

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

CATCHMENT MANAGEMENT PLAN for DOHO II IRRIGATION SCHEME - DRAFT

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SUMMARY

This report covers the Catchment Management Plan for the Doho II irrigation scheme (CMP or Plan). The scheme is located in the eastern part of Uganda and is part of the Mbale, Manafwa (includes Namisindwa), Butaleja and Bududa Districts. The catchment is part of the Lake Kyoga river basin under the Kyoga Water Management Zone of MoWE.

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 5 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 Doho II 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 Doho II 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 plans¹, 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; Management Plan for the Lake Kyoga river basin, BRL/MoWE, April 2016; Mpologoma Catchment Management Plan, BRL/MoWE, March 2017; and the District Development Plans of the Districts located within the Doho II catchment, i.e. Mbale, Manafwa (includes Namisindwa), Butaleja and Bududa.

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 Kyoga 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 Doho II 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 Doho II catchment are related to deforestation, soil erosion, land slides, river bank cultivation, wetland encroachment and floods, drought and effects of Climate Change (environmental challenges), poor farming methods, bush burning, population pressure on land, land tenure, education, gender and 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 4.4 million US\$ occur in the first year (mainly investment) to be followed by 1.2 - 1.5 million US\$ annually operational costs for the next 20 years or so to come.

Implementation Plan for the Investments on Environmental Protection of the Doho II catchment

Investment Options for Doho II	Implementation Priority	Ranking			Period taken for Impact to start	Funding Option	Implementing Agency		Funding Requirements for Investment and Operational Costs (accumulated) (USD '000)		
		MCA ranking ¹	Economic Benefit ² 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	medium to high	high	medium	high - medium	Medium term	Consolidated Gov Funds / Loan	farmers	FSSD, DLG (Mbale, Manafwa, Butaleja, Bududa)	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 (Mbale, Manafwa, Butaleja, Bududa)	Catchment Mng Committees	1,124	255	717
Agro-Forestry	medium to high	medium	high	medium - high	Long term	Consolidated Gov Funds / Loan	DLG (Mbale, Manafwa, Butaleja, Bududa)	farmers, NGOs, CBOs	958	750	2,133
Replanting of Trees in LFRs	medium to high	medium	high	medium - high	Long term	Consolidated Gov Funds / Loan	DLGs		11	7	19
Civil Works	medium	high	low	high - low	Short term	Consolidated Gov Funds / Loan	FSSD	DLG (Mbale, Manafwa, Butaleja, Bududa), MoWE, MoWT	1,506	690	1,962
Buffer Zone Demarcation and Protection	medium	low	high	low - high	Short term	Consolidated Gov Funds / Loan	DLG (Mbale, Manafwa, Butaleja, Bududa)	Catchment Mng Committees	121	97	251

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
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
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
NP	National Park
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
<i>spp</i>	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
UWA	Wild Life Authority
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 Manafwa (or Doho II) irrigation scheme (the CMP or the Plan) with the identification and an 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 Doho II CMP (Chapter 10) were identified within the broader context of the:

- National Sector Development Plans 2015/16-2019/20 of MoWE, MoAAIF and MoEMD;
- Management Plan for the Lake Kyoga river basin, BRL/MoWE, April 2016;
- Mpologoma Catchment Management Plan, BRL/MoWE, March 2017; and
- District Development Plans of the Districts located within the Doho II catchment, i.e. Mbale, Manafwa (includes Namisindwa), Butaleja and Bududa.

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 Doho II 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 Doho II 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 Doho II 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 Kyoga WMZ (Lake Kyoga river basin, see Section 3.1), the management plan for the Lake Kyoga river basin of April 2016, the Mpologoma Catchment Management Plan of March 2017 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 Kyoga 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 Doho II 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 Kyoga WMZ

The CMP for Doho II has been developed within the framework of the management plan for the Lake Kyoga river basin, the Mpologoma Catchment Management Plan (of which Doho II is part) and the District Development Plans of Mbale, Manafwa (includes Namisindwa), Butaleja and Bududa.

The plans outline interventions in infrastructure and other action for the Lake Kyoga river basin, in general and more specific for the Mpologoma Catchment (of which the Doho II is part). The interventions are linked to Natural and Water Resources management works to help resolve conflicts, conserve and protect the areas and its resources, and ensure equitable access. This information has guided the consultants in drafting the environmental protection works for Doho II.

Section 3.1 further elaborates on the Doho II WMZ 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 Doho II:

- 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.

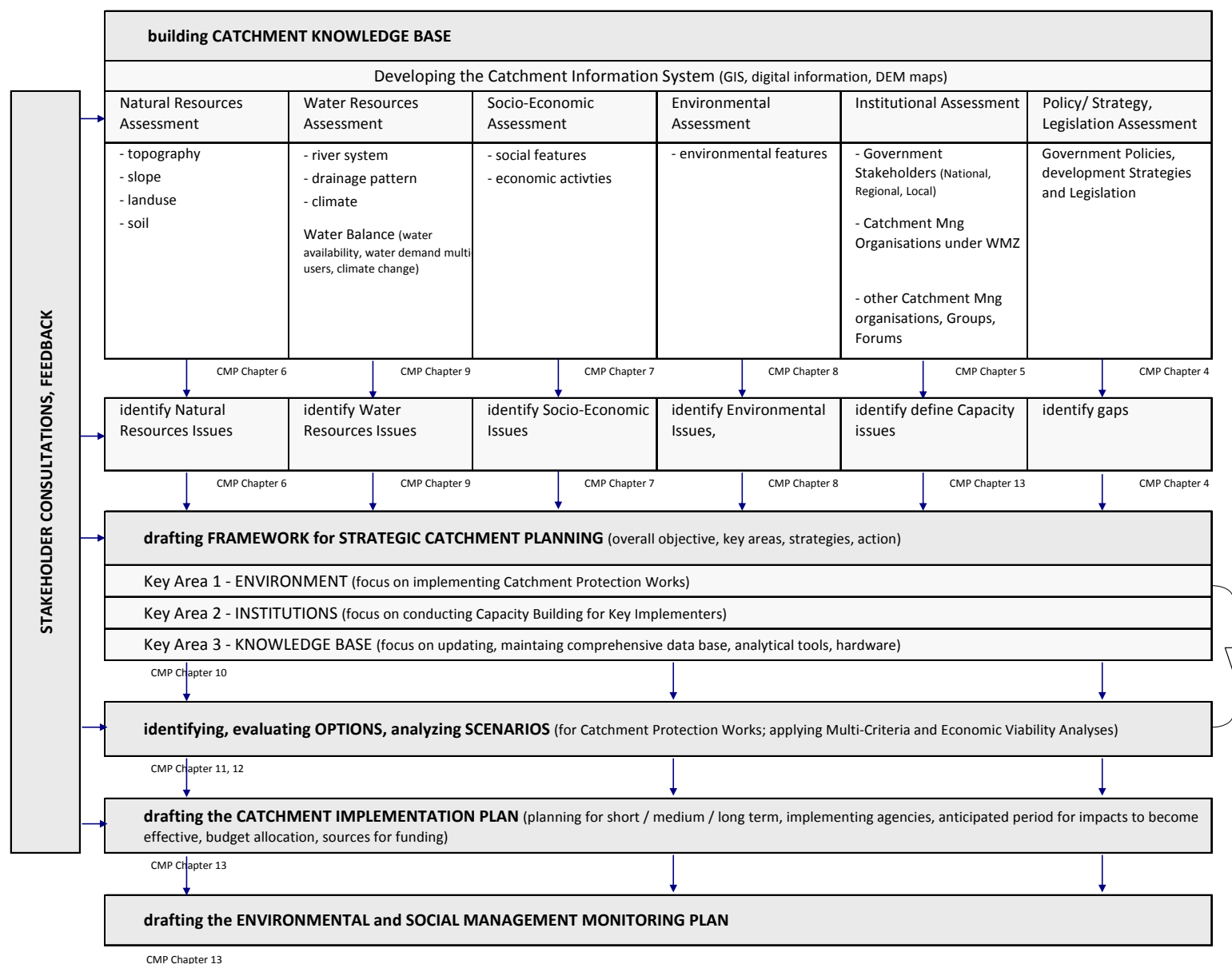


Figure 2.1 - Methodology Diagram for developing the Doho II CMP

3 KNOWLEDGE BASE - STUDY AREA

The Doho II catchment is located in the eastern 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 Doho II 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/library/watermanagement-zones-wmz>). Each region covers a WMZ. Each WMZ comprises of a number of catchments. The Doho II catchment falls within the Lake Kyoga river basin which is part of the Kyoga WMZ that is managed by the Eastern Region WMZ of MoWE with its regional office in Lira. With the Lake Kyoga river basin Doho II is part of the Mpologoma catchment (Figure 3.5).

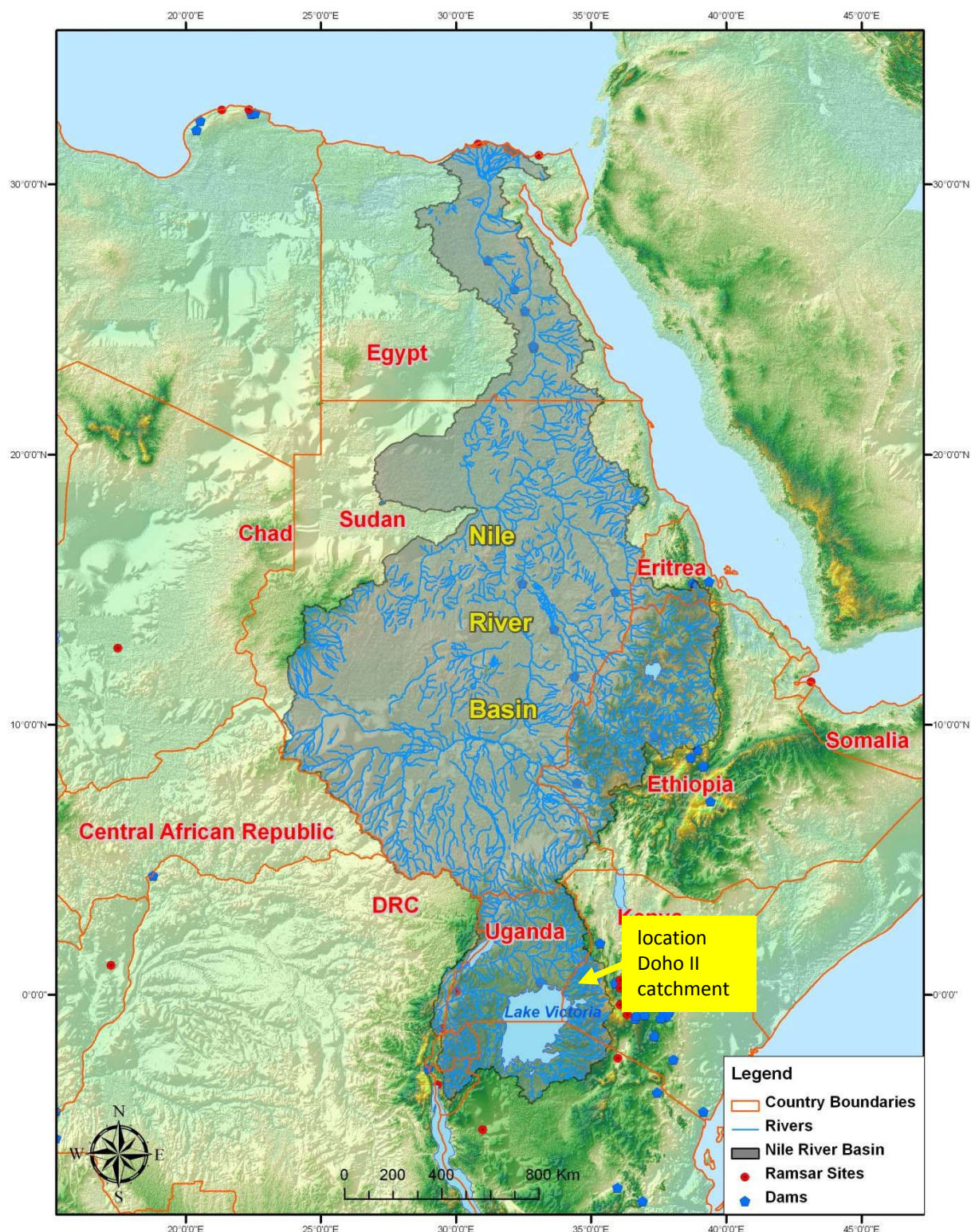


Figure 3.2 - Greater Nile Basin (source: Catchment Management Plan for Awoja Catchment, MoWE/AURECON, December 2013)

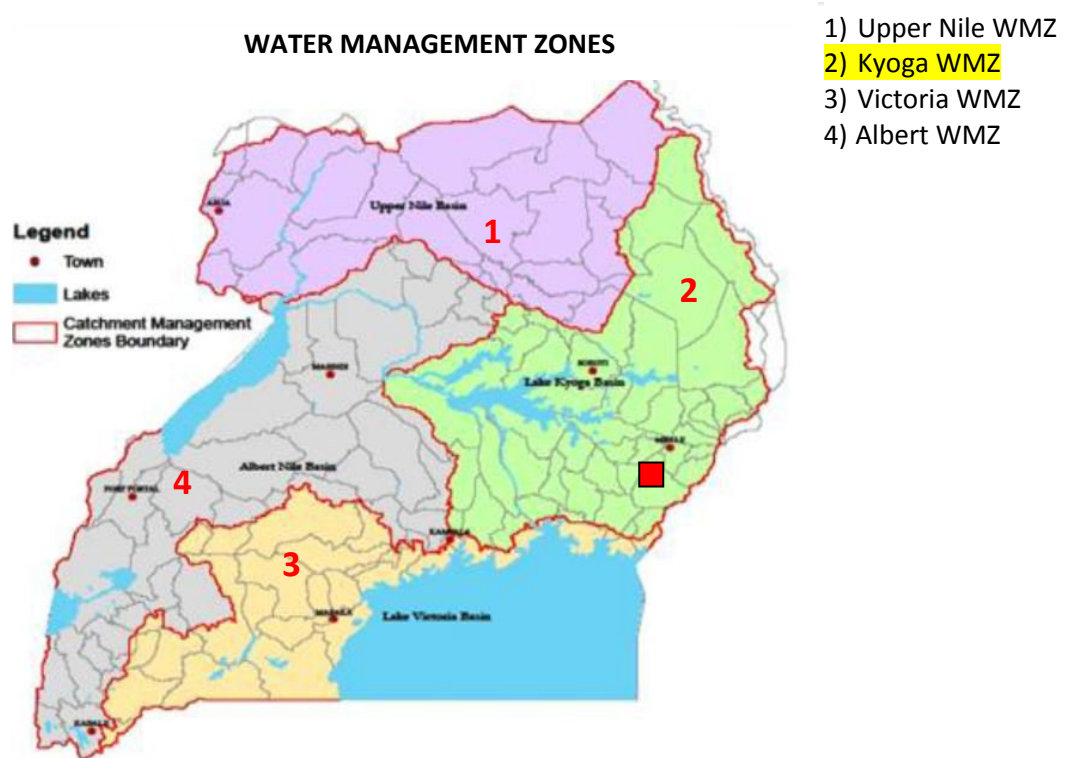
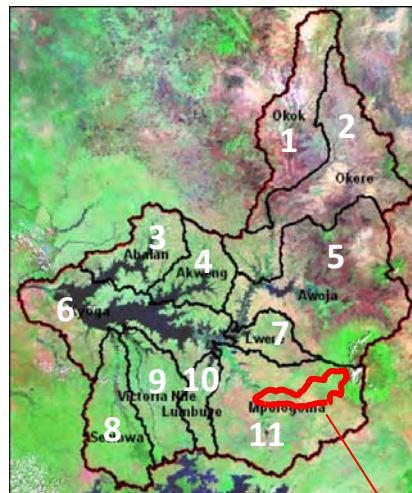


Figure 3.3 - Water Management Zones (source: Uganda National Water Development Report, 2015)



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

LAKE KYOGA BASIN with CATCHMENTS



Catchments Lake Kyoga Basin

- 1) Okok
- 2) Okere
- 3) Abalan
- 4) Akweng
- 5) Awoja
- 6) Kyoga
- 7) Lwere
- 8) Sezibwa
- 9) Victoria Nile
- 10) Lumbure
- 11) Mpologoma

*Figure 3.5 - Catchments of the Lake Kyoga river basin
(source: Catchment Management Plan for the Awoja Catchment in Kyoga Water Management Zone, AURECON / MoWE, 2013)*

**Doho II (or
Manafwa)
watershed**

3.2 River System Characteristics

The water supply for the Doho II irrigation scheme comes exclusively from the river Manafwa. The Manafwa river catchment comprises an area drained by the Manafwa river and its tributaries. This river has its source on the high points of Mt. Elgon at an elevation of over 3,900 m +MSL. The river flows through the mountainous Districts of Bududa, Manafwa and Mbale and the low lying Butaleja where it joins with other streams to form the greater Mpologoma river that flows into Lake Kyoga. The catchment for the irrigation scheme includes the drainage area of the river upstream of the intake gates at Nazimasa and measures 523 km².

River Manafwa is characterized by high levels of sediments, pollution from uncontrolled waste disposal and frequent flooding and drought as seen from physical observations of the river.

The river Manafwa is also a source for domestic water supply to the surrounding built up areas. There are several groundwater boreholes installed with hand pumps for supplying water to the rural communities across the watershed. The river is the sole source of irrigation water to the Doho rice scheme which is located in the river flood plain in the low lying area in the neighbouring Butaleja District to the west of the watershed.

3.3 Administration, Population

There are four Districts, 42 Sub-Counties and 202 Parishes in the catchment. The names of these Districts, Sub-Counties and Parishes are listed in Table 3.1. Figure 3.6 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 within the Doho II 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 Doho II Catchment

District MBALE		District MANAFWA (includes NAMISINDWA)		District BUTALEJA		District BUDUDA	
SUB-COUNTY	PARISH	SUB-COUNTY	PARISH	SUB-COUNTY	PARISH	SUB-COUNTY	PARISH
BUKHIENDE	ISANGO	BUKHABUSI	BUKHABIKULA	MAZIMASA	KACHONGA	BUBIITA	MAABA
	BUNGWANYI		NAMAWONDO		BUFUUJA		SHISHENDU
	BUNASHIMOLO		BUWATUWA	HIMUTU	KANYENYA		SHITEKA
	BUSHANGI		BUTIRU		WANGALE		SHIKHULUSI
	BUMUTSOPA		BUKHABUSI			BUDUDA	BUNEEMBE
	BUMAENA		BUMATANDA				BUSHINYEKWA
BUMASIKYE	BURUKURU	BUKHAWEKA	BUNANGANDA				BUSAI
	LUBAALE		BUNAMBOKO				BUKIBINO
BUSANO	MUANDA		BUKHAWEKA				BUKHATONDI
	BWIKHONJE		BUKHAWEKA TOWN BOARD				BUKIMUMA
	BUFOOTO	BUKUSU	BUBIKALA			BUDUDA TC	BUNAMUTUNYI
	BUYAKA		BUBUTSATSA				BULOLI SOUTH
BUSIU	BUSANO		BUKHWAYA				NASHULA
	BULUSAMBU	BUPOTO	BUKHOMA				BULOLI NORTH
	BUWALASI		KAYOMBE				BUWANABISI
	LUMBUKU		BUWERE			BUKALASI	MAIKA
	BUNAMBUTYE	BUTTA	NAMISINDWA				BUKIBUMBI
	BUFUKHULA		BUWANDYAMBI				NABULALO
BUSOBA	MUSESE		BUYAKA				SHIBANGA
	BUNANIMI		TSAKHANA TOWN BOARD				BUNDESI
	BUSOBA	BUTTA	BUKIBUMBI				KASUNI
	BUNAMBUTYE		BUSANTSA				SUUME
LUKHONGE	BUMASIKYE		TOOMA BUTTA				BUKALASI
	NAMBWA	BUWABWALA	BUTTA			BUKIBOKOLO	NAMETSI
NYONDO	NABWEYE		FULUMA BUTTA				NAMASHETI
	BUFUKHULA		BASAMBATSA II				BUWAKHATA
WANALE	NYONDO		BUSAMBATSA TOWN BOARD				BUIRIMBI
	NABANYOLE	BUWAGOGO	BUMURWA			BUKIGAI	BUKARI
	KHAUKHA		BUSAMBATSA I				BUNAMUKYE
			BUWASU				BULUMINO
			BUWAGOGO			BULUCHEKE	BUTIRIKU
		KAATO	SHAMUKUNGA				BUNAMUBI
			BUWEBOYA				BUMIRUME
			BUKEWA				BUNAKUTI
		KHABUTOOLA	BUNASAKA			BUMASHETI	BUMANGOYE
			BUKIMANAYI				BUNAPORO
			BUNABUTSALE				BUMATANDA
			BUMUKARI			BUMAYOKA	BUMAKUMA
		MANAFWA TC	BUMUFUNI				BUMASATA
			KHABUTOOLA				BUMAEMBA
			BUNANGABO				BUNANZUSHI
		MUKOTO	MAYENZE			BUSHIYI	BUMWALUKANI
			BUBULO				BUMWALYE
			BUMWANGU				SAKUSAKU
			BUBWAYA				BUNAMAE
		NALONDO	MAKUTANO			BUSHIRIBO	BUKHURA
			LUWA TOWN BOARD				BUSAMAALI
			MAALO				BUKIBOKOLO
			BUFUMA			BUWALI	MABONO
		NAMABYA	BUNAMULUNYI				BUBUKASHA
			SIAKALO				BUBUKASHA
			BUTSEMA				NAMUKHUYU
		SIBANGA	BUWASUNGUYI			BUSHIKA	BUNANDUTU
			MASAACA				ULUKUSI
			NAMUNYALI				BUMAYOKA
			BUWASYEBA				BUFUMA
		TSEKULULU	BUNAMUKHEYA			BUSHIRIBO	NAMAKUKYE
			BULAKO				BUNAMANDA
			BUSULWA				NAMAKUTO
			BUNAMBALE				BUMUSHISO
		WESWA	BUTTINGU			BUWALI	BUBUNGI
			BUNAMWANDU				NANGAKO TOWN
			BUSEKELE				BUKHAUKHA
			BUNGATI				BUNABUTITI
		WESWA	BUMUMALI			BUSHIRIBO	BUFUTSA
			BUKHABIKULA				NAKUNGULYU
			BUNASAMBI				MATUWA
			BUNGOOLO				BURABA
		WESWA	BUBUKANZA			BUSHIRIBO	BUNEBOSHE
			BUWESONGA				BURAFULA
			SIBANGA				BUSIRIWA
			BUTOTO				BUSHIYI
		WESWA	BUWESSWA				NAMIRUMBA
						BUWALI	BUNATSAMI
							BUSWALIKHA
							BUSHIRIBO
							BUFUKHULA
		WESWA				BUSHIRIBO	BUWALI
							KITSAWA
							BUKOBORO
							BUNAMWAMBA
		WESWA				BUSHIRIBO	BUWASHI
							BUNANTSUMYA
							BULOB
							BUNAKHAYOTI
		WESWA				BUSHIRIBO	BUNYANGA
							BUNANDUTU
							BUSHUNYA
							BUNAMBATSU
		WESWA				BUSHIRIBO	BUMUSENYI
							BUMUKONYA
							BUWAKIYU
							BUMUSI UPPER
		WESWA				BUSHIRIBO	BUMUSI LOWER
							BUNANGO
							BUMAKHWA
							BUMAKITA

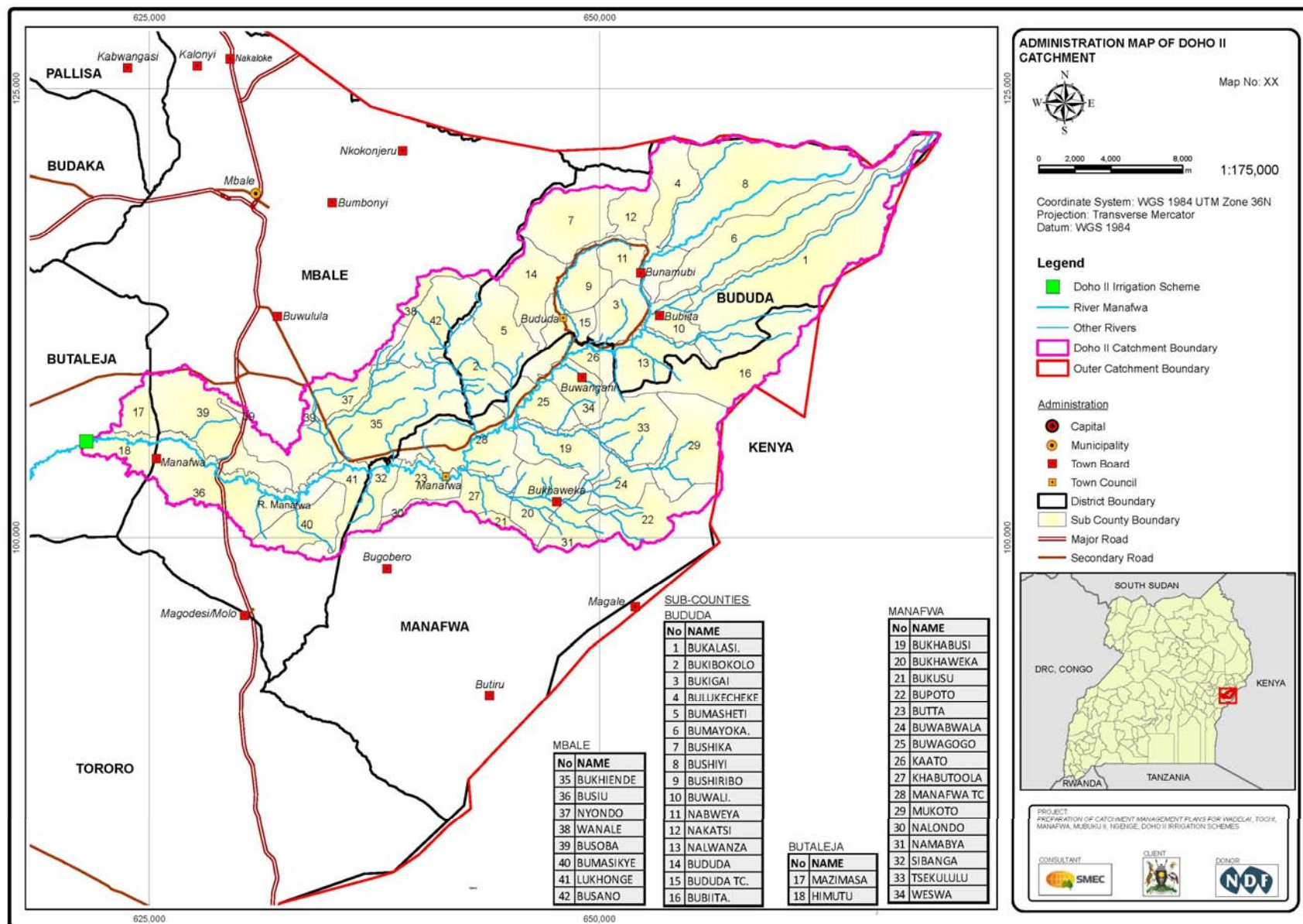


Table 3.2 - Current and Projected Population

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⁾
DOHO I (MANAFWA)	Butaleja	163.4	196.1	252.5	287.8	306.7	358.6	555.9
	Mbale	343.5	403.3	505.5	576.3	614.9	718.0	1,112.9
	Buduuda	128.7	160.9	217.3	247.7	264.0	308.6	478.4
	Manafwa	269.2	304.8	365.7	416.9	444.3	519.5	805.2
Total Manafwa		905	1,065	1,341	1,529	1,630	1,905	2,952

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⁾
DOHO I (MANAFWA)	Butaleja	2.7	3.3	4.2	4.8	5.2	6.0	9.4
	Mbale	84.2	98.9	124.0	141.3	153.7	176.1	272.9
	Buduuda	113.9	142.3	192.3	219.2	232.3	273.1	423.3
	Manafwa	73.8	83.5	100.2	114.3	120.0	142.4	220.7
Total Manafwa		275	328	421	480	511	598	926

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 Doho II catchment are:

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

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

- 8) National Fisheries Policy (2004);
- 9) National Climate Change Policy (2015);
- 10) Energy Policy for Uganda (2002);
- 11) National Agricultural Policy (2013);
- 12) National Gender Policy (2007);
- 13) National Health Policy (2010);
- 14) 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.
National Wildlife Policy (2014)	National	MoTWA	It provides policy framework, guidance and strategic directions for Planning, Development, Management, conservation and utilization of wildlife 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	National	MoFPED	It provides a policy framework, guidelines and strategic directions that integrate

Policy Name	Level	Responsible Entity	Relevance to Catchment Planning and Management
(2008)			population factors in development planning at all levels.
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);
- 8) National Forest Plan (NFP) 2011/12-2021/22.

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 (NDP II) (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	Implementation Period	Implementing 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	2015-2020	MoWE	It is the Water and Environment Sector Development Plan that indicates the sector's investment priorities areas amid to be achieve

National Strategy / Plan	Implementation Period	Implementing Entity	Relevance to Catchment Planning and Management
(2015)			the national goal during the plan period. For instance, the WESDP prioritized restoration of 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.
National Forest Plan (2011)	2012-2022	MoWE, DoEA	It is a sector-wide National instrument which provides strategic directions, guidelines, investment propriety areas as well as implementation modalities for managing, utilizing the Forestry Resources.
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.

National Strategy / Plan	Implementation Period	Implementing Entity	Relevance to Catchment Planning and Management
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 Doho II 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);
- 4) Uganda Wildlife Act (2000).

Other legislation that has an influence on the management of the Doho II 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 through 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			
Uganda Wildlife Conservation Act, 1996	National	MoTWA	It provides the legislative framework for Development, Management and sustainable Utilization wildlife resources.
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

Legislation	Context	Enforcing Entity	Relevance to Catchment Planning and Management
			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.
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 to provide for the decentralization of functions, powers, responsibilities and services to Local Governments.

5 KNOWLEDGE BASE - INSTITUTIONAL FRAMEWORK

The Doho II 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	<ol style="list-style-type: none">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.

Ministry	Department / Agency relevant to Catchment Management	Roles and Responsibilities
	National Environment Management Authority	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 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		<ol style="list-style-type: none"> 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 of Energy and Mineral	National Hydro Power Projects	Establishment, Licensing and Monitoring of Mini-Hydro power stations.

Ministry	Department / Agency relevant to Catchment Management	Roles and Responsibilities
Development		
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	<ol style="list-style-type: none"> 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	<ol style="list-style-type: none"> 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.

These four WMZs are part of DoWRM and are headquartered at the four regional offices located country wide. For the Doho II catchment, the Kyoga WMZ office is located in Mbale (see also Section 3.1). The main roles and responsibilities of the Kyoga WMZ 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 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 Doho II catchment

Irrigation Scheme	Local Government
Doho II	Local Governments of Bududa (all the 15 Sub-Counties), Namisindwa, (Namisindwa TC, Magale TC, Lwakhakha T C., Bukalasi, Bumwono, Bukoreho, Bumbo, Namboko, Magale, Bubutu, Nabweya, Bukhaweka, Bupoto, Tsekululu, Mukoto, Buwobwale and Buhabutsi Sub-Counties) Manafwa (22 Sub-Counties), Mbale (10 Sub-Counties) and Butaleja (Himutu and Mazimasa Sub-Counties)

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 Doho II catchment.

Table 5.3 - WMZ Structures, Roles and Composition

Structures Under WMZ	Roles	Composition
Catchment Management Organization (CMO)	<ul style="list-style-type: none"> ▪ 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) <i>(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)</i>	<ul style="list-style-type: none"> ▪ 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
	<ul style="list-style-type: none"> Supervision and monitoring; Documentation and information exchange; Recommend review of CMP plans; Form an arbitration committee to resolve conflicts. 	
Catchment Technical Committee (CTC) <i>(de-facto the technical arm of the CMO)</i>	<ul style="list-style-type: none"> 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. 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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 <i>(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)</i>	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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
<i>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)</i>	<p>eradication action plans, District water development plans and other relevant plans;</p> <ul style="list-style-type: none"> ▪ 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) <i>(brings together the regional and national partners)</i>	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ 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	<ul style="list-style-type: none"> ▪ 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 Doho II catchment

Irrigation Scheme	Water Management Zone	Catchment Management Organization	Catchment Management Committee	Catchment Technical Committee	Catchment Stakeholder Forum
Doho 2	Kyoga 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 Doho II 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 Doho II Irrigation Scheme served by the Manafwa River in the Districts of Namisindwa, Manafwa, Bududa, Mbale and Butaleja

CBO, CMO or CMG	Roles	Effectiveness	Challenges
NUSAF	<ul style="list-style-type: none"> water shed approach to managing catchment areas Public (labour intensive) works. Sustainable livelihood Sustainable environment. 	<ul style="list-style-type: none"> Is an on-going program Directly implemented by the districts Work directly with communities to identify and fund the projects 	<ul style="list-style-type: none"> Low survival rates of the seedlings they have supplied so far due to different climatic conditions
Lower Local Government	<ul style="list-style-type: none"> procure seedlings monitor the implementation of their projects 	<ul style="list-style-type: none"> closer to the people monitoring is easier 	<ul style="list-style-type: none"> limited resources for both mobilization and monitoring
IUCN:	<ul style="list-style-type: none"> River bank restoration. Catchment restoration through tree planting. Support some communities on livelihood enhancement. 	<ul style="list-style-type: none"> They were working with local communities directly Involved the district technical staff They had the funding to carry 	<ul style="list-style-type: none"> Sustainability is hampered by change of strategy

CBO, CMO or CMG	Roles	Effectiveness	Challenges
		out the identified activities	
Bubita Environment Stewards and caretakers.	<ul style="list-style-type: none"> Organize communities for conservation activities implementation Give seedlings to communities Supply energy saving stoves Support development of other options of livelihood 	<ul style="list-style-type: none"> Work with communities 	<ul style="list-style-type: none"> Limited the resource envelop
Naminyiri Farmers Association.	<ul style="list-style-type: none"> Conduct trainings that contain conservation activities 	<ul style="list-style-type: none"> Work with communities 	<ul style="list-style-type: none"> Limited the resource envelop
Elgon Farmers Association.	<ul style="list-style-type: none"> Energy conserving stoves distribution Tree planting in Bushiyi Sub County. Apiary 	<ul style="list-style-type: none"> Promote alternative energy sources which save the catchment environment 	<ul style="list-style-type: none"> Limited the resource envelop
The Community	<ul style="list-style-type: none"> Plant and take care of seedlings distributed to them from private nurseries. 	<ul style="list-style-type: none"> They are the main beneficiaries They have embraced tree planting especially the commercial tree and fruit species 	<ul style="list-style-type: none"> Limited by the attitude of some community elements to conservation Inadequate land to plant the trees for conservation Exhibit a lot of ignorance about the laws governing river bank conservation Low levels of education that inhibits adoption of new strategies Affected by population that causes land fragmentation
The Salvation Army	<ul style="list-style-type: none"> (With headquarters in the district at Bumbo sub county). They are main supporting the communities 	<ul style="list-style-type: none"> Provide funding to the district departments to cater for funding gap for 	<ul style="list-style-type: none"> Have limited areas of coverage

CBO, CMO or CMG	Roles	Effectiveness	Challenges
	<p>Implementing a project called Environmental Protection and Food Security (EPFOS) in aspects to:</p> <ul style="list-style-type: none"> • Sensitize on environment conservation • Provide seedlings to group members. • Train and give charcoal stove to community members • Emergency response – basic human needs like shelter, food and clothing 	<p>conservation</p> <ul style="list-style-type: none"> • Have a bottom-up approach to planning of their projects 	
Cultural leaders (locally known as Bakuka)	<ul style="list-style-type: none"> • Conserve some sites for cultural practices. Every clan almost has a site for a specific purpose. 	<ul style="list-style-type: none"> • Help in mobilization of communities • People respect and believe in them • Pass on the cultural continuity 	<ul style="list-style-type: none"> • Limited funding • Do not easily adopt to new technological developments
UWA	<ul style="list-style-type: none"> • (Swahili for kill) based at Mt. Elgon national park. • Carry out conservation activities in the national Park 	<ul style="list-style-type: none"> • A source of livelihood for the communities • Promote conservation of the catchment • Their high handedness as helped enforce conservation 	<ul style="list-style-type: none"> • Increasing population pressure that is forcing the communities to encroach on the preserved areas

6 KNOWLEDGE BASE - PHYSICAL CHARACTERISTICS

This Chapter captures part of the knowledge base of the Doho II 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 Doho II 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.

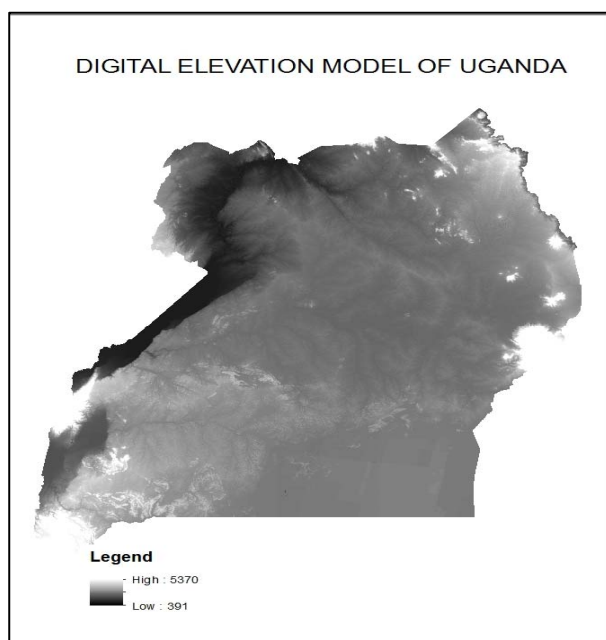


Figure 6.1 - Digital Elevation Model of Uganda

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.naturearthdata.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	UWA
Roads	UNRA

The Digital Elevation model was used to delineate the watershed boundary of the Doho II irrigation scheme whereby the drainage area of the Manafwa 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 Doho II catchment covers 524 km². Its topography ranges from 4,000 m⁺ MSL in the east where the Manafwa river has its origin at the slopes of the Mt Elgon to up to around 1,000 m⁺ MSL near the intake point of the irrigation scheme in the west. The catchment consists of slopes of < 7% in the alluvial flood plain (15% of catchment area). Slopes gradually increase when going to the east and reach levels of > 25% at the slopes of the Mt Elgon.

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.

Table 6.2 - Distribution of Topography Classes

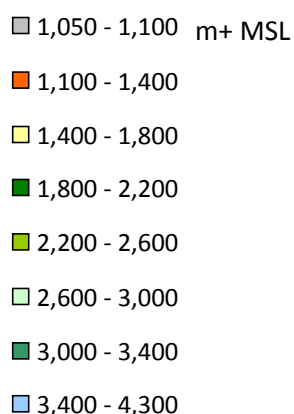
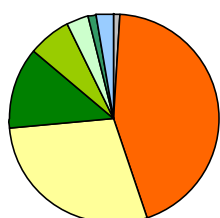
Catchment	Catchment Area (km ²)	Topography (m ⁺ MSL)	Area in Catchment	
			(km ²)	(% of area)
DOHO II	523	1,050 - 1,100	6	1.1
		1,100 - 1,400	228	43.7
		1,400 - 1,800	150	28.6
		1,800 - 2,200	67	12.7
		2,200 - 2,600	34	6.6
		2,600 - 3,000	19	3.6
		3,000 - 3,400	6	1.1
		3,400 - 4,300	13	2.6
Total Doho II			523	100

Table 6.3 - Distribution of Slope Classes

Catchment	Slope Class	Area in Catchment	
		(km ²)	(% of area)
DOHO II	0-7	76.9	14.7
	7-15	115.5	22.1
	15-25	97.3	18.6
	25-30	37.0	7.1
	>30	195.6	37.5
Total Doho II		522	100

Topography Distribution

DOHO II Catchment



Slope Distribution

DOHO II Catchment

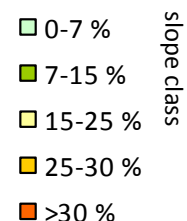
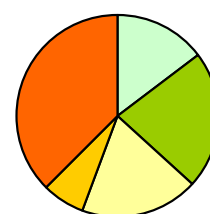


Figure 6.2 - Distribution of Topography Classes

Figure 6.3 - Distribution of Slope Classes

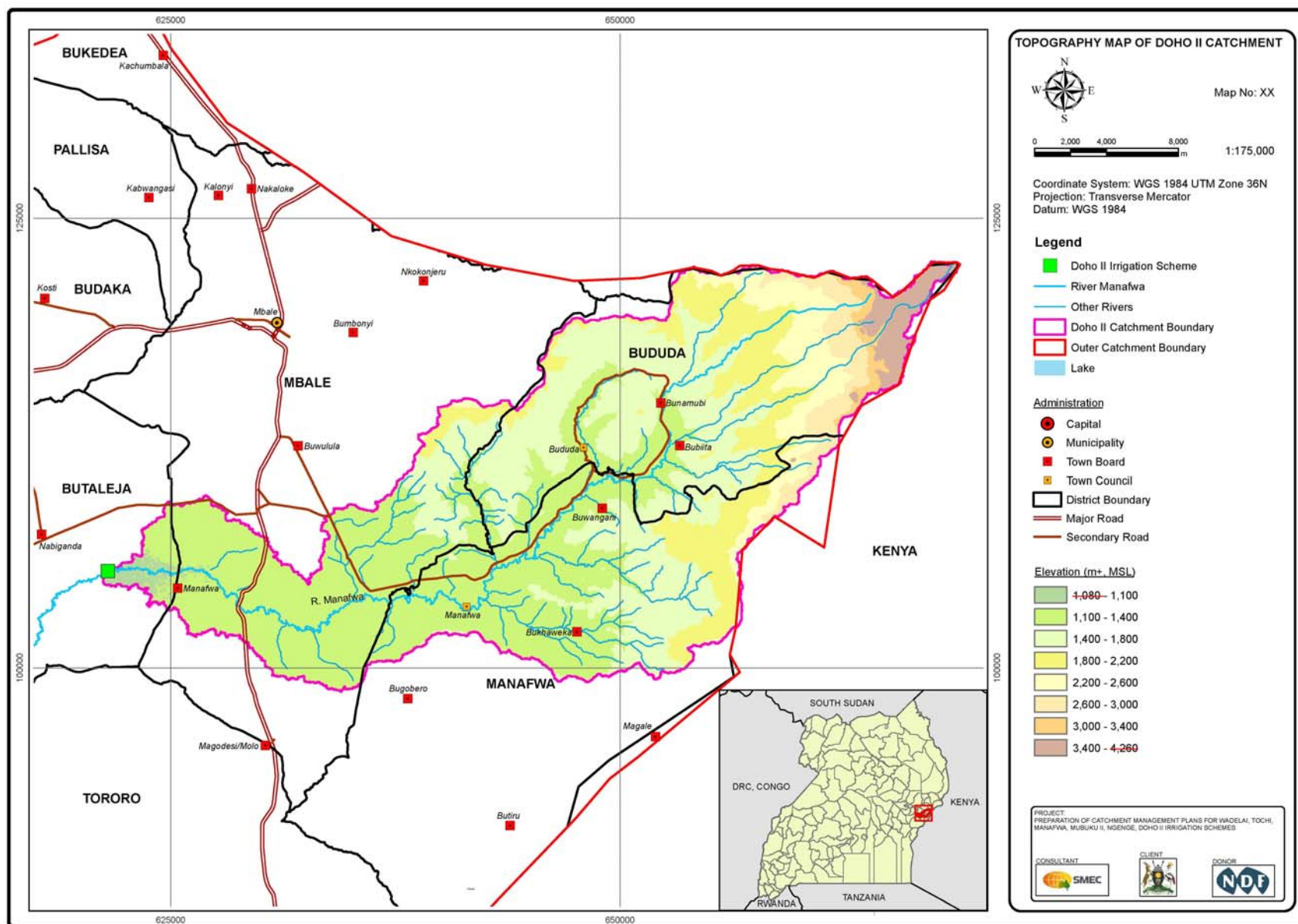


Figure 6.4 - Topography Map

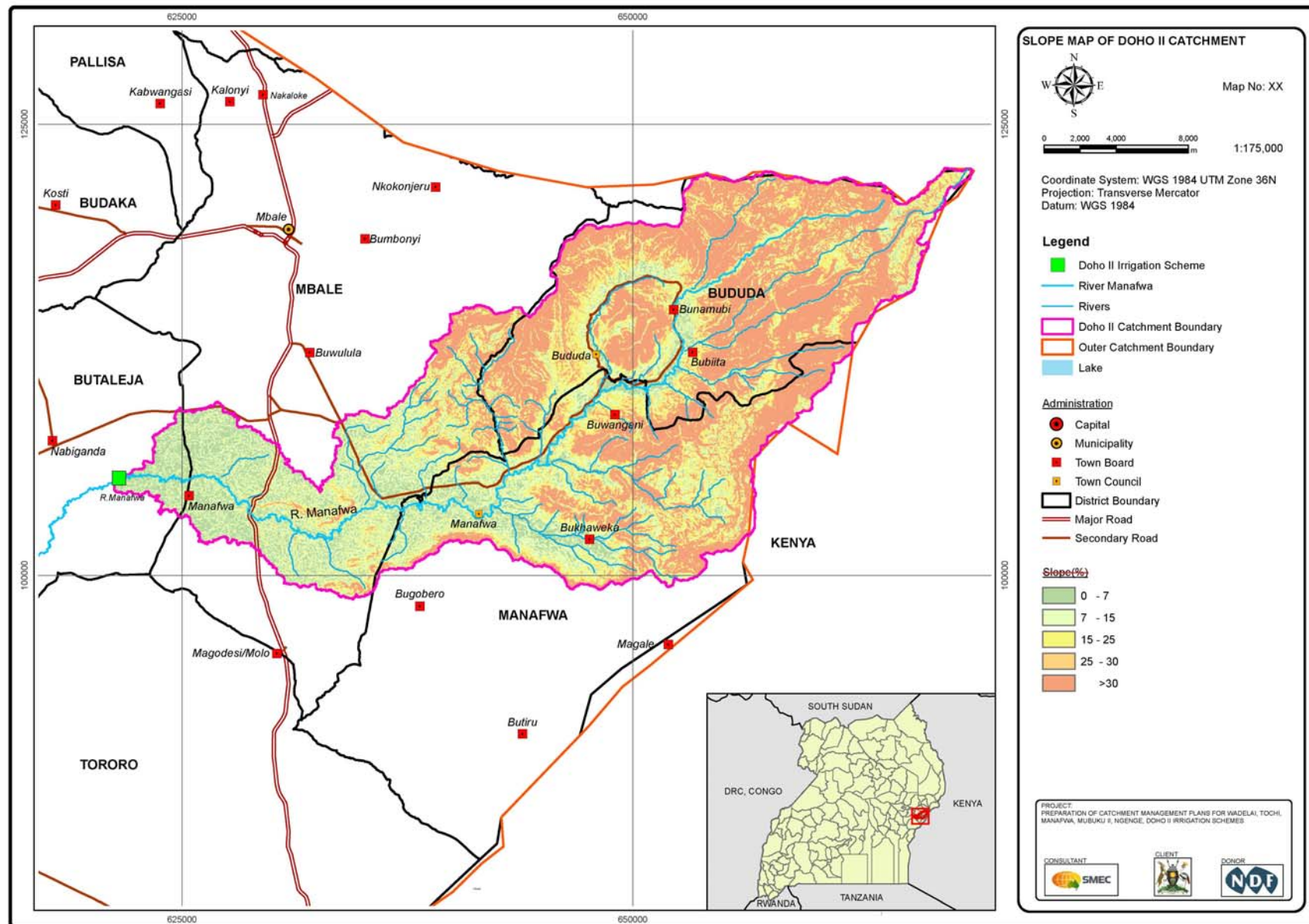


Figure 6.5 - Slope Map

6.3 Land Use

Small scale farmland prevails with 418 km² (or 80%) coverage. The catchment includes 70 km² of tropical forest, being part of the Mt Elgon National Park. A more detailed description of land use is presented in Section 8.1.

The distribution of 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)
DOHO II	523	Broad leaved plantations	0.7	0.1
		Built Up Area	0.3	0.1
		Bush	8.9	1.7
		Commercial Farmland	2.0	0.4
		Grassland	9.4	1.8
		Small scale Farmland	418.1	79.9
		Tropical high forest low stock	8.5	1.6
		Tropical High Forest well stocked	70.9	13.5
		Wetland	3.1	0.6
		Woodland	2.4	0.5
		Others	0.0	0.0
Total Doho II			523	100

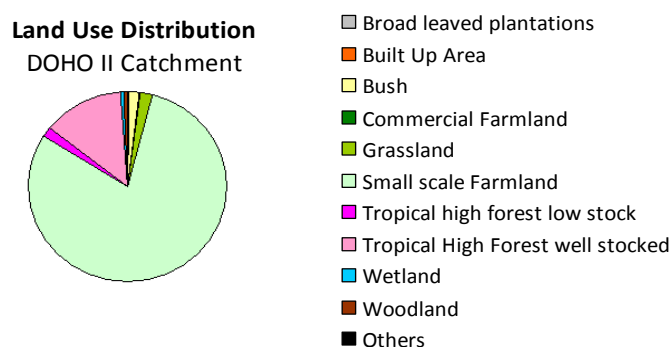


Figure 6.6 - Distribution of Land Use

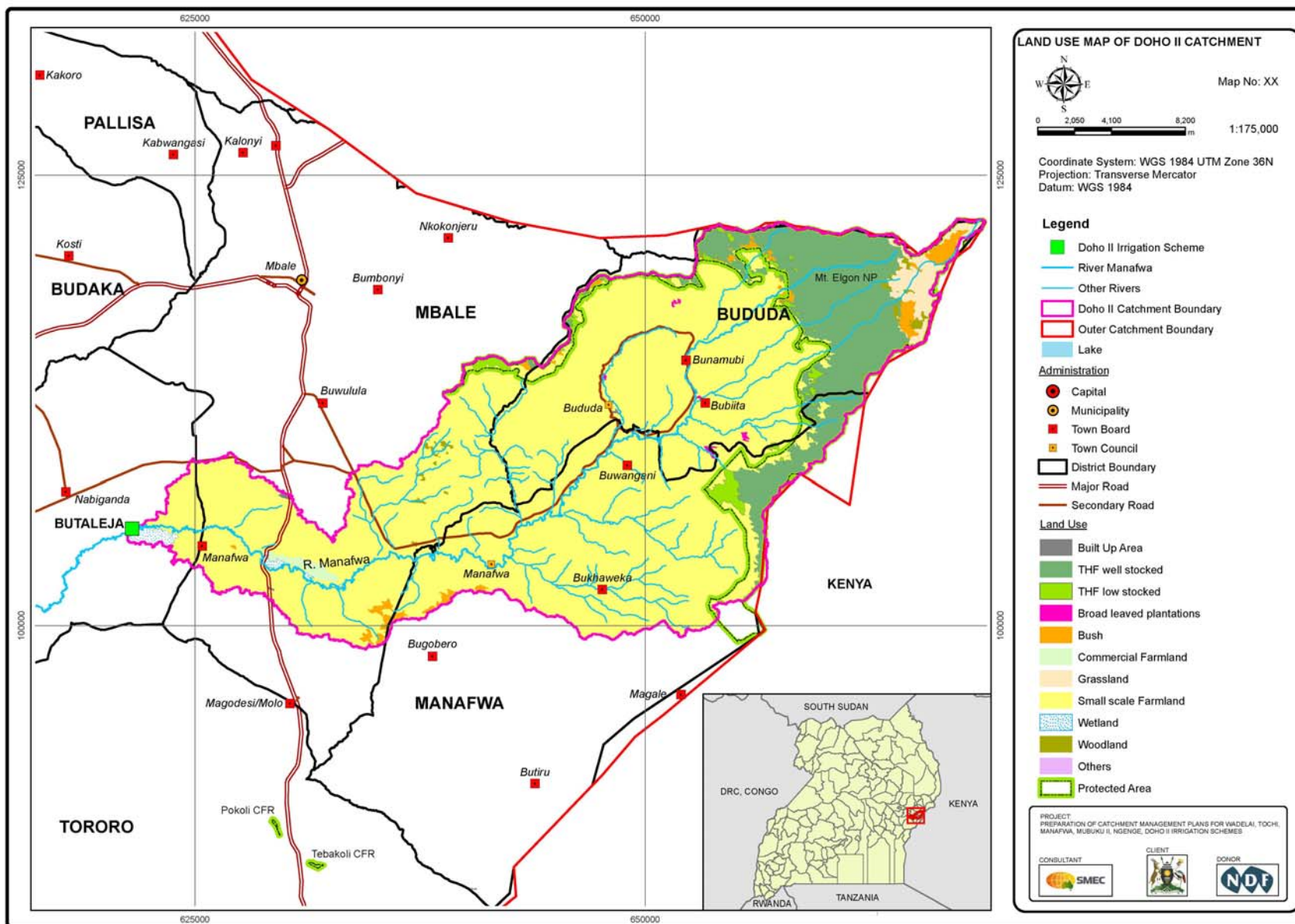


Figure 6.7 - Land Use Map

6.4 Soils

The prevailing soil type in the Doho II catchment belongs to the group of *Ferrallitic* soils (*Lateritic* or *Ferrisols*) with sandy clay loams and sandy sediments.

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.

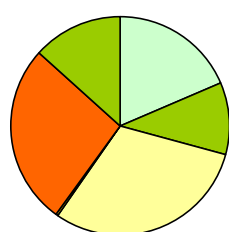
The bulk of all cycling plant nutrients is contained in the upper 10 to 50 cm soil layer. If the process of 'nutrient cycling' is interrupted, e.g. after introduction of low input sedentary subsistence farming, the root zone will rapidly become depleted of plant nutrients. Maintaining soil fertility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

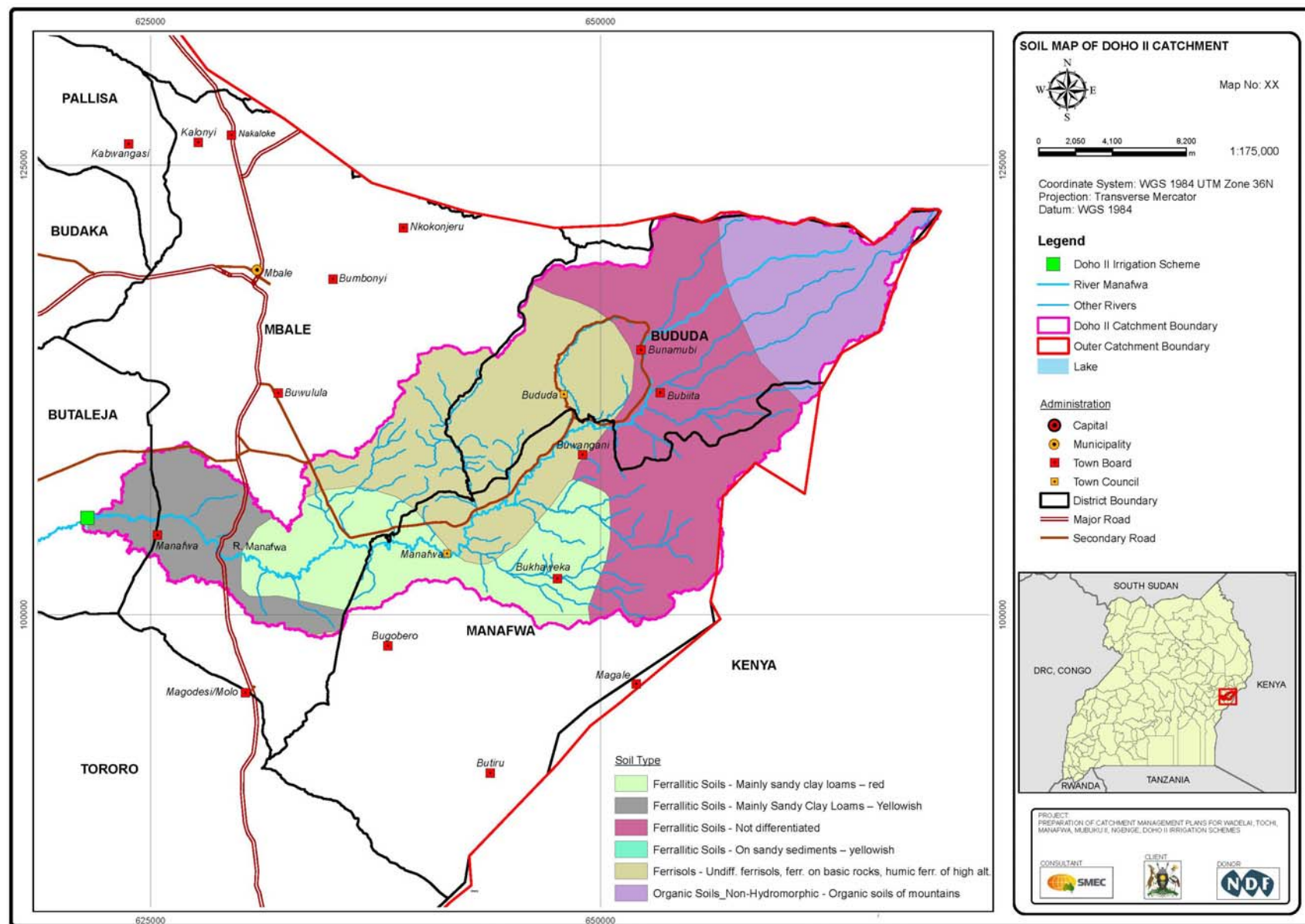
Catchment	Soil Type	Soil Structure and other features	Area in Catchment	
			(km ²)	(% of area)
DOHO II	FERRALLITIC SOILS	mainly sandy clay loams - red	96.5	18
		mainly sandy clay loams - yellowish	55.1	11
		not differentiated	160.8	31
		on sandy sediments - yellowish	0.2	0
		on basic rocks, high altitude	139.7	27
	ORGANIC SOILS	organic soils mountains, non-hydromorphic	69.9	13
Total Doho II			522	100

Soil Distribution
DOHO II Catchment



mainly sandy clay loams - red	Ferrallitic Soils
mainly sandy clay loams - yellowish	Ferrallitic Soils
not differentiated	Ferrallitic Soils
on sandy sediments - yellowish	Ferrallitic Soils
on basic rocks, high altitude	Ferrallitic Soils
organic soils mountains, non-hydromorphic	Organic Soils

Figure 6.8 - Distribution of Soil Classes



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 Doho II 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 and cultural practises.

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 Farming Methods

More than 60% of the private land in the catchment is under substance farming where farmers use rudimentary tools to cultivate various types of crops. Several chunks of land are opened (including steep slopes) without putting up measures to conserve water and soil fertility. With the rains, the nutrients are gradually washed downstream resulting in a gradual reduction in fertility and sedimentation of streams and lakes. 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.
- Acceleration of mudslides and landslides if not mitigated.

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 Doho II catchment area and is severe during the dry season. It is normally intended to burn mature grass to rejuvenate fresh pasture for animals. It was also observed that people occasionally set up fires to burn large chunks of land without having any goal to do so. 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 Doho II 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 such as the Local Forest reserves, wetlands and swamps, river banks and highlands 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 Doho II catchment and will lead to continued siltation of streams and irrigation channels of the Doho II 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 / terraces 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 Doho II 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 Doho II 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 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 Mbale, Manafwa, Namisindwa, Butaleja and Bududa 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 of Mbale, Manafwa, Namisindwa, Butaleja and Bududa have legally recognized cultural instructions and leaders.

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. For example, the Banyole in Butaleja, Himutu Sub-County who reported to have preferred to bury their loved one in flooded graves rather than take them elsewhere. In the Bugisu sub-region newly circumcised boys are encouraged to initiate sexual activity with girls only once. This has left many young girls with unwanted pregnancies leading to increases in school drop-outs for the girl child.

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 Doho II catchment are related to agriculture as discussed before in Section 6.3 under Land Use.

Sand Mining, Stone Quarrying

Sand mining and stone quarrying for the construction industry are the major economic activities. Most of the Sub-Counties depend on sand mining and stone quarry business as a source of income, however, there are illegal activities going on due to a lack in capacity to monitor all the mining sites.

Road Infrastructure

The catchment has the Mbale - Tororo paved road as the major link in the area, paved in 2014. Other major links in the area include the Busowe - Butalejja road, the Busowe - Bulucheke road, the Mbale - Manafwa road, the Mbale - Lwakhaka road and the Tororo - Budumba road. The District roads are generally in a fair condition although affected by poor drainage in the lower regions due to the low lying nature of the area.

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 Situation on Private Land

Private land within the Doho catchment is approximately 39,950 ha accounting to 76% of the total land. Land use on private land is further divided into subsistence farmlands (agricultural fields & private forestry), bush & woodland. A brief elaboration on the extent and importance of each of the land use sub-types is presented in the sections below.

Farmland and Forestry

On the private land, agricultural fields and patches of private woodlots account for about 60% of the land use pattern in the Doho catchment. The catchment is predominantly occupied by subsistence farming characterized by poor methods of farming like monoculture, use of traditional tools like hand hoes, land fragmentation, and continuous tillage. The economy of the catchment Districts (Bududa, Namisindwa, parts of Mbale & Butaleja) is entirely dependent on agriculture, which employs over 90% of the total population. Agriculture is mainly subsistence with 88.8% practiced on small holdings of approximately two acres.

Only 0.35% of the population is engaged in commercial agriculture. Family members form the highest percentage used as labor on farm land. The main crops grown are maize, Irish potatoes, bananas, beans, Arabic coffee, peas, sorghum, finger millet, wheat, rice and vegetables. The main cash crops are maize, barley, sorghum, vegetables, beans, and Irish potatoes. The livestock sector is dominated by small numbers of stock per household, that include, cattle (Indigenous and improved), goats, sheep, poultry that often graze on free range.

Size of land holdings fluctuates with altitude. In the high and mid altitude zone of Bududa, Namisindwa and Manafwa Districts, land holdings range in size between 1-2 acres. In some homesteads, landholdings are even less than 1 acre. In the low-lying areas of the Mbale and Butaleja Districts, land holdings are about 2 acres although this area is dominated with several wetlands which are continuously exploited for rice cultivation. Population is generally high and land has become scarce.

Generally, land in this zone is fertile although unchecked soil erosion has continued to wash out the nutrients downstream.

Forest plantations on private land have been estimated at 11% in the whole of the catchment. The general tree cover for the entire catchment has been estimated at 13%. Patches of plantation forests are observed in private farmlands ranging from 0.5- to about 2 acres in some areas. Scattered wood lots were identified on private land dominated with *Eucalyptus*, *Grevelia robusta* and pine. Agroforestry practices were also identified for example *Grevelia robusta*, *Markemia lutea*, *Albizia spp* and *Maesopsis* species growing in coffee and banana plantations. Tree species planted in stand-alone woodlots were mainly *Eucalyptus spp*, *Pine* and *Grevelia robusta*.



Figure 8.1 - SMEC and the District team inspect an area affected by land slides and land cracking in the Namisindwa District (source: SMEC, 2018)

Bush and Woodland Savannah

Due to the high population density in the catchment (801 persons per square kilometer), almost all bush and woodlands on private land have been eliminated through conversion into agricultural land and settlements. Therefore, bush and woodland on private land account for account for 3%. Patches of bush and woodland savannah are concentrated in specific locations such as Bwikhonje and Bumutsopa Parishes in Bukhiende Sub-County in Mbale District and parts of Nalondo Sub-County in Manafwa District. Woodlands are continuously exploited by the local communities as sources of firewood, charcoal, timber and poles. They are also grazing areas especially for cows, donkeys and goats. An inventory of common tree species that were observed in the private woodlands including those scattered in farmlands around homesteads is presented in Appendix 8.1.

Grassland Savannah

Due to the uniquely and extremely high population density of the catchment Districts, the area hardly has any grasslands left. Generally, the remaining grasslands are less than 0.5% of the entire catchment.

8.1.2 Land Cover of Protected Areas

The protected areas in the Doho catchment are the Mount Elgon National Park, the Bukigai Local Forest Reserve (13.5 hectares), the Bubulo Local Forest Reserve (21 ha), the wetlands, the river banks and some open water bodies. The total protected area is estimated at 12,460 ha or 23.7% of the catchment.

Forest Reserves

There are two Forest Reserves in the Doho catchment, i.e. the Bukigai Local Forest Reserve in the Bududa District which is stocked with *Eucalyptus grandis* up to 60% and 2) the Bubulo Local Forest Reserve in the Manafwa District. Both forests are managed as plantations. About 40% of each forest needs to be replanted. There are no Central Forest Reserves in the Doho catchment.

National Park

Part of the Doho catchment is located in the Mt Elgon National Park. The Park was gazetted in 1992. This section provides a brief of the land cover with the biodiversity status on flora and fauna. The land conflict around the park, encompassing the encroachment of settlers, is discussed in Appendix 8.2.

Flora

The vegetation of Mt Elgon reflects the altitudinally controlled zonal belts commonly associated with large mountain massifs. Howard (1991) recognized four broad vegetation communities:

- Montane forest, up to an elevation of 2,500 m +MSL and comprising 48% of the total Park area;
- Mixed bamboo and low canopy montane forest, from 2,400 - 3,000 m +MSL and comprising 21 % of the Park area;
- High montane heath, from 3,000 to 3,500 m +MSL and comprising 7% of the Park area;
- Moorland, above 3500 meters and comprising 24% of the Park area.

Elgon's slopes support a rich variety of vegetation ranging from montane forest to high open moorland studded with the giant lobelia and groundsel plants. The vegetation varies with altitude. The mountain slopes are covered with olive *Olea hochstetteri* and *Aningueria adolfi-friedericii* wet montane forest. At higher altitudes, this changes to olive and *Podocarpus gracilior* forest, and then a *Podocarpus* and bamboo *Arundinaria alpina* zone. Higher still is a *Hagenia abyssinica* zone and then moorland with heaths *Erica arborea* and *Philippia trimera*, tussock grasses such as *Agrostis gracilifolia* and *Festuca pilgeri*, herbs such as *Alchemilla*, *Helichrysum*, *Lobelia*, and the giant groundsel *Senecio barbatipes* and *Senecio elgonensis*. The botanical diversity of the park includes giant podocarpus, juniper and Elgon olive trees cedar *Juniperus procera*, pillarwood *Cassipourea malosana*, elder *Sambucus adnata*, pure stands of *Podocarpus gracilior* and many orchids. Of the 400 species recorded for the area the following are of particular note as they only occur in high altitude broad-leaf montane forest: *Ardisiandra wettsteinii*, *Carduus afromontanus*, *Echinops hoehnelii*,

Ranunculus keniensis (previously thought to be endemic to Mount Kenya), and *Romulea keniensis*.

Fauna

The Park is considered to be highly significant with respect to small mammals, butterflies, and moths. A total of 30 species of small mammals (shrews and rodents) are known to occur on Mt Elgon, consisting of a mix of highland, forest-dependent and open habitat species. In addition there are a range of larger mammals including monkeys (black and white colubus, blue and the de brazzas) leopards, elephants, bushpigs, Waterbuck, and duikers. Mount Elgon is home to at least 144 bird species. Of particular interest are Jackson's francolin, the eastern bronze-naped pigeon, Hartlaub's turaco, the Tacazze sunbird and the endangered lammergeier, due to their restricted range. The 1996 Biodiversity Report (Howard, 1996) specifically made an inventory of butterflies and moths of MENP's forest zones. 171 species of butterflies and 71 species of moths were recorded.

Wetlands, River Banks and Open Water Bodies

The total area under wetlands is approximately 1,060 hectares (about 2% of the catchment). The largest percentage of these wetlands is in the Mbale and Butaleja Districts towards Dodo irrigation scheme. Other small wetlands (between 1-3 acres) exist in the Namisindwa District such as one in Bubutu Sub-County, and the Nandaya wetland in the Buhabutsi Sub-County. In the Bududa District, the wetlands include Nashinde in the Bududa Town Council, Nalwanza in the Nalwanza Sub-County and Namasho in the Bulcheke Sub-County. The wetlands in the Bududa, Namisindwa and Manafwa Districts are managed and owned by the community and used for cultivation and brick making. These are totally degraded and need to be restored. The vegetation in these wetlands is mainly scattered papyrus. They are said to harbour rear species of birds and snakes including crested crane bird.

The bigger wetlands in the Mbale District are located along the boarder area of the Busiu and Busoba Sub-Counties especially in the Parishes of Musese, Buwalasi, Bufukhula and Lumbuku. In the Busui Sub-County, wetlands are located in the Busoba Parish. In the Butaleja District towards the Doho II irrigation scheme, a large section of Himutu Sub-County in Kanyenya Parish is a wetland. The vegetation species in the seasonally flooded areas of these wetlands include *Cyperus* spp, *Cynodon dactylon*, *Sporobolus* Spp, *Hyparrhenia rufa*, and *Pennisetum mildbraedii*. Other shrubs often found in these wetlands include *Echnochola*, *Galinsonga paviflor*, *Bidens Pilosa*, *Bauhinia*, giant lobelia thickets of *Lantana camara* and other trees pecies such as *Albizia*, *Phoenix reclinata* and *Eucalyptus*.

In terms of flora, reptile species in these wetlands include snakes, monitor lizards, tortoises and several species of lizards. The mammal species include baboons, squirrels, mangoose, wild cats, foxes and rats. Several bird species are in these wetlands including crested cranes, migratory birds (Tropical boubou or Tsinguwi in Lugisu), herons, white-browed coucal (locally called Isooso in Lugisu). Various catfish and mud fish are types of fish species in the Manfwa wetlands system.

The major threats to wetlands ecosystems in the catchment include wetland drainage for unplanned agriculture, dumping of large quantities of industrial waste and sewage, brick making, deforestation, excessive harvest of wetland products and low levels enforcement on wetland regulations and laws. The pressure on the river banks by the extremely high population density coupled with poor farming methods on the steep slopes has contributed

to several flooding incidences on embankments of the river Manafwa and its tributaries. Over cultivation along the river causes the banks to burst open resulting in destructive flush floods. The effects of river bank encroachment have results in poor river water quality and reduced water quantity in the dry season. The starting point to managing the Doho catchment is securing and protecting the river banks in the highly populated areas of the Bududa, Manafwa, Namisindwa and Mbale Districts. The 30-meter buffer zone needs to be revegetated with appropriate cover trees and grasses such as bamboo, phragmites, elephant grass and trees such as Ficus species.



Figure 8.2 - Rice growing in Manafwa wetland system and river bank cultivation along the Manafwa river banks (source: SMEC, 2018)

8.1.3 Trading Centre and Rural Growth Centre

In this context, trading centres 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. Table 8.1 presents a list of towns in the catchment that will require centralised planning of activities. It should be noted that none of these towns has a gazetted waste disposal facility.

Table 8.1 - Major towns and trading centres in the Doho catchment

No	Name of Town or Trading Centre	Size (ha)	% size catchment	District
1	Bududa Town Council	72	0.000	Bududa
2	Bushigai Town Council	15	0.002	Bududa
3	Nangako Town Council	17	0.000	Bududa
4	Kikhorro Trading Centre	21	0.003	Bududa
6	Namusindwa Town Council	34	0.000	Namusindwa
9	Bukhaweka Trading Centre	48	0.003	Namusindwa
13	Manafwa Town Council	96	0.001	Manafwa
14	Busiu Trading Centre	102	0.000	Mbale District
Total area under trading centres		405	0.008	



Figure 8.3 - Catchment view from Namisindwa District town (source: SMEC, 2018)

8.2 Analysis of Environmental Issues and Proposed Mitigation Measures

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

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

8.2.1 Deforestation

According to 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 fuelwood 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. In Districts like Mbale, Bududa, Manafwa and other areas in the Manafwa catchment where the current population density is at 801 people per square kilometer with an average land holding of 1 acre or less, any tree in the vicinity of the households is likely to be converted into fuel wood by 2025;
- 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;
- 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 DLG field staff to do their work, seeking political support at all levels;
- 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 Doho II 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 Land Slides

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. When soil, rock, and other earth debris can no longer hold land together and gives way to gravity, landslides happen. Landslides can be triggered by earthquakes, volcanic activity, changes in groundwater, a disturbance by human activities or change of slope. Intense rainfall over a short period of time tends to trigger shallow, fast-moving mud and debris flows. Slow, steady rainfall over a long period of time may trigger deeper, slow-moving landslides. Different materials behave differently, too.

Landslides are key environmental issues in the Doho catchment. In the Doho catchment, the entire of Bududa, Namisindwa and parts of the Manafwa Districts are heavily prone to landslides resulting in loss of lives and property.

Future impact of landslides if not mitigated

- Serious property damage;
- Death of human beings and domestic animals;
- Loss of biodiversity;
- Destruction of structures like roads and electric power generation facilities;
- Landslides can block roads and disrupt communication;
- The impact of landslides is also associated with high cost implication in repairing damaged systems;
- Results in widespread stripping of natural vegetation cover further accelerating soil erosion.

Proposed mitigation measures

- Need to enforce planting of trees on hill tops to stop erosion and mud flows Proper vegetation like crops and forests can bind the soil together;
- Long-term planning in hilly regions can protect them from landslides;
- Construction of terraces, retaining walls and/or gabions;
- Geological mapping/studies should be carried out to determine the slope hazards and the likelihood of landslide/mudslide occurrences;
- Communities should not be allowed to reside close to hanging masses of hills;
- There is need to build a data bank on the cycle of disaster occurrence;
- Formation and training of disaster management committees at all levels;
- Need for early warning equipment/system to alert the community of pending disasters;
- Community awareness on how to cope up with disaster in all prone Districts should be undertaken;
- First aid should be readily available in areas that are prone to landslides;
- Accumulated water should be properly drained;
- Government needs to allocate a budget line for disasters.

8.2.4 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 Doho II catchment was that most of these are heavily degraded and encroached by farming activities up to 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.

8.2.5 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.

Flooding is pronounced within the Doho II catchment. 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. 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.

8.2.6 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.

8.2.7 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.

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

The usage of agrochemicals is increasingly becoming more pronounced in the catchment. 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:

- These 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.

8.2.9 Poor Waste Management

Doho II 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 centers, 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. A city with poor sanitation, smelly and with waste matter does not attract investors and tourists. Such cities tend to have poor living standards;
- Recycling revenue: Cities/towns 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.

8.2.10 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, problems with water supply for the energy sector and for technological processes in industries, disruption of water supplies for municipal economies etc;
- 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;
- Migration of wildlife which may result in social disorders as result of human life wildlife; conflicts may eventually affect the tourism industry;
- 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 Doho II 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 Doho II 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 Doho II 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 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 Manafwa catchment is shown in Table 9.1. Mbale has large urban centres while urban centres in the remaining districts are small with insignificant industrial demand. Therefore, per capita water demands for Mbale 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 6.1 Mm³ in 2018 to 11.7 Mm³ in 2040 (Table 9.2 and Figure 9.1).

Table 9.1 - Population in river Manafwa catchment (rounded 10²)

Year	Butaleja	Mbale	Buduuda	Manafwa
2002	2,700	84,200	113,900	73,800
2007	3,300	98,900	142,300	83,500
2014	4,200	124,000	192,300	100,200
2018	4,800	141,300	219,200	114,300
2020	5,200	153,700	232,300	112,000
2025	6,000	176,000	273,100	142,400
2040	9,400	272,900	423,300	220,700

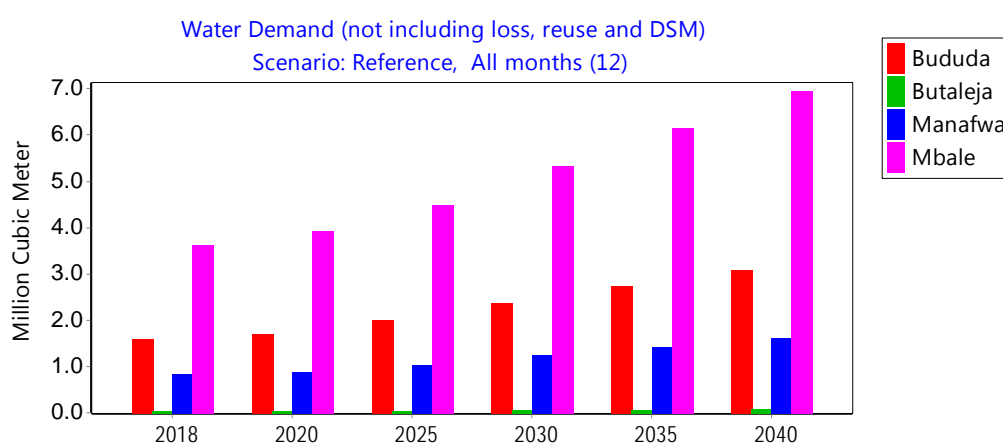


Figure 9.1 - Growth in domestic and industrial demand

Table 9.2 - Domestic and industrial demand (Million M3)

Node	2020	2025	2030	2035	2040
Bududa	1.7	1.99	2.36	2.72	3.09
Butaleja	0.04	0.04	0.05	0.06	0.07
Manafwa	0.88	1.04	1.23	1.42	1.61
Mbale	3.92	4.49	5.31	6.14	6.96
<i>Total</i>	<i>6.54</i>	<i>7.56</i>	<i>8.95</i>	<i>10.34</i>	<i>11.73</i>

Water demand for irrigation

A total gross command area of 1,030 ha of which 617 ha is planned for development in the short term. On the assumption that the command area will be levelled, the irrigation system will be established and only rice crop will be cultivated for which the climate and soils are best suited, the irrigation water demand was estimated as shown in Table 9.3. The annual irrigation requirement per hectare was therefore estimated as 10,922 m³/ha but it varies from nil in February to 3,388 m³/ha in September. For future projections, it was assumed that further expansion of to cover the entire gross command area will be carried out in the medium to long term.

Table 9.3 - Irrigation water requirement

Month	Monthly Requirement (m ³ /s)	Monthly Requirement (m ³ /ha)
Jan	0.230	966
Feb	0.0	0
Mar	0.210	882
Apr	0.720	3,024
May	0.417	1,750
Jun	0.423	1,778
Jul	0.427	1,792
Aug	0.363	1,526
Sep	0.807	3,388
Oct	0.540	2,268
Nov	0.460	1,932
Dec	0.603	2,534
<i>Annual Requirement</i>		<i>21,845</i>

Water demand for the environment

The annual average of the mean annual flow is 8.12 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 in is as shown in Figure 9.2 and Figure 9.3.

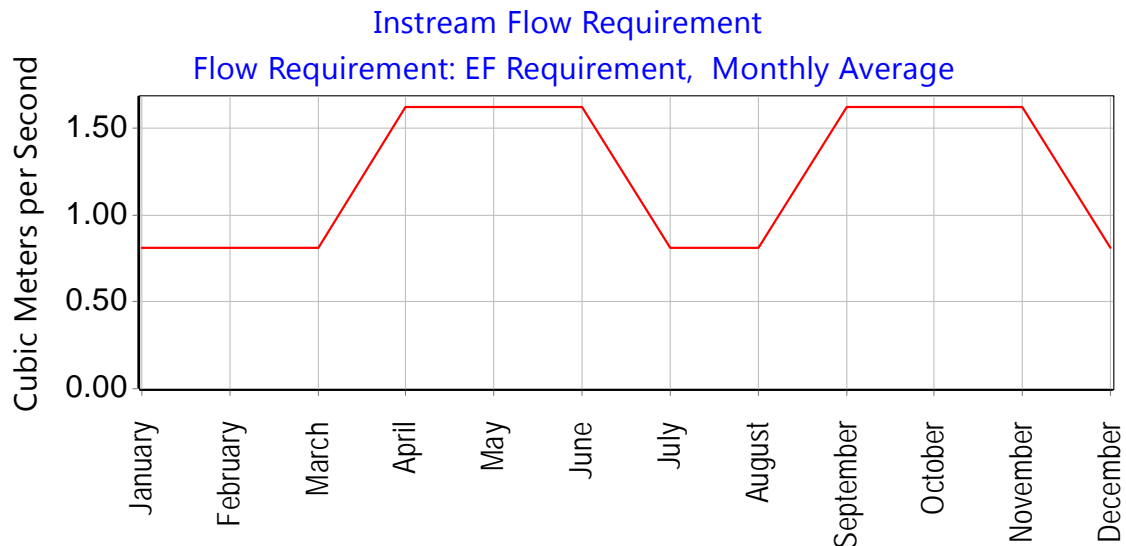


Figure 9.2 - Monthly environmental flow requirement (m^3/s)

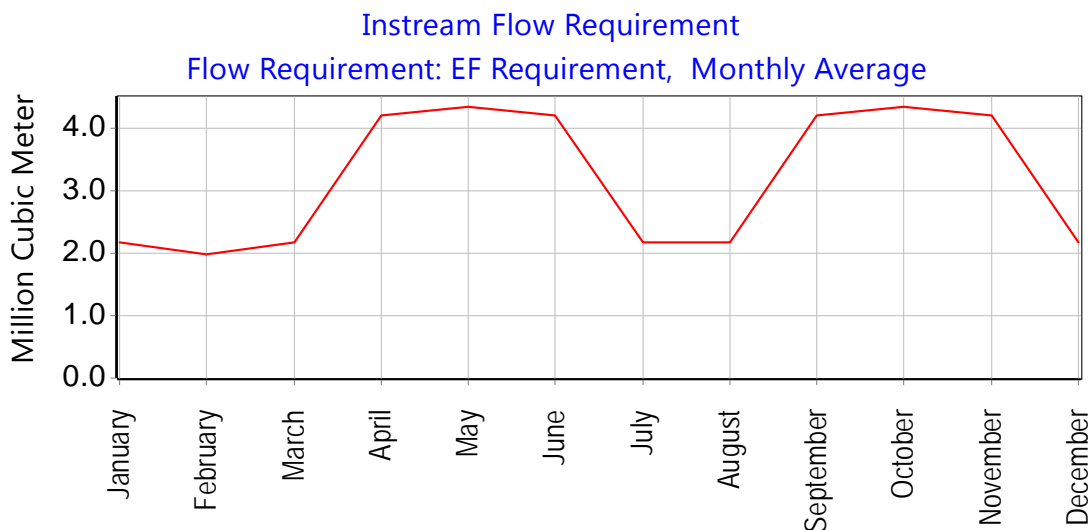


Figure 9.3 - Total monthly environmental flow requirement (Mm^3)

Total water requirement

The projected total water requirements are shown in Figure 9.4. The total requirement rises from 12.8 Mm^3 in 2018 to 14.3 Mm^3 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 18.5 Mm^3 by 2040. If further expansion of irrigated area is undertaken the water requirement will increase to 23 Mm^3 by 2040.

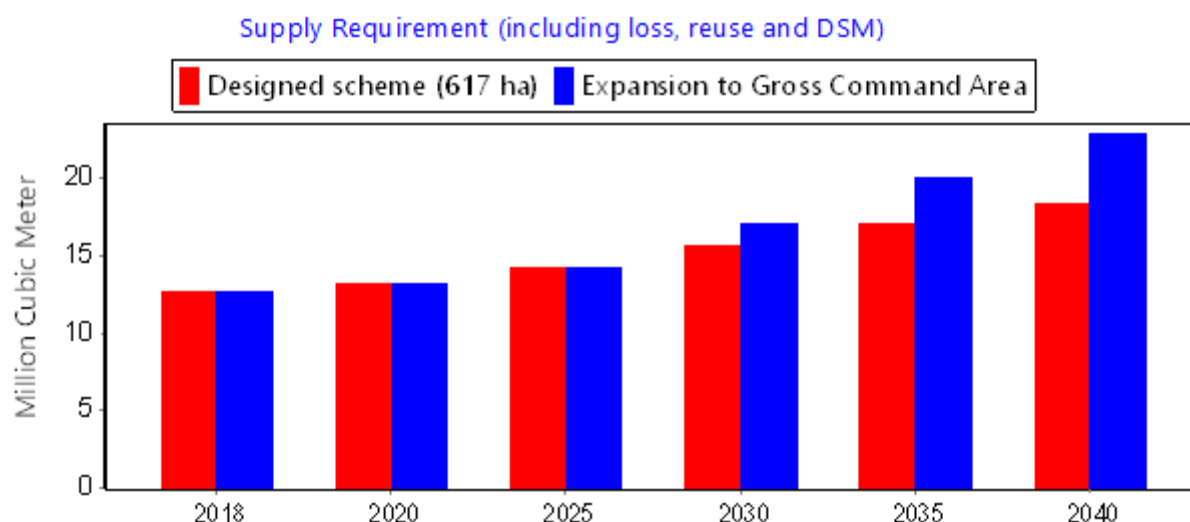


Figure 9.4 - Projections of total water requirement

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 9.5). The unmet demand varies between 0.8 Mm³ in the year 2029 and 4.7 Mm³ in the year 2027 with an average of 0.8 Mm³/s which is just about 4% of the annual demand. If the irrigated area is increased to cover the entire irrigation command area, the demand deficit increased slightly to 5% of the total demand by 2040. Most of the demand deficit is registered in the dry months of January, February, March and December. June and September also register some demand deficits. Figure 9.6 shows the demand deficit frequency.

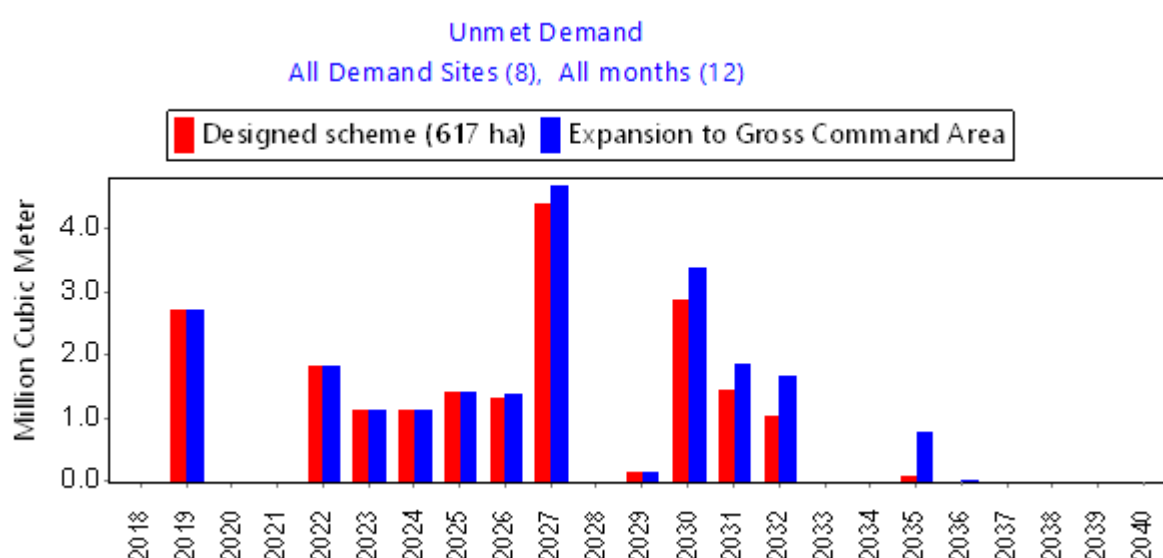


Figure 9.5 - Annual demand deficit for no climate change scenario

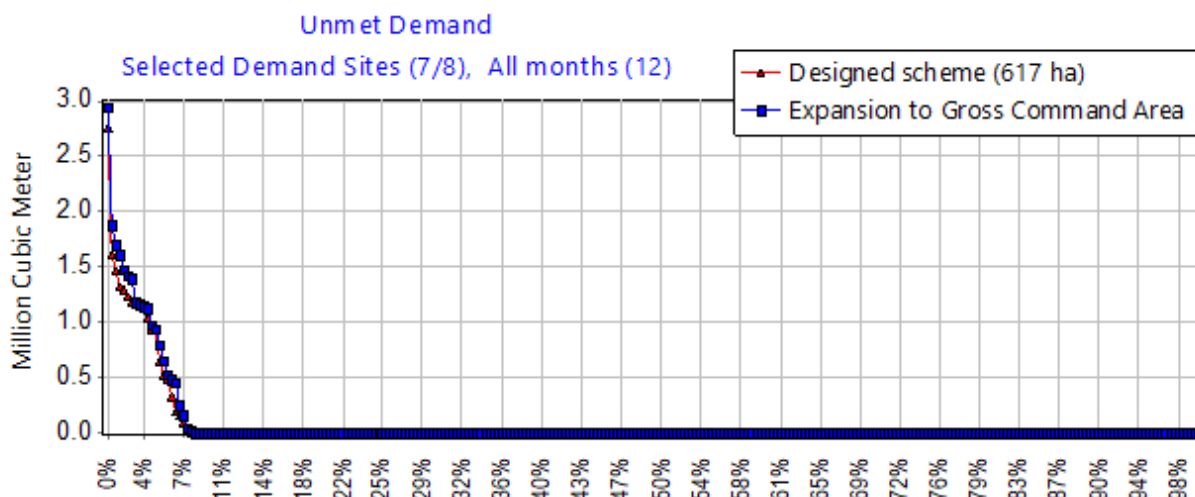


Figure 9.6 - Frequency of monthly demand deficit

With climate change scenario

As explained before a 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 9.4 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 9.7 and Figure 9.8). 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 9.4 - 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 (up 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

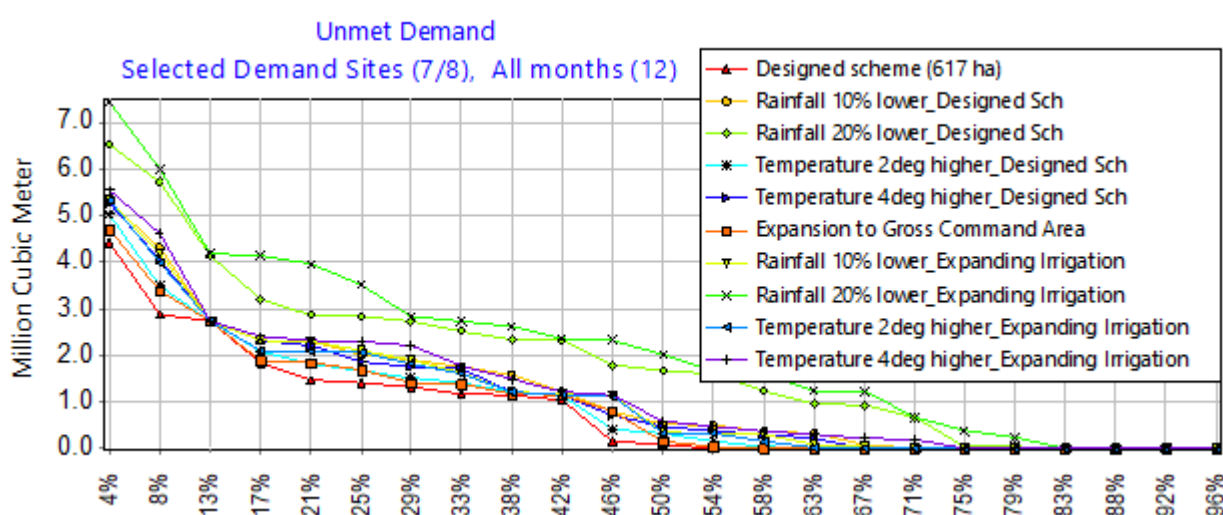


Figure 9.7 - Demand deficit frequency with climate change (annual)

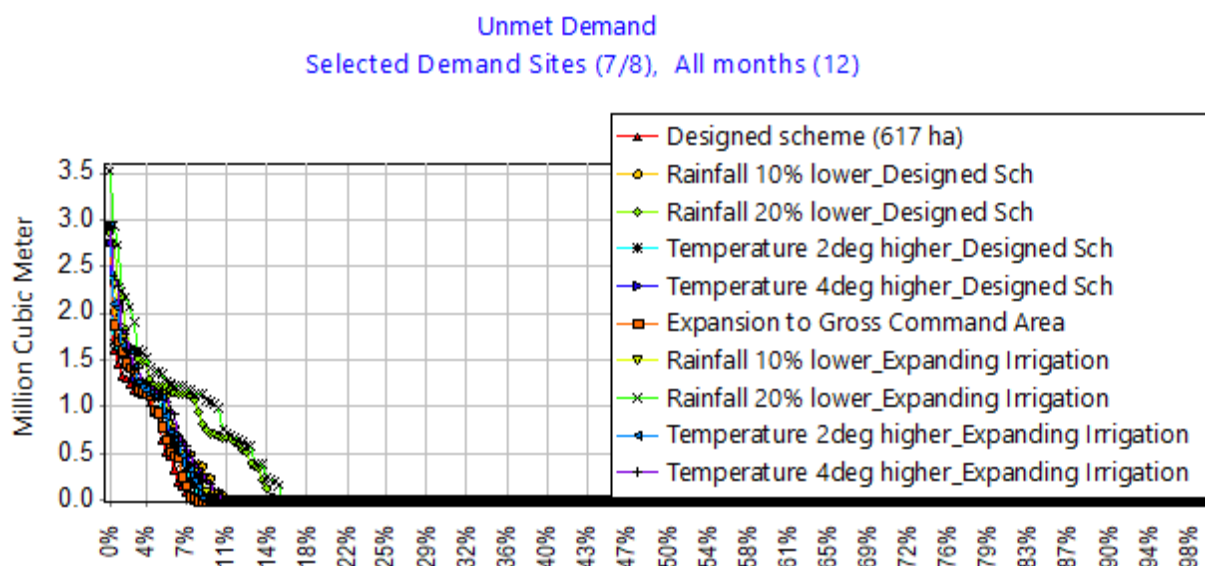


Figure 9.8 - Demand deficit frequency with climate change (monthly)

9.3 Conclusions

The new Doho II irrigation scheme will be fed by a river that exhibits 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 al, 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 Doho II 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.

Conclusions

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

The Manafwa river has a mean flow of 8.1 m³/s which is equivalent to an annual yield of 264 Mm³/year.

In addition to water demand for irrigation, water demands for nearby towns of Bududa, Butaleja, Manafwa and Mbale were considered. The total water demand without any expansion of the irrigation system increases from 20 Mm³/year in 2020 to 25 Mm³/year in 2040. For the no-climate change case, available supply meets demand most of the time apart from a few years. The demand deficits are modest, in the order of a few thousand cubic meters per year or about 4% of the annual demand and are mainly experienced during the dry months of January, February, March and December. Implementation of water management and conservation measures can address the demand deficits without constructing the more expensive larger water storage reservoirs.

If the irrigated area is increased to cover the entire irrigation command area, the demand deficit increases slightly to 5% of the total demand by 2040.

Climate change would result in a reduction in water supply reliability. The resultant reductions due to reduced rainfall are then higher than the reductions due to the increase in temperature. This implies that it is possible to address some of the vulnerability to the climate change through taking robust water catchment protection measures like protection of the remaining forest coverage and the prevention of wetland degradation.

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 Doho II 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 Doho II irrigation scheme against excessive sedimentation, in particular. As such the strategies and interventions identified were designed to fit within the overall development strategies of the Catchment Management Plan for the Mpologoma Catchment in the Lake Kyoga River Basin, - Kyoga Water Management Zone.⁴

10.2 Structure of Framework for Strategic Catchment Planning

The framework for Doho II 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 Doho II catchment. The following three Key Areas were identified:

Key Areas of the Strategic Planning Framework of the Doho II 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.

⁴ Catchment Management Plan for the Mpologoma Catchment in Lake Kyoga Water Management Zone, MoWE/BRL, 2016

- 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 Ffigure 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 Doho II catchment and its Natural Resources against environmental degradation, and protect the Doho II 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).

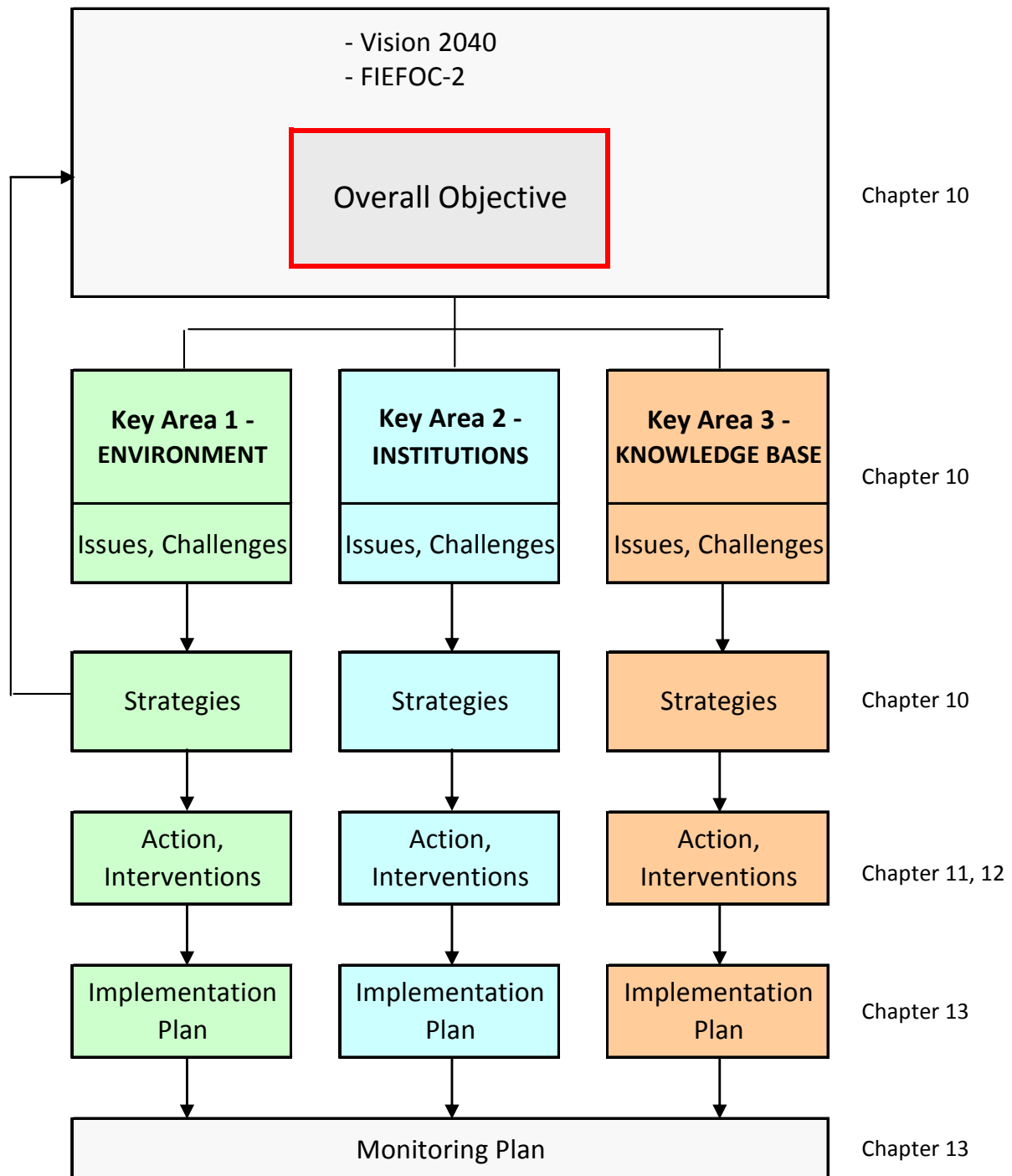


Figure 10.1 - Flow Diagram of the Strategic Planning Framework

10.4 Key Area 1 - Environment

A total of 10 major issues and challenges related to environmental degradation in the Doho II catchment were identified during the Natural Resources Assessment. These are:

- 1) Deforestation;
- 2) Soil Erosion;
- 3) Land Slides
- 4) River Bank Cultivation and Wetland Encroachment;
- 5) Floods;
- 6) Invasive Species;
- 7) Pests and Diseases;
- 8) Pollution from Agrochemicals (fertilizers, pesticides, insecticides, etc);
- 9) Poor Waste Management; and
- 10) 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.
Land Slides	Landslides are key environmental issues in the Doho II catchment where the entire of Bududa, Namisindwa and parts of the Manafwa District are heavily prone to landslides resulting in loss of lives and property.
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	Flooding is pronounced within the Doho II catchment. 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.

Issues	Challenges
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.
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 worm 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 LFRs.
	Government to discourage land fragmentation.	Invest, sponsor other energy sources such as gas, biogas, solar and electricity.	Replanting of Trees in LFRs
	Government supports & improves livelihood options with less impact on vegetation clearance.	Set-up op By-Laws on Ordinances on bush burning	Forest Boundary Marking of 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.	
		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.
Land Slides	Long-term planning in hilly regions with focus on protection against landslides.	Government allocates budget line for disasters.	Construction of terraces, retaining walls, gabions and other civil engineering interventions.
	Secure financing that aims at physical and non-physical interventions to cope with causes and effects disasters.	Promote planting of trees on hill tops to stop erosion and mud flows.	Farmers apply adjusted cultivation with proper SWC on steep upland areas.
		Formulate bylaws where communities not to be allowed to reside close to hanging masses of hills.	Establish early warning equipment/systems to alert the community of pending disasters.

Issues	Strategies	Action - Non Physical	Action - Physical (Chapter 11 elaborates on the catchment protection works)
		<p>Conduct geological mapping/studies to determine slope hazards and likelihood of landslide/mudslide occurrences.</p> <p>Set up data base on cycle of disaster occurrence.</p> <p>Set up and train disaster management committees.</p> <p>Create community awareness on how to cope up with disasters in prone Districts.</p> <p>Arrangements to be made where first aid is readily available in areas that are prone to landslides.</p>	
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.

Issues	Strategies	Action - Non Physical	Action - Physical (Chapter 11 elaborates on the catchment protection works)
		Remove encroachers out of wetlands and river bank buffer zones.	
	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 (<i>Imazapyr</i> -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.

Issues	Strategies	Action - Non Physical	Action - Physical (Chapter 11 elaborates on the catchment protection works)
		Support to farmers in multiplication of resistant varieties.	Availing farmers with clean/certified seeds.
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	Long term re-vegetation of bare hills to be undertaken.

Issues	Strategies	Action - Non Physical	Action - Physical (Chapter 11 elaborates on the catchment protection works)
		other wood requirements.	<div>Introduction of drought tolerant crop varieties.</div> <div>Improved rangeland practices.</div> <div>Improved water management practices like rain water harvesting.</div> <div>Government to consider constructing multipurpose dams & water reservoirs to supply water in terms of drought.</div>

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 key institutions that are considered to have a major stake in the management of the environment of the Doho II catchment, the capacity issues and challenges were indentified. The outcomes of the capacity need assessment are discussed in Section 13.2. These institutions are the Uganda Wild Life Authority and the District Forestry Services for the Mbale, Manafwa, Butaleja and Bududa Districts. 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
Uganda Wild Life Authority	Gaps in funding to undertake daily activities in managing the National Park on a sustainable basis	Government to secure sufficient funding	UWA to mobilize funds from Government or Development Partners to address the management issues.
		Capacity Building for UWA	Training of staff in rescue and climbing skills and acquisition of specialized rescue equipment.
		NP protection	Providing alternative livelihood options to communities living around the Park
			Awareness raising to sensitize communities surrounding the National Park to change their attitude toward conservation.
			Enrichment planting to about 20% of the Mt Elgon National Park area.
			Combating problem animal incidences in communities neighbouring the Park such as Garlic and Red pepper growing.
			Acquisition of fire management equipment and establishment of a high altitude fire management fund

Institution	Issues and Challenges	Strategies	Action
District Natural Resources Services for the Mbale, Manafwa, Butaleja and Bududa Districts.	The Natural Resource Departments at the Districts are underfunded. This incapacitates the Departments to undertake conservation and tree planting activities in the catchment without 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 Local Forest reserves.
		Capacity Building NRD	NRD should consider recruiting more NR staff in the District Local Governments including forestry extension staff at the Sub-Counties.
		LFR protection	Develop a management plan for each Local Forest reserve.
			Open and demarcate all Local Forest reserves 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 Doho II 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 Doho II 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 Doho II 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 insufficiently 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 Doho II 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 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 Doho II catchment

<i>Main Works</i>
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
<i>Complimentary / Cross Cutting Activities</i>
14 Set-up of By-Laws 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 National Park

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 Local Forest reserves
- Section 11.6 - Replanting of Trees in Local 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 By-Law 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 By-Law 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

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 m² 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 Local 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-forestation 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.

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-forestation to be undertaken in each forest will be presented in the investment options /catchment management plan report.

11.6 Replanting of Trees in Local Forest Reserves

Replanting is a terminology used to refer to re-forestation activities in protected areas being managed as plantation forests. Some of the Local Forest reserves need to be replanted. 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 DSF staff indicated 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 the Local 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 Local 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 Doho II catchment and shall be used to improve and stabilise the integrity of the catchment in subsistence farmlands. In the 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*, *Grevillea 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 Doho II 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 Doho II catchment, general Soil and Water conservation measures are recommended for the 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 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 onset 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 Doho II 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 turn 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 Doho II 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.

Farming on Steep Upland Areas

According to FAO, mountain forests are defined as “on land with elevation 300-2,500 m and a slope with sharp changes in elevation within short distance”. The WWF delineated the East African Montane Forest eco-zone from South Sudan, Uganda and Kenya, to northern Tanzania. The mountains stretch from Mt. Kinyeti (Imatong Mountains) in southern Sudan, through Mt. Moroto and Mt. Elgon in Uganda, the Aberdare Range to Mt. Kenya in Kenya, the Nguruman Scarp in southern Kenya and Mt. Kilimanjaro, Mt. Meru, and Ngorongoro in

northern Tanzania. The forest eco-region is found at altitudes between 1,000 to 3,500 meters.

Along with the riparian buffer zones, upland areas are some of the most sensitive areas due to their steep slopes and often-extreme weather fluctuations. In addition, upland ecosystems are vital components that regulate the water regime of entire catchments.

During the consultant's site assessment of the Doho II catchment area, it was observed that most of the river sediments came from higher lands. The stakeholders consulted also informed of population migration to higher areas due to various reasons, including the need for more fertile land for growing crops. It is therefore crucial to implement conservation measures in the upland areas with steep slopes.

For farming activities in the upland areas the following recommendations are made:

- only involve perennial crops to minimize soil disturbance and erosion;
- strictly practice soil and water conservation practices such as land preparation, contour farming, hedgerows and bunds, as described below.

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 Doho II 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. 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 Doho II 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 Doho II 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 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 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 Doho II 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 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. The Mbale Municipal Council which is some of the biggest towns neighbouring the Doho II catchment is already struggling with the burden of unsorted waste despite being funded by the World Bank to initiate waste sorting at the landfill. 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 Doho II 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 National Parks

Although Uganda Wild Life Authority is considered to be well funded and probably in a better position to manage catchment issues in the National Parks, there are some challenges that need to be addressed. Some of the management issues where UWA needs external support include:

- Training of staff in rescue and climbing skills and acquisition of specialized rescue equipment;
- Development and implementation of activities aimed at combating problem animal incidences in communities neighboring the Park such as garlic and red pepper growing;
- Providing alternative livelihood options to communities living around the park;
- Awareness raising to sensitize communities to change their attitude toward conservation;

11.23 Identification and Support to other Livelihood Programs

Some of the suggestions for investment options that contribute to the livelihoods of local communities in the Doho area (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 22 interventions were identified for the Doho II catchment. These comprise of 13 main works and 9 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 works⁶ 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 nine 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 Doho II 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	Q2 ↑ ↓	Medium Priority	Medium Priority
5 Restoration and Enrichment Planting	15	0.33			
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	Q3 ↓	High Priority	High Priority
11 Stabilization River Banks by Civil Works	30	0.83			
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 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 six potential investment works out of the preliminary identified main works. These investment works include:

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

The other initially proposed works were not examined under the EVA due to the limited availability of information on design and investment costs, and the quantification of benefits.

Conclusions

There are six proposed investment options within the Doho catchment. The economic viability analysis results indicate how viable each option is, given the level of investment outlay. The results are presented in Table 12.2.

Investments:

The three topmost investments in terms of investment outlay would be Soil and Water Conservation, followed by Civil Works and Agro-Forestry.

Economy:

The ENPV shows that Agro-Forestry created the highest wealth to the economy given the investment outlay. This was followed by Soil and Water Conservation, stabilisation of river banks with cover crops and buffer zone demarcation and protection. The investment option with lowest generation of wealth for the economy was the replanting of trees in the forest reserves as the area earmarked for this activity is extremely low.

Economic Viability, most attractive options:

As measured by the MEIRR, the most attractive investment option in from an economic viability point of view is Agro-Forestry while the least attractive is Civil Works. Similarly, Agro-Forestry returned the highest amount of dollars (USD 16.4) to the economy for every

dollar invested. Civil works returned least amount of dollars (0.8) for every dollar invested. Accordingly, Agro-Forestry is recommended for Doho II.

Table 12.2 - Economic Viability Results for Investments in Doho II Catchment

Investment	Investment cost (USD, rounded in 10 ³)	ENPV (USD, rounded in 10 ³)	ENPV/C	MEIRR	Ranking
Agro-Forestry	679,000	11,113,000	16.4	29.0%	1
Replanting of Trees in forest reserves	7,000	114,000	16.3	28.1%	2
Buffer Zone Demarcation and Protection	94,000	1,041,000	11.1	26.9%	3
Soil and Water conservation	1,228,000	10,436,000	8.5	25.0%	4
Stabilisation of River Banks with cover plants	966,000	7,870,000	8.1	25.4%	5
Civil Works	1,024,000	823,000	0.8	15.1%	6

*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 Doho II catchment.

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 Doho II catchment are assigned to:

- 1) Soil and Water Conservation;**
- 2) Stabilisation of River banks with Vegetation;**
- 3) 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 4.4 million USD occur in the first year (mainly investment) to be followed by 1.2-1.5 million USD annually operational costs for the next 20 years or so to come.

Table 13.1 - Implementation Plan for the Investments on Environmental Protection of the Doho II catchment (Key Area 1)

Investment Options for Doho II	Implement-ation 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	medium to high	high	medium	high - medium	Medium term	Consolidated Gov Funds / Loan	farmers	FSSD, DLG (Mbale, Manafwa, Butaleja, Bududa)	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 (Mbale, Manafwa, Butaleja, Bududa)	Catchment Mng Committees	1,124	255	717
Agro-Forestry	medium to high	medium	high	medium - high	Long term	Consolidated Gov Funds / Loan	DLG (Mbale, Manafwa, Butaleja, Bududa)	farmers, NGOs, CBOs	958	750	2,133
Replanting of Trees in LFRs	medium to high	medium	high	medium - high	Long term	Consolidated Gov Funds / Loan	DLGs		11	7	19
Civil Works	medium	high	low	high - low	Short term	Consolidated Gov Funds / Loan	FSSD	DLG (Mbale, Manafwa, Butaleja, Bududa), MoWE, MoWT	1,506	690	1,962
Buffer Zone Demarcation and Protection	medium	low	high	low - high	Short term	Consolidated Gov Funds / Loan	DLG (Mbale, Manafwa, Butaleja, Bududa)	Catchment Mng Committees	121	97	251

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

	Short term			Medium term				
	2019	2020	2021	2022	2023	2024	2025	2026
1 Agro-Forestry	679	138	141	144	147	150	153	156
2 Replanting of Trees in Forest Reserves	8	1	1	1	1	1	1	2
3 Buffer Zone Demarcation and Protection	92	11	18	19	19	19	20	20
4 Soil and Water Conservation	1,497	764	779	794	810	826	843	860
5 Stabilisation of River Banks with vegetation	911	165	48	49	50	51	52	53
6 Civil Works	1,249	127	130	133	135	138	141	143
<i>Total</i>	<i>4,436</i>	<i>1,206</i>	<i>1,118</i>	<i>1,140</i>	<i>1,163</i>	<i>1,186</i>	<i>1,210</i>	<i>1,234</i>

	Long term											
	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
1 Agro-Forestry	159	162	165	169	172	176	179	183	186	190	194	198
2 Replanting of Trees in Forest Reserves	2	2	2	2	2	2	2	2	2	2	2	0
3 Buffer Zone Demarcation and Protection	21	21	21	22	22	23	23	24	24	25	25	0
4 Soil and Water Conservation	877	895	912	931	949	968	988	1,007	1,028	1,048	1,069	1,091
5 Stabilisation of River Banks with vegetation	54	55	56	57	58	59	60	61	63	64	65	66
6 Civil Works	146	149	152	155	158	162	165	168	171	175	178	182
<i>Total</i>	<i>1,258</i>	<i>1,283</i>	<i>1,309</i>	<i>1,335</i>	<i>1,362</i>	<i>1,389</i>	<i>1,417</i>	<i>1,445</i>	<i>1,474</i>	<i>1,503</i>	<i>1,533</i>	<i>1,537</i>

13.2 Key Area 2 - Institutions

13.2.1 Key Institutions involved in management of catchment

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

Table 13.3 - Key Institutions involved in management of the catchment

No	Institution	Role in the implementation of the management plan
1	All Local Governments in the watersheds of River Ora and its tributaries and these include; - Mbale District - Butaleja District - Namisindwa District - Bududa District - Manafwa	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	Uganda Wild Life Authority (UWA)	UWA is a key stakeholder because Mt Elgon National Park which constitutes about 23% of the river Manafwa catchment is under its management. In accordance with its mandate, UWA will entirely manage sustainably of the river Manafwa catchment inside the Mt Elgon National Park in accordance with the CMP.
3	Ministry of Agriculture, Animal Industry and Fisheries (MoAAIF)	MoAAIF is a key stakeholder in the sense that catchment restoration & management in the Doho II 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	Kyoga Water Management Zones	The implementation of the Doho II Catchment Management Plan shall be undertaken in the context of the wider management plans undertaken by the Kyoga Water Management Zone on other major rivers such as

No	Institution	Role in the implementation of the management plan
		the river Mpologoma. Therefore, FSSD will have to work within the Kyoga Water Management Zone in the implementation of certain interventions especially the 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 Manafwa 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 the 6 institutions that are listed above 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 II and the Evaluation of Options Report.

13.2.2 Capacity Building Needs Assessment

This Section summarizes the outcomes of a capacity building needs assessment of the key players that will be at the forefront of implementing the CMP. The assessment was conducted in October 2018 among the Kyoga Water Management Zone and the Natural Resources Departments of the District LGs of Mbale, Butaleja, Manafwa, Namisindwa and Bududa.

The capacity building needs assessment identified five major areas for funding. These include infrastructure, tools and equipment, human resources, 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 Departments are supposed to comprise of at least 10-12 staff which include 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. It's recommended that Government speeds up the

process of filling up the human resources gaps to enable the Department to function effectively.

Transport and Communication

The Natural Resources Departments of Mbale, Butaleja, Manafwa, Namisindwa and Bududa lack basic transport means to conduct field-based activities. For each of the five Districts, the only transport means available are 1-2 motorcycles which were provided under FIEFOC or other projects. Based on the nature and magnitude of works that the District LGs have to undertake, it is recommended that each Department gets at least 1 vehicle & 3 motorcycles at the District level and 1 motorcycle for each Sub-County.

Tools and Equipment

All five District LGs lack basic office tools and equipment to function effectively and efficiently. Some of the tools and equipment that are urgently needed include 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 the Mbale and Manafwa Districts which have an office building for the Natural Resource Departments, the rest of the Districts lack office space for their Departments. Most of them are temporarily being housed under other Departments and these are generally scattered. It is recommended that the Natural Resources Departments of the Butaleja, Bududa and Namisindwa Districts secure funding 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.

UWA and the Kyoga Water Management Zone are currently not in need of an office building.

Training Needs

The LG Departments have competent but need refresher training in some of the emerging fields to increase their knowledge base and be able to integrate their work with new development strategies. Based on the training needs assessment, the following training needs emerged:

Training topics for Districts

- Post graduate studies for Masters and Diploma;
- Training in project planning and management;
- Training in management and administration under Natural Resources;
- Training in GIS software such as Quantum GIS, Arc GIS & ILEWIS;
- Monitoring and Evaluation;
- Short training in management planning for woodlots to help farmers on how they can manage their plantations;
- Training in data collection and analysis;
- Remote sensing;
- Financial management;
- Updated information on the conservation status of flora;
- Trainings in Climate change;

- Training in Environmental Impact Assessment.

Training topics for the Kyoga Water management Zone

- GIS;
- Modelling tools;
- Monitoring and Evaluation;
- Monitoring station to monitor sedimentation.

The Capacity Building needs requirements for the District LGs identified 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 it also could be used for the purchase of a departmental vehicle, 3 motorcycles, computer hardware and software, knowledge base enrichment and conducting refresher trainings for the staff.

The UWA unit under the Doho II catchment would also need at least 70,000 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 Doho catchment. In this regard, it is suggested that at least 60,000 USD dollars be set aside.

All action points as indicated in the text above 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.

13.3 Key Area 3 - Knowledge Base

The Capacity Building (Key Area 2) aims at enhancing the knowledge and skills of the key implementers of the Doho II 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 Doho II 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 Doho II 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 Doho II 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 Doho II 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 Doho II.

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 Doho II catchment, in general and the Doho II 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	<ul style="list-style-type: none"> 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 8.2.5	As presented in Section 8.2.5	<ul style="list-style-type: none"> 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)
				<p>is undertaken.</p> <ul style="list-style-type: none"> 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	Land-slides	As presented in Section 8.2.3	As presented in Section 8.2.3	<ul style="list-style-type: none"> Extent of geological mapping on slope hazards conducted. Extent of tree planting undertaken and the general percentage of tree cover in the catchments especially on hill tops. Level of readiness of government to combat disasters. The extent to which communities have been guided to live by avoiding areas susceptible to landslides. 	<p>Annually</p> <p>Every 6 months</p> <p>Every 6 months</p> <p>Every 4 months</p>	<p>-Documented evidence.</p> <p>-Physical observation of phenomena in the catchments.</p> <p>-Testimonies from the local communities.</p>	<p>- Ministry of Water & Environment.</p> <p>- Ministry of Agriculture, Animal Industries and Fisheries.</p> <p>- Ministry of Disaster Preparedness</p>
4	Drought and Climate Change	As presented in Section 8.2.10	As presented in Section 8.2.10	<ul style="list-style-type: none"> 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. 	<p>Annually</p> <p>Every 6 months</p> <p>Every 6 months</p>	<p>-Physical observation of phenomena in the catchments.</p> <p>-Testimonies from the public and the local communities.</p> <p>-Documented evidence.</p>	<p>-Ministry of Water & Environment.</p> <p>-Ministry of Agriculture, Animal Industries and Fisheries.</p>

S/ N	Issues and concerns	Impact	Mitigation Measures	Monitoring indicators	Monitoring Frequency	Means of verification	Responsible Institution(s)
				<ul style="list-style-type: none"> • 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. 	Every 6 months Every 6 months Annually Every 3 months		
5	Poor waste management	As presented in Section 8.2.9	As presented in Section 8.2.9	<ul style="list-style-type: none"> • 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.
6	Invasive Species	As presented in Section 8.2.6	As presented in Section 8.2.6	<ul style="list-style-type: none"> • 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.

S/ N	Issues and concerns	Impact	Mitigation Measures	Monitoring indicators	Monitoring Frequency	Means of verification	Responsible Institution(s)
7	Pests and Diseases	As presented in Section 8.2.7	As presented in Section 8.2.7	<ul style="list-style-type: none"> 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.
8	Deforestation	As presented in Section 8.2.1	As presented in Section 8.2.1	<ul style="list-style-type: none"> Government policy on fuel wood farming per household. Extent of tree planting undertaken and the general 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. 	Every 6 months. Every 6 months. Annually. Every 6 months. Annually Every 3 months. Every 3 months.	-Physical observation of phenomena in the catchments. -Documented evidence. -Testimonies from the community. - Level of mass media engagement.	-Ministry of Water and Environment. -Ministry of Energy and Mineral Development.

S/ N	Issues and concerns	Impact	Mitigation Measures	Monitoring indicators	Monitoring Frequency	Means of verification	Responsible Institution(s)
10	Pollution from Agro-chemicals	As presented in Section 8.2.8	As presented in Section 8.2.8	<ul style="list-style-type: none"> Evidence that both local and commercial farms are not polluting streams and other community water sources. 	Every 3 months	<ul style="list-style-type: none"> -Water quality tests. -Testimonies from the community. -Physical observations of phenomena. 	<ul style="list-style-type: none"> -Ministry of Water and Environment. -Ministry of Agriculture, Animal Industry and Fisheries.
11	River Bank Cultivation & Wetland Encroachment	As presented in Section 8.2.4	As presented in Section 8.2.4	<ul style="list-style-type: none"> 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. 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 3 months Annually. Every 3 months. Every 6 months.	<ul style="list-style-type: none"> -Physical observations of phenomena. -Attitude of the local community towards wetland protection. - Level of mass media engagement. 	<ul style="list-style-type: none"> -Ministry of Water and Environment. -Ministry of Agriculture, Animal Industry and Fisheries.
SOCIAL ISSUES							
12	Poor Farming Methods	As presented in Section 7.1.1	As presented in Section 7.1.1	<ul style="list-style-type: none"> 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 	Every 3 months. Every 6 months. Every 6 months.	<ul style="list-style-type: none"> -Physical observations of phenomena. -Attitude of the local community towards wetland protection. 	<ul style="list-style-type: none"> -Ministry of Water and Environment. -Ministry of Agriculture, Animal Industry and Fisheries.

CATCHMENT MANAGEMENT PLAN for the DOHO II IRRIGATION SCHEME - DRAFT | FIEFOC-2 PROJECT- PREPARATION of CATCHMENT MANAGEMENT PLANS in the WATERSHED AREAS of WADELAI, TOCHI, MUBUKU II, DOHO II and NGENGGE IRRIGATION SCHEMES | Ministry of Water and Environment, Government of Uganda | MoWE/CONS/16-17/00045

S/ N	Issues and concerns	Impact	Mitigation Measures	Monitoring indicators	Monitoring Frequency	Means of verification	Responsible Institution(s)
				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 6 months.	- Level of mass media engagement.	
14	Popula- tion Pressure on Land	As presented in Section 7.1.3	As presented in Section 7.1.3	<ul style="list-style-type: none"> • Nature of farming practices undertaken by farmers in the catchments. • Government's effort to promote and support other livelihood options. • Governments effort to discourage land fragmentation. • Governments effort to promote education for all children. • Governments effort to promote and support family planning. 	Every 6 months. Every 3 months. Annually. Every 3 months. Every 2 months.	- Level of mass media engagement. -Physical observations of phenomena. -Documented evidence.	-Ministry of Water and Environment. -Ministry of Agriculture, Animal Industry and Fisheries. -Ministry of Health. -Ministry of Education. -Ministry of Disaster preparedness.
15	Bush Burning	As presented in Section 7.1.2	As presented in Section 7.1.2	<ul style="list-style-type: none"> • 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.

S/ N	Issues and concerns	Impact	Mitigation Measures	Monitoring indicators	Monitoring Frequency	Means of verification	Responsible Institution(s)
INSTITUTIONAL CHALLENGES							
18	Wild Life Authority	As presented in Section 5.1	As presented in Section 5.1	Evidence that all management issues in Respect of Mt Rwenzori and Mt Elgon National Parks have been addressed.	Every 6 months.	-Physical observations of phenomena. - Level of mass media engagement. -Documented evidence.	-Ministry of Water and Environment.
19	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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APPENDICES

Appendix 2.1 - Project Documents

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

- 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
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- 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 Kyoga WMZ related to CMP

- 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 Doho II Catchment

No	Biological Name	Common name	Common use value
1	<i>Azadrachta indica</i>	Neem	Herbal remedy for malaria, mouth / skin ulcers, anti hyperglycemic agent, tooth brush, common animal dewormer etc
2	<i>Eucalyptus camaldulensis</i>	Eucalyptus	Sold as seedlings, small poles, big poles and firewood
3	<i>Grevelia robusta</i>	Australia silk oak	Firewood, Agroforestry systems
4	<i>Sena siamea</i>	cassia	Firewood, bee forage, timber
5	<i>Mellia volcansii</i>	Giant lira	Timber, has anti termite effects
6	<i>Albizia zygia</i>	Nongo	Precious timber
7	<i>Mellia azadrach</i>	mellia	Has anti termite effects
8	<i>Tamarindus indica</i>	Mukooge	Edible fruits, charcoal
9	<i>Vernonia amygdalina</i>	Mululuuza	Malaria cure
11	<i>Albizia coriaria</i>	mugavu	- Bark effective against cough when mixed with that of mango, bottlebrush and Eucalyptus - Very precious timber
12	<i>Ricinus communis</i>	Nsogasoga	firewood
13	<i>Euphorbia candelebrum</i>	Nkukuulu	Highly poisonous white latex
14	<i>Ficus natalensis</i>	Mutuba	Food for browsers, excellent agroforestry tree
15	<i>Ficus sur</i>		Timber for shuttering, fruits for birds and other wild life
16	<i>Makhamia lutea</i>	Musambya	Precious timber
17	<i>Croton megalocarpus</i>		ornamental
18	<i>Thevetia peruviana</i>	Kasenene	Ornamental, hedge shrub
19	<i>Vangueria apiculata</i>	Mutugunda	Delicious fruits
20	<i>Cordia africana</i>	Mukebu	Famous in boat making
21	<i>Mangifera indica</i>	Muyembe	Fruits
22	<i>Persea americana</i>	Avocado	Fruit
23	<i>Bathdavia</i>		Timber
24	<i>Callistemon citrinus</i>	Bottle brush	Bee forage, medicinal herb for colds and flu
25	<i>Artocarpus heterophyllus</i>	Jack fruit	Delicious fruit
26	<i>Spathodia campanulata</i>	Kifabakazi	Herbal medicine
27	<i>Maesopsis emnii</i>	Musizi	Timber

No	Biological Name	Common name	Common use value
28	<i>Pilliosigma thoningii</i>	Mugaali	charcoal
29	<i>Erythrina abyssinica</i>	Jirikiti	
31	<i>Casuarinas equisetifolia</i>	Whistling pine	ornamental
32	<i>Podocarpus usambalensis</i>	podo	Timber , ornamental
33	<i>Ficus benjamina</i>		Ornamental
34	<i>Erythrococa bongensis</i>		Charcoal
35	<i>Araucaria cunninghami</i>		Timber, Ornamental
36	<i>Entandrophragma angolense</i>	Mahogany	Timber
37	<i>Cidrella odorata</i>		Timber
38	<i>Syzygium jambolana</i>	Jambula	Fruits
39	<i>Combretum molle</i>	Endagi	Charcoal
40	<i>Terminalia ivorensis</i>	Umbrella tree	Timber, Ornamental
41	<i>Leucina leucocephala</i>	Lucina	Bee forage, agroforestry
42	<i>Lannea barteri</i>		Timber
43	<i>Kigeria africana</i>	Sausage tree	Herbal medicine, timber
44	<i>Vitex fisceri</i>		charcoal

Appendix 8.2 - Land Conflicts at Mt Elgon National Park

Mount Elgon National Park was established as a water catchment area with its wildlife including vegetation and landscapes. These resources have been negatively affected by human activities over many years. With improved conservation, the area is again realizing its conservation purpose. However, many threats remain. This section describes boundary management, control of illegal resource use, restoration and regional environmental management issues. It also examines the threats and prescribes actions to counter them.

One of the major challenges UWA is facing in managing Mt Elgon NP is encroachment. Between 1992 and 1993 the Forest Department, then managing the then Mt. Elgon Forest Reserve, carried out re-opening of the Park boundaries in an effort to resolve the issue of the Park boundary and resulted into the so called “1993 boundary”. Unfortunately, in some areas the boundary re-survey was erroneous and on discovery, UWA tried to rectify the error with the resulting conflict to date. Earlier on, in 1983, Government had attempted to re-settle the Benet who was then residing in the Forest Reserve in the areas commonly known as Benet. The area set aside for this purpose was 6,000 ha. However this area was never measured off the Forest Reserve but rather rough estimates were made. This resulted into the people settling up to a well-known cliff within the reserve well beyond the 6,000 ha intended. When a final gazettment was done however, Government only provided for the original 6,000 ha resulting into several people already settled remaining in the park. Although attempts have been made by GoU to look for funding to resettle them out of the park, this has not been successful and the Kapsegek and Benet groups have been temporally resettled along the Park boundary. The area they are settled in is also already degraded since they have been there since 1983. Another group living at Kapsegek remained in the forest far from any social services and therefore have lagged behind in education and other development indicators.

UWA has made several efforts to try and stop encroachment on Mt Elgon NP with a lot of challenges over the years. Management zones were established so to better control encroachment and illegal tree cutting (see Figure below). After extensive consultations with the Ministry of Tourism, Trade and Industry as well as with both communities and the leadership in the area, UWA has proposed to provide ownership rights to the local people who are currently residing in sections of the National Park through boundary re-alignment to leave out the agreed upon areas. It is hoped that this will reduce community-park conflicts and gives better harmony in the area. The proposed re-alignment will exclude the communities in sections of the following areas: Kapsegek, Benet, Zesui, Wanale, Busano, Bumwalukani, Buraba, Bushiyi, Bufuma, and Soono (Bumbo) from the Park. A boundary steering committee has been already identified whose membership include the affected people and further encroachment will not be allowed. The total area covered by these families is estimated at 2,960 ha out the total area of 1,121 km² of Mt Elgon NP (see Table below)

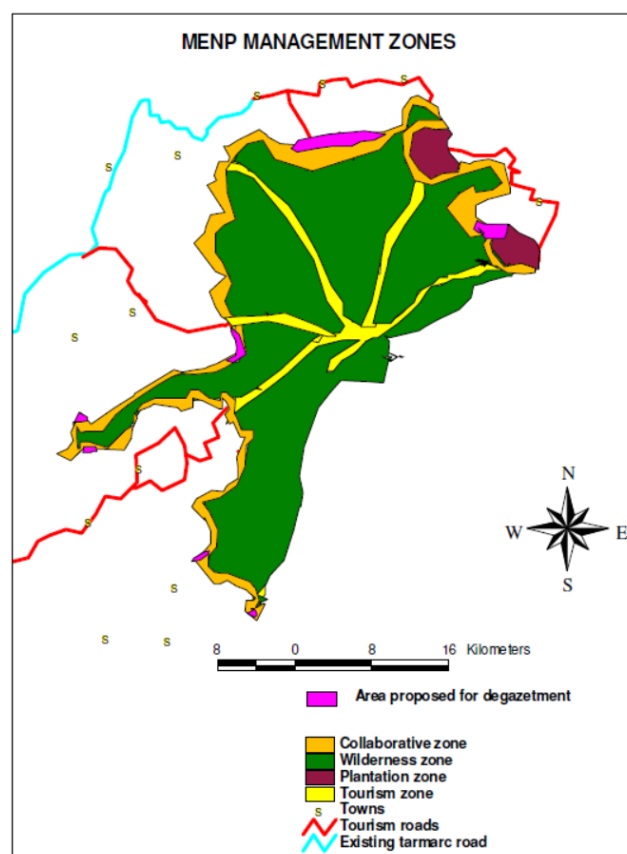


Figure 1 of Appendix 8.1 - Map of Mt Elgon National Park showing the location of the various management zones

Table 1 of Appendix 8.1 - Number of families proposed to be re-aligned out of the Mount Elgon National Park boundary

No	Area	Area (ha)	Number of families
1	Benet	2,225	22
2	Kapsegek	318	43
3	Zesui	237	38
4	Wanale	115	30
5	Busano	8	11
6	Bumwalukani	4	4
7	Buraba	3	4
8	Bushiya	6	24
9	Bufima	2	3
10	Soono	42	15
Total		3,960	392

Source: UWA (Mt Elgon National Park Management Plan for 2009/2019)

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 stream 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°) 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 interventions 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°

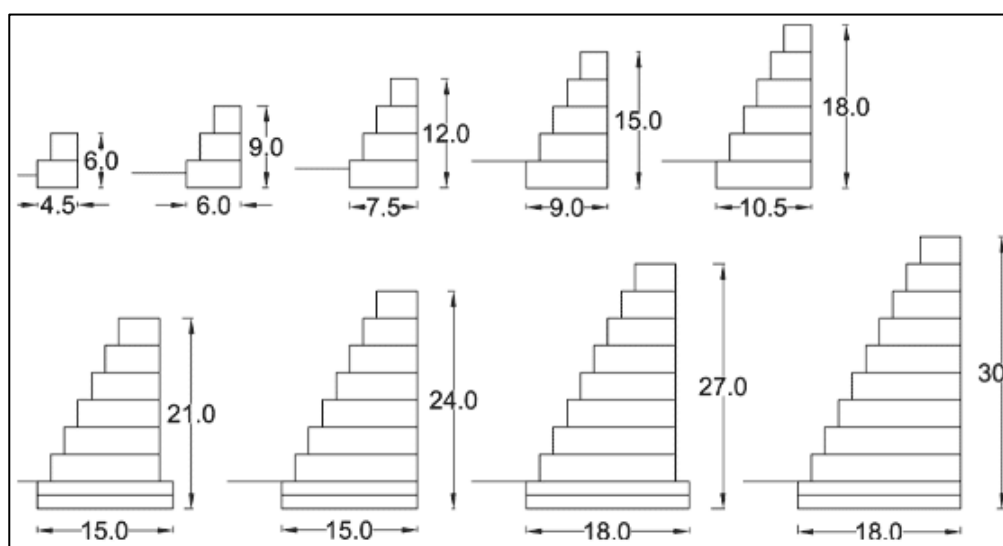


Figure 1 - Sample design dimensions and arrangement for Gabion walls

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 m² 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.

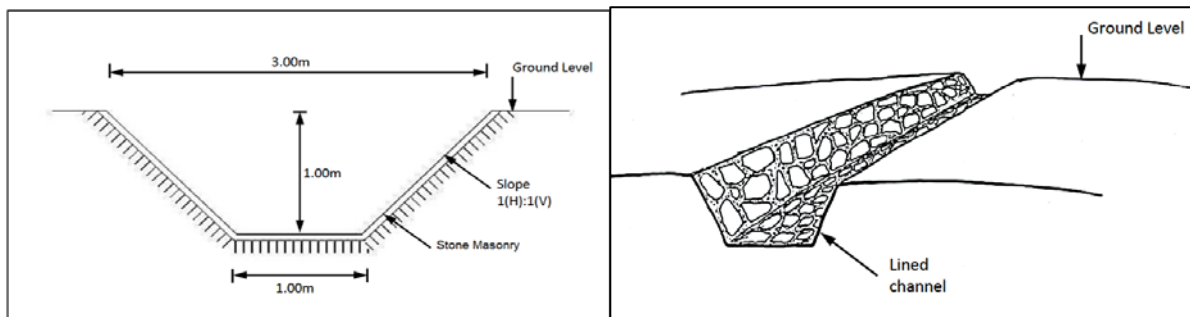


Figure 3 - Sample section of a trapezoidal Stone Pitching

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.

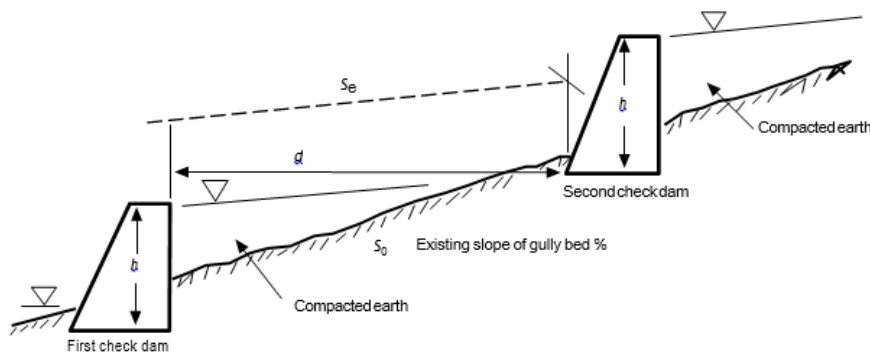


Figure 4 - Longitudinal layout of check dams

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

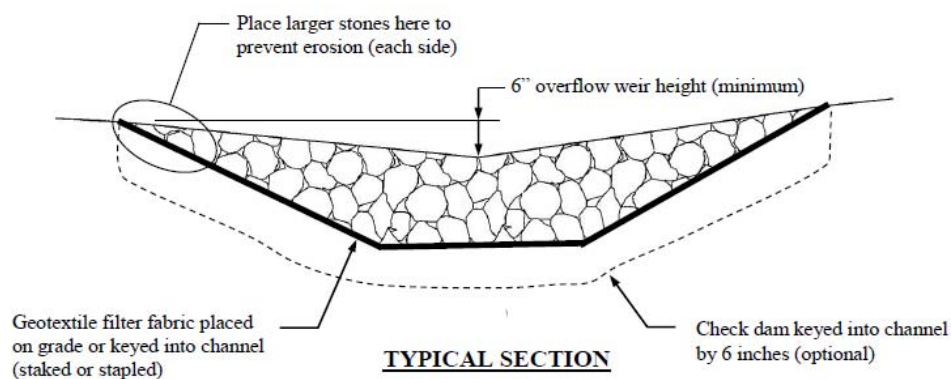
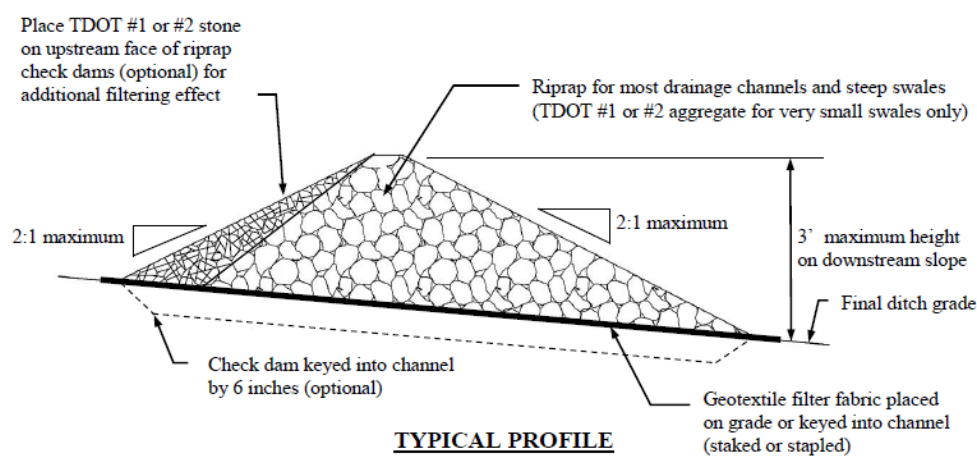
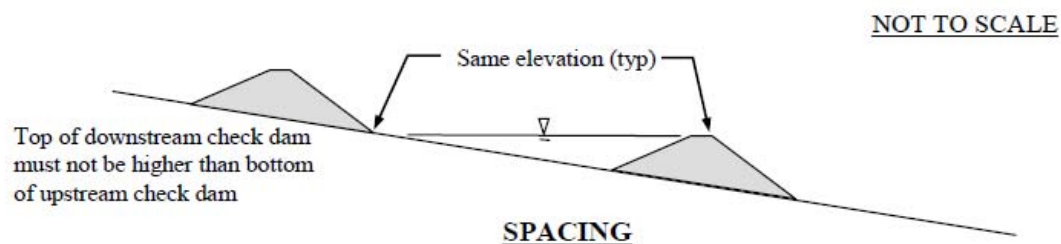


Figure 6 - Sample sections of Check Dam

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 Doho II

Institution	Thematic area	Existing situation	What needs to be done
Butaleja District Natural Resource Department	Human Resources	According the Local Government structure, the Department is not fully constituted. Several positions have not been filled.	Government needs to recruit the following officers in accordance with the approved structure of the District: <ul style="list-style-type: none"> • Assistant Senior Forest Officer • Forest Guard • Forest Ranger • Cartographer • Staff Surveyor • Natural Resource Officer • Wetland Officer • Based on the labor 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 has no single means of transport such as functional motorcycles. This scenario incapacitates the Department from functioning effectively.	Department needs at least 1 vehicle and 4 motorcycles at the District level to facilitate field activities.
	Equipment and tools	The Department has 1 desktop and 1 laptop. Other equipment includes 1 GPS.	Department needs at least the following equipment: <ul style="list-style-type: none"> • 12 more extra laptops • 2 GPSs • 1 photocopier • 2 printers • scanner
	Infrastructure	The District has no office building for the Natural Resource Department. Currently, the Department is hosted under 1 room in the	Department is in need of an office block of its own which should come along with office desks and cabinets.

		Department of Education. A foundation for the main building of the District has been put up but it is said that there are no funds to progress with its construction.	
	Training needs	The existing staff has basic training in forestry, environment and land management.	Department needs the following training: <ul style="list-style-type: none"> • Post graduate studies for Masters (3 people) and Diploma for 1 person. • Training in project planning and management. • GIS and remote sensing. • Training in management and administration under Natural Resources.
Bududa District Natural Resource Department	Human Resources	According the local government structure, the Department is fully constituted.	Based on the labor 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 1 desktop which was given by FIEFOC.	Department needs at least the following equipment: <ul style="list-style-type: none"> • 10 laptops & appropriate software • survey equipment • 3 GPSs • projector • generator for the outreach programs to be able to show videos. • 2 printers (A3 printing) and 2 scanners • 1 photocopier

	Infrastructure	The Department has an office building of its own.	No further action is required.
	Training needs	The existing staff has basic training in forestry, environment management.	Department needs the following training: <ul style="list-style-type: none"> • Training in GIS software such as Quantum GIS, Arc GIS & ILEWIS. • Monitoring and Evaluation. • Short training in management planning for woodlots to help farmers on how they can manage their plantations.
Mbale District Natural Resource Department	Human Resources	According the local government structure, the Department has some few staff gaps that need to be filled.	Government to recruit the following officers in accordance with the approved structure of the District: <ul style="list-style-type: none"> • Principal Natural Resource Officer • Register of Titles • Assistant Forest Officer • Forest Ranger • Basing 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	Department only has 2 motorcycles. This is very inadequate and this scenario incapacitates the Department from functioning effectively.	<ul style="list-style-type: none"> • Department needs at least 1 vehicle and 2 motorcycles to facilitate field activities at the District.
	Equipment and tools	The Department has 3 desktops, 2 desktops and 1 Laptop.	Department needs at least the following equipment: <ul style="list-style-type: none"> • survey equipment • 3 more laptops at the District • A3 printer (colored) • internet Services • projector • photocopier • scanner • store for the land titles

	Infrastructure	The Department has office building for all staff.	No further action is required.
	Training needs	The staff has basic training in forestry, environment and land management.	Department needs the following training; <ul style="list-style-type: none"> • Training in data collection and analysis. • Use of GPS and GIS software. • Remote sensing. • Financial management. • Masters training for 2 people.
Manafwa District Natural Resource Department	Human Resources	According the local government structure, the Department has several staff gaps that need to be filled.	Government to recruit the following officers in accordance with the approved structure of the District; <ul style="list-style-type: none"> • Forest Ranger. • Senior Lands Officer. • Natural Resources Officer. • Environment 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 2 motorcycles from FIEFOC and MERICP. This is very inadequate and this scenario incapacitates the Department from functioning effectively.	Department needs at least 1 vehicle and 1 motorcycle to facilitate field activities at the District.
	Equipment and tools	The Department has 2 GPSs, 1 desktop and 1 laptop.	Department needs at least the following equipment; <ul style="list-style-type: none"> • 2 more laptops at the District • A3 printer (colored) • Internet Services • projector • photocopier • scanner
	Infrastructure	The Department has office building for all staff.	No further action is required.
	Training needs	The existing staff has basic training in forestry, environment and land	Department needs the following training; <ul style="list-style-type: none"> • Use of GPS and GIS software.

		management.	<ul style="list-style-type: none"> • Updated information on the conservation status of flora. • Trainings in Climate Change.
Namisindwa District Natural Resource Department	Human Resources	According the local government structure, the Department is not fully constituted. Several positions have not been filled.	<p>Government needs to recruit the following officers in accordance with the approved structure of the District:</p> <ul style="list-style-type: none"> • Senior Environment Officer • Natural Resource Officer • Physical Planner • Assistant Forest Officer • Senior Lands Officer • Forest Ranger • Forest Guard • Cartographer • Staff Surveyor • Records Officer • 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 has no single means of transport. . This scenario incapacitates the Department from functioning effectively.	Department needs at least 1 vehicle and 3 motorcycles at the District level to facilitate field activities.
	Equipment and tools	The Department has no equipment at the moment.	<p>Department needs at least the following equipment:</p> <ul style="list-style-type: none"> • 10 extra laptops • 2 GPSs • 1 photocopier • 2 printers • scanner • projector • generator • survey equipment
	Infrastructure	The District has no office building for the Natural Resource Department. Currently, the Department is hosted under 1 room in the	Department is in need of office desks and cabinets.

		<p>Department in the Engineering Department. Sometimes, they use the Council hall.</p> <p>A foundation for the main building of the District has been put up but it is said that there are no funds to progress with its construction and that it may take some time to complete.</p>	
	Training needs	<p>The existing staff have basic training in forestry, environment and land management.</p>	<p>Department needs the following training:</p> <ul style="list-style-type: none"> • GIS and Remote sensing to help in decision making • Training in EIA.



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