check Dams

Type of check dam	General characteristics	Advantages	Disadvantages
Brushwood	Made of wooden poles and brush Suitable for small gullies 1–2 m deep Low cost where materials are locally available	Simple Uses local materials Low cost If roots and shoots develop, they can form a long-term barrier	Least permanent of all types if not rooted Takes a long time for the dams to develop roots and become established
Loose stone	Made of loose stone or rock Stability and strength depends on the size of rocks and quality of the construction Commonly used in gully control where boulders or rocks are abundant	Uses local materials Simple Low cost (where stones are abundantly available)	If not made properly or stones are too small, they can be washed away
Boulder	Made of big boulders or rocks Stability and strength depends on the size of the boulders or rocks and quality of construction Commonly used in gully control where boulders or rocks are abundant	Uses local materials Simple Low cost If properly made, are almost permanent and durable	Transportation of big boulders is difficult (if not available upslope of the site) If large voids are not properly filled they, may create water jets, which can be destructive if directed towards the bank
Gabion	Made with wire gabions of different sizes filled with stones Flexible Preferred where big boulders are not available	Flexible and permeable Suitable where the land mass is unstable Economical compared to other solid structures	More expensive than loose stone or boulder structures The gabions have to be brought from outside which increases the cost Need skilled labour for construction
Masonry	Made of cement masonry or concrete Generally only used to protect important infrastructure such as roads and buildings	Permanent solid structure Good appearance	High cost Materials not locally available (cement, rods) Need more engineering design, and skilled labour for construction

Site selection

Before installing a check dam, careful inspection of the site must be undertaken. The drainage area should be ten acres or less. The waterway should be on a slope of no more than 50% and should have a minimum depth to bedrock of 0.6m.

Design

A check dam should not be more than 1m high and the centre of the dam should be at least 0.15 m lower than its edges. They may kill grass linings in channels if water stays high or sediment load is great. This criterion induces a weir effect, resulting in increased water surface level upstream for some, if not all flow conditions.

Spacing

In order to effectively slow down water velocity to counter the effects of erosion and protect the channel between dams in a larger system, the spacing must be designed properly. The check dams should be spaced such that the toe of the upstream check dam is equal to the elevation of the downstream check dam's crest. By doing so, the water can pond between check dams and thus slow the flow's velocity down substantially as the water progresses down slope. Sample longitudinal layout of the check dam is given in Figure 4.

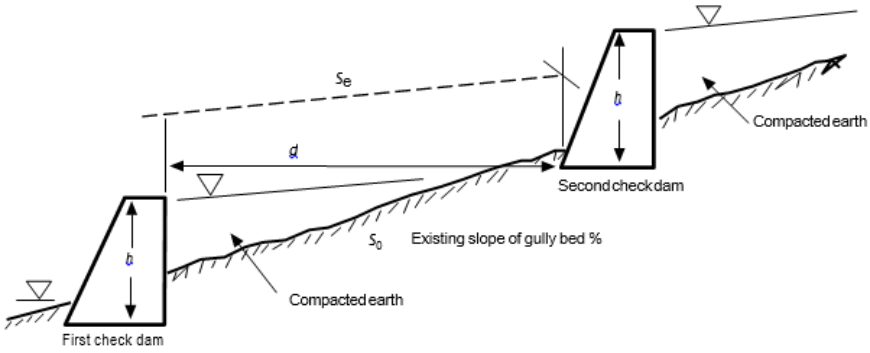

Figure 4 - Longitudinal layout of check dams

Advantages

Check dams are a highly effective practice to reduce flow velocities in channels and waterways. Contrasting big dams, check dams have a faster implementation timeline, are cost effective, and are smaller in scope. Because of this, their implementation will not typically displace people or communities nor will they destroy natural resources if careful design considerations are undertaken. Sample check dams are given in Figure 5 and 6.

Figure 5 - Sample of Check Dams

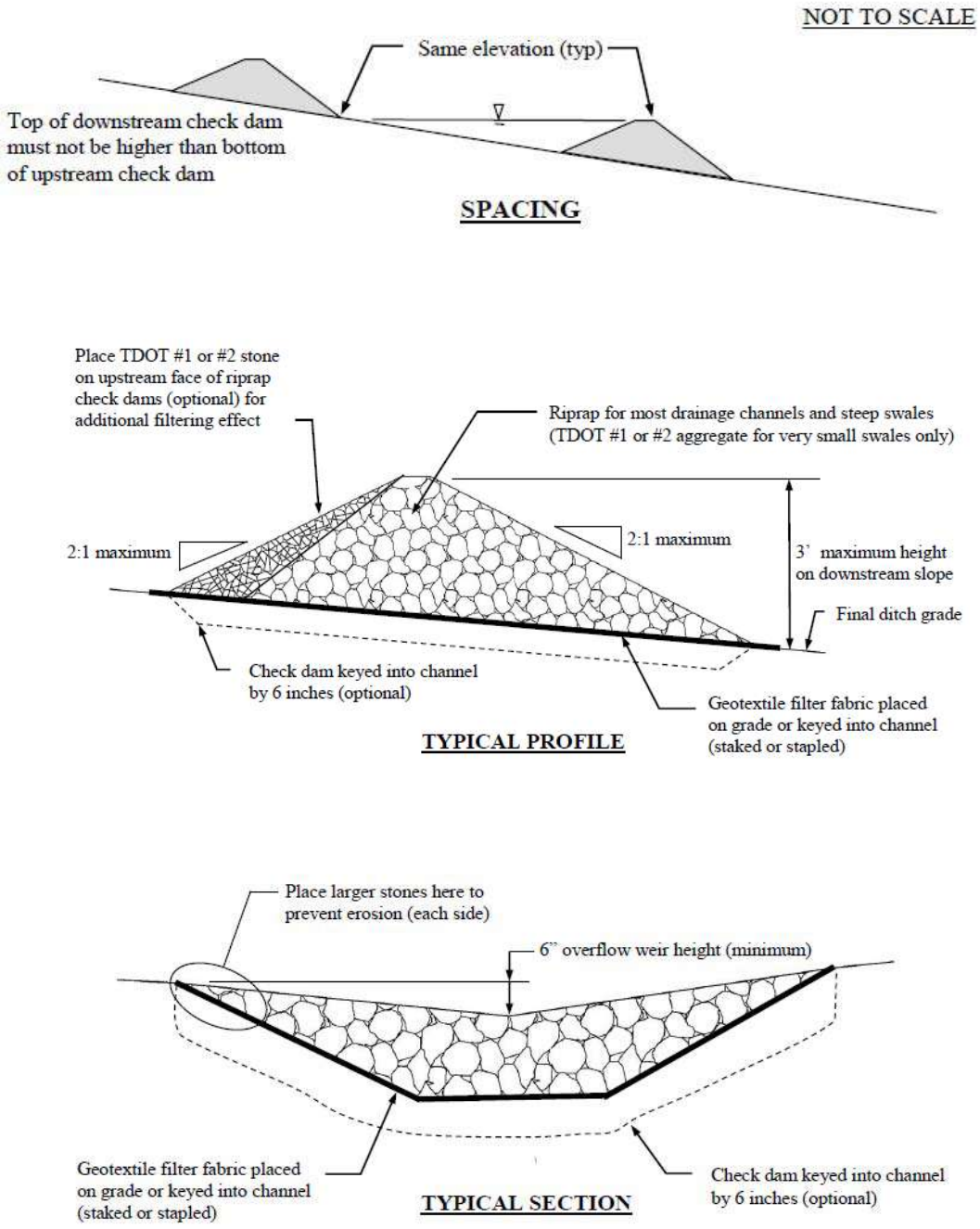

Figure 6 - Sample sections of Check Dam

Estimation of Quantities

In deriving Quantities for check dams and other civil works, the main purpose is to minimize silt accumulation in the main river feeding the irrigation schemes. This is done by minimizing scouring of the main channel and its tributaries and trapping Silts in the tributaries before reaching the main channel. Check dams work by reducing the speed of water in the channel and also trapping the silt. The reduced speed in the channel can then facilitate growth of plant and grass especially in swales hence stabilizing the soils.

Temporary check dams shall be applied in slope ranges from 1% to 8% and then permanent check dams in slopes ranging from 8% to 10%. Check dams are not considered for slopes beyond 10%. The quantities are estimated using GIS slope maps and Arial Photography (Table 6).

Table 6 - Estimation of quantities for Check Dams

Catchment	Permanent Concrete / Stone Masonry Check Dams	Temporary Rock Check Dams
Tochi	1.500	3,000
Wadelai	700	2,000
Mubuku II	20	300
Doho II	200	1,000
Ngenge	10	200

Appendix 13.1 - Capacity Building Needs Assessment for key players in implementing CMP Tochi

Institution	Thematic area	Existing situation	What needs to be done
Gulu District Natural Resource Department	Human Resources	According the Local Government structure, the Department is not fully constituted. A few positions have not been filled.	Government needs to recruit the following officers in accordance with the approved structure of the District: • Senior Forest Officer • Based on the labour gaps identified, government should recruit an environmental focal person at the Sub-County to improve efficiency of the District staff.
	Transport and communication	The Department only has few functional motorcycles. This is very inadequate and this scenario incapacitates the Department from functioning effectively.	Department needs at least 1 vehicle at the District level and 1 motorcycle at each Sub-County to facilitate field activities.
	Equipment and tools	The Department has 1 desktop and 1 laptop. Other equipment include 1 GPS.	Department needs at least the following equipment: • 4 extra laptops • 1 GPS • mensuration equipment (such as campuses, Diameter tapes, Calipers, Suntos, hypsometers & Linear tapes). • 2 printers (A3 colored) • 1 photocopier
	Infrastructure	The District has adequate office for all the staff.	No extra assistance is needed.
	Training needs	The existing staff have basic training in forestry, environment and land management.	Department needs the following training: • Land restoration. • GIS and remote sensing software. • Watershed management.
Oyam District Natural	Human Resources	According the local government structure, the Department is not	Government needs to recruit the following officers in accordance with the approved

Resource Department		fully constituted. Some substantive positions need to be filled.	structure of the District: • Natural Resource Officer • Senior Environment Officer • Cartographer • Registrar of Titles • Based on the labour gaps identified, Government to recruit an environmental focal person at the Sub-County to improve efficiency of District staff.
	Transport and communication	The Department only has 1 functional motorcycle. This is very inadequate and this scenario incapacitates the Department from functioning effectively.	Department needs at least 1 vehicle and 4 motorcycles to facilitate field activities.
	Equipment and tools	The Department has only 2 desktops, 1 laptop and a GPS.	Department needs at least the following equipment: • 4 laptops • survey equipment • GPSs • 2 cameras • projector • generator for the outreach programs to be able to show videos. • 2 printers (A3 printing) and 2 scanners • 1 photocopier • water testing kit
	Infrastructure	The Department has no office building of its own. Currently, it is housed under the Community Development Office.	• Department is need of an office block of its own which should come along with office desks and cabinets. • There is a dire need for office space for the land registry.
	Training needs	The existing staff has basic training in forestry, environment management.	Department needs the following training: • It was stated that a number of wetlands in Oyam District are under threat. Therefore, there is need for training in wetland management

			planning. • Environmental Impact Assessment. • Area Land Committees and District Land Board need be trained further on their roles in land management. • Physical Planning Committees also need to be trained on their roles in physical planning. • GIS and a functioning Information Management System.
Omoro District Natural Resource Department	Human Resources	According the local government structure, the Department is not fully constituted and several staff is still needed to fill the vacant positions.	Government needs to recruit the following officers in accordance with the approved structure of the District: • Environment Officer • Physical Planner • Natural Resource Officer • Surveyor • Forest Officer • Forest Ranger • Focal person in charge of GIS • Based on the labour gaps identified, government should recruit an environmental focal person at the Sub-County to improve efficiency of District staff.
	Transport and communication	The Department only has 1 functional motorcycle. This is very inadequate and this scenario incapacitates the Department from functioning effectively.	Department needs at least 1 vehicle and 3 motorcycles to facilitate field activities at the District.
	Equipment and tools	The Department has only 2 desktops and 1 GPS.	Department needs at least the following equipment: • 2 lap tops at the District • A3 printer (colored) • 2 GPSs and GIS software • Internet Services • projector

			• photocopier • scanner
	Infrastructure	The Department has no office building/space of their own. Currently, the Department is housed under a residential house which belongs to the Lalogi Sub-County Chief which is supposed to be his store.	Department is in dire need of an independent office building. The building should come along with office desks, cabinets, board rooms and others. It was stated that land is available.
	Training needs	The existing staff has basic training in forestry, environment and land management.	Department needs the following training: • Income enhancement skills and alternative livelihood options such as apiary, goat rearing and others. • GIS and remote sensing for monitoring of activities in catchment.
Nwoya District Natural Resource Department	Human Resources	According the local government structure, the Department is not fully constituted and several staff is still needed to fill the vacant positions.	Government needs to recruit the following officers in following the approved structure of the District: • Natural Resource Officer • Forest Rangers (2) • Cartographer • Physical Planner • Based on the labor gaps identified, Government to recruit an environmental focal person at the Sub-County level to improve efficiency of District staff.
	Transport and communication	The Department only has 2 motorcycles. This is very inadequate and this scenario incapacitates the Department from functioning effectively.	Department needs at least 1 vehicle and 2 motorcycles to facilitate field activities at the District.
	Equipment and tools	The Department has 2 Laptops and 1 GPS.	Department needs at least the following equipment: • 5 extra laptops • 3 extra GPSs and GIS software • survey equipment

			• Internet Services • projector • photocopier • scanner • A3 printer (colored)
	Infrastructure	The Department has no office building/space of their own. Currently, the Department is housed under the engineering block (2 rooms) and another building.	Department is in need of an independent office building. The building should come along with office desks, cabinets, board rooms and others.
	Training needs	The existing staff has basic training in forestry, environment and land management.	Department needs the following training: • Monitoring and Evaluation • GIS and remote sensing for monitoring of activities in the catchment. • EIA.
National Forestry Authority	Transport and communication		• Natural Forest Department needs at least 1 vehicle and 4 motorcycles. • Plantations Department needs at least 3 motorcycles.
	Equipment and tools	The Range has some office equipment at the Range Office but the field offices lack certain basic equipment.	The range is need of • 6 GPSs • 4 computers • 4 scanners • 4 printers • 1 photocopier • 30 protective gears for all staff. • Arc GIS Soft ware
	Infrastructure	The Range and field offices have offices except that they lack office desks.	office desks
	Training needs	The staff in the Department has basic training in forestry although they stated that they need refresher trainings in some areas.	Natural Resource Department needs training in the following areas: • Stakeholder engagement. • Forest boundary surveying and mapping. • GIS and biomass monitoring. • Case study visits (in Uganda and outside Uganda (e.g. it

			was stated that several staff in the Range have never seen an irrigation scheme).
Albert Water Management Zone	Human resource	The Department has a capacity gap for some of its key staff.	Government to recruit the following officers for effective functioning of the WMZ: • 2 Agricultural Officers • 2 Irrigation Engineers • 1 Sociologist
	Transport and communication	The WMZ has 3 vehicles which were stated to be very old (have mileage of 400,000 km) with high maintenance costs.	Albert WMZ needs at least 2 vehicles and 1 motorcycle.
	Equipment and tools	The WMZ has basic office equipment although there are some gaps.	Albert WMZ needs the following tools & equipment: • 2 desktops with high RAM and storage space to be used for modelling and database management. • 3 laptops • river gauging equipment for at least 2 rivers. • water quality testing kits
	Infrastructure	The Albert WMZ currently has limited office space but a new building is under construction and is expected to be completed in December 2018.	No extra capacity needed.
	Training needs	The WMZ has trained staff in their fields of specialisation but these need refresher trainings in some specialised fields.	Department needs the following training: • Water modelling. • Courses in Climate Change interventions and remediation. • Stakeholder engagement and management. • Tailored made courses such as in development of irrigations schemes. • General Management • Soil and Land Management.

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