REPUBLIC OF RWANDA

Ministry of Environment

Muvumba Catchment Management Plan (2018-2024)

Kigali, October 2018

Acknowledgment

We express our sincere gratitude to the Kingdom of the Netherlands (EKN) through Water for Growth Program for technical and financial supports of Muvumba Catchment management plan. We also take this opportunity to thank the members of Technical Focal Group, members of steering committee of the program, members of Catchment Task Force and staff of Nyagatare, Gicumbi, and Gatsibo Districts who greatly contributed to the formulation of this plan. We would like to thank the local Authorities for their facilitations and cooperation; we would like to thank the friendship for accepting nothing less than excellence from the teams. Last but not the least; our appreciation goes to the staff of Ministries and the IWRM Department for supporting the Catchment Planning process throughout writing this final document which will be used for future water resources management.

Content

Annexes

Tables

Figures

List of Abbreviations

7YGP	7 Year Government Plan
ABAKIR	Kivu-Rusizi Basin Agency (for transboundary cooperation RW-BU-DRC)
AIP	Annual Implementation Plan
AU	African Union
CBA	Cost-Benefit Analysis
CCA	Cross Cutting Area (of NST1)
CGIS	Centre for Geographic Information Systems (of UR)
CITES	Convention on International Trade of Endangered Species
CKIV	Congo-Kivu catchment
COP	Conference of Parties
CP	Catchment Plan
CPIP	Catchment Plan Implementation Project
CRAG	Climate Resilient Altitudinal Slopes
CSO	Civil Society Organisation
CTF	Catchment Task Force
DCA	Demonstration Catchment Area
DD	Detailed Design
DDP	District Development Plan (up to 2018)
DDS	District Development Strategy (from 2018)
DFID	Department for International Development
DFMP	District Forestry Management Plan
DLRP	District Landscape Restoration Plan
DPSIR	Driving force – Pressure – State – Impact – Response
DRC	Democratic Republic of the Congo
EAC	East African Community
EDPRS	Economic Development and Poverty Reduction Strategy (up to 2018)
EIA	Environmental Impact Assessment
EICV4	Integrated Household Living Conditions Survey 4 (of NISR)
EKN	Embassy of the Kingdom of the Netherlands
ENR	Environment and Natural Resources (sector)
ESMP	Environmental and Social Management Plan
ESRI	Company developing and supplying ArcGIS software
EWSA	Energy and Water Supply Authority
FAO	Food and Agricultural Organisation (of UN)
FEWS	Flood Early Warning System
FFS	Farmer Field School
FONERWA	Environment and Climate Change Fund for Rwanda
FPG	Focal Point Group
FS	Feasibility Study
GALS	Gender Action Learning System
GBS	Gender Budget Statement
GDP	Gross Domestic Product
GGCRS	Green Growth and Climate Resilience Strategy (Rwanda, 2011)
GHG	Greenhouse Gas

GIS	Geographical Information System
GMO	Gender Monitoring Office
GPS	Global Positioning Satellite
HH	Household
ICS	International Citizen Service (NGO)
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGC	International Growth Centre
IIF	IWRM Investment Fund
INDC	Intended Nationally Determined Contribution
IP	Implementation Project
IP+	Implementation Project with IWRM additions
IPRC	Integrated Polytechnic Regional Centre
ISU	IWRM Support Unit
ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
IWRMD	Integrated Water Resources Management Department
JADF	Joint Action Development Forum
LAFREC	Landscape Approach to Forest Restoration and Conservation project
LVEMP	Lake Victoria Environmental Management Programme
LWH	Land Husbandry, Water harvesting and Hillside irrigation project
LSR	Landscape Restoration
M&E	Monitoring and Evaluation
MCA	Multi-Criteria Analysis
MCAP	Micro-Catchment Action Planning
MIDIMAR	Ministry of Disaster Management and Refugee Affairs
MINEACOM	Ministry of Trade, Industry and East African Affairs
MIGEPROF	Ministry of Gender and Family Promotion
MINAFFET	Ministry of Foreign Affairs
MINAGRI	Ministry of Agriculture
MINALOC	Ministry of Local Government
MINECOFIN	Ministry of Economy and Finance
MINENV	Ministry of Environment
MINICT	Ministry of Information and Communication Technology
MINILAF	Ministry of Land and Forestry
MINIRENA	(former) Ministry of Environment and Natural Resources
MINISANTE	Ministry of Health
MIS	Management Information System
NAEB	National Agricultural Export Board
NCEA	Netherlands Commission for Environmental Assessment
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
NISR	National Institute of Statistics of Rwanda
NST (1)	National Strategy for Transformation (1)
NWRMP	National Water Resources Master Plan
PES	Payment for Ecosystem Services

PoM	Programme of Measures
PPP	Policy, Plan, or Programme
PS	Permanent Secretary
PSC	Programme Steering Committee (of Water for Growth Rwanda)
PSTA	Strategic Agricultural Transformation Programme
QGIS	Quantum GIS (software)
RAB	Rwanda Agriculture Board
RCMRD	Regional Centre for Mapping of Resources for Development
RDB	Rwanda Development Board
REG	Rwanda Energy Group
REMA	Rwanda Environmental Management Authority
RNRA	(former) Rwanda Natural Resources Authority
RLMUA	Rwanda Land Management and Use Authority
RWFA	Rwanda Water and Forestry Authority
RWH	Rainwater Harvesting
SACCO	Community savings and credit cooperative
SDG	Sustainable Development Goal
SEA	Strategic Environmental Assessment
SEAD	Strengthening Education for Agricultural Development project
SEI	Stockholm Environment Institute
SEIA	Social and Environmental Impact Assessment
SSP	Sector Strategic Plan
SWOT	Strength-Weakness-Opportunity-Threat (analysis tool)
UN	United Nations
VTC	Vocational Training Centre
VUP	Vision 2020 Umurenge Programme
W4GR	Water for Growth Rwanda
WASAC	Water and Sanitation Corporation
WASH	Water, Sanitation, and Hygiene
WEAP	Water Evaluation and Planning (modelling software)
WRM	Water Resources Management
WRMD	Water Resources Management Department
WUA	Water User Association

Introduction

Catchment plan is an important tool for integrated Water Resources Management (IWRM) and for management of related land and natural resources. Catchment management is based on hydrological boundaries. It includes all surface water emanating from rainfall-runoff within these boundaries and that runs downhill towards the shared outlet. It also includes those groundwater bodies that are wholly or partly within the same area, especially those that contribute to surface water flow. Catchments also contain people and businesses, such as industry, agriculture and these are all also affected by and have an impact on water resources within the catchment area. The strong relationships between land, water, environment people and the economy within a catchment, call for an integrated management thereof.

Muvumba catchment plan was developed by taking into consideration national orientations as articulated in National Transformation Strategy (NTS1), vision 2050 and the Nation's Green Growth and Climate Resilience Strategy (GGRS). It was developed in highly participatory manner. Centrally, Rwanda Water and Forestry Authority (RWFA) was designated as lead agency, and partner ministries were represented through Programme Steering Committee (PSC) and Focal Points Group (FPG). At catchment level, officials and staff, as well as representatives of a number of special interests from each district within the catchment, jointly constituted a Catchment Task Force.

Methodology of catchment plan development

Being a strategic plan, carrying out a Strategic Environment Assessment (SEA) was obligatory according to Rwandan Organic law on the environment and international best practice. Supported by the Netherlands Commission for Environmental Assessment (NCEA), a tailor-made approach was developed that integrated plan development and SEA requirements. Adoption of a participatory approach is one of the requirements of both IWRM and SEA principles. To this end, a locally based CTF was established by the Minister of Environment, comprising stakeholder representatives from all districts with a significant surface area in the catchment, with members from District Government, District administration, and representatives of the National Women Council, NGOs, and the Private Sector Federation. From among each category, representatives were elected to form a core team for catchment plan development. In the core team, each district is represented, as well as each member category. The CTF is chaired by a Vice Mayor for Economic Development elected from among the districts in the catchment.

In a scoping workshop with the entire CTF, the catchment was characterised in environmental and socio-economic terms, a vision and objectives were developed; issues and opportunities listed and mapped; and a set of potential development alternatives was formulated. After detailed analysis by the catchment officer, the programme officer, and an expert team from WRMD and the IWRM Support Unit, joined in W4GR, alternatives were assessed against a set of IWRM criteria and compared with the baseline situation (the period of 2006 - 2015) and projections of potential future developments up to 2050 if there were no catchment plan.

Muvumba Catchment Management Plan being the first of this kind prioritizes addressing the matters directly linked to water management such as catchment restoration, maximum water availability and equitable water allocation to all water users within the catchment.

REMA reviewed compliance with SEA requirements, and their feedback was integrated in the current catchment plan. Upon Cabinet endorsement of the plan, implementing partners collaborate in the development of Annual Implementation Plans to streamline their sector and district interventions within catchment boundaries. The CC oversees joint monitoring and evaluation of the extent and effectiveness of implementation, as well as the timely development of the next version of the plan, covering the period 2024-2031, to be aligned with the next seven-year Government Programme and the wider institutional framework of which the catchment plan forms an integrated part.

Muvumba catchment situation analysis

Muvumba is a Level 1 catchment located in the Kagera sub-basin and is part of the most upstream section of the Nile River Basin. The Muvumba River is a transboundary system, shared with Uganda, with a total surface area is 3,714 km² (only 1.568 km^2 within Rwanda itself), the latter being approximately 5.95 % of the total surface area of Rwanda (26,338 km²). The source of the Muvumba catchment is the Mulindi River located in the mountainous and high rainfall central, northern part of the country at an altitude of 2,030 masl (meters above sea level). The Muvumba catchment rises in the Buberuka highlands, with altitudes up to 2,500 masl. The Warufu sub-catchment starts in the Eastern Plateau, which extends over highlands (around 1,750 masl) and hills of medium altitude and flows through the Eastern savanna, where it joins the main Muvumba River. Here, the Eastern Savanna has gentle slopes, and includes numerous lakes and wide areas covered by marshes extending along the Akagera River into which Muvumba River discharges at an altitude of around 1,250 masl at the confluence. The Mulindi River flows north entirely within Rwanda for a length of 22.5 km towards the Ugandan border and then it crosses the national border onto a flat, wetland zone near Kabale. Here, in Uganda, it joins the Muvumba River, before eventually flowing back into Rwanda. The length of the Muvumba river in Rwanda is around 56 km. Major tributaries are the Warufu River, and its tributary Ngoma River. In Nyagatare district, the Warufu River joins the Muvumba, which then flows north-east and forms the border between Rwanda and Uganda, before finally joining the Akagera River where the borders of Uganda, Rwanda and Tanzania all meet.

The most extensive soil types within the low lying, north-eastern section of the catchment are Ferralsols. These are derived from deeply weathered siliceous rocks and are of low fertility, acidic and increasingly with aluminium toxicity. They are generally deep, easy to work and less erodible than other deeply weathered soils. In the south-western uplands, on steep slopes, there are Cambisols and Alisols that are moderately deep and more fertile than Ferralsols since they possess a higher cation exchange capacity (CEC). Being located on steep slopes they are especially susceptible to erosion. Along valley bottoms and associated with swamps are the clay soils of moderate fertility and low infiltration capacity.

The mean annual precipitation varies between 756 mm at Nyagatare to 1,128 mm in the highlands at Byumba. The dry season runs from late May to early September, with the rainy period in October to early December, a slight dip around the month of January and a peak rainy season during the months of March up to early May. The dry season months are prolonged in the lower altitude areas and towards the east.

The western part of the catchment is characterised by alternating schist and quartzite layers with average groundwater holding potential. The eastern part has granite as the dominant basement aquifer that results in low storage capacity and conductivity. Some long-term river flow observations are available for the confluence of River Muvumba with Akagera River, at Kagitumba. The seasonal distribution of discharge intensity is an annual average flow of about 14 m^3/s.

Fertilisers and pesticides from irrigation schemes, e.g. Mulindi tea factory, were cited as major causes of poor water quality in the Cyondo and Muvumba rivers. Pollution also emanates from emerging urban centres, such as Byumba, Gatuna, Yaramba and Rukomo, have been cited as being polluted by the sediment from mining activities located in Mubuga. Other alleged point source pollution emanates from the EAGI (Granite production) and Inyange (SAVANA, milk production) industries located in Rutaraka and Nyagatare. High levels of contamination with *E coli* and Faecal coliform, both exceeding acceptable levels, have been recorded at Nyagatare and Kagitumba. High levels of turbidity, Lead (Pb), Manganese (Mn), Iron (Fe) and Copper (Cu) also exceeded their allowable threshold values, along with and elevated levels of BOD and COD. Turbidity and Total Suspended Solids (TSS) have also been found above levels prescribed by the World Health Organisation (WHO, 2011) and Rwanda Standards Board (RSB, 2013) in the Muvumba and Warufu Rivers.

A basic analysis of the catchment-wide green and blue water balances reveals that about 65% of all precipitation is used by vegetation (rainfed agriculture, forests, and nature), or lost to evaporation. Only 2% of all precipitation, three times the amount of blue water, is eventually abstracted by anthropogenic users (for domestic, industrial, irrigation or livestock use). Outflow from the catchment and groundwater recharge are other important components. The Ngoma sub-catchment makes the smallest contribution to the water balance and all catchment surface water leaves via the downstream Muvumba sub-catchment at Kagitumba.

Almost all economic growth in the catchment is linked to water use, be it in agriculture, livestock, industry, or purely related to providing drinking water to urban and rural areas.

The economy of the catchment relies strongly on rain-fed agriculture, indeed 90% of Rwanda's population is engaged in agricultural activities. In the Mulindi sub-catchment, Gicumbi District, tea processing factories and plantations are present. In the Muvumba upstream sub-catchment in Nyagatare, dryland agriculture and cattle/livestock ranching, producing dairy, meat and hides, is important. In the Muvumba downstream sub-catchment in Gatsibo and Nyagatare, cattle ranching, wetland irrigation (rice, cereals and other crops) and hillside irrigation are key. The Ngoma sub-catchment in Gicumbi has tea plantations and hydro-power and the Warafu sub-catchment, also in Gicumbi District, has the same activities as the Muvumba downstream sub-catchment. Other economic activities in Muvumba catchment include artisanal mining of wolfram, cassiterite and coltan, as well as quarrying.

The 2012 national population and housing census indicated that 600,000 people live in Muvumba catchment, with 7.7% urban, and 92.3% rural. 51.7% of population is female and 54% (both men and women) aged <20 (EICV4). Highest densities (536-767 persons/km^2) were in Rukomo, Katabagemu and Mimuli in the central area, in Gatsibo in the south east and in Nyankenke, Byumba, Manyagiro, Cyumba, Bungwe, Rubaya in the south west. Kageyo had the highest density (768-998 persons/km^2).

Poverty rates within the catchment area are very high and linked to high population growth and declining soil fertility in a largely agrarian based economy.

Consistency alignment with existing legal framework, policies, strategies, and programmes

The catchment plan covers a wide array of policy fields and tries to provide an integrated approach to sustainable economic development (green growth) of the catchment. To avoid conflicts with other relevant policy documents from the Government of Rwanda (laws and regulations, policies, strategies, and major programmes) and maximise synergies, a thorough *analysis* and *alignment* has been made of existing policy documents. This was done in two phases. In 2016 an in-depth *analysis* was made of numerous key documents of that time. This included the national development framework (EDPRS2, Vision 2020 and the seven-year Government Programme 2010-2017) and the very important Green Growth and Climate Resilience Strategy (GGCRS); and relevant policies, strategies, programmes, and plans in the water sector and water related sectors (irrigation, water supply and sanitation, housing, local government, tourism, gender, etc). SWOT analyses were conducted to arrive at recommendations for the catchment plan, but also for future updates or revisions of the analysed documents.

In 2017-2018 a new national development framework was introduced, comprising Vision 2050 and the National Strategy for Transformation (NST) including NST1, the seven-year Government Programme for 2017-2024. Together with GGCRS this provided the starting point for a new set of Sector Strategy Plans (SSPs) and District Development Strategies (DDSs), all incorporating a set of national Cross Cutting Areas (CCAs). Catchment Plans were situated in the middle, bridging the gap between national sector strategies and district strategies, optimising integration at catchment level and pro-actively optimising *alignment* between all three spatial scales (national, catchment, district). The alignment process further culminated in the integration of catchment plans and catchment restoration opportunities in the greening of DDSs, conducted by MINALOC in 2018.

Main issues in Muvumba Catchment

The main source of pollution of surface water is from mines, as well as from soil erosion from hillside agriculture, resulting in high to extremely high river sediment loads. The latter have an adverse impact on dams, and high removal costs for, drinking water intakes, as well as turbines and related infrastructure for hydropower stations. Both hydropower and drinking water intakes often need to shut down during periods of extreme sediment loading and operations also suffer regular interruptions as a result of the need to undertake sediment removal from settling basins associated with the intakes. Mining may also lead to contamination with heavy metals from mine ores, or with substances used in ore processing posing a human health risk. Although the drought is the most important issue but there are also cases of floods specifically in Mulindi tea plantations. Vegetation and forest cover is very low and this is exacerbated by deforestation. The conflict over water use between livestock and agricultural farmers is recurrent. Being transboundary, there is no strong water cooperation framework.

Main opportunities in Muvumba catchment

Muvumba presents many opportunities as follows:

- Available land for agriculture suitable for irrigation and mechanization
- Potential for hydropower
- Commitment for Bilateral cooperation to jointly manage water resources
- Water storage potential
- Livestock products value chain
- Fish culture, tea plantation, (eco) Tourism

Catchment vision and objectives

A catchment vision, as well as an overall objective, and a set of specific objective/s, were jointly developed by the Catchment Task Force, national focal points, and the WRMD; supported by the project and the Netherlands Commission for Environmental Assessment (NCEA). The process took into account local issues and opportunities, the United Nations Sustainable Development Goals (SDGs), and international best practice examples and guidelines.

The vision for Muvumba was agreed as:

'*A catchment that is managed in an environmentally friendly manner to addresses the socio-economic needs of communities taking into consideration the transboundary nature of the catchment*.'

The overall objective was agreed as:

'*Effectively managed land, water and related natural resources that contribute to sustainable socio-economic development and improved livelihoods, taking into consideration environmental flow, downstream water demands and resilience to climate change, and that minimise water-related disasters*.'

Specific objectives of Muvumba catchment areas are the following:

1: Improved water quality and quantity in water bodies taking into account resirience to climate change in the catchment

2: Reduce the pressure on natural resources by diversifying alternative livelihoods

3: Ensure equitable allocation of available water resources for all users of current and future generations in the catchment

4: Strengthen the water governance framework and transbondary cooperation to ensure effective implementation of integrated

Programme of measures

A coherent Programme of Measures (PoM) was developed for the Muvumba catchment plan, primarily for the implementation period 2018-2024.The main focus of the Muvumba Programme of Measures was on landscape restoration, water allocation, water governance and knowledge management. These are explained as follows:

- **Landscape restoration**

Practical measures that need to be undertaken to restore the physical status of the catchment from its existing state into a future, better one. These measures include terraces, agroforestry, afforestation and gullies rehabilitation. Focus here will primarily be on reduction of soil erosion and improvement of land and water productivity. Making decisions on which measures were needed to achieve these outcomes required many criteria to be taken into account, including local field conditions and stakeholder consultation and agreement. To assist with the decision-making process, a geographical decision support system, called the Catchment Restoration Opportunities Map Decision Support System (CROM-DSS), was developed. CROM-DSS helped identify the areas that need to be restored. It was found that an estimate of 11000ha in Muvumba catchment will be rehabilitated.

- **Water allocation**

This refers to water demand and management measures that may need to be implemented to ensure that the amount of water available in the catchment, both now and in the future, meets and will continue to meet demands for it from a range of sectors, e.g. agriculture, industry, public water supply etc. The preferred alternative, i.e. 'RI+SLM+E', for reduced development of new irrigation scheme (RI), sustainable land management (SLM) and enhanced water use efficiency (E), was translated into water allocation plans for all sub-catchments, per month, per water user, and for the plan horizons of 2024, 2030, and 2050. These then formed the basis for water permits and operational water resources management following a prioritisation 'ladder', as follows:

- First priority was given to domestic water supply, followed by;
- Livestock;
- Environmental flow (to provide water to ecosystems and downstream water users);

- Industrial water demand (due to its very limited size and the fact that demand is constant throughout the year and independent of rainfall); and
- Irrigation[1].

Water governance

This refers to institutional, policy and legislative measures that need to be implemented to ensure implementation of all other measures. It refers to the way in which a catchment is 'governed', by whom and how and under what framework. A catchment task force was established to represent catchment stakeholders in the development of this catchment plan, within the Water for Growth Programme. The New Water Law stipulates the creation of Catchment Committees. Following Ministerial Order, these committees will be established and operationalized.

- **Knowledge management**

This refers to the measures needed to manage, store and effectively use information, data and 'knowledge', including practical and intellectual capacities that are required for effective catchment management. Considering the fact that catchment planning is a form of spatial planning, it will be important to enhance GIS skills to produce spatial information, and to strengthen capacities of decision makers to interpret and use maps in their management tasks.

To ensure that programmes of measures are implemented in an integrated manner, rather than as a series of stand-alone interventions, projects proposed in the same priority areas were combined into 'IWRM packages', targeting specific issues in a confined area, usually sub-catchment, and that were in-tune with the catchment plan's preferred water allocation alternative. In Muvumba, IWRM packages were developed for three areas within the catchment, and around the themes of water supply, hydropower, catchment restoration, drought management, livestock, agriculture, tea and forestry (either issue-focused or opportunity-focused). Each package has a high demonstration value, in that the same theme usually also has relevance in other parts of the catchment, or in other catchments in Rwanda.

The three IWRM package to date are as follows:

1. Support to sustainable water supply and hydropower generation through catchment restoration in Ngoma sub-catchment;
2. Drought management to improve access to water for supporting livestock and agriculture value chains, and;
3. Support improvements in sustainable water and catchment management (floods and sediments mitigation) through developing the tea and forestry value chains in Mulindi.

As gender and climate change are of prime importance in catchment planning, the PoM and IWRM packages all include gender and climate change mitigation / adaptation aspects that are strongly associated with the projects' key components, outputs and related indicators. These aspects will demonstrate how to address IWRM related gender and climate change issues.

Implementing the Catchment Plan

[1] This is as in areas where irrigation takes place, or will be developed, it was immediately clear that irrigation is the largest water user by far and could easily take all available water if not carefully managed.

This catchment plan is a joint plan of many stakeholders, each with their own mandate and interests. The plan is, however, the starting point for joint sector and agency planning and subsequent coordinated implementation. Planning for implementation will take place yearly, resulting in annual implementation plans (AIPs). Pre-feasibility studies for a series of IWRM packages have already been completed. Funds needed for the implementation of this catchment plan will be secured from Government of Rwanda and its development partners. With many stakeholders involved in implementation of projects on the ground, either as singular entities or in collaboration between agencies (as per the needs of each project), coordination is needed at district and catchment level to ensure consistency of individual projects with the catchment plan, as well as overall coherence between projects in the same area, especially those that rely on the same natural resources (water, land, and related resources).

The development of Muvumba catchment plan presented a learning opportunity, both in IWRM and spatial planning, for all involved stakeholders. Likewise, implementation of the first series of catchment plans in Rwanda will also offer many opportunities for learning, as well as associated challenges. Institutional and technical lessons learnt during implementation, are important for development of the next series of catchment plans, for 2024-2031 and 2031-2038.

Intervention logic and monitoring and evaluation

The Catchment Plan's strategic intervention logic and monitoring and evaluation framework are aligned with NST1, CCAs, SSPs, and DDSs. Progress at district level will be spatially aggregated to catchment level, and can subsequently by aggregated to the national level, to demonstrate the contribution of Catchment Plans to achieve national and local goals.

Incamake

Igenamigambi ry'imicungire y'icyogogo ni inyandiko yifashishwa mu kubungabunga umutungo kamere w'amazi, ubutaka n'indi mitungo kamere mu buryo bukomatanyije. Gucunga ibyogogo bishingira ku mbibi z'inzuzi, imigezi, ibiyaga n'imitembere y'amazi y'imvura avuye ku mabanga y'imisozi n'amazi y'ibidendezi by'ikuzimu. Mu cyogogo dusangamo abaturage n'ibikorwa bitandukanye birimo inganda, ubuhinzi, ubworozi, ubucukuzi bw'amabuye y'agaciro n'ibindi. Urwo rusobe rugira, rukanagerwaho n'ingaruka ku mutungo kamere w'amazi, ubutaka, abaturage, ibidukikije n'ubukungu muri icyo cyogogo. Bityo rero bigasaba kubibungabunga mu buryo bukomatanyije.
Igenenamigambi ryo kubungabunga icyogogo cya Muvumba ryakozwe rishingiye kuri Gahunda ya Guverinomay'imyaka 7 (2017-2024), Icyerekezo cya 2050 na Gahunda y'Igihugu y'Iterambere rishingiye ku kubungabunga ibidukikije. Iri genamigambi ryakozwe kubufatanye n'inzego zitandukanye. Ku rwego rw'igihugu, Ikigo cy'Igihugu Gishinzwe Gucunga no Guteza Imbere Amazi n'Amashyamba cyahawe inshingano yo kuyobora iki gikorwa. Minisiteri zitandukanye zifite aho zihuriye n'imicungire n'imikoreshereze y'umutungo kamere w' amazi zari zihagarariwe binyuze muri komite ngishwanama.
Ku rwego rw'icyogogo, Uturere tukigize twari duhagarariwe n'abakozi bafite umutungo kamere n'ibidukikije mu nshingano, hakiyongeraho uhagarariye abari n'abategarugori, urubyiruko, abikorera ku giti cyabo n' umuyobozi w'Akarere wungirije ushinzwe Ubukungu n'Iterambere. Abo bakaba bagize komite y'icyogogo.

Uburyo bwakoreshejwe mu gukora igenamigambi ry'icyogogo

Iri genamigambi rikenera isuzuma ry'ingamba ku bidukikije nkuko bisabwa n'itegeko rigenga ibidukikije ndetse n'amahame mpuzamahanga yo kurengera ibidukikije. Mu rwego rw'igikorwa cyo gusuzuma ingamba kubidukikije kuri iri genamigambi, hifashishijwe ubunararibonye bwa Komisiyo y'Ubuholandi yita ku isuzuma ngaruka ku bidukikije (NCEA). Uruhare rw'abafatanyabikorwa bakorera mu cyogogo ni rimwe mu mahame yitaweho mu gukora iri genamigambi. Bityo, hashyizweho komite y'icyogogo igizwe n'ingeri zitandukanye z'abantu bafite inyungu mu cyogogo. Komite y'icyogogo iyoborwa n'Umuyobozi w'Akarere wungirije ushinzwe ubukungu n'iterambere.
Mu nama zitandukanye n'abagize komite y'icyogogo hakusanyijwe amakuru ku miterere rusange y'icyogogo, imibereho y'abaturage, ubukungu, ibibazo ndetse n'amahirwe ahari bityo bishingirwaho mu kugena icyerekezo cyo gucunga icyogogo cya Muvumba.
Bitewe nuko ari ubwa mbere hagiyeho igenamigambi ry'imicungire y'icyogogo cya Muvumba, iri genamigambi rishyira imbaraga mu gukemura ku ikubitiro ibibazo byo kubungabunga umutungo kamere w'amazi aribyo gusubiranya icyogogo harwanywa isuri, gufukura amavomo no kongera ubwiza n' ingano y'amazi ndetse no gusaranganya amazi hagati y'abayakoresha.
Ikigo Gishinzwe Kubungabunga Ibidukikije nk'uko kibifite mu nshingano cyagenzuye niba irigenamigambi ry'icyogogo cya Muvumba ryaritaye ku gukora isuzuma ry'ingamba zo kurengera ibidukikije, inama cyatanze zagendewo mu kunoza iri genamigambi. Iri genamigambi ry'icyogogo cya Muvumba rizashyirwa mu bikorwa biciye mubufatanye bw'abafatanyabikorwa batandukanye aho bazagenda bashyira ingamba zikubiye muri iri genamigambi muri gahunda n'ibikorwa byabo.

Isesengura ku miterere y'Icyogogo cya Muvumba

Icyogogo cya Muvumba kibarizwa ku rwego rwa mbere rw'ibyogogo by' u Rwanda kikaba giherereye mu cyogogo cy'uruzi rw'Akagera kiri mu cyogogo kinini cy'uruzi rwa Nili. Icyogogo cya Muvumba gifite ubuso bungana na km^2 3,714 igice kiri mu mu Rwanda kingana na 42% ($km^2$1,568) kingana na 5,95% y'ubuso bw'u Rwanda ($Km^2$26,338) naho 58% iri mu gihugu cya Uganda. Isoko ya Muvumba ituruka mugezi wa Mulindi uherereye mu misozi miremire igwamo imvura nyinshi mu majyaruguru y'u Rwanda ku butumburuke bwa m 2030 hejuru y'inyanja.

Icyogogo cya Muvumba gihera mumisozi ihanamye ya Buberuka ifite ubutumburuke bwa m 2500 hejuru y'inyanja. Icyogogo cya Warufu gihera mu bibaya by'iburasirazuba ikagera ku butumburuke bwa m 1750 hejuru y'inyanja igakomeza mu mirambi n'igice cy'umukenke mu burasirazuba by' u Rwanda aho ihurira n'umugezi wa Muvumba ukubutse mu gihugu cya Uganda. Igice cy'iburasirazuba bw' U Rwanda kigizwe n'imirambi n'ibibaya birimo ibiyaga byinshi n'ibishanga bikikije inkombe y'uruzi rw'akagera aho umugezi wa Muvumba wirohera ku butumburuke bya m 1250. Umugezi wa Mulindi ureshya na Km 22.5 mbere yo kwinjira muri Uganda aho ukomeza ugaca mu mu gishanga hafi y'umujyi wa Kabale. Aha uhura n'umugezi wa Sasha bigakora umugezi wa Muvumba mbereyo kugaruka mu Rwanda. Umugezi wa Muvumba mu Rwanda ureshya na km 56. umugezi w'ingenzi wiroha mu Muvumba ni warufu n' umugezi wa Ngoma uwirohamo. Umugezi wa Muvumba wiroha mu ruzi rw'Akagera ku mupaka w'u Rwanda, Uganda na Tanzaniya.

Ubutaka bwiganje mu majyaruguru y'iburasirazuba bwiganjemo ubutare bwa feri bwaturutse ku rutare siliceous bukaba butera cyane bukaba bufite ubusharire bwiyongera bujyanye no kwiyongera kw' uguhumanya k'ubutare bw'aluminiyumu. Nubutaka burebure budatwarwa ni isuri byoroheje. Mu majyepfo y'iburengerazuba hari imisozi ihanamye ubutaka bwaho ni cambisol na ambisols bugufi ugereranyije n'ubwavuzwe hejuru kuberako buherereye mu misozi miremire biroroshye ko butwarwa n'isuri. Ubutaka buri ku bishanga bukikije umugezi bugizwe n'ibumba bukaba burumbuka ariko bukaba budacengerwamo n'amazi byoroshye.

Impuzandengo y'imvura igwa mu cyogogo iri hagati ya mm 756 Nyagatare na mm 1,128 i Byumba. Icyi gitangira mu kwezi Gicuransi kikagera mu ntangiriro za Nzeri, igihe cy'imvura y'umuhindo gitangira mu mpera za Nzeli kikagera mu ntangiro z'ukuboza, hagakurikiraho urugaryi rutangira mu Mutarama rukagera mu ntangiriro za Werurwe hagakurikiraho igihe cy'itumba gitangira muri werurwe kikagera mu Gicuransi. Amapfa akunze kugaragara mu bice by'imirambi y'Umutara.

Igice cy'iburengerazuba kirangwa n'ibitare rwa schist na quartite bifite ubushobozi bwo kubika amazi mu bidendezi by'ikuzimu, igice cy'iburasirazuba kigizwe n'urutare rwa granite rufute ubushobozi bucye bwo kubika amazi mubidendezi by'ikuzimu. Ibipimo by'amazi atemba by'igihe kirekire bigaragazwa na sitasiyo iri Kagitumba igaragaza impuzandengo ya $m^3$14/s.

Ifumbire mvaruganda n'imiti iterwa mu myaka byagaragajwe nk'ibihumanya amazi mu mugezi wa Ngoma ku ruganda rwa cyondo no mu mugezi wa Muvumba, imyanda ituruka mu dusantere twa Byumba, Gatuna, Yaramba na Rukomo yagaragajwe nk'iyanduza umugezi wa Mulindi.

Mikorobi zituruka kumyanda y'abantu n'inyamaswa (E-coli na Feacal coliforms) byagaragaye mu migezi wa Muvumba na Warufu i Nyagatare na Kagitumba, ugutobamwa, ubutare bwa plomb, Manganeze, Feri na cuivre, BOD igaragaza ko hari imyanda ibora ijya mu mazi, COD n'ibyondo bwagaragaye ko biri hejuru y'igipimo cyemewe kuba mu mazi atemba n'amazi akoreshw mu ngo biri hejuru y'ibipimo byemewe n' Umuryango w'Abibumbye Gishinzwe Ubuzima Ku isi n'Ikigo cy'Igihugu Gishinzwe Ubuziranenge mu Rwanda.

Isesengura ryakozwe ku mazi y'ikuzimu n'atemba ku butaka ryagaragaje ko hafi 65% by'imvura igwa ikoreshwa n'ibimera no gukamuka, naho 2% y'imvura yose igwa, hafi inshuro eshatu y'amazi atemba, ikoreshwa mu bikorwa bya muntu. Hari igice cy'amazi gisohoka mu cyogogo n'ava mu bidendezi by'ikuzimu.

Ukwiyongera k'ubukungu mu cyogogo bushingiye ku mikoreshereze y'amazi mu bikorwa bikurikira: ubuhinzi, ubworozi, inganda no guha amazi imigi n'ibyaro. Ubukungu bushingiye cyane kubuhinzi kuko mu Rwanda 90% by'abanyarwanda batunzwe n'ubuhinzi.

Mubyogogo bya Mulindi na Ngoma mu Karere ka Gicumbi hari igihingwa ngengabukungu cy'icyayi n'uruganda rugitunganya, ubworozi bw'inka butanga amata, ibihingwa by'ibinyampeke n'ibinyamisogwe n'urugomero ruto rw'amashanyarazi rwa rushaki, mu bindi bice by'umuvumba hari ubworozi butanga amata, inyama n'impu, ubuhinzi bw'umuceri, ibigori, ibishyimbo n'imboga biri mu byinjiza amafaranga.

Mu bindi bikorwa bitanga amafaranga twavuga ubucukuzi bw'amabuye y'agaciro (zahabu, gasegereti, wolufaramu na koruta) na kariyeri.

Ibarura ry'abaturage ryo mu mwaka wa 2012 ryagaragaje ko icyogogo cya Muvumba cyari gituwe n' ibihumbi magana atandatu (600,000). 7, 7% baba mu mijyi naho 92, 3% baba mu cyaro. 51.7% ni abagore naho 54% bari munsi y'imyaka 20 (EICV4). Ubucucike buri hejuru buri hagati y'abantu 536-767 /km^2 muri Rukomo, Katabagemu na Mimuli mu dusanteri. Mu Karere ka Gatsibo mu gice cy'amajyepfo y'iburasirazuba no muri Gicumbi i Nyankenke, Byumba, Manyagiro, Cyumba, Rubaya n'agace gato ka Bungwe muri Burera, mu majyepfo y'iburengerazuba mu murenge wa Kageyo mu krere ka Gicumbi ubucucuke buri hagati y'abaturage 768-998/Km^2. Igipimo cy'ubukene kiri hejuru cyane bitewe n'ubwiyongere bukabije bw'abaturage no kugunduka k' ubutaka kuberako ubukungu ahanini bushingiye kubuhinzi.

Guhuza itegurwa ry'igenamigambi ry'imicungire y'icyogogo cya Muvumba n'izindi gahunda, ingamba na politiki bya Leta bisanzwe

Iri genamigambi ku micungire y'icyogogo cya Muvumba ryateguwe hashingiwe kuri gahunda, ingamba ndetse na Polikiti za Leta zisanzwe mu rwego rwo kuzuzanya. Hasesenguwe Gahunda y'iterambere rirambye rishingiye ku kubungabunga ibidukikije (Green Growth and Climate Resilience Strategy (GGCRS), Gahunda ya Guverinoma y'imyaka 7 (NTS1), icyerekezo cy'iterambere 2050 ndetse na porogamu zifite aho zihuriye no kuhira imyaka, gukwirakwiza amazi yo kunywa, imikoreshereze y'ubutaka, ubucukuzi bwa mine na kariyeri, imiturire, igishushango mbonera kigaragaga ingano y'umutungo kamere w'amazi, ubukerarugendo ndetse n'uburinganire. Igenamigambi ry'imicungire y'icyogogo cya Muvumba rihuza igenamigambi ryo ku rwego rw'igihugu n'uturere. Isesengura ryatumye haboneka ibitekerezo byifashishijwe hakorwa iri genamigambi ku micungire y'icyogogo cya Muvumba. Kugeza ubu igenamigambi ku micungire y'icyogogo cya Muvumba ryagendeweho mu gutegura gahunda z'iterambere(DDSs) z'uturere duhuriye mu cyogogo cya Muvumba aritwo Gicumbi, Gatsibo na Nyagatare.

Ibibazo by'ingenzi biri mu cyogogo cya muvumba

Ubucukuzi bw'amabuye y'agaciro n'isuri iva mu buhinzi ku misozi nibyo byingenzi byanduza amazi atemba bikarohamo ibyondo byinshi bigasaba inganda zitunganya amazi yo kunywa ko zongera ingano y'imiti iyacayura bityo bikazamura igiciro cyo kuyatunganya, ku nganda z'amashanyarazi n'izitunganya amazi iyo urwondo rwabaye rwinshi biba ngombwa ko zihagarara gukora kugirango babanze barukuremo. Ibyondo n'imicanga biva mubirombe by'amabuye y'agaciro cg ibinyabutabire bikoreshwa mu koza amabuye bishobora kwanduza amazi bishyiramo ibinyabutabire bihumanya byangiza ubuzima bw'ubinyweye.

Imyuzure yo mucyayi cya Mulindi yangiza imirima y'icyayi bikagabanya umusaruro, amapfa akunda kwibasira ibyogogo bito bya muvumba ya ruguro niye epfo bigabanya umusaruro w'abahinzi n'aborozi, amatungo n'imyaka bigapfa n'abahaturiye bakagira ikibazo cyo kubura amazi bigatuma habaho no gucuranwa amacye abonetse.

Ugusarura amashyamba bitemewe n'ikibazo cyingorabahizi kuko bisiga ubutaka bwambaye ubusa bigatuma isuri igera mu mugezi byoroshye ndetse bikanatiza umurindi umuyaga ugasenyera abaturage.

Ukwiyongera kw'abaturage nacyo n'ikibazo cy'ingutu kuko bituma ubutaka buhingwa bugakoreshwa cyane ntibwisubize.

Amahirwe yingenzi aboneka mu cyogogo cya Muvumba

- Ubutaka bwera buberanye no guhingwa hakoreshejwe imashini no kuhira
- Inzuri za kijyambere n'umukamo uhagije kuburyo basagurira amasoko
- Ahantu nyaburanga n'andi mahirwe y'iterambere nk'urujya n'uruza rw'abaturiye umupaka
- Hari umujyi wunganira kigari (Nyagatare) ufite amahirwe yo kubona ibikorwa remezo bihamye
- Hari amabuye y'agaciro (Zahabu, Gasegereti, Wolufaramu, koluta, na kariyeri)
- Hari amahirwe yo kubaka inganda z'amashanyarazi n'izisukura amazi yo kunywa

Icyerecyezo n'intego zo kubungabunga icyogogo cya Muvumba

Icyerecyezo n'intego zihariye zo kubungabunga icyogogo cya Muvumba zateguriwe hamwe n'abagize komite yo kubungabunga iki cyogogo, n'abatekinisiye baturutse muri Minisiteri zikoresha umutungo kamere w'amazi, abakozi bo mu Kigo Gishinzwe Guteza Imbere Amazi n'Amashyamba bafashijwe n'impuguke zaturutse muri komisiyo yo kubungabunga ibidukikije yo mu Buholande, ubu buryo bwibanze ku bibazo n'amahirwe biri mu cyogogo, intego z'iterambere rirambye ,imirongo mpuzamahanga n'amabwiriza yo kubungabunga ibidukikije ku rwego rw'isi.

Icyerecyezo cyo kubungabunga icyogogo cya Muvumba

Icyogogo kibungabunzwe mu buryo buhamye, kikaba icumbi ry'urusobe rw'ibinyabuzima, bibanye mu buryo bunoze buvoma imibereho myiza n'umubukungu mu mutungo kamere w'amazi n'uw'ibidukikije bihari.

Intego rusange:

Umutungo kamere w'ubutaka, amazi n'indi bifitanye isano bibungabunzwe mu buryo bunoze bigira uruhare rufatika mw'izamuka ry' imibereho myiza y'abaturage, no kongera ubukungu hazirikanwa kandi isaranganywa ry'amazi ry'abatuye aho amazi aturuka n'abatuye aho amazi atemba agana, amazi agomba gusigara atemba mu mugezi no kwita kumihindagurikire y'ibihe n'ibiza bifitanye isano nabyo.

Intego zihariye zo kubungabunga icyogogo cya Muvumba zateguye mu buryo bukurikira:

- Intego ya 1: Kongera ubwiza n'ingano y'amazi duhangana nihindagurika ry'ibihe
- Intego ya 2: Kugabanya ikoreshwa ry'umutungo kamere hahangwa imirimo mishya
- Intego ya 3: Gusaranganya amazi mu buryo bungana hashingiwe kungano y'amazi ahari kubayakoresha ubu hazirikanwa n'abazabakomokaho
- Intego ya 4: Guha ingufu inzego n'imiyoborere y'ikoreshwa ry'amazi, no gushyiramubikorwa gahunda zo kubungabunga umutungo kamerere w'amazi mu buryo bukomatanye no guhimbaraga ubufatanye ndengamupaka

Gahunda y’ibikorwa

Igenamigambi ku bizakorwa mu cyogogo cya muvumba ryarakozwe kuva 2018 kugeza 2024, Kwikubitiro ibikorwa by’ingenzi byerekeye kubungabunga ubutaka, gusaranganya amazi no kongera ubumenyi.

Mu kubungabunga ubutaka: hazarwanywa isuri mu buryo burabye, hacibwa amaterasi yikora n’ay’indinganire hakanaterwaho ibiti bivangwa n’imyaka, haterwa amashyamba hakanasazurwa ashaje, hacukurwa imiringoti hakanasubiranywa imikoki. Hazibandwa ku kurwanya isuri; hongerwa umusaruro ku butaka n’ikoreshwa ry’amazi. Mu gufata ingamba ku bikorwa bikenewe bidusaba kureba aho ibikorwa bibera n’amasezerano y’abafatanya bikorwa.

Mu gufata ibyemezo, hifashishije ikoranabuhanga ry’ikarita ngarangaza miterere n’indeshyo y’ubutaka buharanga (CROM-DSS).

Gusaranganya amazi

Ibi birajyana n’ ingamba zifatwa mu gusaranganya amazi mu buryo burambye muri iki gihe no mu bihe bizaza haba mwikoreshwa ry’amazi mu buhinzi n’ubworozi, mu mikoreshereze y’amazi yo gukoreha mu ngo, mu nganda n’ibindi.

Amwe mu mahitamo y’imikoreshereze myiza yo kuhira, gukoresha ubutaka neza n’amazi mu buryo buryo hakoreshwa macye ashoboka (RI+SLM+E) byashyizwe mw’igenamigambi mw’isaranganya ry’amazi mu byogogo ku kwezi, ku bakoresha amazi kugeza icyerekezo cya 2024, 2030,2050. Icyo cyerekeza cy’igenamigambi mu gusaranganya amazi cyabaye imbarutso yo gushyiraho impushya zo gutanga amazi n’imikoreshereze y’umutungo kamere w’amazi, duhereye ku nzego nkuko bikurikira: Gukoresha amazi mu ngo, ubworozi, amazi ku binyabuzima, mu nganda no mu kuhira.

Imiyoborere y’ikoreshwa ry’amazi

Iyo miyoborere ireba inzego, politiki n’amategeko akurikizwa mw’ishyirwa mu bikorwa ry’ingamba z’ibikorwa biteganijwe. Iyo miyoborere ireba uyoboye icyogogo n’imirongo migari ngenderwaho.

Hashyizweho Komite yo kubungabunga icyogogo mwikurikirana ry’igenamigambi ryo kubungabunga icyogogo. Itegeko rishya ry’ Imikoreshereze n’Imicungire y’Umutungo Kamere w’Amazi mu Rwanda riteganya ishyirwaho rya komite y’icyogogo; rishimangirwa n’iteka rya Minisitiri ufite umutungo kamere w’amazi munshingano.

Ubushakashatsi n’amahugurwa

Ubwo bushakashatsi bureba ingamba zo kubika no gukoresha amakuru ku mibare n’ububenyi bw’amazi hiyongereye ho ubumenyi n’ubuhanga bwo kubungabunga umutungo kamere w’Amazi.

Kubera igenamigambi ryo kubungabunga icyogogo, ubumenyi bwo gukoresha amakarita ngaragaza shusho n’ikoreshwa ryayo n’inzego zifata ibyemezo bizatuma kubungabunga icyogogo bikorwa mu buryo bukomatanije. Nicyo gituma imbumbe y’ imishinga yashyizwe hamwe haherewe ku ngamba zihamye z’icyogogo mu duce twibanze. Mu cyogogo cya Muvumba, imishinga itatu yatoranijwe haherewe ku kurwanya amapfa hafatwa amazi, isuri hakorwa ubuhinzi burabye kandi bubyara umusaruro, gucukura amabuye y’agaciro bya kinyamwuga n no kubungabunga icyogo cy’urugomero zrw’amashanyarazi rwa Rushaki.

Iyo mbumbe y’imishinga itatu ni iyi ikurikira:

1. Kubungabunga mu buryo buhamye amabanga y'imisozi n'inkombe bikikije umugezi wa Ngoma mu rwego rwo kurinda ibyondo n'imicanga bizanwa n'isuri bikiroha mu idamu y'urugomero rw'amashanyarazi rwa Rushaki bikaniroha ahafatirwa amazi y'uruganda rusukura amazi rwa Cyondo muri Kiyombe agaburira umujyi wa Nyagatare ku mazi akoreshwa mu ngo n'ayuhira amatungo.
2. Guhangana n'ikibazo cy'amapfa mu buryo burambye, hongerwa ingano y'amazi akenerwa mu kuhira amatungo n'imyaka no kongerera agaciro umusaruro ukomoka kubuhinzi n'ubworozi.
3. Guhangana n'ibibazo by'umwuzure n'ibyondo byangiza imirima y'icyayi hasiburwa imiferege itwara amazi habungabungwa n'amabanga y'imisozi ikikije igishanga cy'imirima y'icyayi cya Mulindi, haterwa icyayi aho imirima yacyo yangiritse ndetse hagaterwa amashyamba abungabunga icyogogo kandi akaziba icyuho cy'inkwi zikoreshwa mu gutunganya icyayi hibandwa ku bwoko bw'ibiti bitanga ingufu z'umuriro udashira vuba.
Igenamigambi ry'iyo mishanga ryibanze ku buringanire n'imihindagurikire y'ibihe n'ibibazo by'insobe bibishamikiyeho.

Ishyirwa mu bikorwa ry'igena migambi

Iri genamigambi ry'icyogogo ni igikorwa gihuriweho n'abafatanyabikorwa benshi, kuburyo buri wese agiramo inshingano, inyungu n'igihe ntarengwa cyo gushyira mubikorwa iyo migambi. Igenamigambi rikaba ariryo ntangiriro ihuza abafatanya bikorwa batandukanye mu buryo bwo kugena uko iyo migambi izashyirwa mu bikorwa. Gushyira mu bikorwa igena migambi bizajya bikorwa buri mwaka, kuburyo bujyanye na gahunda ya buri mwaka. Imbumbe y'imbanzirizanyigo y'imishinga igendanye n'imikoreshereze ikomatanye y'imicungire y'umutungo kamere w'amazi mu cyogogo cya Muvumba yarangije gukorwa. Inkunga ikenewe mu gushyira mubikorwa iri gena migambi ryo kubungabunga icyogogo izatangwa na Guverinoma y'u Rwanda ifatanyije n'abandi bafatanyabikorwa bayo batandukanye. Abo bafatanyabikorwa batandukanye bahuriye mu ishyirwa mu bikorwa ry'igenamigambi ry'icyogogo, baba abikorera ku giti cyabo cyangwa amashyirahamwe, bafite uruhare rugarara mugushyira mu bikorwa iri genamigambi, bakeneye guhuriza hamwe ibikorwa ku rwego rw'akarere no mu cyogogo mu rwego rwo gukurikirana imigendekere myiza y'umushinga n'ishyirwa mubikorwa ry'igenamigambi ryo kubungabunga icyogogo, cyane cyane ku mishanga ifite aho ihuriye n'imikoreshereze y'umutungo kamere w'amazi, ubutaka n'indi mitungo kamere.

Inyigo yo kubungabunga icyogogo cya Muvumba igaragaza inyungu zo kubungabunga umutungo kamere w'amazi mu cyogogo cyose, ku bidukikije, ndetse n'abantu bose bafite aho bahuriye nacyo. Ni muri urwo rwego icyiciro cyambere cyo gushyira mubikorwa igenamigambi ryo kubungabunga ibyogogo mu Rwanda, rizagira inyungu rikanatwigisha uburyo twacyemura ibibazo bigaragara mu cyogogo. Ubumenyi butandukanye buzava mu bikorwa by'iri genamigambi buzadufasha gutegura neza no gushyira mubikorwa irindi gena migambi ryo kubungabunga icyogogo mu myaka ya 2024-2031-2038.

Uburyo bwo gushyira mubikorwa, gukurikirana no gusuzuma igenamigambi

Gahunda yo gushyira mu bikorwa, gusuzuma no gukurikirana igena migambi ryo kubungabunga icyogogo zahujwe na gahunda ya Guverinoma y'imyaka 7 (NTS1), Icyerekezo cy'iterambere 2050, Igenamigambi na politike ya za ministeri zitandukanye na gahunda y'iterambere ry'uturere.

Uruhererekane rw'ibikorwa ku rwego rw'akarere ruzajya rushyirwa mu bikorwa mugice cy'icyogogo gaherereyemo, nyuma bikazajya bihurizwa hamwe ku rwego rw'igihugu, kugirango hagaragazwe uruhare rw'igenamigambi ryo kubungabunga icyogogo mu iterambere ry'igihugu.

1. Introduction

1.1 The integrated catchment planning process

Catchment planning is international best practice for integrated management of water, land, and related natural resources, based on the hydrological boundaries of a catchment or watershed. A catchment is an area of land where precipitation collects and drains off into a common outlet, such as a river, lake, or other body of water. A catchment includes all the surface water from rainfall runoff, snowmelt, and nearby streams, which runs downhill towards the shared outlet, as well as all groundwater bodies wholly or partly within the same area. The strong relationships between land and water within a catchment, call for an integrated management thereof.

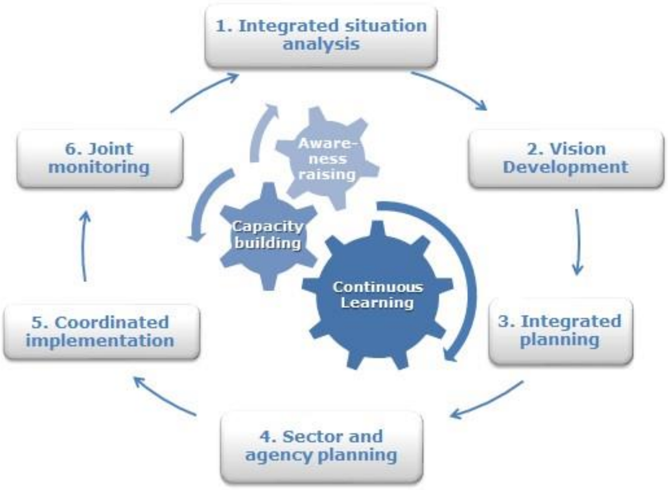


Figure 1: The IWRM and catchment planning cycle

Catchment Plans in Rwanda are developed for a period of six years, congruent with other main strategic plans like Sector Strategy Plans (SSPs) and District Development Strategies (DDSs). The development of catchment plans for a set period implies a cyclical planning and review process, which is introduced in the Integrated Water Resources Management (IWRM) cycle in Figure 1 above. The IWRM cycle covers the entire six-year management cycle; while the integrated catchment plan (this document) comprises the first three steps (integrated situation analysis, vision development, and integrated planning); annual implementation plans are developed in the fourth step (sector and agency planning); and coordinated implementation (fifth step) and joint monitoring (sixth step) follow the annual implementation plans. Whereas implementation of individual projects is mostly managed by individual, mandated agencies, integration needs to be safeguarded by strong coordination within the catchment, which in turn also requires joint monitoring. Midway through the six-year period, the development of the next catchment plan starts again with an updated integrated situation analysis.

The continuous learning and improvement process that is characteristic of IWRM is incorporated within the IWRM cycle. The process is also reflected in the iterative development of successors to this catchment plan. Every new version will be an upgrade of the previous one, yet catchment planning will never be fully complete as any good planning process will always identify data gaps, policy issues etc. that need to be addressed during development of the next plan. The current version of this plan is, however, 'fit-for-purpose' and delivers its main purpose of allowing issues to be addressed through development of Annual Implementation Plans, in this instance for 2018-2019 and the support of the final alignment with NST1.

IWRM and SEA

An important aspect of the legal context for catchment planning is captured in Article 67 of Organic Law no. 4/2005: *'every project shall be subjected to an Environmental Impact Assessment (EIA), before obtaining authorisation for its implementation.'* In addition, the article mentions *'this applies to plans, programmes and policies that may affect the environment.'* International best practice, however, recommends use of the Strategic Environmental Assessment (SEA) instrument for plans, programmes, and policies, whereas EIAs are the preferred instrument for projects. In the guidelines for SEA (under development by REMA, the Rwanda Environmental Management Authority under MoE) it is obligatory to implement an SEA process and to submit an SEA report to MoE/REMA for approval of any plan, programme, or policy.

As IWRM and SEA have much in common, both processes were integrated into a singular approach. The detailed participatory approach that was followed, and an overview of the legislation and regulations for SEA, are summarised in Annex 4.

1.2 Institutional embedding

The Water Law (2008)[2] and the National Water Resources Management policy (2011) of the former Ministry of Natural Resources, both provide a sound basis for integration of land and water management at the catchment level. The overall goal of the policy is: '*to manage and develop the water resources of Rwanda in an integrated and sustainable manner, so as to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations, with the full participation of all stakeholders in decisions affecting water resources management.'* According to international best practice, this goal translates into the development of catchment plans in a participatory manner, and the subsequent implementation of the plans in an as-much-as-possible decentralised process. A summary of the key points of the Water Law (2008) and the water resources management policy is provided in Water for Growth Rwanda's Technical Report 'Consistency Analysis' (W4GR TR16, 2016).

Catchment planning is an important instrument to contribute to the achievement of the objectives and goals of Vision 2020, Vision 2050, and the National Strategy for Transformation (NST1: the 7 Year Government Plan 2017-2024) of the Government of Rwanda, as well as for the implementation of the Green Growth and Climate Resilience Strategy (GGCRS) of Rwanda (Government of Rwanda, 2011) and other relevant sectorial policies, plans, and programmes. NST1, GGCRS, SSPs, CCAs, Catchment Plans, DDSs, and their annual implementation plans, budgets, and Imihigos, are intrinsically linked, as visualised in Figure 2. An introduction to the links between the catchment plan and the main sector strategies and cross-cutting areas of NST1 is provided in Annex 4.

An organisational structure for the development of catchment plans was set up at the central and catchment levels. The Water Resources Management Department (WRMD) of the Rwanda Water and Forestry Authority (RWFA) was designated as the lead agency to guide development of the plans. Partner ministries were represented through their membership of the Water for Growth Rwanda / IWRM Programme Steering Committee (PSC) and in the Focal Group (FG). At the catchment level, officials and staff, as well as a number of special interest representatives from each significant district within the demonstration catchment, jointly constituted the Catchment Task Force. It needs to be noted that most of these were temporary arrangements, based on the IWRM Programme between the Government of Rwanda (GoR) and the Embassy of the Kingdom of the Netherlands (EKN) in Rwanda. Sustainability of the institutional collaboration framework has been secured for the new Water Law (2018) and related Ministerial Orders. In these, the CTF created for the programme will be transformed into a permanent Catchment Committee, and stipulations are included for formal approval and endorsement of future

[2] And its successor, the Law Nr 49/2018 of 13/08/2018 determining the use and management of water resources in Rwanda.

catchment plans. The composition of the (temporary) Catchment Task Force was developed by the (then) IWRM Department[3] in 2016, and was as follows for each district in the catchment:
Vice Mayor for Economic Development;

- District Environment Officer;
- District Agronomy Officer;
- District representative of National Women Council;
- District representative of NGOs/CSOs;
- District representative of the Private Sector Federation.

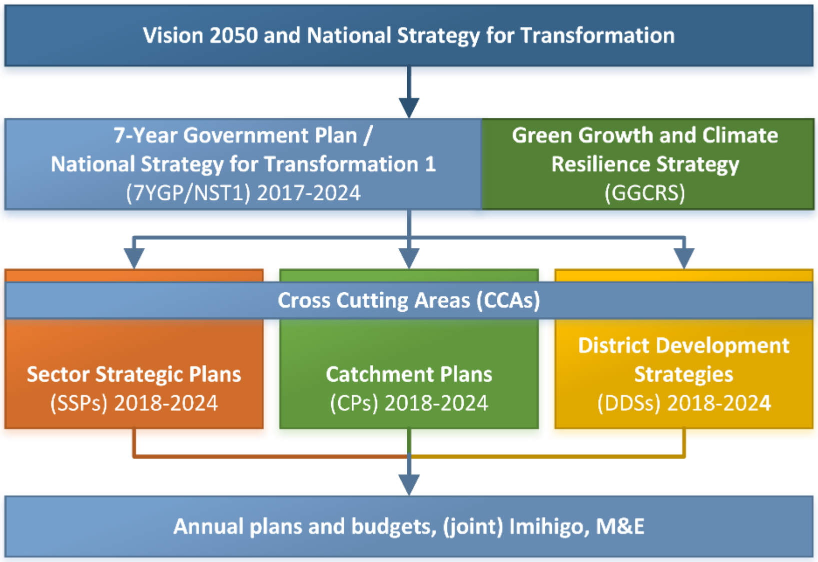


Figure 2: Embedding of CPs in NST and GGCRS framework

Members of the core team (the day-to-day board) of the Catchment Task Force were elected by and from the CTF members and were endorsed by a letter from the Minister of Natural Resources. The composition of the CTF core team and the complete CTF are provided in Annex 7.

1.3 Joint catchment plan implementation

The development of catchment plans was done in an integrated manner, using a participatory approach with key stakeholders in the catchment. This participatory character is one of the requirements of both IWRM and SEA principles. The development of catchment plans relates to Steps 1-3 of the planning cycle (Figure 1). Step 4 (sector and agency planning) refers to mandated entities, preparing the implementation of their own elements of catchment plans: Ample time and attention was given to ensure optimal inclusion of existing and planned programmes, and projects of plan partners at central and local level. This was reflected in a long-list of potential IWRM (proof) interventions in the catchment (paragraph 4.5). Whereas the preparation of the projects of plan partners is largely their own internal process, implementation of Step 5 needs to be well coordinated. Different projects, carried out in the same sub-catchment, may have multiple interactions because they use the same land and water resources.

To this end, the Catchment Task Force will need to assume a coordination role, in close collaboration with designated representatives of the projects-implementing partners. Similar collaboration between the Catchment Task Force and the national plan partners is required in the joint monitoring and evaluation of catchment plan implementation (Step Six), also for the timely development of the next catchment plan for 2024-2030.

[3] The name of the IWRM Department has been changed to Water Resources Management Department upon the reorganisation of MINIRENA into MINENV and MINILAF. The Rwanda Water and Forestry Authority, under which the WRMD falls, reports to both ministries.

1.4 Plan structure

The structure of this catchment plan generally follows the steps of the IWRM cycle in Figure 1. Chapter 2. is the starting point of the cycle, covering the technical and socio-economic elements of an integrated situation analysis. The institutional embedding of the catchment plan is presented in Annex 4, Consistency Alignment. This background chapter contains an analysis of laws, policies, regulations, plans, the framework of Vision 2050, the National Strategy for Transformation, and an analysis of Sector Strategic Plans, District Development Strategies, and Cross Cutting Areas. Vision development and the catchment objectives are the topic of Chapter 3. (Vision and objectives). The integrated plan follows in the form of Chapter 4. (Programme of Measures). Sector and agency planning, as well as coordinated implementation, are the topic of Chapter 5. (Implementation arrangements). Stipulations for joint monitoring are laid down in Chapter 6. (Intervention logic, monitoring and evaluation). A series of annexures provide background information on e.g. Water for Growth Rwanda (Annex 1), the glossary of terms (Annex 2), the SEA-planning process description (Annex 7), as well as guidelines for mainstreaming of gender (Annex 10) and climate change (Annex 11). **Error! Reference source not found.** provides the catchment plan's intervention logic a nd M&E framework.

2. Integrated situation analysis

2.1 Catchment characteristics

2.1.1 Physiography

Muvumba is a level 1 catchment located in the Kagera sub-basin and is part of the most upstream section of the Nile River Basin. The Muvumba River is a transboundary river, shared between Rwanda and Uganda (see Figure 31, Annex 3) with a total catchment area of 3,714 km². The catchment within Rwanda is 1,567.8 km² and represents 5.95 % of the total surface area of Rwanda (26,338 km² including water bodies). This section presents the main characteristics of the catchment, based on information from the National Water Resources Master Plan (NWRMP; MINIRENA, 2014), the National Institute of Statistics of Rwanda (NISR), and from several studies carried out by Water for Growth Rwanda.

Rivers and elevation

The source of the Muvumba catchment is the Mulindi River located in the mountainous and high-rainfall central, northern part of the country at an altitude of 2,030 masl (meters above sea level). The Mulindi River flows north entirely within Rwanda for a length of 22.5 km towards the Ugandan border and then it crosses the national border onto a flat wetland zone near Kabale. Here, in Uganda, it joins the Muvumba River, before eventually flowing back into Rwanda. The length of the Muvumba river in Rwanda is around 56 km. Major tributaries within Rwanda are the Warufu River, and its tributary, the Ngoma River. In Nyagatare district, the Warufu joins the Muvumba, which then flows north-east and forms the border between Rwanda and Uganda, before finally joining the Akagera River where the borders of Uganda, Rwanda and Tanzania meet.

The morphology of a catchment is a crucial characteristic that determines a significant part of its hydrological response to rainfall. The Muvumba catchment rises in the Buberuka highlands, with altitudes up to 2,500 masl. The Warufu sub-catchment starts in the Eastern Plateau, which extends over highlands (around 1,750 masl) and hills of medium altitude and flows through the eastern savanna, where it joins the main Muvumba River. Here, the Eastern Savanna has gentle slopes, and includes numerous lakes and wide areas covered by marshes extending along the Akagera River into which the Muvumba River discharges at an altitude of around 1,250 masl at the confluence. Figure 3 (also included in Annex 3) shows Muvumba's transboundary hydrology and elevation.

Geology, soils and ecology

The western part of the catchment, draining into Uganda through the Mulindi River, is characterised by alternating schist and quartzite layers with average groundwater holding potential. The eastern part has granite as the dominant basement aquifer, which results in low storage capacity and conductivity. A geological map is provided in Figure 32, Annex 3.

The most extensive soil types within the low lying, north-eastern section of the catchment are Ferralsols. These are derived from deeply weathered siliceous rocks and thus are of low fertility, acidic and prone to toxicity due to aluminium. They are generally deep, easy to work and less erodible than other deeply weathered soils. In the south-western uplands on steep slopes are Cambisols and Alisols, which are moderately deep and more fertile than Ferralsols since they possess a higher Cation Exchange Capacity (CEC). Being located on steep slopes they are especially susceptible to erosion. Along valley bottoms and associated with swamps are the clay soils of moderate fertility and low infiltration capacity. A soil map of the catchment is provided in Figure 33, Annex 3.

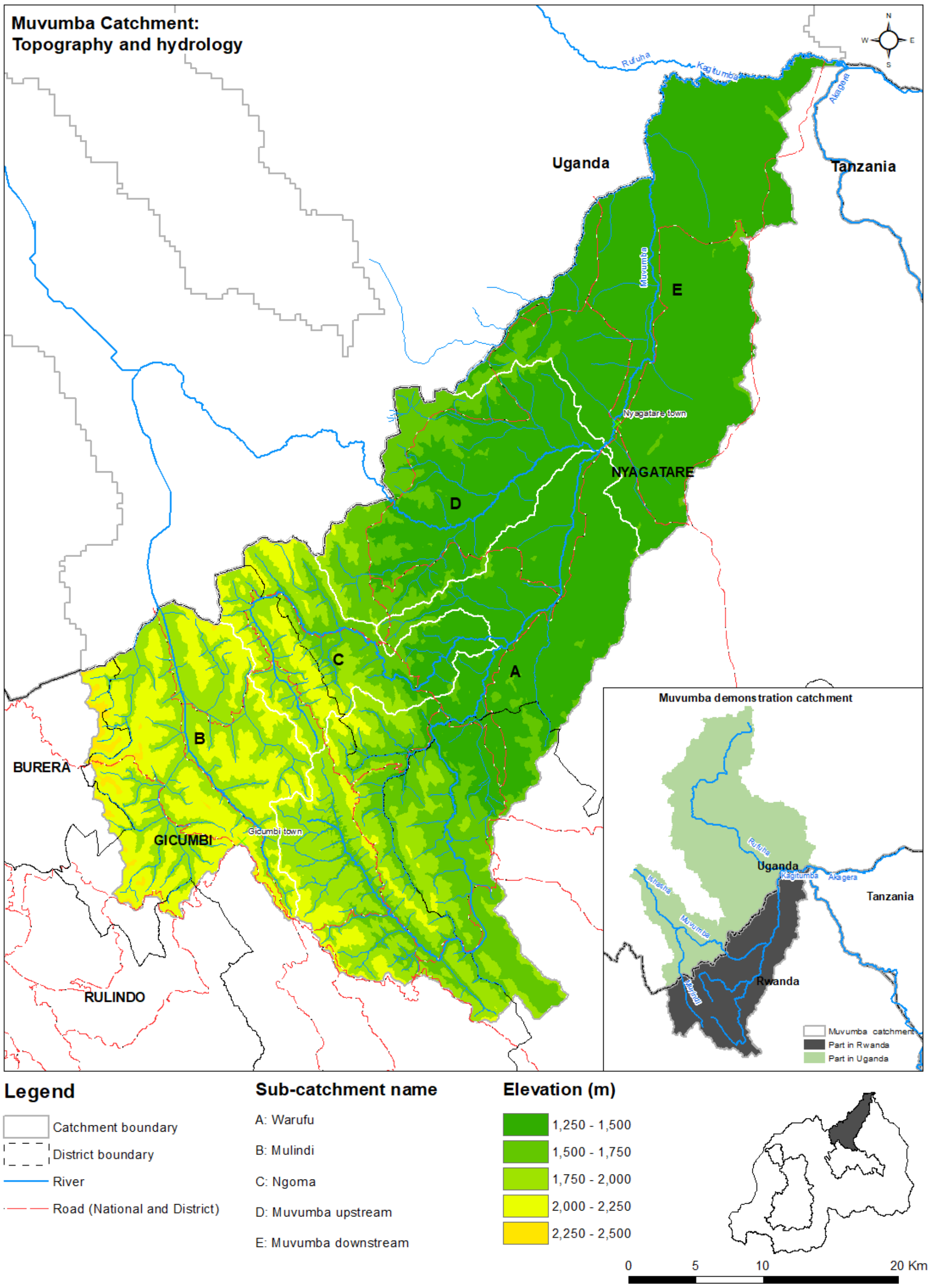


Figure 3: (Transboundary) Muvumba catchment elevation, waterbodies and waterways

Averaged climatic information (temperature, rainfall and altitude) has been used to divide Rwanda into ten agro-climatic zones (ACZs) and these are used to classify the country according to agricultural suitability.

While ACZs are defined by temperature and rainfall, Agro-Ecological Zones (AEZs) are characterised according to soils and climatic criteria. An AEZ is a land resource mapping unit, defined in terms of climate, landform and soils, and/or land cover, and having a specific range of potentials and constraints for land use. The ecoregions and agro-ecological zones of Rwanda are presented in Figure 4 and Figure 5.

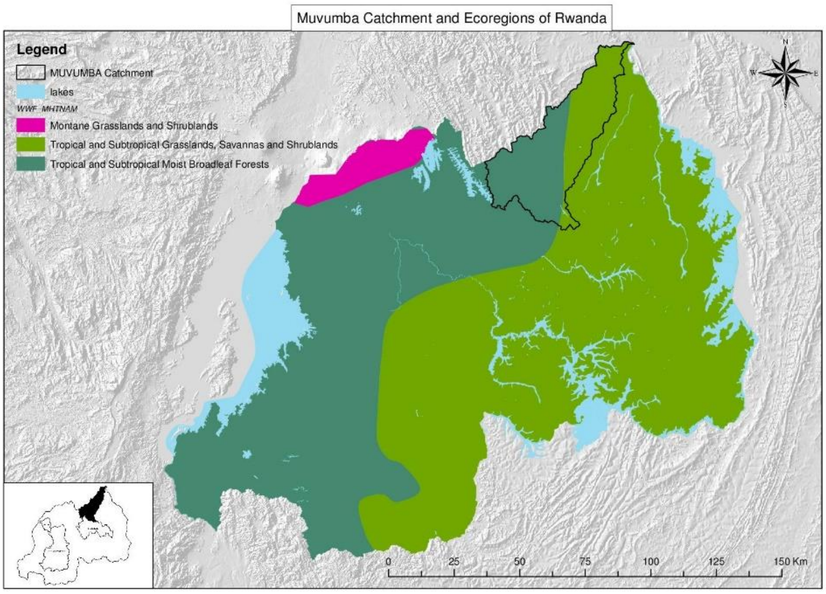


Figure 4: Muvumba catchment and the ecoregions (WWF) of Rwanda

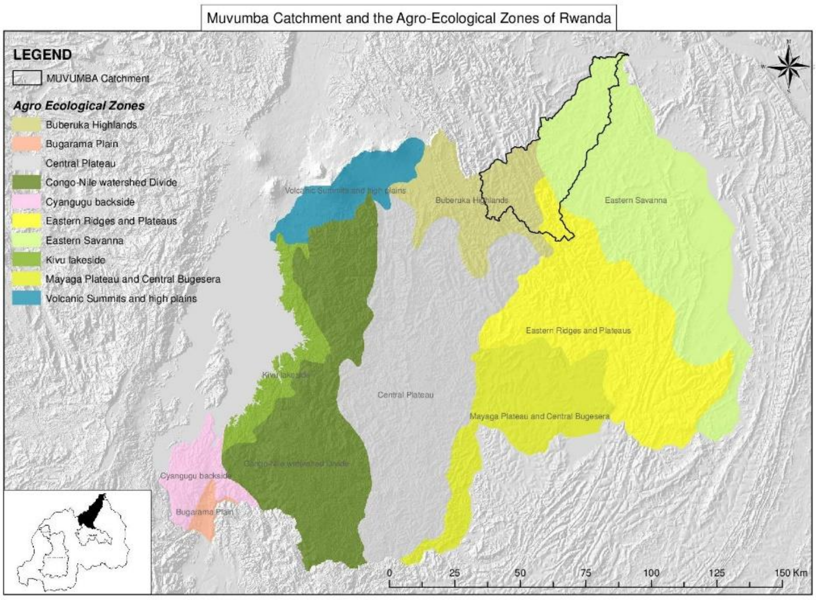


Figure 5: Muvumba catchment and the agro-ecological zones (WWF) of Rwanda

Rainfall

The rainfall pattern in Uganda and Rwanda is bi-modal, i.e. it has two rainy seasons. Rainfall depends on progression of the Inter Tropical Convergence Zone (ITCZ) as it follows movement of the sun between its northern (June) and southern summer solstices (December). This pattern results in 'long rains' (March, April, and May), and 'short rains' (September, October, November and December). The mean annual precipitation varies between 756 mm at Nyagatare and 1,128 mm in the highlands at Byumba. The dry season runs from late May to early September, with the rainy period in October to early December, a slight dip around the month of January and a peak rainy season from March to early May. The dry season months are prolonged in the lower altitude areas and towards the east.

Despite its location in the tropical belt, Rwanda experiences a temperate climate as a result of its high elevation. The average temperature for Rwanda is around 20°C and varies with the topology but relatively little throughout the year. The warmest annual average temperatures are found in the eastern part which includes the areas drained by the Muvumba catchment. Temperature observation data within the catchment indicates a maximum daily temperature of 21.9°C and minimum daily temperature of 13.2°C in the highlands at Byumba and a maximum daily temperature of 27.5°C and minimum daily temperature of 14.3°C at Nyagatare in the lowlands.

Climate change

Rwanda has a climate with an average temperature around 20°C and low monthly variation. As Muvumba is located in the north, the mean altitudes are lower, and temperatures are a bit higher than the country averages (20-21°C). Rwanda has a drier climate in the east (lower elevation), and a wetter climate in the west (high-altitude mountains), resulting in a large and varied pattern of agro-ecological zones. This variation leads to a complicated and uncertain picture for potential changes in Rwanda's overall climate.

The Global Facility for Disaster Reduction and Recovery (GFDRR)[4] maintains a risk atlas with hazard vulnerability maps for Rwanda. Muvumba catchment covers 5 districts, each vulnerable to hazards (drought vulnerability, landslides, and windstorms) to differing degrees:

1. Burera: Drought vulnerability (none), landslides (high), windstorms (moderate);
2. Gicumbi: Drought vulnerability (moderate), landslides (high), windstorms (moderate);
3. Nyagatare: Drought vulnerability (high) landslides (low), windstorms (moderate);
4. Gatsibo: Drought vulnerability (high), landslides (low), windstorms (low);
5. Rulindo: Drought vulnerability (moderate), landslides (moderate), windstorms (very low).

Recently, a 30-year historical dataset for Rwanda was completed, using a combination of station and satellite data (Rwanda Meteo Maproom[5]), allowing some insight into expected climate change effects. It shows that the climate is already changing, with temperatures increasing about 0.35°C per decade since the 1980s, which is higher than the global average. Data from Prasad *et al.* (2016) indicate a general increase in temperature across the country for the next 30 years but it isn't possible to tell whether the east will heat faster than the west, and to what extent exactly due to high uncertainty caused by limited data availability.

Changes in rainfall are less certain, partly due to high levels of year-to-year precipitation variability, and the limited dataset for the country. There are, however, some reports that indicate a recent drying in the rainy season (mainly in April), but it is too early to confirm this as a robust long-term trend (CRU, 2016: from WHO Indices). Other reports indicate changes in the variability of rainfall, with shorter, more intense rainy seasons (Mutabazi, 2011).

Groundwater

Information on groundwater is very limited. As a result, a study into the groundwater bodies of Eastern Province has been initiated by Water for Growth Rwanda. Dependent on the outcomes of that assessment, due later in 2018, it is possible that groundwater may be used to augment water resource requirements, particularly during the dry season.

Hydrology

Hydrological data for Rwanda in general, and the catchment in particular, is scarce. In particular data from the past 2.5 decades is very limited. Water for Growth Rwanda and other partners are assisting Rwanda in redeveloping the water monitoring network.

Some long-term river flow observations are available for the confluence of the Muvumba with the Akagera at Kagitumba, the location where Rwanda, Uganda, and Tanzania meet. The seasonal distribution of discharge intensity is depicted in Figure 6, indicating an annual average flow of about 14 m^3/s. The

[4] https://www.gfdrr.org/rwanda

[5] Source: http://maproom.meteorwanda.gov.rw/maproom/index.html

significance of the different colours is as follows: Q95 is the average monthly flow exceeding 95% of monthly flow events in m³/s; similarly, Q65 is the flow exceeding 65% of events, etc.

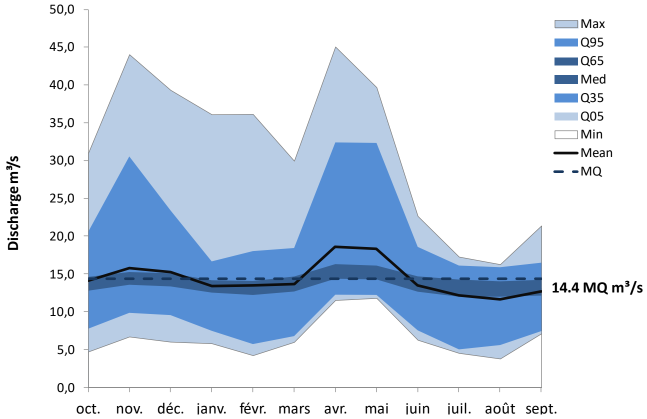


Figure 6: Flow regime curves for station 70001 Kagitumba - Muvumba[6]

Meteorological and hydrological data, especially observed flows and rainfall data, is essential in order to derive runoff estimates and although some historical data is available, time series data is extremely fragmented. Recent comprehensive data is also difficult to obtain, as although there is now monitoring, it has limited spatial coverage and extensive data quality checks and quality control have to be performed. Global initiatives of various research groups around the world have, however, resulted in compilation of consistent datasets for precipitation, based on remote sensing work, observational data, and advanced assimilation techniques. Data from such initiative can readily be utilised as it is accepted as of high quality. One such example, is the so-called CHIRPS precipitation dataset where daily data is collected for the entire continent. Using QGIS and python scripting, this data could then be used and was aggregated to monthly values for each sub-catchment. A new online tool for evapotranspiration data is the water productivity portal WaPOR, which contains detailed remote sensing-based data for Rwanda and can be used free of charge[7].

Average monthly temperature and humidity at Kigali (elevation 1,567 masl) were utilised within a water evaluation and planning (WEAP) system model to derive water balance estimates for Muvumba for a baseline period of 10 years (2006 to 2015). Calibration and assessment of the model performance based on flow records at Kagitumba is illustrated below in Figure 7.

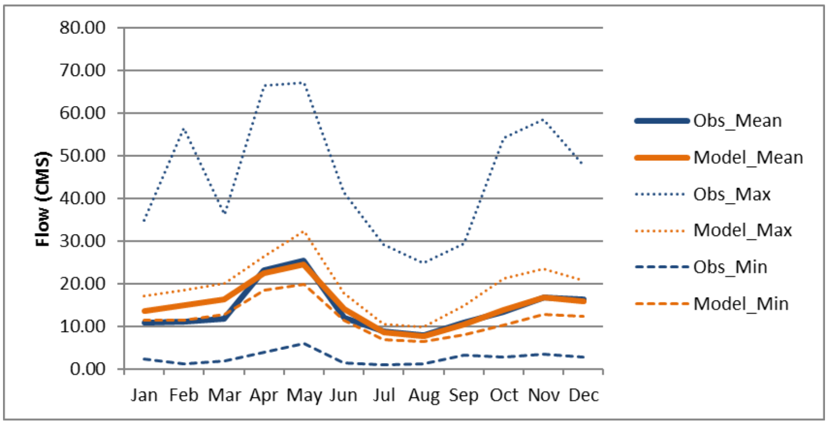


Figure 7: Observed and simulated mean, min, and max flow for station Kagitumba

[6] Source: NWRMP Exploratory Phase Report; Volume of Annexes, 2014.

[7] WaPOR is developed by FAO and technological partners from the Netherlands, who also invested in its development. Rwanda was selected among its pilot countries, and several Rwandan scholars and experts have been trained in its application by IHE Delft Institute for Water Education from the Netherlands, and Water for Growth Rwanda.

Water balance

Adequate and quantified knowledge of current water resources utilisation by sector is limited due to unregulated water use and lack of monitoring. In November 2016, a Water Users' Survey was carried out to get an overview of water usage in the catchment (W4GR TR28, 2017). Recorded water users included: Coffee washing stations, small to medium hydropower plants, water treatment plants, mineral extraction sites, dams, irrigation schemes, fish farms, and other industries, all of which can be found in the catchment. GPS coordinates of individual water users have been recorded, and maps of the known water users in the catchment are included in the survey report (W4GR TR28, 2017) and in Annex 3 of this catchment plan.

Self-assessment of actual use by these abstractors appears unreliable as of yet and a subsequent national-scale water use study, carried out by the University of Rwanda within the MINIRENA RBM project (MINIRENA, 2017), developed estimates of typical use of water per unit of production (e.g. a cow, or a hectare of irrigated land), or per water using entity (e.g. a mine or a factory). Both sources of data were combined in the latest version of the water balance and allocation model for Muvumba (see Annex 9, and W4GR TR62, (2017).

Current water balances for the whole catchment and its sub-catchments are shown in Table 1 to Table 7. These balances were based on WEAP model simulations undertaken by the water resources management department and reported in W4GR TR62 (2017). Current 'blue' water[8] use is very limited compared to actual resources (Figure 14, **Error! Reference source not found.**). In all sub-catchments, the largest amount o f allocated water is dedicated to environmental flow; irrigation comes second followed by minimal domestic, livestock and industry use. Surplus water is currently discharged to downstream users (on top of the environmental flow), but also offers potential for use within the catchment or (via inter-catchment transfers) in neighbouring catchments, by different categories of water users, and thus offers a resource for growth and development.

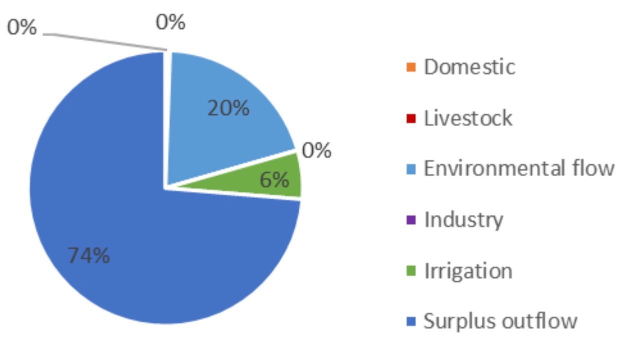


Figure 8: Annual water allocation per water use sector, baseline scenario (source: WEAP model, WRMD, 2018)

Table 1: Green water balance entire catchment, baseline

IN	(MCM/y)	OUT	(MCM/y)
Precipitation	1543.32	Evapotranspiration	995.47
Return flows	10.08	Withdrawals	31.54
Storage change	0.72	Outflow	469.01
inflow	148.2	Groundwater recharge	206.24
Total	**1702.26**	**Total**	**1702.26**

Table 2: Blue water balance entire catchment, baseline

IN	(MCM/y)	OUT	(MCM/y)

[8] 'Blue' water is the manageable water in surface water bodies and groundwater. The 'Green' water balance incorporates 'blue' water, but also all precipitation that never reaches surface water bodies or accessible groundwater bodies and instead is lost from the catchment through evapotranspiration or via recharge of inaccessible, deep groundwater layers.

Runoff	39.42	Domestic	2.11
Base flow	302.84	Industry	0.19
Groundwater	0.00	Irrigation	28.58
Return flows	10.08	Livestock	0.66
Inflow	148.2	Outflow	469.01
Total	**500.54**	**Total**	**500.54**

Table 3: Blue water balance Warufu sub-catchment, baseline

IN	(MCM/y)	OUT	(MCM/y)
Runoff	7.72	Domestic	0.66
Base flow	78.68	Industry	0.06
Groundwater	0.00	Irrigation	4.00
Return flows	1.70	Livestock	0.24
Inflow	29.13	Outflow	112.28
Total	**117.23**	**Total**	**117.23**

Table 4: Blue water balance, Mulindi sub-catchment, baseline

IN	(MCM/y)	OUT	(MCM/y)
Runoff	1.90	Domestic	0.51
Base flow	48.25	Industry	0.10
Groundwater	0.00	Irrigation	0.00
Return flows	0.38	Livestock	0.16
Inflow	0.00	Outflow	49.76
Total	**50.53**	**Total**	**50.53**

Table 5: Blue water balance, Ngoma sub-catchment, baseline

IN	(MCM/y)	OUT	(MCM/y)
Runoff	2.64	Domestic	0.22
Base flow	26.68	Industry	0.03
Groundwater	0.00	Irrigation	0.00
Return flows	0.12	Livestock	0.06
Inflow	0.00	Outflow	29.13
Total	**29.43**	**Total**	**29.43**

Table 6: Blue water balance, Upper Muvumba sub-catchment, baseline

IN	(MCM/y)	OUT	(MCM/y)
Runoff	4.68	Domestic	0.26
Base flow	47.37	Industry	0.00
Groundwater	0.00	Irrigation	0.00
Return flows	0.18	Livestock	0.07
Inflow	197.92	Outflow	249.82
Total	**250.15**	**Total**	**250.15**

Table 7: Blue water balance, Downstream Muvumba sub-catchment, baseline

IN	(MCM/y)	OUT	(MCM/y)
Runoff	22.47	Domestic	0.28
Base flow	101.86	Industry	0.00
Groundwater	0.00	Irrigation	24.58
Return flows	7.57	Livestock	0.13
Inflow	362.10	Outflow	469.01
Total	**494.00**	**Total**	**494.00**

A basic analysis of the catchment-wide green and blue water balances reveals that about 65% of all precipitation is used by vegetation (rainfed agriculture, forests, and nature), or lost to evaporation. Only 2% of all precipitation, three times the amount of blue water, is eventually abstracted by anthropogenic users (for domestic, industrial, irrigation or livestock use). Outflows from the catchment and groundwater recharge are other important components. The Ngoma sub-catchment makes the smallest contribution to the water balance and all catchment surface water leaves via the downstream Muvumba sub-catchment at Kagitumba.

Water quality

Systematic monitoring of water quality data in Rwanda has only recently been taken up by the RWFA-WRM[9] department at a limited number of locations throughout the country. Currently, water quality is monitored at Nyagatare and Kagitumba in Muvumba.

During district pollution surveys, fertilisers and pesticides from irrigation schemes, e.g. Mulindi tea factory in Kaniga sector of Gicumbi district, were cited as major causes of poor water quality in the Cyondo and Muvumba rivers. Pollution also emanates from emerging urban centres, such as Byumba, Gatuna, Yaramba, Miyove and Rukomo. Other alleged point source pollution emanates from the EAGI (granite production) and Inyange (SAVANA, milk production) industries located in Rutaraka and Nyagatare cells (Nyagatare sector).

Results from the established sampling points at Nyagatare and Kagitumba show high levels of contamination with *E coli* and faecal coliform both exceeding acceptable levels. in addition to high levels of turbidity, concentrations of lead (Pb), manganese (Mn), iron (Fe) and copper (Cu) also exceeded their allowable threshold values and elevated levels of BoD and CoD have also been reported. During recent water quality surveys undertaken by WRMD at sampling sites along the Muvumba and Warufu rivers, turbidity and Total Suspended Solids (TSS) were also found to be above the levels prescribed by the World Health Organization (WHO) and Rwanda Standards Board (RSB).

2.1.2 Socio-economic profile

Besides Muvumba's transboundary character, it is covered by five districts (see Figure 9). Nyagatare in the north and Gicumbi in the south cover the largest areas, with only small parts of Gatsibo, Rulindo and Burera, in the south, also in the catchment.

Almost all economic growth in the catchment is linked to water use, be it in agriculture, livestock, industry, or purely related to providing drinking water to urban and rural areas. The transboundary nature of the catchment demands careful planning and close collaboration with Uganda, where a catchment plan already is in place for the two parts of the catchment (both discharge into Rwanda, but at separate points).

[9] RWFA-IWRMD (2017). Semi-annual water quality report 2016/2017.

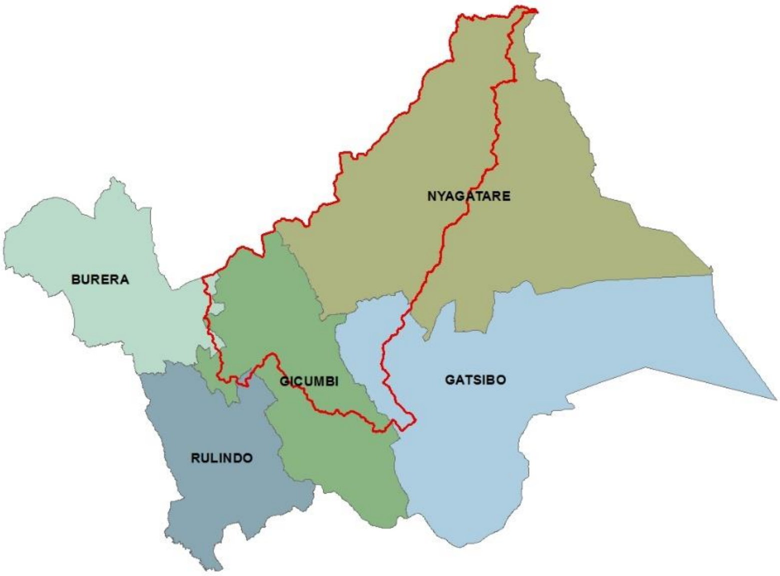


Figure 9: Muvumba catchment and district boundaries

Economic activities and basic services infrastructure

According to information from the Rwanda Development Board, almost 80% of Rwanda's population is dependent on rain-fed, subsistence agriculture. Agriculture accounts for a third of the country's GDP, constituting the main economic activity for the rural households (especially for women) and remains their main source of income. Today, the agricultural population is estimated to be a little less than 80% of the total population whilst the sector meets 90% of national food needs and generates more than 70% of the country's export revenue. Other economic activities in Muvumba catchment include artisanal mining of tungsten, cassiterite and coltan, as well as quarrying.

In terms of power supply, Muvumba remains significantly below the national average, with access per household under 12.4% as against 20 % nationally. There is, consequently, an over-dependence on forest resources for energy, with 82% of households using firewood to cook meals, and with use of alternative energy sources, like biogas and improved cooking stoves, still limited. Pit latrines are the most common form of sanitation facility and are used by 89.2% of the population, while 64.6 % of the population use compost dumping for other waste disposal. There are no sewerage systems in any of the large towns (Byumba and Nyagatare) although 61.2% of urban households have access to improved water sources.

According to WASAC (2012) figures at district level, access to safe water is low at between 40 and 50% on average in Rwanda, with 49.2 % in Gatsibo and 52.8% in Nyagatare. This means that about half the population uses dirty water from streams, dams, valleys or swamps and thus does not have access to safe and reliable supplies of water for productive and domestic uses.

Socio-economic drivers of catchment development

Economic drivers of development are understood as existing and emerging economic sectors and value chains with a high potential for creating sustainable jobs and generating government revenues (tax, VAT, levies, etc.). Economic drivers aligning to the priority sectors as identified in the National Strategy for Transformation 2018-2024 are: energy; agriculture (horticulture for export); private sector development; environment and natural resources ('green' economy and revenue from mining); green urbanisation (incl. Special Economic Zones (SEZ), Business and Industrial Parks); transport; tourism (meetings, incentives, conferences and exhibitions); manufacturing "Made in Rwanda" and ICT "Smart Rwanda" (MINECOFIN, 2017).

Examples of drivers with strong links to water resources in the sub-catchments of Muvumba are presented in Table 8.

Table 8: Economic drivers in Muvumba sub-catchments

Sub-catchment	Economic drivers	Districts
Mulindi	Tea value chain (processing factory and plantations).	Gicumbi
Muvumba upstream	Dryland agriculture and cattle/livestock ranching value chain (dairy, meat and hides).	Nyagatare
Muvumba downstream	Cattle ranching value chains, wetland irrigation (rice, cereals and other crops) and hillside irrigation.	Gatsibo, Nyagatare
Ngoma	Tea (plantation), Hydro-power.	Gicumbi
Warafu	Cattle ranching value chains, wetland irrigation (rice, cereals and other crops) and hillside irrigation.	Gicumbi

These economic drivers were identified by observing, analysing and discussing current land use patterns, investments, production and other economic data. Key guiding questions were:

1. Where do people work and how do they earn their money?
2. What value chains, sectors and industries exist and are growing?
3. What is the importance of the activity for the local and national economy?

Important information for identifying the socio-economic drivers was also found in the National Sector Strategic Plan (SSPs), District Development Strategies (DDSs), Local Economic Development plan (LED) and master plans.

Catchment planning aims to maximise socio-economic development around such drivers and their value chains in relation to the available water resources in sustainable ways. The value chain concept includes all steps from producer to consumer including processing and transport and related support services. For example, the coffee value chain includes: farms, coffee washing stations, roasting, transport, packaging, customs, advisory services and finance.

Value chains are often organised around so-called anchor companies: e.g. a tea factory in the tea value chain, an irrigation system, or a mine (cluster). Anchor companies are often instrumental for improvement of products, and the creation of jobs and income in the area. Such prominent companies, can develop entire value chains through their forward and backward linkages. Value chains also promote rural-urban linkages since parts of the chain are found in urban areas and other parts in rural areas. Value chains and operations of anchor companies were assessed in relation to the overall catchment plan and IWRM criteria[10].

Anchor companies in most cases directly benefit from catchment environmental services, such as: clean water; protection against flooding, and; reliable sustainable firewood supplied by renewable forestry. Such environmental services are provided by the natural capital of catchments, consisting of forests, soil, lakes, wetlands, etc. Companies along value chains transform and valorise catchment natural resources and, aware of this dependency, also have a clear incentive to restore and protect natural capital and the environmental services they benefit from.

The natural capital of an ecosystem is traditionally considered a public good and, so far in Rwanda, is largely managed by local and national government agencies. The interdependency between nature and economy, however, creates a shared interest in protecting natural resources. This offers the opportunity for joint

[10] This can be done in combination with the socio-environmental criteria applied in the respective sector as for fair trade networks or the sustainable forest alliances.

public-private partnerships and investments, and the formation of co-management between public and private players. For example, by co-investing in sustainable forest management, a tea factory can assure its supply of sustainable firewood needed for curing tea leaves. In this case, both the forest and the business benefit from cooperation. Other joint venture opportunities exist to achieve more inclusive development, for example, through integrating smallholder farmers in out-growers' schemes. Joint investments generate multiple returns, an improved environment with regard to services, as well as an enhanced and diversified economy, in addition to sustainable livelihoods and stronger, resilient communities.

Population distribution and poverty rates

The 2012 national population and housing census indicated that 600,000 people live in Muvumba catchment, with 7.7% in urban areas, and 92.3% in rural areas. 51.7% of the population is female and 54% (both men and women) are younger than 20. Figure 35, Annex 3 illustrates the spatial variability of population density (person/km^2) in each administrative district. The highest densities (536-767 persons/km^2) were in Rukumo, Katabagemu and Mimuli in the central area, in Gatsibo in the south east and in Nyankenke, Byumba, Manyagiro, Cyumba, Bungwe, Rubaya in the south-west. Kageyo had the highest density (768-998 persons/km^2).

Poverty rates within the catchment area are very high (see Table 9) and this is linked to high population growth and declining soil fertility in a largely agrarian based economy. The principal economic activity is agriculture, i.e. crop production and livestock rearing.

Table 9: Population % identified as poor and extreme poor for the Muvumba catchment (EICV4)[11]

District	% poor[12] (district population)	% extreme poor (district population)
Nyagatare	44.1 %	19.5%
Gicumbi	55.3 %	24.7%
Gatsibo	43.8 %	18.5%
Nyagatare	44.1 %	19.5%

Land use

A national land use / land cover (LULC) map was developed by Water for Growth Rwanda (Figure 10, also included in Annex 3), using remote sensing technology combining radar and optical imagery from 2016-2018, and ground truthing in the field. The area and relative proportion of each LULC class for the Muvumba catchment is presented in Table 10.

Total forested area covers 10% of the catchment area, which is below the national average and below the national target of 30%. From this, about 20% is considered sparse forest, showing signs of tree felling or other forms of degradation. Efforts are required to increase both the area of land covered by forest and to improve the management of existing (and new) forest areas.

The influence of pressure resulting from a high population is very clear with different LULC classes related to agriculture (adding up to 90%)[13], consisting of agriculture (seasonal), agriculture (perennial) and open areas or grass; the predominance of this class therefore also reflects the enormous impact of agriculture on land cover and, combined with the high soil erosion risks on steep slopes, contributes strongly to sediment ingress from such land into rivers. Bare soils could also represent mines, quarries, and their tailings, which similarly contribute to sediment ingress into rivers.

[11] Source: EICV4 - 2013/2014.

[12] The percentage poor population comprises the percentage extreme poor population.

[13] The figure of 90% is the sum of all LULC classes that represent some form of agriculture, namely 'agriculture (seasonal)', 'agriculture (perennial)', 'open areas or grass' and 'bare soils'.

The LULC classes of ‘bare soils’, ‘settlements and buildings’, as well as ‘water’ and ‘wetlands’ were recorded but cover an insignificant portion of the catchment.

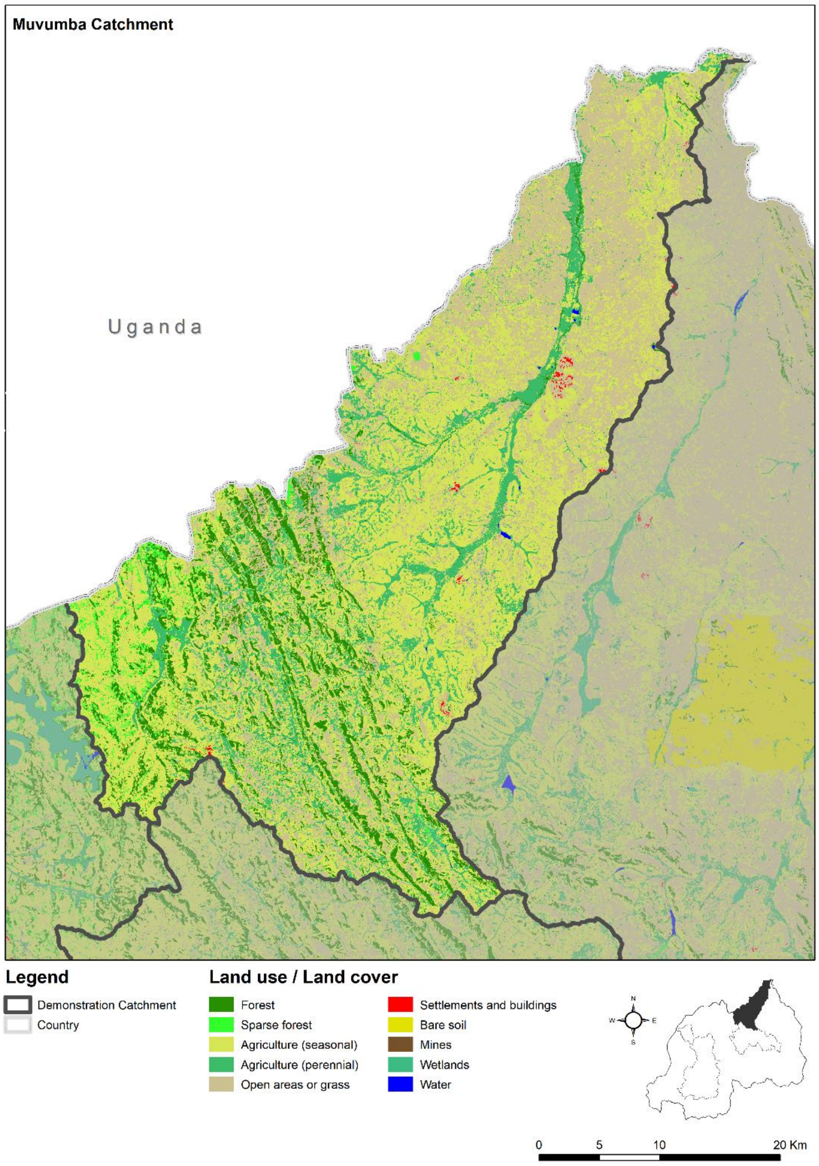


Figure 10: Land Use / Land Cover map (LULC) (W4GR 2018)

Table 10: Land use / land cover classification Muvumba (W4GR, 2018)

Class	Area (ha)	Percentage (%)
Forest	12,233	8%
Spare forest	2,475	2%
Open areas or grass	44,147	28%
Agriculture (seasonal)	75,286	48%
Agriculture (perennial)	22,235	14%
Bare soil	3	0%
Settlements and buildings	261	0%
Water	75	0%
Wetlands	63	0%
TOTAL	**156,779**	**100%**

Key geographic features of Muvumba’s sub-catchments

Figure 37 to Figure 41 in the Catchment Atlas (see Annex 3) present the key features of each of Muvumba's level 2.5 sub-catchments.

2.2 Catchment issues and opportunities

An inventory of catchment land and water related issues and opportunities was developed using a participatory process. Initially, an inventory of typical catchment issues and opportunities was made by the Catchment Task Force and national CP partners. Then, CTF members scored and ranked these issues in their perceived order of importance for them (W4GR TR52, 2016). Finally, the exact locations of key issues were mapped in CP and DDS alignment work sessions with district staff and spatial information was subsequently digitised in GIS. The latter is presented on maps per sub-catchment in the catchment atlas (Annex 3). Opportunities for water-based green growth can be found throughout the catchment and have been captured in IWRM packages (Section 4.3) for a number of areas targeted for priority implementation.

2.2.1 Issues

Catchment issues were ranked as follows:

1. Soil erosion;
2. Pollution (from agriculture);
3. Deforestation;
4. Lack of water storage (water scarcity);
5. Drought;
6. Domestic water shortage;
7. Unprotected river banks;
8. Inefficient water management;
9. Conflicts over water use (agriculture/livestock);
10. No coordination with Uganda;
11. Illegal mining;
12. Dam siltation;
13. Non-Productive forest.

Consultation in the scoping workshop and further analysis of water resources led to identification of the following top priority issues: Erosion and flooding, poor water quality mainly caused by high sediment load, population pressure, and insufficient drinking water supply and sanitation. These key problems together with the underlying causes and opportunities are discussed in detail below.

1. **Erosion and flooding:** Both the Ugandan and Rwandan sections of the catchment are characterised by fragmented, small farms on mountainous terrain in high-altitude areas. Given that these areas are also subject to abundant rainfall, they are prone to soil erosion, with soil ending up as sediment in rivers and streams. Loss of fertile soils leads to reduced soil fertility and poor agricultural productivity in higher parts of the watershed. In addition to agriculture, over-grazing and collection of fuelwood have contributed to high rates of deforestation particularly in the upland watersheds. The sub-catchment in Kabale district in Uganda is reported to be very highly degraded, with faster loss of top soils than in Rwanda. Projections of future climate for Rwanda indicate a trend towards a warmer and wetter climate. Intense rains on steep slopes will aggravate soil erosion;
2. **Population pressure:** Muvumba is a densely-populated catchment with a population of about 0.6-million, mainly living in emerging urban areas of Gatsibo, Byumba and Nyagatare, with population densities as high as 500 inhabitants/km^2 in urban centres; overall, the population is expected to triple by the year 2020. Due to population pressure, cultivation of food crops has been extended from upland areas down into valley wetlands. Large drainage channels have been constructed to drain excess water from these areas to reclaim them for cultivation with *circa* 71% having been

converted into agriculture of various types. These irrigated systems are, however, often poorly developed and characterised by inefficient water use;

3. **Poor water quality:** The emerging urban centres, such as Byumba, Gatuna, Yaramba, Miyove, Rukomo and Nyagatare, lack solid waste, storm water, and sewerage facilities and most waste finds its way into rudimentary drainage systems and ends up polluting main watercourses. Other sources of pollution are those attributed to industries, mining activities and some informal settlements in Gicumbi. Pollution arising from application of fertilisers and pesticides from irrigation schemes is also a major cause of poor water quality in downstream river sections;
4. **Poverty reduction:** Poverty rates in some parts of the catchment area are still very high, with approximately 60% of the population in Nyagatare classified as poor. The cause of poverty has often been linked to high population growth and declining soil fertility, and recurring droughts in a largely agrarian based economy.

Several of the ranked issues display causal relationships and these were further analysed using the DPSIR approach. The causal framework (explained in Figure 11) describes the interactions between society and the environment (in or beyond the catchment) through (D) driving forces, (P) pressures, (S) states, (I) impacts, and (R) responses. DPSIR analysis supports selection of IWRM responses to mitigate negative impacts identified in the catchments. Responses may target causes as well as effects, i.e. the driving forces, pressures, and/or impacts. For each situation, an optimal mix of responses is defined in the programme of measures for this catchment plan (Chapter 4.) to achieve sustainable solutions.

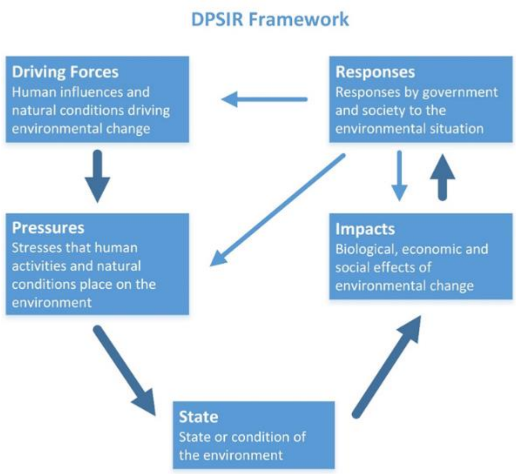


Figure 11: DPSIR framework explained

The DPSIR analysis for Muvumba catchment, based on inputs from the participatory process, integrated assessment of catchment physiography (paragraph 2.1.1) and catchment socio-economic profile (paragraph 2.1.2), is presented in Table 11. Here, the focus is on Drivers, Pressures, States, and Impacts; Responses are presented in the Programme of Measures in Chapter 4.

- **Drivers:** The main driving forces behind many of the issues in the catchment are high population density and growth, economic development, and climate change. Further driving forces are high poverty levels and low education levels, a poor institutional environment including limited enforcement of e.g. environmental legislation, and the mountainous terrain. The same driving forces can, however, also be addressed and improved, to develop an enabling environment for green growth;
- **Pressures:** The pressures that follow from the Drivers cover a wide range of topics and constituted many of the issues identified by the CTF;
- **States:** The states that are the result of the pressures, are typically parameters that can be measured. They describe the state of the environment and socio-economics;
- **Impacts:** The impacts, lastly, are the final result of adverse state variables on the lives of the people in the catchment. They can often be expressed as low levels of security in terms of water, energy, and

food; high costs of water treatment and use; and regular occurrence of water and land related disasters, taking lives and damaging properties.

Table 11: Muvumba catchment Drivers, Pressures, States and Impacts

DPSIR Muvumba Catchment
Driving Forces
High population density and population growth and urbanisation
Economic development
Industrialization e.g. in economic zones and industrial parks
Climate change
Poverty
Low education, skills, and awareness levels
Little environmental enforcement in mining sector
Little or no spatial planning / enforcement aimed at providing room to the rivers to flood
Low public sector investment capability
Low private sector investment capability
Uncoordinated/sectoral development/ haphazard developmnent investments
Limited long-term holistic development information for decision makers
↓
Pressures
Flooding in areas with anthropogenic assets
Soil over-exploitation, soil erosion, land degradation
Dependence on wood fuel, deforestation
Concentration of rain water in built up areas, leading to soil erosion and gully forming
Cattle watering in rivers, trampling river banks and polluting water with E. coli and soils
Limited management of solid and liquid waste
Flooding in areas with anthropogenic assets
Small farmland plot size, encroachment on forests
Sub-optimal farming and mining practice, aggrevating soil erosion, pollution, and low water use efficiency
Limited private sector investment in efficient water use and protection of the environment
Limited public sector investment in efficient water use and protection of the environment
More intense rainfall and longer dry spells due to climate change
Low levels of access to markets, i.e. to storage, transportation, distribution facilities for agricultural produce
Limited coverage of water supply and sanitation infrastructure
Ignorance and negligence of people and business on environmental vulnerabilities
Increasing water consumption per capita, following changes in consumption patterns at increasing household income levels
Spreading of illegal settlements including into high risk zones
Pollution from industries (industrial waste)
↓
States
Lack of water resources
High turbidity in rivers
Low water quality, including high E. coli counts in surface water
Low land productivity
Low water productivity
Low connectivity and reliability of electricity grid
Low coverage of water supply and sanitation networks
Low protection of public assets, habitation, and crop lands in floodplains
Low aquatic biodiversity
↓
Impacts
River water often unsuitable for drinking water intake
High costs of drinking water treatment and maintenance of distribution networks
Many people with low water security (low quality, low quantity)
High costs of operation and maintenance of hydropower infrastructure
Low levels of energy security among businesses and households
Gully development, reducing suitability of land
Landslides, damaging property and taking lives
Impeded levels of food security
Floods damaging public infrastructure, private properties, and taking lives
Health issues related to low water, energy, and food security increased water borne diseases
Increased competion and conflicts around water resources

2.2.2 Opportunities

The CTF identified and ranked the following main opportunities:

1. Irrigation;
2. Potential for hydropower;
3. Mechanisation of agriculture;
4. Land use planning;
5. Bilateral cooperation;
6. Fish culture;
7. Land for agriculture;
8. Tea plantation;
9. Land husbandry;
10. Employment opportunities;
11. (Eco)Tourism;
12. Water resources;
13. Marshland;
14. High rainfall (water resources);
15. Water storage potential (Resources).

Opportunities exist for poverty reduction through adoption of green growth strategies to ensure that environment and natural resources are utilised and managed productively in support of equitable and sustained national development. There is significant potential to enhance irrigated agricultural productivity through more productive utilisation of water resources, increase of storage to decrease water shortage, empowering youth and women, while increasing resilience to drought induced by a changing climate. There is also a unique opportunity to influence other sectors, ministries and districts in the catchment in implementation of measures to address these issues in a coordinated manner within the framework of a catchment plan. There is potential to expand the current acreage under irrigated agriculture in marshlands through intensive utilisation of water resources in sub-catchments with sufficient water resources.

In summary, the natural resources that the catchment offers form a strong basis for socio-economic development and green growth. The CTF stressed the importance of protecting these resources as a foundation for sustainable development and translated this into the catchment vision and objectives (Chapter 3.). More tangible opportunities from Table 11 are reflected in the programme of measures, forming the R for Responses in the catchment DPSIR analysis (Chapter 4.).

3. Vision and objectives

3.1 Catchment vision and objectives

3.1.1 Vision and objectives development process

A catchment vision, overall and specific objectives were developed jointly by the Catchment Task Force, national focal points, and the Water Resources Management Department (WRMD) of RWFA. In this development process, they were supported by the Water for Growth Rwanda ISU, and by the Netherlands Commission for Environmental Assessment (NCEA). The development process[14] took into account local issues and opportunities, the United Nations Sustainable Development Goals (SDGs), and international best practice examples and guidelines for IWRM and for SEA. The process is summarised in Annex 7. The main results are presented in the sections below.

3.1.2 Vision statement

In a series of workshops[15] and work sessions, experts from the WRMD and Water for Growth discussed and synthesised the workshop messages and outcomes, followed by formulation of an agreed vision[16] for Muvumba catchment:

‘A catchment that is managed in an environmentally friendly manner to addresses the socio-economic needs of communities taking into consideration the transboundary nature of the catchment.’

3.1.3 Overall objective and specific objectives

The overall objective for development of the catchment was initially developed by the CTF[17], and subsequently completed with insights from the other demonstration catchments to make it more inclusive, and reads as follows:

‘Effectively manage land, water, and related natural resources, to contribute to sustainable socio-economic development and improved livelihoods, taking into consideration environmental flow, downstream water demands and resilience to climate change, and minimise water related disasters.’

[14] The first step was made in the CP scoping phase and SEA development where the vision, overall objective and specific objectives were determined through a participatory process. These were then ameliorated by WRMD and W4GR ISU and incorporated in CP1.0 and CP2.0. Subsequently, the overall and specific objectives of the four Catchment Plans were harmonised in the workshop of 17-18 March 2018, where the Catchment Plans log frames were aligned to NST-1, SSP, CCA and DDSs. The general and specific objectives are now generic for all catchments.

[15] At the original scoping workshop, taking the United Nations (UN) Sustainable Development Goals (SDGs) as a starting point, a broad range of catchment stakeholders reached a common understanding on the water and land resource issues and opportunities in Muvumba catchment, and put forward what they felt should be addressed in the catchment plan and achieved in future.

[16] The Catchment Task Force adopted this vision, as well as the overall objective and specific objectives presented in the following paragraph and as first included in the interim catchment characterisation and vision report (W4GR TR18, 2016).

[17] Refer to W4GR TR66 (2018), version 2.0 of the Catchment Plan, for the original overall objective, which read ‘Effectively manage land, water, and related natural resources, to contribute to sustainable socio-economic development and improved livelihoods, taking into consideration environmental flow, downstream water demands and resilience to climate change.’

Specific objectives (SOs) were also developed by the CTF and national plan partners with a subsequent update made in 2018[18]. The full set of specific objectives are provided in **Error! Reference source not f ound.**, alongside their main areas of contribution to the overall objective. The original catchment specific objectives, representing the initial CTF priorities, are highlighted in bold text.

Specific objectives of Muvumba catchment areas are the following:

Specific objective 1: Improved water quality and quantity in water bodies taking into account resilience to climate change in the catchment

Specific objective 2: Reduce the pressure on natural resources by diversifying alternative livelihoods

Specific objective 3: Ensure equitable allocation of available water resources for all users of current and future generations in the catchment

Specific objective 4: Strengthen the water governance framework and transbondary cooperation to ensure effective implementation of integrated

[18] The original set of vision, overall objective, and specific objectives, was developed in 2016, at the start of the participatory plan development. The alignment process with NST1, SSPs, CCAs, and DDSs (see Annex 4) and the development of a generic log frame for catchment plans (see Chapter 6 and Annex 16), in line with these national and local strategies, required a renewed analysis of specific objectives. The set of SOs was subsequently augmented with insights gained during the process, and enriched with specific objectives from other demonstration catchments, because nearly all objectives mentioned in different catchments are equally important in each catchment, and jointly, they respond better to national apex strategies (NST1 and SSPs). Wording of some SOs was slightly adapted to cover comparable SOs from different catchments.

3.2 Comparing different plan alternatives

Transparent decision-making: Comparing plan alternatives in the SEA process

Decision-making on good water management is the mandate of the Government of Rwanda. Decentralisation policy, local government legislation, and the new Water Law are the responsibility of Ministries, the Cabinet and Parliament and not of catchment authorities or stakeholders. Building on international best practice, however, use of a catchment planning approach strengthens water governance at all levels, including within a catchment itself, and promotes enhanced knowledge management to improve the quality of this decision-making.

Many different development paths could be followed in delivery of a catchment plan's vision and objectives and each path would have its own level of successes, obstacles and failures. In SEA terms, different potential development paths are called 'alternatives' and comparison of a series of clear and distinguishable alternatives is key to transparent decision-making. The first step in this process consists of participatory development of meaningful alternatives with subsequent assessment of the effectiveness of each alternative using jointly defined criteria. In the case of this catchment plan, 'alternatives' focused primarily on water allocation options

A catchment vision, its overall and specific objectives (see paragraph 3.1) were developed to result in specific outcomes. The ultimate aim of the vision is that water and land management should contribute to "*A catchment that is managed in an environmentally friendly manner to address the socio-economic needs of communities taking into consideration the transboundary nature of the catchment*". The vision's theme of *an environmentally friendly manner* is further reflected in the overall objective, through its reference to environmental flow, downstream water demands, climate change resilience, and minimisation of water related disasters. It is clear from this vision and the overall objective that some of the key things that need to be well managed, are water balance and water allocation, taking into account the water needs of Ugandan neighbours in the same catchment. The vision's aspect of a *catchment management* referred to the need for adequate and appropriate management capacity that, among other things, supports accurate assessment of water balance, as well as of decision-making, resulting in equitable water allocation to all users: commercial, domestic, and environmental.

Water balance models were developed as part of the catchment management process to support decision-making specifically on water demand reduction (SO 4 and 5), water availability (SO 6), and allocation (SO 8). Alternatives for pollution control (SO 7) require strict water permitting and enforcement of environmental legislation as part of an effective water governance framework (SO 1). Ecosystem contribution to water quality management (part of SO 7) requires detailed study on a national or transboundary, and case by case basis, in particular for wetlands and floodplains on either side of the national border with Uganda. Alternatives for infrastructure providing access to water (SO 9) need to be assessed in individual feasibility studies and environmental impact assessments (EIAs). Alternative solutions related to flood risk management (related to SO 10) require detailed flood modelling studies, which are also beyond the scope of catchment plan alternatives.

Rwanda is a water scarce country and this scarcity is exacerbated by its growing population, economic development, and climate change. A series of scenarios was simulated in a water balance and allocation model. The first scenario is the baseline, which is the point of reference for any development. Second, autonomous development scenarios were simulated for 2024, 2030, and 2050. These 'future projections' were simulated for scenarios of high, medium, and low economic development, population growth, and climate change impacts on the water balance. The overall medium scenario of this formed the reference against which different management alternatives were assessed. Moreover, a series of sub-alternatives was developed and simulated to obtain more insight in the level of impact of different sectors (such as agriculture or industry). The management alternatives were developed to respond to adverse conditions that would evolve if nothing were done (the autonomous developments), by optimising water allocation to meet the needs of all users, including the environment, and to concomitantly avoid unmet water demand or water shortage under average to wet conditions, as well as to optimise economic growth and poverty reduction. Extremely dry years were not considered and were rather left to management by drought management plans, including water rationing if needs be.

Catchment hydrology was modelled in the water balance and allocation software WEAP (Water Evaluation and Planning), a widely used software package used to simulate water management scenarios. The catchment model consists of five sub-catchments of a level 2.5, and transfer points with Uganda. Muvumba is a level 1 catchment for Rwanda, but with an equally large share of the catchment in Uganda. Sub-catchment level 2.5 has been introduced for the water balance models. Level 3 and 4 sub-catchments, as defined within the NWRMP, were too small to be used for meaningful water balance modelling, considering the limitations in data availability[19]. The same five sub-catchments are also used throughout the rest of the catchment plan, for example for mapping of key features; determination of issues, and choice of interventions. A map of the sub-catchments is provided in Annex 3, Figure 34.

Water balance and allocation model governance

The water allocation alternatives that have been produced using the WEAP model for Muvumba catchment are not to be considered end-products. They can be regularly updated, improved, and made more detailed and will be used for assessment of water permit requests. Moreover, the model can be run again in an updated form (with more/different information), for the development of the next catchment plan for 2024-2030. Improvements that can be made in a next version include: the incorporation of a new land use, land cover map for 2018, and the introduction of water permit data. Other additions may include better descriptions of soil moisture processes and groundwater, subject to research into these topics in Rwanda. A model governance plan will be developed to ensure the quality of the models, their improvements, and their continuous usage. This knowledge measure will be key to safeguarding the sustainability of model use and the relating knowledge within the WRM department, plan partners, and research institutes, such as the University of Rwanda.

Baseline, projections and plan alternatives

Before a meaningful assessment can be done of different development alternatives, a reliable description of the baseline situation is required, as well as an understanding of what would happen in the future, if no action were taken. The latter is called a ‘projection’ or an ‘autonomous development’, and considers developments in population growth, climate change, and economic development without intervention and based on current understanding. The baseline and a series of potential future projections for autonomous development were simulated in WEAP[20].

Muvumba catchment currently provides more than enough water to satisfy current demand. According to projection modelling, however, the availability of, and demand for water in the catchment will change drastically over time. The baseline situation is taken to be the average of the period 2006 until 2015. Three scenarios (‘possible futures’) were distinguished in the development of projections that combined different possible impacts from the key driving forces of economic development, population growth, and climate change. These scenarios were as follows:

- The first was a scenario with limited impact on water demand and availability based on low economic development, low population growth, and limited climate change impact;
- The second was a scenario with high impact on water demand and availability based on high economic development, high population growth, and intense climate change impact;

[19] Catchment levels were introduced in the NWRMP and are explained in Annex 2 of this catchment plan: the glossary of terms. Level 1 is the largest scale, and higher-level numbers refer to sub-catchments of the previous level with a lower number.

[20] Details of the modelling approach and results are provided in dedicated reports (W4GR TR29 (2017), W4GR TR57 (2017), and W4GR TR 61 (2018). The approach and key results are summarised in this section and in Annex 7 of this catchment plan.

- A third middle scenario with medium impact on water demand and availability based on moderate economic development, moderate population growth, and moderate climate change impact.

The first WEAP report (W4GR TR29, 2017) presented the resulting impacts of these scenarios on water demand and availability and the middle scenario was used as the reference scenario against which potential management alternatives were compared. Figure 12 shows the resulting water demands (both met and unmet) of this middle scenario for three-time horizons: 2024 (the first catchment plan horizon); 2030 (the plan horizon for the United Nations Sustainable Development Goals), and; 2050 (for Vision 2050).

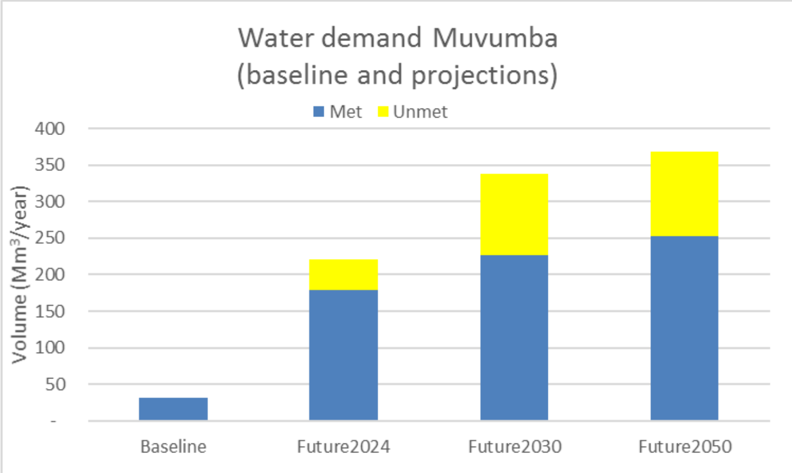


Figure 12: Baseline / projections of met and unmet water demand (water shortage) up to 2050, BaU (W4GR, 2017)

Figure 12 clearly shows that already by 2024 significant water shortages will occur if nothing is done to manage use. In order to minimise future water shortages and sustainably manage water resources, a series of water use alternatives were developed in an iterative way and simulated for different time horizons. Several iterations were needed before eradication of unmet demand was achieved[21]. The results of the final iteration, in terms of met and unmet water demand in 2050 of the most promising alternatives are shown in Figure 13, where they are plotted against the 'do nothing/Business as Usual (BaU)' scenario of the medium future projections of autonomous developments. Table 12 presents the main characteristics of the final catchment plan alternatives.

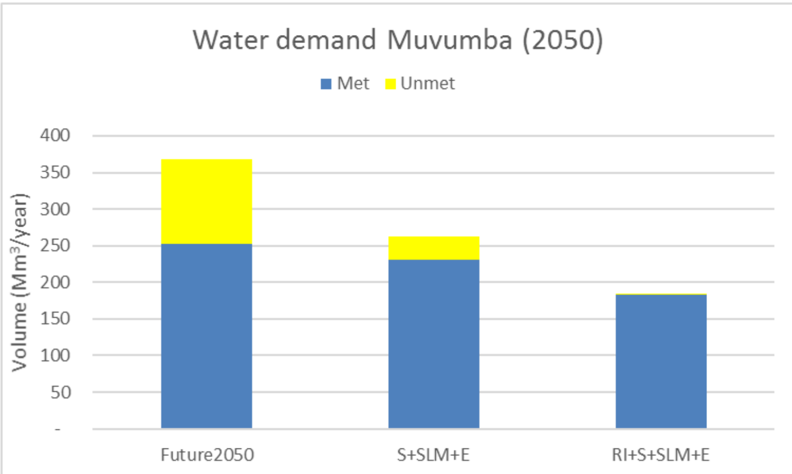


Figure 13: Met and unmet demand under BaU and different promising alternatives by the year 2050

[21] The very small remaining amount of unmet demand at catchment level in the RI+S+SLM+E alternative (Figure 13) is ultimately eradicated in the water allocation plans at sub-catchment level, as presented in Annex 9.

Table 12: Final catchment plan alternatives

Alternative	Key approach
S	Increased Storage
S+SLM	Increased Storage + Sustainable Land Management
S+SLM+E	Increased Storage + Sustainable Land Management and water use Efficiency
S+RI+SLM+E	Increased Storage + Reduced Irrigation, Sustainable Land Management and water use Efficiency

Preferred alternative for Catchment Plan 2018-2024

The alternative 'RI+S+SLM+E' has been adopted as preferred alternative for Muvumba and translated into a water allocation plan for all sub-catchments therein (Annex 9). The effectiveness of this most ambitious water demand and use management alternative has the desired effect, i.e. complete avoidance of water shortage. This can be achieved by combining development of water storage, sustainable land management, and enhanced water use efficiency in all sectors with a restricted development of new irrigation schemes[22]. A more detailed assessment of water demand and use management alternatives at sub-catchment level was done to finetune the water allocation to irrigation schemes in detail, to prevent any unmet water demand in average to wet years in any of the sub-catchments.

[22] Based on these outcomes, RWFA/WRMD and RAB have already joined hands in updating the Irrigation Master Plan.

4. Programme of Measures (PoM)

4.1 Enabling environment

The programme of measures (PoM) for Muvumba comprises a list of actions, projects, interventions etc., collectively referred to as measures, which need to be undertaken in order to improve or enhance catchment management. As the catchment plan is developed in the context of integrated water resources development, such measures can be derived from a broad range of technical and non-technical areas and geared towards implementation of the preferred alternative. Here the main focus is on catchment restoration, water allocation, water governance and knowledge management measures briefly defined as follows:

- **Catchment restoration** – this refers to practical measures that need to be undertaken in order to restore, from the existing state to a future better one, the physical status of the catchment. Focus here is primarily on reduction of soil erosion, enhanced water storage in soils, and improvement of land and water productivity;
- **Water allocation** – this refers to water demand and management measures that need to be implemented in order to ensure that the amount of water available in the catchment, both now and in the future, meets and will continue to meet the demands for it from a range of sectors, e.g. agriculture, industry, public water supply etc.;
- **Water governance** – this refers to institutional, policy and legislative measures that need to be implemented in order to ensure implementation of all other measures. It refers to the way in which a catchment is 'governed', by whom, how, and under what framework;
- **Knowledge management** – this refers to the measures needed to manage, store and effectively use information, data and 'knowledge', including practical and intellectual capacities, which are required for effective water management at catchment and sub-catchment scale, but also at farm level.

Jointly, water governance and knowledge management form the foundation of an enabling environment for efficient, effective, and equitable management of land and water resources in the catchment. Together with the (sub)catchment specific catchment restoration plans and the water allocation plans they form the basis for development and implementation of a programme of measures (Section 0 and beyond).

4.1.1 Catchment restoration

A key element of sustainable management of Muvumba is the restoration of the catchment. Currently, a significant proportion of the catchment is not sufficiently well-managed or protected against soil erosion, resulting primarily from agricultural practices and mining. Current farming methods, such as frequent intensive tillage of soil, combined with an absence of any anti-erosion measures, such as terraces, swales, contour markers and trenches, lead to high levels of soil erosion and loss of soil fertility. Rapid runoff on such soils leads to, at best, gully formation and, at worse, landslides. Poor mining practices in active mine sites, both formal licensed and informal unlicensed (often artisanal) mines, leads to the runoff of large quantities of sediment into rivers and watercourses. Even when no longer active, and despite regulations requiring post-closure rehabilitation, many abandoned mines continue to contribute large amounts of sediment to the downstream environment.

Ingress of large quantities of sediment to rivers leads to high turbidity levels, often rendering water physically unsuitable for irrigation, water supply or hydropower generation without prior treatment. In addition, and although data on chemical and biological water quality is scarce or absent, it is highly likely that there are also potentially high levels of contaminants, such as heavy metals, resulting from mining, and possibly eutrophication resulting from ingress of fertiliser from agriculture.

The locations of gullies and active or abandoned mining sites were mapped, and restoration measures formulated (see infrastructure measures Table 23, Annex 6) to enhance and/or promote adherence to 'best practice' mining (see knowledge measures in Table 25, Annex 6).

The largest investments by far for this catchment plan will be for catchment restoration and the core intervention therein will be intensification and diversification of agroforestry techniques. This will involve extending the range of species diversity and increasing the intensity of planting of agroforestry trees already being used to stabilise terrace slopes of and improve soil fertility. Use of perennial species, tree-crops (including tea, shade coffee, fruit trees, etc), intercropping or planting of 'in-field trees', and shelter-belts / live-fences are being promoted. Suitable local species include conifers (*Podocarpus*), Parasol trees (*Polyscias fulva*), Kenya croton (*Croton megalocarpus*), Nile tulip (*Markhamia lutea*), Bitter leaf (*Vernonia amygdalina*), and *Syzygium*, in addition to exotics like Alder (*Alnus acuminata*), Arabic gum (*Vachellia nilotica*) and Australian blackwood (*Acacia melanoxylon*).

Farmland can be protected in a number of ways, such as by construction of progressive or, under specific circumstances, radical terraces (dependent on soil and slope suitability), and/or other land husbandry measures, such as construction of contour trenches and marker ridges, use of swales, mulching etc. Wetlands and rivers can be protected by creation of buffer zones, vegetated with suitable species of bamboo and trees, and in-stream and bankside erosion control structures. Many studies have demonstrated the effectiveness of vegetative buffers in reducing the concentration of nitrates, phosphorous, and pesticides from water running off cultivated fields. Concentrations of nitrogen trapped and assimilated by buffer strips or wetlands can be reduced by up to 94% before entering a stream. Phosphorus runoff can be reduced by 25–95 %. The ability of buffers to retain pesticides is variable because each pesticide has unique mobility and soil-binding properties, but they can be especially effective when pesticides are tightly bound to the soil.

Catchment restoration opportunities mapping DSS

Deciding which catchment restoration measures are best for any particular location, as well as where to start, requires analysis of many physical and socio-economic parameters. To assist with this process, a decision support system (DSS) was developed to help prioritise areas for intervention and decide which restoration measures should be taken at these sites. The DSS is a tool to assist in the process but ultimately, decision making will always require additional consideration of actual field data, local criteria, land use plans, and of particular importance, stakeholder consultation and agreement. The Catchment Restoration Opportunities Mapping (CROM) DSS developed by W4G for the IWRM programme, and used in this catchment plan, has a modular structure (also see Figure 82 in **Error! Reference source not found.**), consisting of the following components:

- A geodatabase of all available relevant spatial datasets:
  - The new national land use / land cover map[23];
  - Many other datasets, such as key issues, water users, etc., bespoke to demonstration catchments, that have been collected, collated, or developed by W4GR);
  - Other, national datasets, such as the rivers network, Digital Elevation Map, soil maps, etc;
- Several GIS models. These were used to analyse, process and combine national or catchment level spatial data into informative maps (results for the catchment are provided in **Error! Reference source n**

[23] In 2018, Water for Growth Rwanda commissioned the development of a new Land Use Land Cover (LULC) map, using radar-based remote sensing data (SAR technology). A map was generated for the whole country, at a 20 m *20 m resolution, and disseminated online.

ot found.). The latter formed the building blocks for CROM DSS, and were grouped along a series of themes, as follows:

- Actual catchment degradation and catchment degradation risks, e.g. locations of mines or gullies, roads with limited drainage infrastructure on steep slopes, and soil erosion risks. The latter are mapped using the Revised Universal Soil Loss Equation (RUSLE), a widely used method to estimate soil loss from sloping agriculture land;
- Areas that can be considered already protected, or not subjected to rural catchment restoration, and thus need to be excluded from restoration opportunities mapping. These include:
  - Existing forested areas;
  - Existing terraces of known good quality;
  - Existing buffer zones along rivers, lakes and wetlands;
  - Areas with perennial crops (e.g. tea, bananas, fruit trees);
  - National parks (requiring their own dedicated restoration / protection plans); and
  - Urban areas (again, requiring their own dedicated urban restoration / development / protection plans);
- The above are then combined to create 'target areas', i.e. those areas within a catchment that require, at higher or lower priority, restoration and/or protection measures to avoid soil erosion, reduce risks of landslides, and to enhance agriculture productivity;
- Added to this then come prioritisation criteria and 'opportunity factors', such as:
  - The number of downstream intakes[24] that any area of land eventually drains towards;
  - The very and extremely high RUSLE classes that highlight areas most **in need of restoration / protection**; and
  - An analysis of market accessibility measured by distance to the nearest road. This is as roads provide access to markets and thus acts as a proxy measure of opportunities for good **return on investment / value for money**.

Definition of restoration / protection alternatives (options), is per the newly developed W4GR CROM classification and based, among others, on a technical overview of catchment restoration opportunities in Rwanda (W4GR TR51, 2018). CROM provides 8 main classes and four sub-classes (Table 16), each with multiple options or alternatives for restoration approaches, compared to the 6 prescriptive classes, without any options within each of them, in the 2011 LWH classification.

The modular structure of the CROM DSS[25] also allows introduction of updates of any of the input maps, and of new themes in the geodatabase, and / or new analyses in any of the main components.

The CROM DSS results in a series of maps of catchment restoration opportunities and priorities that provide key input to detailed consultation and decision-making at the local level, in so-called micro-catchment action planning (MCAP). This level, local field data and local knowledge, as well as any additional spatial information or spatial plans that may influence selection of preferred options, need to be incorporated. The latter may include District Land Use Plans (DLUP) and District Forestry Management Plans (DFMP). Field data may include details on soil type, soil depth, and soil fertility, but also local information on access to market, access to manure, local private sector investment capabilities and above all, local opinion and preferences on acceptable and desirable restoration approaches.

The most important map of the CROM DSS is presented in **Error! Reference source not found.** and shows h ow Muvumba catchment is generally exposed to Soil erosion risks

[24] The more intakes (water supply, hydropower etc) downstream of an area of land (often a sub-catchment), the higher the adverse impact that soil erosion, mining etc from and within that area will have, and hence the greater the value (economic, social and technical) restoring it will have.

[25] The DSS has been developed in ArcGIS (version 10.5, and also made available in version 10.2), using the model builder capacities of the software.

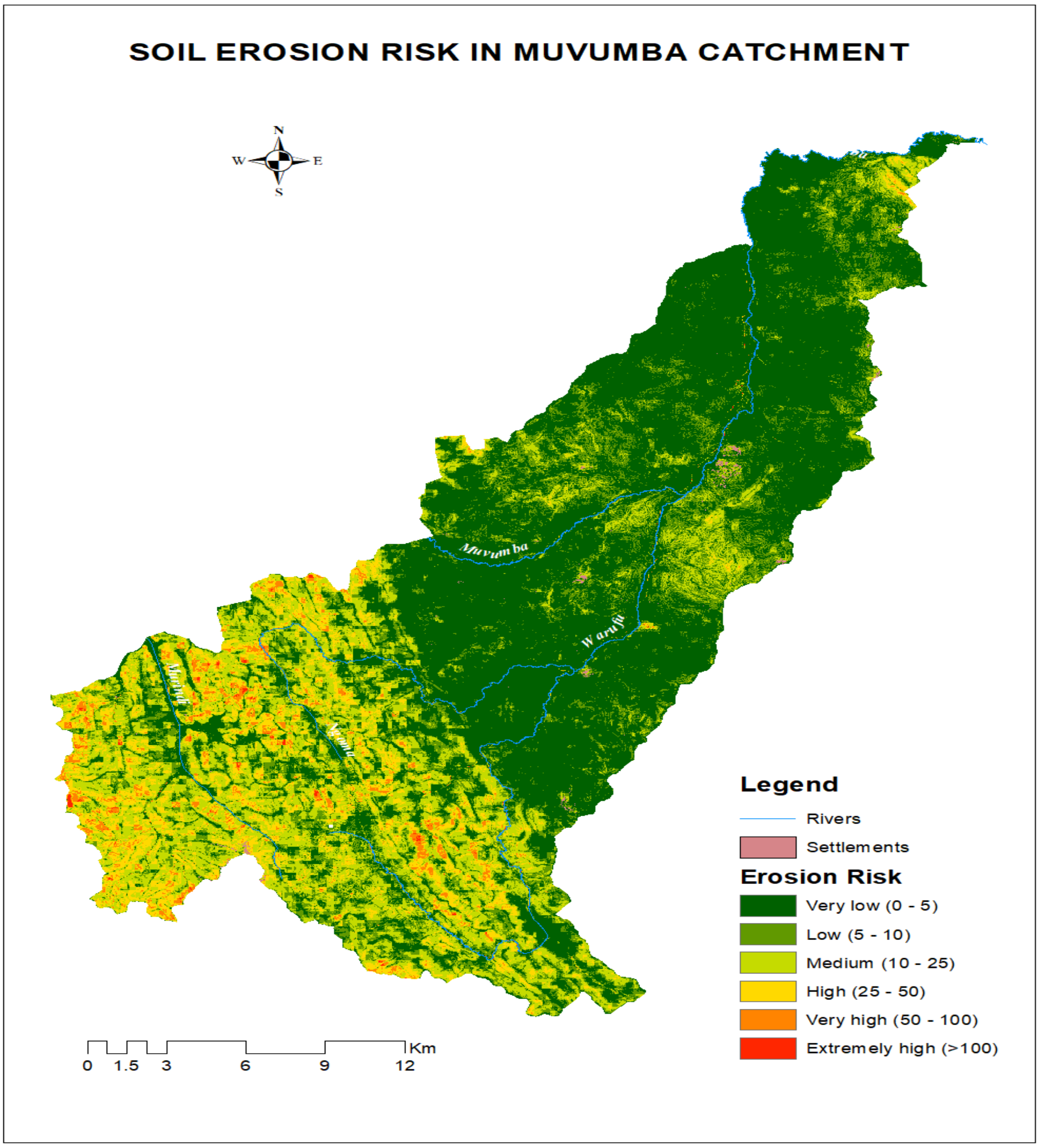


Figure 14: CROM map - indicating soil erosion risk in Muvumba catchment

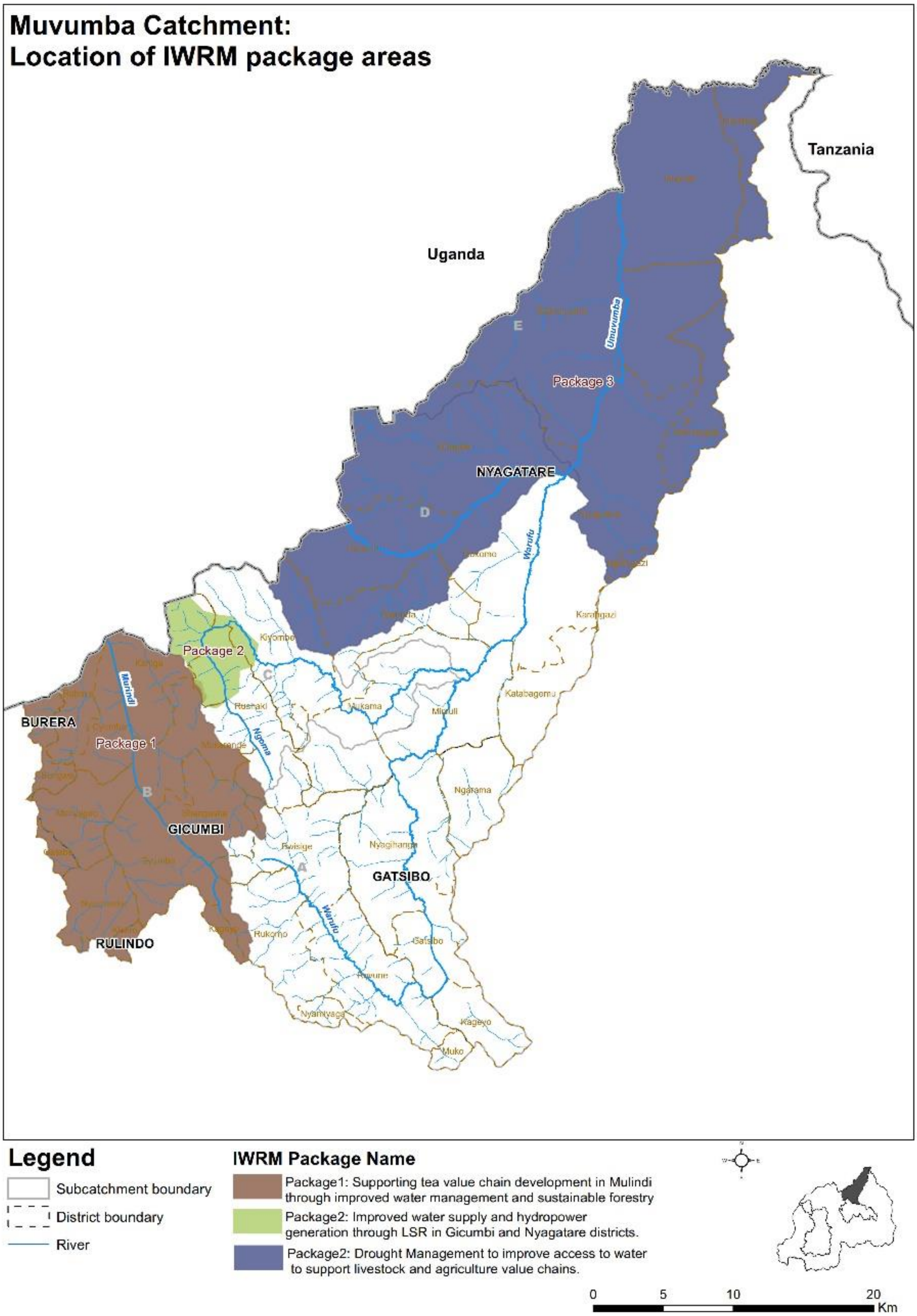


Figure 15: Map indicating the priority subcatchments that will be rehabilitated

Table 13: Budget estimation for landscape restoration in Ngoma sub catchment

No	Description	Unit	Qty	Unit cost (Rwf)	Total cost (Rwf0
CPIP #1	**Watershed rehabilitation to sustain the HPP in Gicumbi and the WTP in Nyagatare**				
1	Terraces + agro forestry, manure and lime on steep slopes	ha	800	2,430,000	1,944,000,000
2	Terraces on moderate slopes	ha	200	633,000	126,600,000
3	Afforestation	ha	115	750,000	86,250,000
3	Ngoma river buffer zone/banks protection	ha	45	236,000	10,620,000
4	Capacity building to farmers	LS	1	50,000,000	50,000,000
5	Water users forum (facilitated by IWRM expert) Joint field visits in the area and 1 exchange visit /stakeholder tbd	Ls	1	5,000,000	5,000,000
Total CPIP #1					**2,222,470,000**

Table 14: Budget estimation for **Drought Management to improve access to water for supporting livestock and agriculture value chains** in Muvumba upper and down steam subcatchments

No	**Item description**	**Unit**	**Qty**	**Unit cost (Rwf)**	**Total cost (Rwf)**
I	**Landscape rehabilitation in catchment and around the future multipurpose dam**				
I.1	Progressive terraces (trenches + agroforestry)	ha	1236	633,000	782,388,000
I.2	Afforestation	ha	250	750,000	187,500,000
I.4	Buffer zone/river banks protection (80 km)	ha	120	236,000	28,320,000
1.5	Gullies treatment	LS	1	3,000,000	3,000,000
1.6	Capacity building to sustain LSR measures	LS	1	50,000,000	50,000,000

Sub-total I					**1,051,208,000**
II	**Support the development of efficient irrigation water use techniques**				
II.1	Develop pilot project which demonstrates high efficient water use rate in SSI	ha	6	4,000,000	24,000,000
II.2	WUAs capacity building	LS	1	50,000,000	50,000,000
Sub-total II					**74,000,000**
III	**Surface water storage and use of ground water**				
III.1	Optimization of valley dam use in cooperation with RAB and the district	Nbr	2	250,000,000	500,000,000
III.2	Water shed rehabilitation around the valley dams	ha	200	633,000	126,600,000
III.3	Support installation of roof tank on HHs, public building and trading centres	LS	1	80,000,000	80,000,000
III.3	Ground water use pilot projects	LS	1	125,000,000	125,000,000
Sub-total III					**831,600,000**
Grand Total (I+II+III)					**1,956,808,000**

Table 15: Budget estimation for supporting improvements in sustainable water and landscape management (floods and sediments mitigation) through developing the tea and forestry value chains in Mulindi

No	Description	Unit	Quantity	Unit cost (Rwf)	Total cost (Rwf)
IP+	**Improvement of water management in the tea plantation**				
1	Recalibration of primary (210,000m)	m^3	315,000	2 500	787,500,000
2	Recalibration of secondary drains (1,220,000 m)	m^3	915,000	2,500	2,287,500,000

3	Installation of water regulation structure in concrete with metallic gate in the drains to raise the water level during dry season	nbr	14,300	100,000	1,430,000,000
Sub-Total IP+					**4,505,000,000**
No	**Description**	**Unit**	**Quantity**	**Unit cost (Rwf)**	**Total cost (Rwf)**
CPIP#1	**Floods and sediments mitigation through LSR and roof tank RWH in the watersheds surrounding the tea plantation valleys**				
1	Terraces on steep slopes+ agroforestry and manure	ha	670	2,430,000	1,628,100,000
2	Terraces on moderate slopes + agroforestry + manure	ha	100	633,000	63,300,000
3	Afforestation + trenches	ha	347	750,000	260,250,000
4	Restoration of old forests	ha	269	800,000	215,200,000
5	Agroforestry in existing radical terraces + cut off drains	ha	1613	300,000	483,900,000
6	Roof tanks RWH in settlement sites (Imidugudu) and public buildings (schools, health centres, etc.)	LS	1	80,000,000	80,000,000
7	Gullies treatment (5000 m)	LS	1	500,000,000	500,000,000
8	Incentive for ecosystem services (IES)	LS	1	50,000,000	50,000,000
9	Capacity building to farmers to sustain infrastructure put in place	Ls	1	50,000,000	50,000,000
Total CPIP#1					**3,330,750,000**

The re-classified W4GR CROM matrix, developed with inputs from soil management and land husbandry scientists from Rwanda and national task force for soil erosion mapping coordinated by Ministry of Environment, is provided in **Error! Reference source not found.**.

Table 16: The matrix of soil erosion control measures according to soil depth and land slope

Land slope↓	Soil erosion control measures	Erosion risk
1: (0-6%)	**Class I** ▪ Agroforestry + contour ploughing + alley cropping with grass strips. ▪ Forestation where soil depth is too limited and unsuitable for crops; ▪ Perennial crops, coffee, tea, banana, fruit trees.	**Very low and low risk**
2: (6 - 16%)	**Class II** ▪ Progressive terraces (reinforced by agroforestry hedges and grass strips); ▪ Perennial crops, coffee, tea, banana, fruit trees. ▪ Forestation where soil depth is too limited and unsuitable for crops.	**Medium risk**
3: (16 - 40%)	**Class III** ▪ Bench terraces (option only in case of suitable, stable parent material / geology; avoid introducing landslide risks); ▪ Progressive terraces (reinforced by agroforestry hedges and grass strips); ▪ Perennial crops, coffee, tea, banana, fruit trees. ▪ Forestation where soil depth is too limited and unsuitable for crops;	**High risk**
4: (40- 60%)	**Class IV** ▪ Narrow cut terraces (option only in case of suitable, stable parent material / geology; avoid introducing landslide risks); ▪ Progressive terraces (reinforced by agroforestry hedges and grass strips); ▪ Forestation (Biological measures); ▪ Perennial crops, coffee, tea, banana, fruit trees.	**Very high risk**
5: (> 60)	**Class V** ▪ Forestation (Biological measures) + trenches / ditches; ▪ Perennial crops, coffee, tea, banana, fruit trees.	**Extremely high risk**

4.1.2 Water allocation

A WEAP model was used to compare alternative water use scenarios for the Muvumba catchment as a whole and can also be used to manage water allocation per water user category and per sub-catchment. A resultant water balance was determined for each (level 2.5) sub-catchment, and for each water use scenario.

A key requirement of water allocation plans was that water should never be over-allocated, i.e. that any unmet water demand should be avoided. This was achieved through application of a priority ladder for water allocation, as follows:

1. Priority was given to domestic water supply, followed by;
2. Livestock;
3. Environmental flow (to provide water to ecosystems and downstream water users);
4. Industrial water demand, due to its very limited size and the fact that demand is constant throughout the year and independent of rainfall;
5. The remainder was made available to irrigation. In areas where irrigation takes place, or will be developed, it is immediately clear from the water balance that it is the largest water user by far.

In most catchments of Rwanda, irrigation is still under development offering the opportunity to adapt plans now according to expected water availability and thereby avoiding the development of irrigation infrastructure for which there will be no water to allocate in future. MINAGRI, RAB, and the WRMD jointly updated the Irrigation Master Plan (IMP) for Rwanda, based on available water resources. The water allocation plans per sub-catchment and per time horizon (baseline (2015), 2024 (this catchment plan; relative allocation per user group is depicted in Figure 16), 2030 (SDGs), and 2050 (Vision 2050) in Annex 9.3 provide the exact information on how much water could be supplied in an average year to each water use category. Values in the water allocation plans represented the average of ten years of current or expected rainfall and evapotranspiration, under a medium climate change scenario.

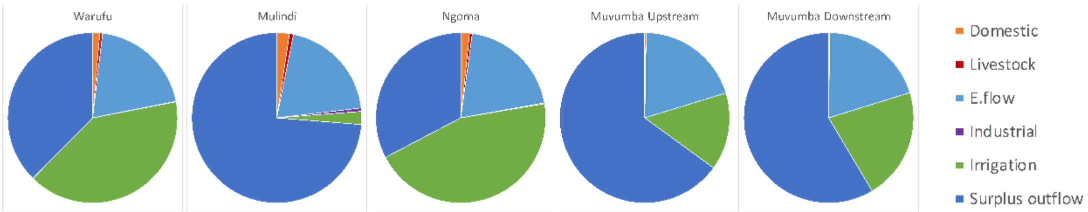


Figure 16: Water allocation plan for sub-catchments for 2024

In the new IMP, a decision needs to be made for the best combination of irrigated area, technology to be used, and cropping patterns / seasons. Checks need to be made that the combined water demand per month of a chosen crop, per sub-catchment, and per time horizon, are =/< the amount of water available according to the water allocation plan for that month, sub-catchment, and time horizon. Use of water efficient technologies and crops with low(er) water demand, and/or limited cropping in the dry season, may all improve the acreage to be developed and the total yield obtained, leading to optimal land and water productivity and food security. A development reduction factor should also be built in, to reduce the occurrence of water shortages in years with less than average rainfall. This choice will need to be made in the IMP.

Water allocation plans will facilitate a water permitting process whereby, as long as combined individual permits do not add up to the total allocation per category up to the applicable time horizon (e.g. 2024) and per sub-catchment, new permits can be issued. Once a limit is (nearly) reached, the WRMD will have to consider their options. Options might include re-allocation of water between/across categories, thereby allowing for quicker growth (but staying within growth allocations for 2030 and 2050), and/or denying permits within a sub-catchment and perhaps referring of applicants to other sub-catchments or catchments where there is more water.

WEAP also allows for storage of water permit data (water use for individual permit holders per category) and can, therefore, regularly be used to determine and report on remaining available water. This quantity of 'available water' could be announced, for example, in annual catchment plan M&E reports and communicated to potential investors.

An integral part of the water allocation plan is that users within each water use category need to enhance efficiency over time. For each category, the required efficiency gains are listed as achieving a reduction in water usage per typical water user or area of water use (per hectare, in the case of irrigation) (see Table 12). An important role will have to be played by WASAC, private water supply companies, industrial umbrella organisations, and RAB, in promoting water savings. Ultimately, the private sector needs to adopt the efficiency targets and implement them. Water users who demonstrate higher water efficiency improvements than required may receive priority in the assignment of water permits.

Table 17: Final catchment plan alternatives

Time horizon	Domestic water supply	Industrial water use	Irrigation
2024	10%	5%	5%
2030	15%	10%	15%
2050	20%	20%	30%

The water allocation plan relies partly on the development of water storage reservoirs, as per the National Water Resources Master Plan (MINIRENA, 2014). A map of existing and planned dams / storage reservoirs is provided in Figure 17.

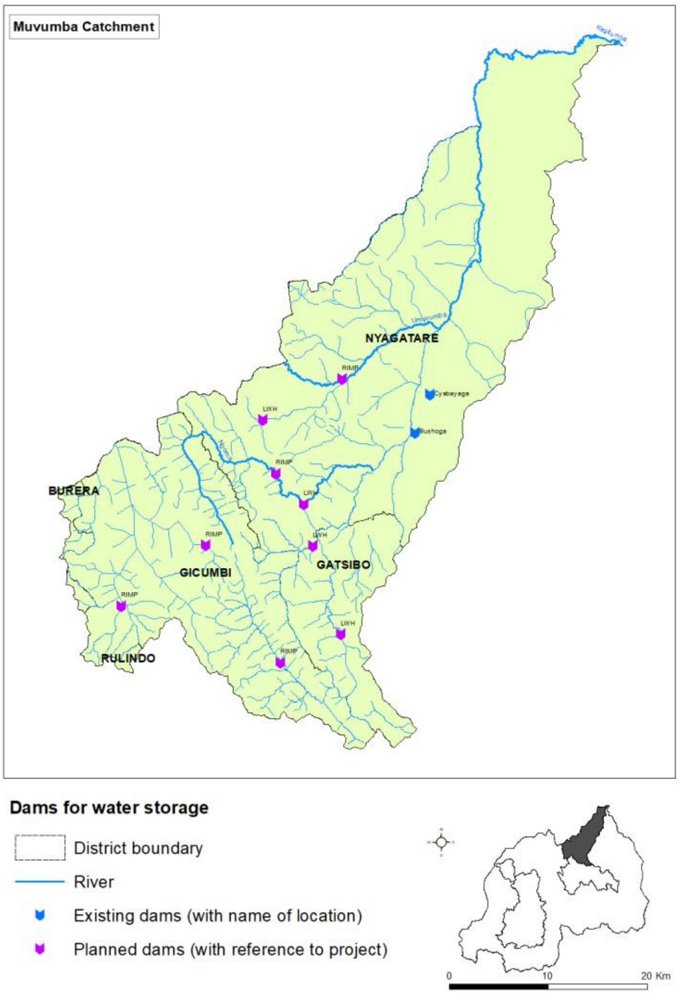


Figure 17: Map of existing and planned dams in the catchment

Institutional development for catchment planning and management

Water governance refers to the political, social, economic and administrative systems in place that influence the use and management of water. It regulates who gets how much water, when and how, and who has the right to water and related services, and their benefits. Water governance determines the equity and efficiency in water resource and services allocation and distribution, and balances water use between socio-economic activities and ecosystems. Governing water includes the formulation, establishment and implementation of water policies, legislation and institutions, and clarification of the roles and responsibilities of government, civil society and the private sector in relation to water resources and services. The outcomes depend on how the stakeholders act in relation to the rules and roles that have been taken or assigned to them[26].

This current catchment plan has been developed solely within a project setting, using temporary arrangements for plan development, and partial plan implementation funded by money from the IIF and from the W4GR technical assistance budget. A project environment is, however, always only temporary and used to introduce a new practice, e.g. of integrated planning, and to enhance the level of investments in IWRM measures in catchments. In this instance, several new institutional measures were required (see Table 16), and these will embed the principles of IWRM and catchment planning firmly into the Rwandan water governance context. By their nature, most of the initial institutional developments will have to be at

[26] http://watergovernance.org/governance/what-is-water-governance/

the national level, in order to pave the (regulatory) way for catchment or lower scale institutional improvements. In the Annual Implementation Plans that will come from the catchment plan, and in the mid-term review of the plan's implementation phase, additional, institutional measures need to be added to the list. An overview of potential institutional measures is provided in Table 24, Annex 6.

A major institutional development is the update of the legal basis for water governance. The new water law (adopted by parliament in 2018) provides for the establishment of permanent catchment committees, one per catchment. This will require sustainable transformation of the current catchment task force and providing them with a clear mandate. The exact composition and mandate/s of catchment committees will be laid down in the Ministerial Orders (currently under development) that accompany the Water Law. At a minimum, Catchment committees will need to be supported technically and organisationally, by some form of a permanent secretariat.

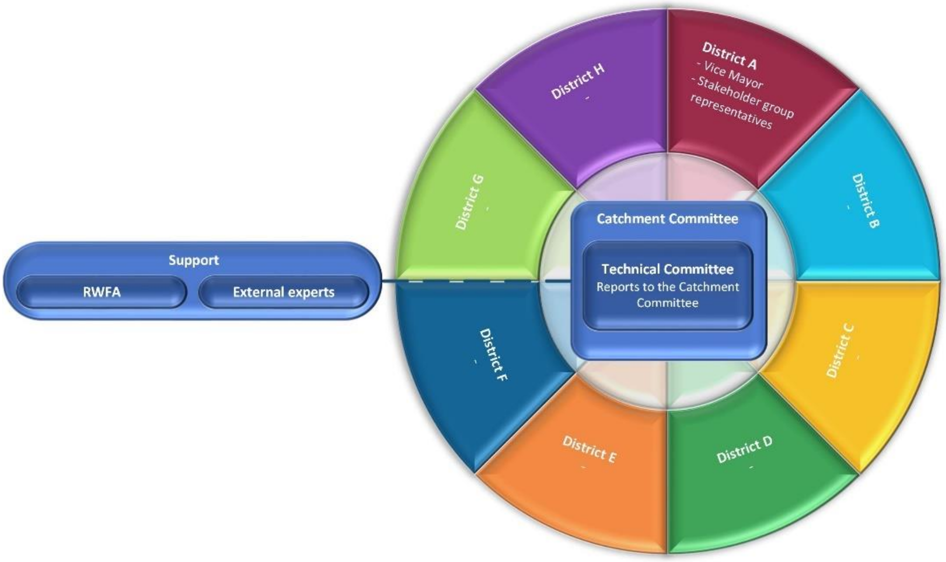


Figure 18: Catchment Committee Infographic

Gazetting of the new Water Law and related Ministerial Orders has/will also reinforce the water permitting process, to enforce adherence to the water allocation plan. Water permits are a key tool to guide all sectors, especially the private sector, in their use of water. Although all candidates for water permits will be targeted pro-actively by the WRMD and the districts, to enhance their governance of water use, the private sector can flourish, but only within a good and transparent water governance framework.

Private sector innovations for water-based economic development

Companies and their value chains are continuously adapting to new market opportunities and pressures from the environment, society, etc. In Rwanda, where land and water are both limiting production factors, there is a need to maximise production per unit of land and unit of water.

Future water demand and use scenarios (W4GR TR55, 2017) show that water stress in Muvumba will gradually increase and that, therefore, to achieve Vision 2050 goals, a balanced approach of catchment protection and maximisation of water productivity will be required. One way to achieve this would be to create a 'value' per unit of water, with this value commonly expressed in monetary terms. This may eventually translate into a water use fee, connected to water permits.

Catchment management increasingly, however, uses concepts such as 'total value counting' and natural capital accounting, which also take into account environmental and social, as well as financial, returns. In the case of food production, nutritional value maximisation is also considered a relevant indicator, linking to SDG indicators on food security.

To maintain and improve their competitive edge, private sector companies need to innovate and find ways to lower their production costs, making businesses particularly good at improving operational efficiency. There is a growing awareness among businesses that taking care of the environment and community within which they operate, is necessary for their long-term survival. With the right national policies, the private sector can be further encouraged, and/or legislated to incorporate social and environmental values into their business model. The private-sector can, therefore, be a key source of innovation in the valorisation and sustainable management of water resources.

Opportunities for innovation can be found in all parts of a value chain, from improved business models, marketing to finance, and policy and regulatory incentives. Table 18 provides an overview of areas of innovation with examples that impact water resources management within catchments.

Table 18: Innovation areas contributing to achieving inclusive sustainable socio-economic development

Areas of innovation	Examples
Business Models	▪ Nature-based enterprises; ▪ Co-operative/shared use facilities; ▪ Out-grower supplier relationships; ▪ Payments for eco-system services.
Commercialisation	▪ Public natural resources – e.g. protected forests becoming paid access national parks; ▪ Valorisation of water supply.
Financial Support Services	▪ Introduction of blended finance approaches to facilitate investments in new technologies and processes; ▪ Improved access to private investment capital.
Know-How	▪ Knowledge dissemination for 'best practice' adoption; ▪ Education and capacity building.
Partnerships	▪ Public-Private Partnership approaches; ▪ Multi-stakeholder coordination; ▪ Build Operate Transfer (BOT) or similar public-private project financing approaches that create public ownership-private management operational concessions like those used in utility development.
Policy and Regulatory Incentives	▪ Environmental and Enforcement Requirements; ▪ Tax breaks and 'green' investment and finance incentives.
Technology and Industrial Processes	▪ Ore extraction efficiency processes (i.e. jig-based water extraction equipment); ▪ Water and waste management re-cycling processes.

This catchment plan provides the framework for the design of innovative responses to enhance development and sustainability of economic drivers. Water and energy efficient innovation creates jobs, while state of the art technologies increases competitiveness and open market opportunities in regional and global markets. More efficient processes, such as modern ore extraction and water and waste management technologies, can also have a positive impact on the generation of taxable business revenues, and a growing private sector will grow the tax base and lay the foundation of a self-sufficient Rwanda, thereby helping to realise Vision 2050.

Long-term government and private sector interest in sustainable socio-economic innovation converge in catchment planning. Understanding this shared interest will be key for expanding targeted Government policies to enable and support SMEs to respond to green market-based business opportunities, in line with the goal of private sector led development.

Successful, profitable value chains are often organised around so-called anchor companies (e.g. a coffee factory, a sugar cane processing plant, an irrigation scheme, mining hubs/clusters, or a water supply company). When supported and strengthened, strong anchor companies can leverage investments that develop value chains and improve livelihoods and create jobs and income at local and national levels.

The development of anchor companies can be facilitated by government approaches that promote the desired growth and diversification of the economy through the offer of public funding to essentially co-share investment risks.

Access to water and other natural resources is often referred to as natural ecosystem or natural infrastructure services. The productive activity of a company valorises natural resources in the catchment. Investment costs can be high with only long-term contributions to a company's financial performance. In such circumstances, anchor companies have a clear incentive to participate in the maintenance and rehabilitation of catchments and the natural resources and environmental services they provide, but these activities require a risk-sharing commitment from both public and private sector actors. This is where Public-Private Partnerships (PPP), possibly with addition of Civil Society (PPCSP), become relevant, especially as neither partner acting in isolation can meet the challenge of sustainably managing natural resources, or exploiting them sustainably for the wider benefit of society.

Natural ecosystems are typically seen as 'public goods', managed by local authorities under a national government mandate. Shared public-private-civil society interest in protecting resources at catchment level offers an opportunity for PPCSP investments and management. For example, if a tea factory can reliably secure a supply of firewood[27], through a co-investment PPP or PPCSP project to establish sustainable forestry in the vicinity of the factory, input costs can be more reliably fixed, minimising the investment risks involved and ensuring more predictable output pricing. Other PPP/PPCSP opportunities exist through increasing the supply of timber production and green tea through integrating smallholder farmers into out-growers' schemes.

Government policy and programmes can facilitate development of anchor companies through public funding that aims to share investment risks, while purchasing custodianship of the nation's water and natural resources. For example, the future sustainable management and reliable provision of clean water, timber production and the national landscape on a catchment basis.

Investments regulated and framed by the public sector but co-financed by the private sector and supported by specific sector expertise, can generate multiple returns that include the preservation of the environment and natural resources, along with an enhanced and diversified local economy, improved local income levels and livelihoods and stronger, more resilient communities. It needs to be stated, however, that unregulated or uncontrolled development of drivers can also result in negative impacts on IWRM and socio-economic development, as competition for resources becomes unbalanced or unsustainable.

As such, opportunities exist for innovation in improved business models, commercialization, PPPs/PPCSPs, know-how and technology transfers, adoption of industrial processes, offer of financial support services, and policy and regulatory incentives.

In conclusion, the type of innovation either sought or promoted within a given (driver) sector will depend on the Government's policy for facilitating IWRM initiatives and its ability to create an enabling environment, through formulation of viable incentives to encourage partnership with the private sector. With instruments established to promote PPPs/PPCSPs in IWRM, the success of partnership arrangements

[27] For curing locally harvested tea leaves.

will be determined by the plans of the private sector to respond to market-based business opportunities in line with SSP and DDS objectives.

4.1.3 Knowledge management

Knowledge measures (IPs or mostly CPIPs) are generally catchment-independent. Any knowledge development, or development of systems of tools, that can be used in one catchment, is usually equally important for other catchments. Table 25 (Annex 6) presents a series of useful knowledge measures that were defined during the development of the four catchment plans. Knowledge management, which includes the development of knowledge, and the provision and use of tools and systems for its development and its use, is one of the key prerequisites for good catchment management. In the DPSIR analysis, most proposed projects respond to the driving force of a lack of, or limitations in and of, knowledge or skills. The many knowledge projects proposed in this catchment plan aim to dramatically and sustainably improve this situation.

4.2 PoM 2018-2024 development process

As already stated, this chapter introduces a coherent, programme of measures for the Muvumba catchment plan, primarily for the implementation period 2018-2024, but also partly for subsequent catchment plan periods (2024-2031 and onwards), as some catchment restoration activities will take more time than six years to implement. This chapter also describes the process that will be used to develop Annual Implementation Plans (AIPs), with the first section briefly describing the process and the following sections describing detailed individual process steps (using 'filters' as assessment and selection tools). Details of individual workshops and meetings that were held as part of the process can be found in Annex 7, on the SEA process.

The PoM is the core of the catchment plan and constitutes the means by which all catchment stakeholders intend to jointly meet the plan's objectives, and ultimately contribute to achieving its long-term vision. The PoM is more than just a sum of implementation programmes and projects of plan partners; it is an integrated programme that translates abstract, generic measures[28] into a coherent, internally consistent set of implementable projects and temporary or permanent institutional or knowledge management interventions. Between them, these jointly address issues and opportunities that, among other things, make optimal use of different drivers of economic development.

An incremental process was followed in development of the PoM. An initial inventory was made by CTF and key, relevant national stakeholders of ongoing projects at a workshop in October 2016 (W4GR TR64, 2016). The nature and physical location of interventions was mapped, and full details were collected. This inventory was then updated through addition of all ongoing projects, as well as of planned projects, the information for which was obtained during a catchment plan alignment and integration workshop held at each district. These workshops were designed to align catchment plans with District Development Strategies, Sector Strategic Plans and national Cross Cutting Areas; for more details on the overall alignment process see Annex 4. In these workshops, several new projects were proposed for inclusion and existing and new projects were digitised as far as their geographical scope was known by district staff and included in a first version of a projects geodatabase.

Once compiled, this long list of projects (ongoing, existing, and proposed) was subject to a filtering exercise, and refinement process (see Figure 19 and Sections 4.3 to 4.6). As well as the initial categories of ongoing/planned projects (so-called implementation projects or IPs) and new project proposals (catchment plan implementation projects or CPIPs), an additional category of implementation projects plus or IP+, was added. These refer to IPs with additional elements of IWRM that enhance the contribution of the IP (upgraded to IP+) in delivery of the catchment plan's objectives and vision.

The filtering, selection, and refinement process (Figure 19) can undergo several iterations. The initial CP PoM (the shortlist in the filter) contained many projects or project ideas that required further detailing. The filters 2, 3, and 4 (DPSIR analysis, consistency check, and MCA) can be re-run upon completion of feasibility studies for IWRM packages for the AIP 2018-2019. In subsequent years, new project ideas may be passed through to the first filter (relevance screening) and new IWRM packages will have to be developed for AIP 2019-2010 and beyond.

[28] Of preferred alternatives, as described in paragraph 3.2, simulated in the water balance and allocation model and selected by the catchment task force and national plan partners.

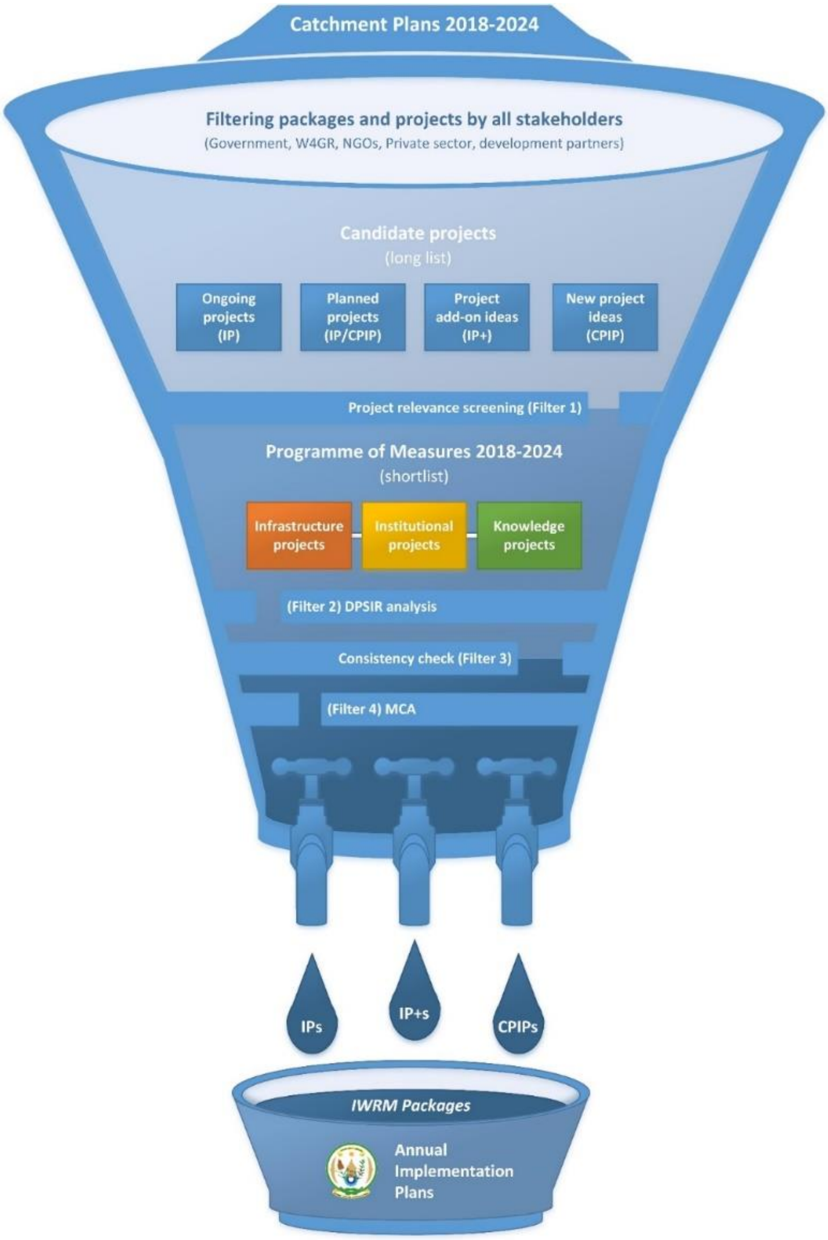


Figure 19: Filtering candidate projects into the programme of measures 2018-2024 and subsequent annual implementation plans

4.3 Project relevance screening (filter 1)

Individual projects were firstly screened on their relevance to the catchment plan. This was done in a series of PoM sessions at Water for Growth Rwanda, which involved determining and assessing the scale and timing of a project and determining whether or not it fitted with the preferred alternative[29] in terms of e.g. land husbandry and water allocation. A project's significance, with regard to its likelihood to contribute to achievement of its catchment plan's goal and objectives, was also determined and, based on their scope, projects were also categorised into three groups: Infrastructural; institutional, and; knowledge. Combinations of these categories also exist in individual projects; in particular, many catchment restoration projects of an infrastructural nature also require awareness raising (knowledge) among the recipients, as well as institutional capacity building among government, communities, and the private sector.

[29] At the time of relevance screening of projects, a draft preliminary alternative was available. This alternative was eventually adopted and is the basis for the water allocation plan and landscape restoration opportunities mapping in this catchment plan.

Infrastructure measures

The geographical intervention areas of projects that contain significant infrastructure elements were mapped, provided that spatial data was available for the project[30].

All projects of a primary or significant secondary infrastructure nature in the catchment, and for which GIS data existed, are presented in Figure 36 to Figure 41 in Annex 3 (Catchment Atlas) and in Table 23, in Annex 6 (Programme of Measures). The maps are based on a first version of the projects geo-database. For each of the projects included in Table 23, information is provided on the type of project, the technical and geographical scope (as far as available), and the DPSIR framework response level, i.e. whether the measure targets the driving forces behind catchment issues, or the pressures, or the impacts.

Figure 42 presents all infrastructure projects in the catchment, by their project classification ($IP_{ongoing}$, $IP_{planned}$, IP+, or CPIP). Figure 43 to Figure 47 present the main scope of the same projects, for level 2.5 sub-catchments. Projects that cover entire districts or similar large areas and projects or project ideas for which there was no spatial scope or data could not be mapped and so do not appear on the maps. They are, however, listed in Table 23.

4.4 DPSIR analysis (filter 2)

The second filter was used to analyse the contribution of projects as a Response (the final element of the DPSIR methodology) to Driving forces, Pressures, States, and Impacts. The DPSIR methodology (see Section 2.2) presented an analysis of priority issues in the catchment and broke these down into the causal relationships around them, as well as into driving forces, pressures, states, and impacts. The responses identified constitute the PoM of the catchment plan. A generic DPSIR was, therefore, completed for the entire catchment (Figure 20), based on the DPSIR analysis in Section 2.2, and narrow-focus DPSIRs were developed for individual IWRM packages (further introduced in Section 4.3).

Generic DPSIR for the catchment

Generic responses (R) were developed for all relevant D-P-S-I levels. In Table 23, Table 24 and Table 25 in Annex 6, columns have been included that link the ongoing, planned, and proposed projects (infrastructure, institutional, and knowledge) to the DPSIR response levels. Noteworthy is that knowledge and institutional projects mostly target driving forces, giving them the highest potential for sustainable change in the catchment. Infrastructure projects may also target driving forces, but more often target pressures or impacts. End of pipe solutions (responses that only target impacts) are hardly ever sustainable by themselves, as, without addressing the underlying causes (driving forces and pressures), states will not change, resulting in a repetition of the same harmful impacts if the response is not kept active infinitely.

An analysis was subsequently made whether projects in the database (the shortlist from the filter system) were suitable as responses to catchment issues. This assessment was made in relation to their response to driving forces, pressures, or impacts, and whether they were properly in line with the preferred alternative, i.e. focused on development of storage, sustainable catchment management, enhanced water use efficiency, and restricted development of new irrigation areas in those sub-catchments where water is available.

[30] This is not always the case in Rwanda; spatial planning is a relatively new phenomenon, and locations of projects are often only recorded in tabular form. In such cases, the district(s), sector(s), and cell(s) may be known, but the actual perimeter of the intervention area is not always digitised in a Geographical Information System (GIS). Water for Growth Rwanda introduced a first version of a projects geodatabase for Rwanda and this will be provided to the plan partners at national, catchment, and local level, in order to enhance the level of spatial planning in the country.

Figure 20: DPSIR for Muvumba catchment

DPSIR analysis of the overall PoM, as developed with the districts in the catchment and augmented with known national interventions and large projects, reveals that not all identified potential generic responses are addressed. Table 19 provides a list of responses that have not been addressed sufficiently; it also provides a first list of measures that could be added to fill the gaps. Some of these may be considered beyond the mandate of the current plan partners, and additional governmental stakeholders may need to step in, or the private sector facilitated and stimulated to take up these interventions. Other measures may refer to regular operation and maintenance, rather than investment projects. In subsequent versions of the catchment plan, and in annual implementation plans, these potential measures (and more) need to be investigated and added to the PoM if deemed opportune.

Table 19: DPSIR responses insufficiently covered to date

Response level	Response	Potential measures
Driving forces	Enhance levels of urbanisation, optimising 'climate smart' and 'sustainability' concepts in secondary cities and introducing similar measures in smaller cities and villages.	Introduce sustainability concepts in urban areas, e.g. Gicumbi and Nyagatare and smaller towns.
Pressures	Develop off-farm jobs.	Enhance stimulation programmes for (private sector led) job creation.
	Develop sewerage systems, wastewater treatment plants, sludge collection, and treatment facilities.	WASAC and other operators to share information on their current plans and discuss opportunities for additional works.
Impacts	Enhance maintenance of infrastructure, e.g. of water supply networks.	Regular O&M tasks which may need to be enhanced, and for which fees collected may need to increase to cover recurrent costs sustainably.
	Enhance capacity of hydropower equipment to operate under high turbidity conditions.	REG and private sector to design new or existing hydropower infrastructure in more robust ways.

4.5 IWRM packages (filter 3)

A key principle of IWRM is that programmes of measures need to be integrated, rather than delivered as a series of stand-alone interventions. The third filter step was, therefore, to combine projects into IWRM packages, targeting specific issues in a confined area of the catchment, usually a sub-catchment, to ensure consistency between projects in the same area, and to enhance the overall programme of measures where needed. This step also occasionally led to additions to individual projects (IP+, CPIP), or to new CPIP proposals. It also occasionally led to recommendations to alter, stop, or drop ongoing or planned projects, due to significant inconsistencies between them and the catchment plan's preferred alternative, and with the detailed scope for the IWRM package area.

All land and water using activities and projects in a catchment rely on the same limited natural resource base and all life in the catchment is spatially connected through these resources. Catchment plan implementation projects are equally interconnected, often competing[31] with or reinforcing[32] each other and a consistency analysis can be done to reveal potential conflicts, and to identify win-win situations. An initial consistency analysis was carried out for the IWRM packages developed to demonstrate the added value of an integrated approach as soon as possible. To further enhance this understanding, a narrow-focus DPSIR analysis was carried out at IWRM package level.

Overview of IWRM packages

IWRM packages have been developed for three areas within the catchment, and around the themes of water supply, hydropower, catchment restoration, drought management, livestock, agriculture, tea and forestry (either issue-focused or opportunity-focused) (Figure 48, Annex 3). The integrated approach of responding to the key issues and opportunities is explained via a focused DPSIR analysis for each package. Each package has a high demonstration value, in that the same theme usually also has relevance in other

[31] e.g. requiring the same resources at the same time/place.

[32] e.g. effectively making use of the same resources in sequence without deterioration.

parts of the catchment, or in other catchments in Rwanda. The solutions may be replicated there and adapted to lessons learnt in these first IWRM packages.

The three IWRM package to date are as follows:

1. Support to sustainable water supply and hydropower generation through catchment restoration in Ngoma sub-catchment;
2. Drought management to improve access to water for supporting livestock and agriculture value chains, and;
3. Support improvements in sustainable water and catchment management (floods and sediments mitigation) through developing the tea and forestry value chains in Mulindi.

As gender and climate change mainstreaming are CCAs of prime importance in the catchment plan, IWRM packages and CPIPs include gender and climate change mitigation / adaptation aspects that are strongly associated with the projects' key components, outputs and related indicators. These aspects will demonstrate how to address IWRM related gender and climate change issues. IWRM concept notes can be found in Annex 13.

Narrow-focus IWRM package DPSIRs were developed around the key issues at stake in individual IWRM package areas, with responses formulated in line with local opportunities or drivers of economic development (see below for the DPSIRs and narrative, and Annex 13 for the complete IWRM packages). These analyses revealed whether IWRM packages contained a complete and suitable set of measures for the key issues at stake and assessed whether strategic solutions for the preferred alternative were properly translated into suitable concrete response-projects.

Support to sustainable water supply and hydropower generation through catchment restoration in Ngoma sub catchment

The Ngoma sub-catchment is covered by the two districts of Gicumbi (Rushaki sector) and Nyagatare (Kiyombe, Mukama and Mimuri sectors). It is the smallest sub-catchment in Muvumba at only 9% of the total catchment area. The Ngoma river feeds the Karungeli River before it joins the Muvumba River. The Ngoma sub-catchment is an important source of water for humans and livestock for many sectors.

A micro hydropower plant was constructed on the Ngoma River in 2007. This 50-kW scheme is managed by the district and supplies electricity locally to Kaniga sector, serving about 250 households. It is fed by a small reservoir with a dam, which raises the water level by about 4 m.

Downstream of the hydropower scheme, WASAC has a water supply intake that provides drinking water to 4,400 households. Reduced flow in the dry season is presently less than that needed by both the hydropower and water supply schemes, whereas in the rainy season, high sediment levels in the river hinder normal operation. Both, therefore, require investment for works to their intakes in order to better manage sediments, but these only really make sense if implemented in coordination with catchment-wider improvements of water and catchment management.

This analysis of issues, their causal relationships, and potential responses, is summarised in the focused DPSIR framework in Figure 21.

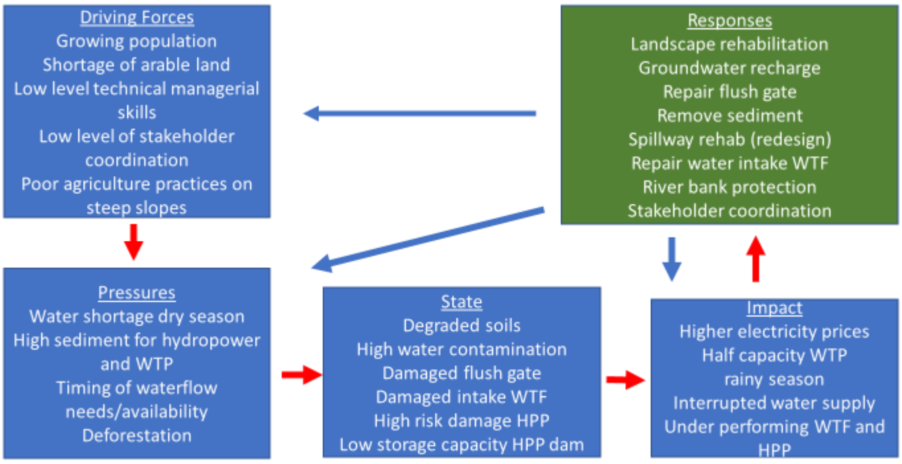


Figure 21: Focused DPSIR analysis for IWRM package 'Support to sustainable water supply and hydropower generation through catchment restoration in Ngoma sub catchment'

Drought management to improve access to water for supporting livestock and agriculture value chains

The Muvumba ‘Upstream’ and ‘Downstream’ sub-catchments are part of a complex, shared transboundary river system. Within Rwanda, they are covered by Nyagatare district and either entirely or partially by Matimba, Musheli, Rwempasha, Rwimiyaga, Nyagatare, Karangazi, Karama, Gatunda and Tabagwe sectors. The two sub-catchments are characterised by undulating land with high potential for livestock production and high demand for a number of competing water uses, such as irrigation and livestock production.

The eastern part of Rwanda including the sub-catchment area, has frequently suffered long and recurrent droughts and water shortages are likely to worsen in the future (as demonstrated by WEAP simulation results). During dry periods, competition for the scarce water resources between different users, such as between livestock and irrigation, has been observed and this can lead to conflict.

Upper and Lower Muvumba sub-catchments are also home to some of the largest livestock populations in the country and provide the basis for busy dairy, meat and hide value chains. Unfortunately, overgrazing by cattle has degraded the soil in some parts reducing the water holding capacity and increasing runoff. Impoverished soil has a lower holding capacity.

Natural and gallery forests, and other natural vegetation, that used to exist along the Muvumba River have also been cleared for crop production and cattle ranches and cut for use in construction or for firewood. Almost 95% of riverbanks and their catchment areas are used for agriculture. Most of the ranches and farms are, however, poorly managed, as a result of overgrazing and poor farming methods, and ground (grass) cover is almost completely depleted. Soil compaction is common with most soils having developed a hard pan and having lost their water retention capacity resulting in reduced groundwater recharge, excessive surface water run-off and soil erosion. As a result of farming, chemicals (insecticides and herbicides) are also released into the river and during prolonged dry spells and drought periods, flows reduce substantially, causing a water crisis for livestock, plants and humans.

To address these issues, a buffer zone will be developed (or restored) along about 80 km of the Muvumba River and its tributaries. It will be planted with various useful tree and fodder grass species (bamboo, agroforestry, elephant grass, etc.) to stabilise riverbanks and prevent / reduce ingress of pollutants to the river system. A planned multi-purpose dam will also need to be protected against sedimentation by silt-rich surface runoff and thus catchment restoration measures will also be implemented in the area comprising afforestation on steep slopes and progressive terraces with agroforestry on moderate slopes.

There is also a plan to increase water storage, improve cattle ranching practices, and water use efficiency by providing water resources away from the river, although studies have to prove the viability of boreholes, as well as of the restoration and improvement of valley dams. The multipurpose dam could possibly also increase water availability in the river during the dry months.

Nyagatare District also intends to promote raising of livestock through intensive farming for milk and meat production. This will require minimising distances to access water and production of high quality fodder. Rainwater harvesting, through small-scale water storage infrastructure, such as valley dams, may be one measure to help achieve this objective but rehabilitation of existing valley dams will be required. Existing valley dams are, however, facing many challenges, such as:

- Rapid drying after the rainy season;
- Poor maintenance; and
- Absence of water user associations (WUAs) to manage infrastructure.

An early warning system for drought coordinated with Uganda can help planning of prioritisation of water users. The set-up of a water user's forum is important to avoid conflicts and jointly learn about managing the limited water resources. For example, water can be allocated to the survival of cattle at the expense of smaller area with irrigated rice. In time the processing and other elements of the cattle products value chain needs to be addressed to deal with contamination of water resources by slaughter houses.

In order for there to be more productive and more resilient agriculture, a major shift will be needed in the ways that land and water are used and managed to ensure that they are used more efficiently, thereby keeping social peace. In addition, land fragmentation and high population density, also constitute major reasons to explore new farming systems to increase agricultural productivity and water efficiency. To achieve this objective, new crop varieties with higher economic value and less intensive water use need to be introduced. New water saving technologies, such as drip irrigation, should also be introduced and farmers will need to be trained in such technology, as well as in efficient water delivery and scheduling, and in maintenance of irrigation facilities with the target to meet the full crop water demand.

To date MINAGRI/RAB have been supporting development of small-scale irrigation technology (SSIT); they have provided farmers with equipment such as hoses, motors and treadle pumps, as well as sheet lining for small, upland reservoirs. This expanded, farmer-based, small-scale technology has been demonstrated, discussed and adopted in various forums, including the Irrigation Forum and in and through various district and farmer consultations. The SSIT approach has the advantage that it does not require complex pumping stations or a buried pipe network, as it is entirely portable and has a low cost per hectare making it attractive to individual and small farmers.

Most of the efforts and investments made in Rwanda, for irrigation development have focused on water resources development and very few on on-farm water use improvement. In this instance, the project intends to implement improved irrigation methods and techniques on small farms to promote higher irrigation efficiency, improved utilisation of water and intensification and diversification of production. The capacity of WUAs in managing, mainly rice producing, irrigation schemes can also be improved as farmers are neither familiar with how to deliver efficient water use, nor the potential human health problems or environmental pollution issues caused by pesticides and chemical fertilisers used on their crops.

In this IWRM package, the only source of water is the Muvumba River and its main tributary, the Warufu stream. People who are living far away from Muvumba and Warufu rivers do not have any other source of water. To contribute to tackle this issue, an assessment of the contribution that groundwater resources could make will also be conducted.

This analysis of issues, their causal relationships, and potential responses, is summarised in the focused DPSIR framework in Figure 22.

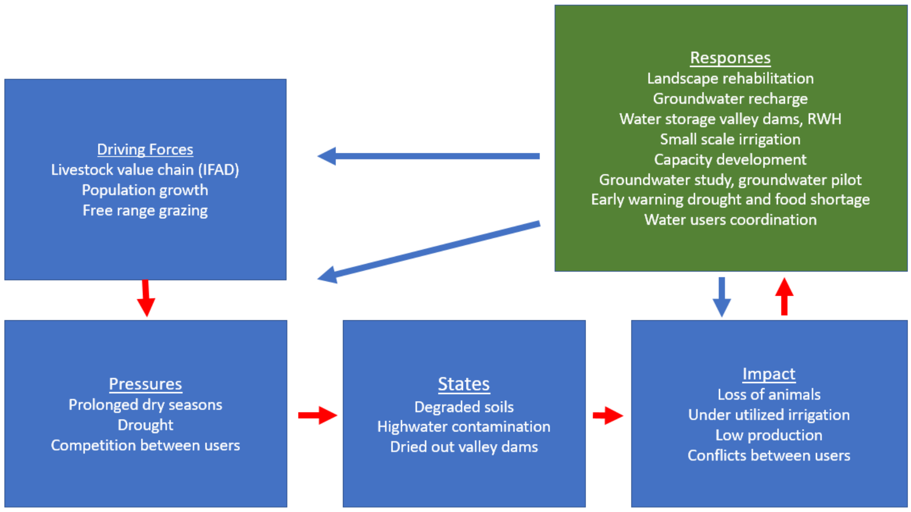


Figure 22: Focused DPSIR analysis for IWRM package 'Drought management to improve access to water for supporting livestock and agriculture value chains'

Support improvements in sustainable water and catchment management (floods and sediments mitigation) through developing the tea and forestry value chains in Mulindi

Tea has been cultivated in the Mulindi marshlands since 1959 with the first factory established in 1962 and run by the Government of Rwanda until 2012 when it was privatised. The Wood Foundation Africa (TWFA), within the East African Tea Investment (EATI), currently owns 55% of the factory and tea grower cooperatives own the remaining 45%. TWFA provides technical assistance to the two tea leaf supplier co-ops, COOPTHE and COOPTHEVM, and work with them to improve green tea yield, provide organisational advice, 'best practice' information, as well as seedlings to increase the productivity. COOPTHE has an area of 694 ha and COOTHEVM 1,015 ha and between them they have 4,940 members (71% of men and 29% of women).

The overall objective of TWFA is to support development of the tea value chain and tea production in Mulindi, as well as upgrading of the factory with new, more efficient technologies. Once completed, all shares owned by the TWFA will be handed over to the cooperatives and management of the factory also transferred.

There are, however, several challenges facing the tea plantations and factory, as follows:

1. **The impact of climate change and demographic pressure**: Recent changes in rainfall patterns in the region are adversely affecting tea production. Although average annual rainfall remains the same, distribution is now characterised by intense rainfall creating flash floods and dry spells which threaten the peat valley bio-system. Development of villages (imidugudu) and agriculture on steep slopes in the watersheds are also contributing to a changed hydrology resulting in more flash floods. They have also resulted in the creation of big gullies in the surrounding catchment, and in the marshlands. The gullies are unstable and quickly result in the loss of peat soils. Sand and mud brought by floods tend to cover tea plots, causing significant maintenance costs and even loss;
2. **Water management in tea plantations**: Tea production is negatively impacted by water logging (high rainfall and poor drainage of the marshlands) and by drought (low rainfall or excess drainage during dry season). Tea productivity among the co-operative farmers varies significantly according to hydraulic conditions in water dependent peat soils. During the rainy season, the high-water table impedes development of the root system, while the shallow root system also suffers from a lack of water during the dry season. Water levels in drains must, therefore, be carefully managed and drains need to be deep enough to allow drainage during the wet season, but check dams are also necessary to raise water levels up to the root system during the dry season. The drainage system in the tea plantation is composed of about 210 km of main drains and 1,220 km of secondary drains.

These need regular maintenance since they regularly receive sediments from the surrounding hills. Recent floods (10/2017) destroyed about 44 ha of tea plantations, which were covered by sand, gravel and even boulders. A drought occurred in 2017 and impacted 392 ha of tea of which 128 ha were severely damaged. Gullies are often created by runoff from settlements and roads on top of the hills. It is possible that introduction of rainwater harvesting in the catchment could reduce runoff and that gullies could be controlled and removed through the use of replicable, low cost, bio-engineering technology;

3. **Poor drainage and collapse of peat:** Downstream, near the Ugandan border, around 200 ha of marshland tea plots have been abandoned since 1994 because of poor drainage and a collapse in the peat bio-system. Water works are needed to restore drainage and favourable conditions to reinstall tea. Two cooperatives are already implementing maintenance works in Uganda through informal cooperation. This activity could be more effective when implemented through formal transboundary cooperation involving local leaders from Rwanda and Uganda;
4. **Tea factory use of water and energy**: Water used in the factory comes from two springs (one pumped, one gravity fed). Rainwater harvesting is planned, as is the reuse of waste water (from cleaning equipment only). 12,000 m³ of firewood per year are needed for curing of the tea leaves and the factory owns 284 ha of forests, but this only provides it with 40% of its energy needs. Additional firewood is bought from farmers with private woodlots, as well as from District-owned forests.

It is clear that tea is the important economic driver in the Mulindi sub-catchment; it provides work and income to 4,000 families. The tea value chain consists of tea plantations, transport of leaves to the factory, forest to supply the firewood and the factory. Changes in weather patterns, lack of maintenance and damage by floods and erosion threaten the productive capacity of the plantations and the livelihoods of Mulindi inhabitants. Before the involvement of TWFA, costs were increasing while productivity was decreasing putting at risk the survival of the tea business. To reverse this trend several responses have been designed, including modernisation of the factory, protecting the catchment and improving water management in marshland plantations. If a coordinated effort between the GoR, the TWFA, W4GR and the cooperatives was made, the tea value chain could regain its competitiveness and continue to improve the livelihoods of thousands of families in Mulindi and Ngoma sub-catchments.

This analysis of issues, their causal relationships, and potential responses, is summarised in the focused DPSIR framework in Figure 23.

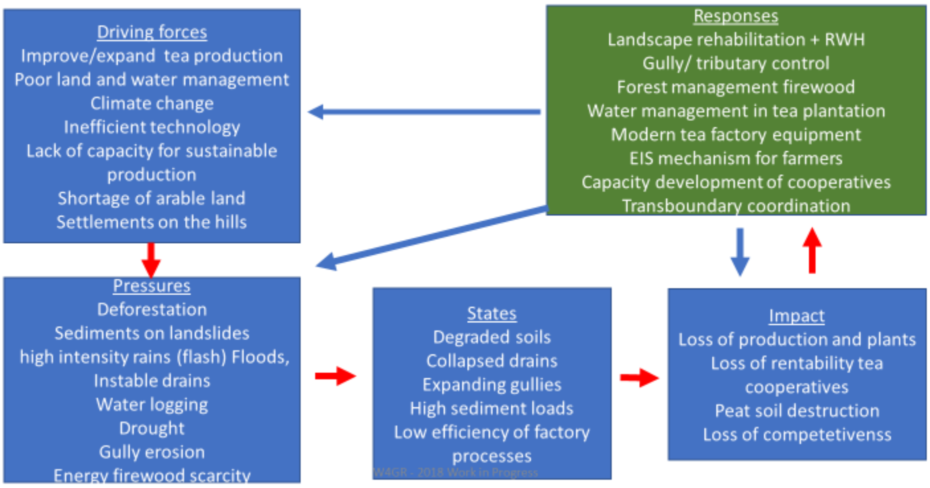


Figure 23: Focused DPSIR analysis for IWRM package 'Support improvements in sustainable water and catchment management (floods and sediments mitigation) through developing the tea and forestry value chains in Mulindi'

4.6 Multi-Criteria Analysis (filter 4)

The fourth and final step is a prioritisation of IWRM packages through an assessment of their constituent CPIPs, using a multi-criteria analysis (MCA) tool, in order to effectively allocate funds from the IIF for the fiscal year 2018-2019. An initial MCA was carried out on the basis of the concept notes of IWRM packages in Annex 13. Total scores per package were attained by averaging the scores of the individual CPIPs within the package. As mentioned earlier, several iterations may be required before arriving at a selection of projects and IWRM packages for implementation. Ultimately, prioritisation allows for selection of the best packages, which can subsequently be incorporated in annual implementation plans. The MCA methodology is briefly explained in the sections below, and in more detail in Annex 12.

MCA Methodology

MCA is a tool to compare and rank different options (e.g. alternatives, packages, and projects) in a structured way. MCA allows experts and stakeholders alike to be involved in the decision-making process. Advantages of MCA are that the steps are clear, decisions are recorded in a transparent way and that the process can continue to be used as a planning tool beyond the lifetime of the project and be applied to other catchments as well.

The most prominent objectives of the MCA exercise for this catchment plan were as follows:

- Obtaining stakeholder ownership through participation in the CPIP/IWRM package prioritisation process;
- Obtaining insight in stakeholder preferences;
- Ranking IWRM packages and CPIPs;
- Making the decision-making process transparent.

The MCA process comprised the following steps:

1. Develop a set of criteria within a set of themes (by MCA developers);
2. Develop a scoring system for each criterion (by MCA developers);
3. Assign a relative importance (weight) to each criterion (by stakeholders);
4. Score the projects for each criterion and multiply the score by the weights, to obtain an overall score for each CPIP (by technical scoring team);
5. Calculate the IWRM package score by averaging the scores of its constituent CPIPs;
6. Check the technical scores by a group of experts.

The most highly ranked packages per catchment were then proposed to be included in the Annual Implementation Plan 2018-2019.

A set of criteria was developed, based on MCA literature, CP objectives, MCA criteria developed in the CP/SEA Workshop of 2016 (W4GR TR 64, 2016), similar catchment plan MCA exercises in other countries (notably Afghanistan's Helmand River Basin Management Plan, 2013) and consultations with stakeholders. There were four key criteria, as per the initial themes defined in the CP/SEA workshop:

- Environment;
- Economic;
- Social;
- Governance.

A full description of the MCA methodology is provided in Annex 12, and the set of themes and criteria are provided in Figure 24[33] (weights in this overview are theoretic, for illustration).

[33] The weights per theme and criterion in this overview are solely illustrative

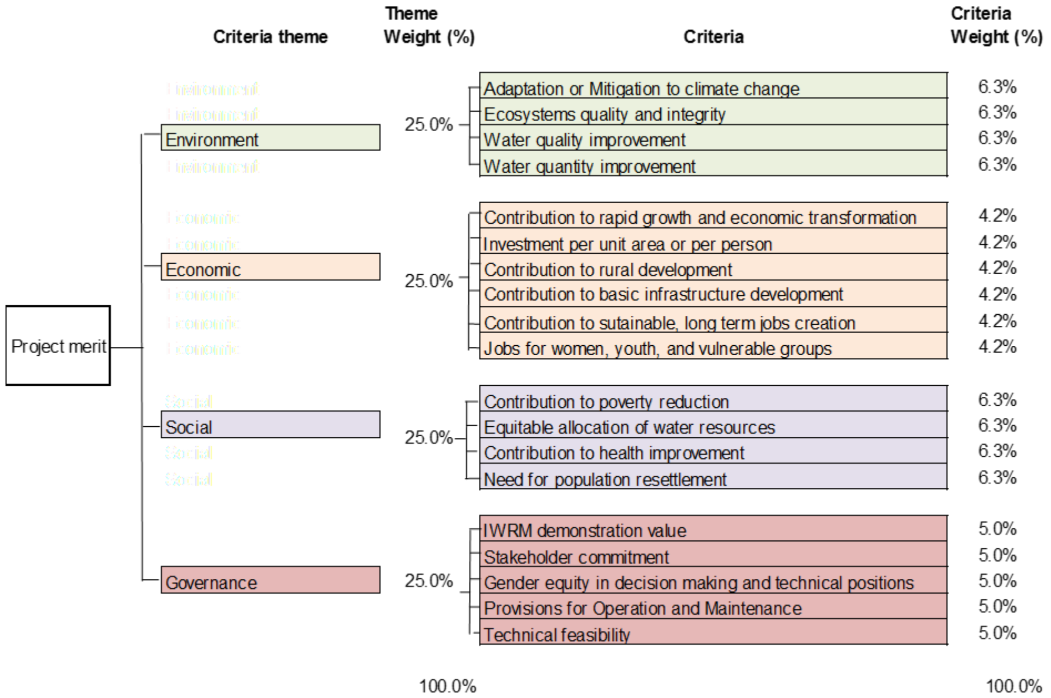


Figure 24: Theme and criteria weights (example with equal weights for themes and for criteria within themes)

4.7 Highlights of Programme of Measures

In developing this catchment plan, many proposed measures have been harvested from plan partners at central and local level. A full overview of individual infrastructural, institutional, and knowledge measures is presented in Annex 6and several of these have been combined in IWRM packages introduced in Section 4.5. A brief overview of high priority measures, proposed for implementation in the period 2018-2024, is as follows.

Infrastructural measures

Enhance water use efficiency in all water-using sectors

In line with the requirements of the water allocation plan, all main water using sectors shall enhance their water use efficiency (expressed as the typical use per unit, e.g. the raw water intake for domestic water supply, in litre per capita per day, the irrigation in cubic metre per hectare per year, and the volume of water per unit produced in industry) by the following percentages by 2024:

- Domestic water supply: 10%;
- Industry: 5%;
- Irrigated agriculture: 5%.

Surface water storage

- Construction of multipurpose dam on Muvumba river for irrigation, domestic water supply, livestock and for electricity generation. The multipurpose dam will contribute to reduce conflicts amongst different water users during water shortage periods;
- Extending the rehabilitation of existing valley dams mainly to avail drinking water for livestock.

Irrigation development

- Extending Small Scale Localised Irrigation (SSLI) and capacity building on how to manage irrigation systems. The objective is to increase water use efficiency and water productivity. The SSLI will contribute also to reduce the conflicts among different water users.

Landscape restoration

- Catchment restoration following the priorities set in map 8 of the CROM DSS (**Error! Reference source n ot found.**);
- Buffer zones and river bank protection along all rivers in the catchment.

Institutional measures

Establishment of permanent Catchment Committee (CC)

- Transformation of Catchment Task Force into Catchment Committee, with adaptations as required, upon gazetting of new Water Law and Ministerial Order.

Transboundary collaboration

- Transboundary facilitation of catchment dialogue (Operational collaborative framework) between Gicumbi & Nyagatare districts (Rwanda) and Kabale & Ntungamo districts (Uganda);
- Develop operational transboundary cooperation at lower administrative level for identifying, negotiating, and implementing transboundary water management issues.

Knowledge measures

Early warning capability for drought and food shortage in Nyagatare and Gatsibo districts/drought risk assessment and management

- Develop an early warning system, based on GIS and remote sensing;
- RMA and MINAGRI to be involved;
- The objective is to enhance food security;
- Strong potential to involve private sector (ICT) to provide information at farm level. Radio may be used as well.
- Proposed outputs include seasonal weather forecast; drought preparedness measures; emergency water supply, such as mobile decentralised drinking water treatment infrastructure; easy access to information;
- Facilitate water permit allocation (supporting the institutional measure of water permitting).

Irrigation Water Users Organisations (IWUOs) capacity building

- Develop capacities on how to manage irrigation infrastructure in order to increase water use efficiency and water productivity.

Water quality

- Assess the drainage water pollution and potential for treatment of effluent before it is discharged into the main rivers.

Groundwater

- Investigate groundwater potential for domestic use, livestock and irrigation (SSLI) to diversify the source of water.

Pest management in Mulindi tea plantations

- Assess sustainable pest management techniques in Mulindi tea plantation to control plant parasites and pathogens in tea plantations and other crops;
- Advise on pollution / downstream water use aspects as criterion of sustainability;
- Investigate opportunities for production of organic tea at higher prices;
- Learn from e.g. Sorwathe.

Development of IWRM training programme for local stakeholders and beneficiaries

- Capacity building plan for Catchment Committees and its secretariat, to continue developing capacities for catchment planning and catchment management;
- Capacity building of other stakeholders and beneficiaries to improve and spread participatory and adaptive catchment planning;

- Develop understanding of the scalability of IWRM concepts, from household or company level up to transboundary collaboration.
- The intervention logic and M&E framework (with accompanying legend) are presented on the following pages.

Table 20: Strategic logframe of Muvumba catchment management interventions

Hierarchy of results	Key Performance Indicator	Target 2024	Means of Verification	Cost estimates (RWF)	Assumptions
Impact 1: All water demands for socio-economic development in terms of quantity and quality are met	Unmet demand for key economic sectors (Domestic, Agriculture, industry) (MCM)	0	Annual WEAP Model simulations		National and District Land use plans respected for all investments in the catchment
	% of water bodies meeting water quality standards in the catchment	30%	IWRM Annual survey reports		
	Water availability per capita (MCM/cap/Yr)	0.001032	WRMD Annual survey reports/WEAP		
Impact 2: Water and land productivity increased	Yield of main crops in the catchment	3T/ha for beans 7T/ha for Maize and rice 30T /ha for Banana	Districts Imihigo Reports		
Specific objective 1: Improved water quality and quantity in water bodies taking into account resilience to climate change in the catchment					
Outcome 1.1: Critical sub catchments are rehabilitated and basic ecological	Area (ha) & % of land protected against soil erosion in the catchment	See table 13,14 and 15	W4GR/WRMD Reports	See table 13,14 and 15	Ministries, central agencies and, districts have mainstreamed erosion control in their DDPs, sectoral

Hierarchy of results	Key Performance Indicator	Target 2024	Means of Verification	Cost estimates (RWF)	Assumptions
functions restored					and annual action plans
Output 1.1.1: areas prone to erosion are protected with terraces and agroforestry	Number of ha of new bench terraces or progressive terraces with agroforestry	See table 13,14 and 15	Reports	See table 13,14 and 15	All stakeholders in the district committed to mainstream erosion measures
	Number of ha of radical (narrow cut) terraces constructed with agroforestry	See tables 13,14 and 15	Reports	See tables 13,14 and 15	All stakeholders in the district committed to mainstream erosion measures
	Number of ha covered by forest	See tables 13,14 and 15	Forest Department Quarterly reports	See tables 13,14 and 15	All stakeholders in the district committed to mainstream erosion measures
Output 1.1.2 Gullies and degraded old mines rehabilitated	Area (ha) and % of gullies and old mines rehabilitated	See tables 13,14 and 15	WRMD Quarterly reports	See tables 13,14 and 15 for mining to be determined	Enforcement of laws regulating mining and quarries
Output 1.1.3 Mining companies adopt the application of sustainable mining practices	Number of Model mining sites constructed and operational through PPP	TBD	WRMD Quarterly reports	TBD	Mining companies are willing to comply with mining law and their mining licenses
Output:1.1.4 Quarry and mineral exploitation improved	Rate of mining implementation master plan	TBD	Report	TBD	District commitment to implement Mining masterplan plan implemented
Outcome1.2: Flood and drought hazard reduced	Area of high risk zones protected against flooding (ha)	See tables 13, 14 and 15	WRMD Quarterly reports	See tables 13,14 and 15	Early warning capability for floods and drought or shortage of rains is established and regularly updated

Hierarchy of results	Key Performance Indicator	Target 2024	Means of Verification	Cost estimates (RWF)	Assumptions
	Command area for marshland and hillside irrigation	TBD	WRMD Quarterly reports	TBD	Availability of funds
Output 1.2.1 Rural roadsides protected with drainage of excess water	Length of feeder roads rehabilitated and protected with drainage facilities (km), and with suitable reservations for O&M	TBD	MININFRA / RTDA Quarterly reports	TBD	Budgeting of O&M costs in GoR annual budgets is assured.
Output 1.2.2 Households relocated from high risk zones to IDP/green model villages	Number of households relocated from high risk zones to IDP/green model villages	TBD	Districts Imihigo reports	TBD	Sufficient IDP/model village's capacity is made available. Or relocate to other low risk zones.
Output 1.2.3 Rain water harvesting facilities increased to residential houses and public buildings	Number of residential houses with rain water harvesting systems	See tables 13,14 and 15	WRMD reports	See tables 13,14 and 15	
Outcome 1.3. Water pollution by solid and liquid waste in urban and villages areas reduced	% reduction in solid and wastewater discharges into rivers	TBD	MININFRA Annual reports	TBD	Catchment plan mainstreamed in relevant sectoral plans
Output 1.3.1. Waste water treatment plants and landfills constructed	% of HHs with access to solid waste collection; % of HH with access to sewerage systems and subsequent wastewater	TBD	MININFRA Quarterly reports	TBD	

Hierarchy of results	Key Performance Indicator	Target 2024	Means of Verification	Cost estimates (RWF)	Assumptions
	treatment facilities in urban cities				
	% HHs with access to solid waste collection facilities in rural areas	TBD	MINAGRI/ Districts /Quarterly reports	TBD	
Output 1.3.2: Industries and Hotels are supported to adopt resource efficient and cleaner production (RECP) technologies	% of Industries and hotels adopting RECP technologies	TBD	MINICOM	TBD	
Specific objective 2: Reduce the pressure on natural resources by diversifying alternative livelihoods					
Outcome 2.1. Protected areas to maintain biological diversity increased	Proportion of protected area to maintain biological diversity (%)	TBD	IWRMD Quarterly reports	TBD	Business opportunities in the catchment are known by the communities
Output 2.1.1. Buffer zone protection along rivers	Area of buffer zone created along rivers	See tables 13,14 and 15	IWRMD Quarterly reports	See tables 13,14 and 15	District c0mmitment and Fund availability
Output 2.1.4. New business created to reduce the pressure on natural resources	Number of farmers creating new businesses as alternatives to reduce the pressure on natural resources	TBD	MoE Quarterly reports	TBD	

Hierarchy of results	Key Performance Indicator	Target 2024	Means of Verification	Cost estimates (RWF)	Assumptions
Output 2.1.1. Buffer zone around reservoirs demarcated and protected	Area of buffer zones around reservoirs protected(ha)	See table 13,14 and 15	IWRMD Quarterly reports	See table 13,14 and 15	
Specific objective 3: Ensure equitable allocation of available water resources for all users of current and future generations in the catchment					
Outcome 3.1: equitable allocation of water resources ensured to sector use	Number or % of water users satisfied with water allocation framework	100%	WRMD annual survey report	TBD	Water allocation framework in place and aligned to the national land use master plan
Output 3.1.1 Water users with abstraction permit increased	Percentage of water users with water abstraction permit	100%	WRMD quarterly report	TBD	Decision makers committed to conduct a water user survey
Output 3.1.2 Water demand for main economic sectors met by supply (Domestic, industry, irrigation, electricity)	Water Demand for Domestic use (MCM/y)	3992	Water permits, WASAC and other water supply companies	TBD	
	Water Demand for industry (MCM/y)	430	Water permits and monitoring data	TBD	
	Volume of water needed for irrigation (MCM/Y)	1,763,32	Water permits and monitoring data	TBD	
	Volume of water needed for electricity	1,650,91	REG studies	TBD	

Hierarchy of results	Key Performance Indicator	Target 2024	Means of Verification	Cost estimates (RWF)	Assumptions
	generation per day				
	Water Demand for livestock	1419	Water permits and monitoring data	TBD	
Output 3.1.3. Water ponds , dams, valley dams, dam sheets constructed to collect and conserve water for domestic **use,** animal watering and irrigation	Number of constructed valley dam	TBD	reports	TBD	
	Number of rehabilitated valley dam	TBD	reports	TBD	
	Number of dam sheet constructed	TBD	reports	TBD	
Output 3.1.4 Sustainable access of the population to safe water for domestic use	– % of households with access to safe drinking water – Number (%) of protected water sources	TBD	MININFRA and WASAC Quarterly reports Study Reports	TBD	Availability of sufficient water supplies for essential activities (short-term) Rainfall seasons resume (long-term)
Specific objective 4: Strengthen the water governance framework and transboundary cooperation to ensure effective implementation of integrated					
Outcome 4.1: An effective water institutional framework that integrates the principles of IWRM strengthened at catchment and District levels	% of districts mainstreaming approved catchment plans in their DDSs and Annual work plans	100%	WRMD Quarterly reports Catchment Plan annual M&E report	**TBD**	IWRM Mainstreaming guidelines (by WRMD) available and endorsed by the Ministry of finance and economic planning
	% of central institutions mainstreaming approved catchment plans in their strategic and	100%	WRMD Quarterly reports Catchment Plan annual	TBD	IWRM Mainstreaming guidelines (by WRMD) available and endorsed by the Ministry of finance and economic planning

Hierarchy of results	Key Performance Indicator	Target 2024	Means of Verification	Cost estimates (RWF)	Assumptions
	annual work plans		M&E report		
Output 4.1.1 Catchment management committees is established and operationalized	One catchment committee is established and operationalized	One catchment committee in place	WRMD Quarterly reports Catchment Plan annual M&E report	TBD	IWRM-supportive legal & regulatory framework in place
	Number of regular reports produced by Catchment Committees	100%	WRMD Quarterly reports Catchment Plan annual M&E report	TBD	IWRM-supportive legal & regulatory framework in place
Outputs 4.1.2 Conflicts among water users identified, discussed & solved	% of water conflicts raised and solved annually	90%	WRMD Quarterly reports Catchment Plan annual M&E report	TBD	IWRM-supportive legal & regulatory framework in place
Output 4.2.1. The Skills Gap Analysis relevant to IWRM conducted in local organizations (GoR, NGOs, CBOs, Private Sector)	Availability of Skills Gap Analysis report	1	Skills gap Assessment report	TBD	
Output 4.2.2 The capacity building plan relevant to IWRM in local organizations (GoR, NGOs, CBOs, Private	Availability of the capacity building plan relevant to IWRM in the catchment	1	The capacity building plan	TBD	

Hierarchy of results	Key Performance Indicator	Target 2024	Means of Verification	Cost estimates (RWF)	Assumptions
Sector) elaborated					
Output 4.2.3 Staff of partner organizations (GoR, NGOs, CBOs, Private Sector) empowered to effectively participate in integrated water management processes	% of people (disaggregated by gender) at local level trained according to skills gaps Number of study tours organized Number of staff that participated in study tours (disaggregated by gender)	100% 6 120	WRMD Quarterly report Catchment Plan annual M&E report	TBD	
Outcome 4.3: Knowledge Management for evidence-based decision making in IWRM improved	Satisfaction rate of IWRM professionals on IWRM knowledge accessibility	75%	Questionnaire WRMD Quarterly reports Catchment Plan annual M&E report	TBD	
Output 4.3.1 Water monitoring stations installed and operational	Number of water monitoring stations installed and operational	6	WRMD Quarterly reports Catchment Plan annual M&E report	TBD	
Output 4.3.2 Water related surveys and studies conducted	Number of knowledge CPIPs implemented	See tables 13,14 and 15	WRMD CPIP progress and completion reports	TBD	

Hierarchy of results	Key Performance Indicator	Target 2024	Means of Verification	Cost estimates (RWF)	Assumptions
			Catchment Plan annual M&E report		
Outputs 4.3.3: Study on the sustainability of Ecosystem Services in the catchment is conducted and disseminated	Availability of the study report	Report available	IWRMD Quarterly reports	TBD	
Output 4.3.4 Knowledge on IWRM transferred and disseminated	Number of best practices and lessons documented and shared Number of disseminated publications (reports, flyers, brochures, videos &radio shows…) Water MIS is online accessible and actively used (number of hits, downloads and unique users) Number of participants in IWRM-focused TVET courses (gender disaggregated)	6 6 20	WRMD Quarterly reports Catchment Plan annual M&E report	TBD	

Hierarchy of results	Key Performance Indicator	Target 2024	Means of Verification	Cost estimates (RWF)	Assumptions
Output4.3.5. A comprehensive study on the water storage for multipurpose use in the catchment conducted**.**	Availability of the study report	Water storage study report available	WRMD Quarterly reports	TBD	
Outcome 4.4. Trasbondary cooperation	Estabishment of muvumba cooperation framework	-Number of meeting 2 -Catchment management plan	WRMD Quarterly reports	**TBD**	
Output 4.4.1 Estabishment of muvumba	Operationalized catchment committee	4 meetings	WRMD Quarterly reports	TBD	
Output 4.4.2 Catchment management plan	Alignment of Muvumba Catchment plan with Maziba catchment plan to produce the management plan for the entire catchment	1 catchment management plan		TBD	

5. Implementation arrangements

This catchment plan is a joint plan of many stakeholders. Each of these stakeholders has their own mandate and interests, but in the first three process steps of the IWRM and catchment planning cycle (Figure 1, chapter 1), they have merged these into a coherent and integrated spatial plan (this catchment plan). This is the starting point for sector and agency planning (Step 4 in the cycle) and subsequently coordinated implementation (Step 5). This chapter presents implementation arrangements for these two steps.

5.1 Sector and agency planning

Planning for implementation will take place yearly, resulting in annual implementation plans (AIPs). Figure 25 demonstrates links between long- and mid-term strategies (the framework of NST1 and related SSPs, CCAs, and DDSs), mid-term plans (operational plans of districts and sector ministries, as well as catchment plans), and AIPs and Imihigos. Catchment plans bridge the gap between strategic and operational planning and are an innovative instrument to help central and local government to manage natural resources most sustainably, at the natural level of catchments.

The first AIP will be developed for the period of 2018-2020, to take into account the fact that fiscal year 2018-2019 already commenced. This AIP will set the stage for subsequent years. DDSs and SSPs were in their final stage of completion at the time of completion of this catchment plan and Districts and Sector Ministries had not as yet mapped out all planned activities geographically making development of a concrete AIP for 2018-2019 difficult. Water for Growth Rwanda will assist catchment plan partners in mapping their activities at district level. Subsequently, a geographical analysis can be made to arrive at an overview of concrete activities within catchment boundaries, for each district with a significant area within the catchment. Combined, these activities will form the programme of measures for 2018-2019. The development of implementation plans for 2019-2020 will follow the normal annual budget development procedures. Local level detailed planning and design will follow the new process of Micro-Catchment Action Planning, for micro-catchments of circa 500 ha. This is the final step of the CROM-DSS flow chart (Figure 82 in **Error! Reference source not found.**) and the approach will be first tested in planning for the Muhazi I WRM package selected by the Water for Growth Rwanda Programme Steering Committee for implementation using IIF funds in July 2018.

When it comes to funding the programme of measures, the AIP 2018-2019 will benefit from the funds that are still available in the IIF. Pre-feasibility studies for a series of IWRM packages were completed by June 2018, and it will be upon these studies that funds will be allocated to the best projects in order for their implementation to start in 2018-2019. An investment opportunities meeting will be held to obtain additional funding for proposed measures; additional funds may come from government institutions or development partners for purely public-sector works, or from a public-private-partnership fund for interventions that also involve the private sector. On a case by case basis, these interventions may also start in fiscal year 2018-2019, or at a later stage.

The Water Resources Management Department of RWFA, assisted by Water for Growth Rwanda, may assist implementing partners in IWRM-proofing projects.

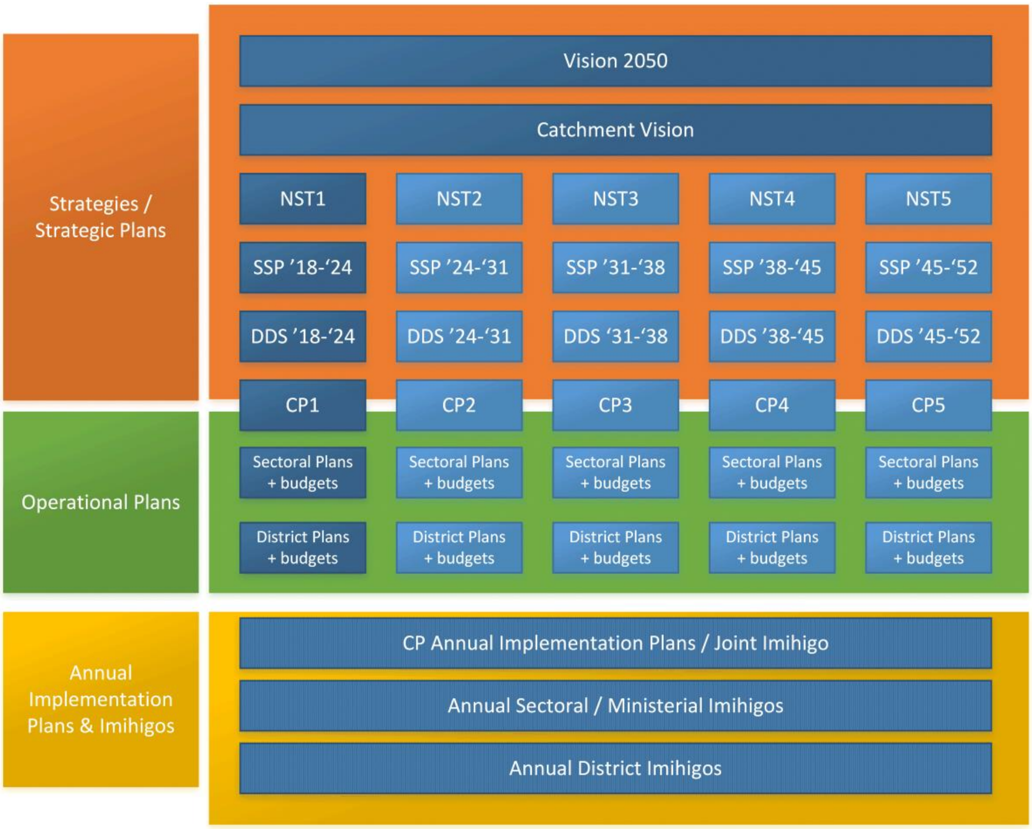


Figure 25: Overview of strategies, plans, and Imihigos

5.2 Coordinated implementation

With many stakeholders involved in implementation of projects on the ground, either as singular entities or in collaboration between agencies (as per the needs of each project), coordination is needed at district and catchment level. This is to ensure consistency of individual projects with the catchment plan, as well as overall coherence between projects in the same area (e.g. within one IWRM package area), especially those that rely on the same natural resources (water, land, and related resources).

Key arrangements for coordination consist of the formalisation of catchment committees (the permanent successor to project-based 'catchment task forces'), and creation and operationalisation of permanent teams of government staff at both central and local level, to their functioning. Being spread across the districts in the catchment, as well as at RWFA, this team will function like a 'virtual secretariat' or catchment support team. The name, composition, and mandate of these teams will be regulated by the new Water Law and a related Ministerial Order, just like the establishment of catchment committees.

The support given by central and local teams will include logistical and organisational support to regular meetings of catchment committees and their support teams, but also for more complex tasks, like developing AIPs, annual and mid-term M&E reports, and support to the development of subsequent catchment plans (initially, 2024-2030). During implementation, the team might also be tasked with oversight of all implementation projects and organisation of regular coordination meetings.

A coordinated approach is also required for funding of AIPs. As projects become more integrated, funds will need to be combined from different budget lines. The projects geo-database, proposed as one of the knowledge management and capacity building measures for catchment plans, can play a key role in joint development of integrated projects, and in assessing overall investment needs. MINECOFIN will need to play a key role in making funds available for catchment plan implementation and plan partners will need to analyse budget requirements and identify funding gaps. Well-coordinated budget requests to MINECOFIN and development partners will subsequently enhance possibilities of securing funds.

5.3 Looking ahead – Catchment Plan 2024-2030

The Catchment Plan 2018-2024 is the first of its kind. Development of the plan presented a learning opportunity in IWRM and spatial planning for all involved stakeholders and presented a ‘real-life’ planning exercise (see the central portion of the IWRM / catchment planning cycle in Figure 1, Chapter 1). Likewise, its implementation will also offer many opportunities for learning, as well as associated challenges. Institutional and technical lessons learnt during implementation are important for development of the next series of catchment plans, for 2024-2030 or 2024-2031 and subsequent plans.

Annual and mid-term monitoring and evaluation of catchment plan implementation will capture important information and ‘lessons learnt’ and in doing so, inform development of subsequent catchment and annual implementation plans. M&E will also be instrumental in adjusting current plans and their implementation at the mid-way stage. Development of the next plan should start no later than two years in advance and should be developed in the same, participatory manner.

6. Intervention logic and Monitoring & Evaluation

Strategic intervention logic

Catchment plans are vital instruments for development and implementation of integrated spatial planning along hydrological boundaries which create and build on horizontal and vertical linkages between different sectors and administrative entities; the process is visualised in Figure 2. As per its institutional embedding, the intervention logic for this catchment plan comprises a geographically focused selection of IWRM-relevant interventions by all national and local plan partners active in the catchment. The intervention logic is not, therefore, a typical one-dimensional *project-style* logical framework or log frame, but rather a multi-dimensional, integrated *plan-style* strategic intervention logic. It is a coherent set of relevant outcomes and outputs of plan partners, much like the selection of sector outcomes in NST1[34]. The overview of relevant outcomes and outputs is presented in **Error! Reference source not found.**.

Indicators were selected from all strategic planning documents (NST1, CCAs, SSPs, and DDSs), and augmented with specific ones from the catchment plan. During analysis of the different documents, it was found that many of the indicators used across different strategies were the same, or very similar, and that a selection of them were also suitable for undertaking the monitoring and evaluation of catchment plan implementation as well.

Alignment of indicators provided several benefits:

1. **Spatial aggregation:** Using the same indicators from national, sector, district, and catchment plans provides an opportunity to monitor progress of all of these within the same spatial area, i.e. the catchment;
2. **Integrated evaluation:** Using the same set of indicators allows for benchmarking progress and quality both between catchments and at district, sector and national levels. Progress in one catchment, district, sector etc. can be compared against progress in others. In addition, in-depth evaluation of progress, quality etc. for combinations of indicators may reveal underlying systemic factors conducive to, or hindering, integrated sustainable development;
3. **Efficiency gains through information sharing:** Aligning indicators at the different levels provides an impetus for data sharing and coordination between the various institutions responsible for their monitoring, leading to potential reduced duplication of effort, as well as greater opportunities to improve linkages between the various levels of intervention. Aggregating spatial data can also be used in GIS to show physical progress of the different planning processes;
4. **Demonstration of added value of IWRM approach:** Integrated assessment of progress on implementation of IWRM relevant indicators from all four strategic planning levels allows for quantification of the added value of IWRM, to development of the nation. The contribution of the Catchment Plan, DDSs, SSPs, and NST1 to each other and to achieving national, district and catchment goals and visions demonstrates the added value of an integrated (IWRM) approach to spatial planning and management.

[34] The basis for selection of relevant outcomes and outputs, and their indicators, is the consistency alignment (Annex 4). Overlaps between the CP and NST1 and SSPs were identified, and high-level outcomes to which the catchment plan contributes were selected, as well as related outputs in DDSs. Selection of relevant outputs and outcomes from the NST framework was made in a participatory alignment process between September 2017 and May 2018, in close collaboration with MINALOC and the districts, and with MINECOFIN and partner ministries. This was augmented with a selection of related indicators at all levels (NST1, SSP, CCA, DDS), to allow for geographical aggregation of indicator data at catchment level, building on M&E frameworks of plan partners and thus minimising the need for additional monitoring for the CP as such.

Analysis of IWRM relevant indicators throughout the set of strategic plans reveals that the same or a similar indicator may function as output indicator in one strategy, and as outcome indicator in another. This results from the scope of the document of origin, as DDSs are rather output orientated, NST1 only considers outcomes, and SSPs cover both. For this reason, and for the reason of aggregation to any spatial or strategic level, this Catchment Plan's strategic intervention logic does not break its set of indicators down into specific outputs, outcomes, or even impacts.

In the overview in **Error! Reference source not found.**, outcomes, outputs, and indicators are grouped a ccording to the main structure of NST1 pillars and priority areas, to help identify the contribution of the Catchment Plan to achieving goals of NST1, SSPs, CCAs, and DDSs. To facilitate evaluation from an IWRM perspective, indicators can furthermore be reported on according to the catchment plan's related specific objectives, for example, by analysing all indicators that relate to water quality management, or to equitable allocation of water to different water users.

In Annual Implementation Plans, activities will be defined and target values (laid down in Joint Imihigos) set for each.[35]

Joint monitoring and evaluation of catchment plan implementation

This catchment plan is a joint plan of multiple stakeholders. As explained in the IWRM and catchment planning cycle (Figure 1 in Chapter 1.), joint monitoring and evaluation constitute a crucial, last step to learn from implementation of the plan. Such learning is needed to enhance understanding of the catchment and its stakeholders, and to develop an even better plan for the next plan period. The catchment management support team (consisting of national and district level staff), as introduced in Chapter 5. , will play a vital role in M&E. This team will be charged with reporting on all catchment plan indicators, collating catchment-specific information on project implementation from all districts and plan partners, evaluating progress made, and reporting to the catchment committee and national partners.

An M&E plan will be developed in the first year of catchment plan implementation, in which reporting structures and frequencies, as well as roles and responsibilities will be stipulated. Target values, which depend strongly on district level mapping of individual projects, will be set in the Annual Implementation Plan and subsequently incorporated in M&E reports and M&E plan updates.

[35] Projects are often developed at district level, i.e. from an administrative boundary starting point. GIS mapping and analysis is required to assess which part of a project falls within the catchment. Subsequently, target values 'within the catchment' need to be calculated for each of the indicators linked to the project, e.g. the number of beneficiaries (gender disaggregated), the number of hectares to be restored, etc. To date, the use of GIS at district level is still in its infancy. Water for Growth Rwanda developed a beta version of a projects geo-database. An operational version thereof may be developed in the first year of CP implementation, as key knowledge measure of the Catchment Plan (see Annex 6, Programme of Measures).

General references

- MIDIMAR, 2012. National Disaster Management Policy;
- MIDIMAR, 2015. National Risk atlas;
- MINAGRI, 2016. ICT 4 Agriculture Strategic Plan (2016-2020);
- MINAGRI, 2017. Strategic Plan for Agricultural Transformation 4 (PSTA4);
- MINALOC, 2018. Rubavu District Development Strategy 2018-2024, second draft. January 15th;
- MINALOC, 2018. Ngororero District Development Strategy 2018-2024, second draft. January 15th;
- MINALOC, 2018. Nyabihu District Development Strategy, second draft 2018-2024. December 27th;
- MINALOC, 2018. Rutsiro District Development Strategy, second draft 2018-2024. January 15th;
- MINECOFIN, 2017. National Strategy for Tranformation-1, draft- under finalisation 28th December 2017;
- MINENV, 2017. Strategic Programme for Climate Resilience (SPCR), Rwanda. FONERWA;
- MINILAF, 2017. National Forest Management Plan 2017 – 2024;
- MINIRENA, 2017. Baseline study on water users and water-use in level 2 catchments in Rwanda, MINIRENA Results Based Monitoring & Evaluation Project, NIRAS;
- MINIRENA, 2014. National Water Resources Master Plan (NWRMP), SHER;
- MINIRENA, 2014. Consultancy services for development of Rwanda national water resources master plan, Appendices 1-9, catchment master plans for Rwanda's level 1 catchments, SHER;
- NCEA, 2015. National Training Workshop of SEA for IWRM. Workshop Report, Roadmap, and Workshop Outputs;
- Republic of Rwanda, 2011. Green Growth and Climate Resilience – National Strategy for Climate Change and Low Carbon Development (GGCRS);
- W4GR: see list of technical reports (TR) below for a full overview of reports by Water for Growth Rwanda (reports developed in partnership between the IWRM Support Unit (technical assistance team) and the Water Resources Management Department of RWFA).

References specific to gender mainstreaming

- MIGEPROF,2010. Rwanda National Gender Policy, 2010 review;
- MINAGRI, 2010. Agriculture Gender Strategy, 2017 review;
- MIGEPROF, 2016. National Gender Strategic Plan, 2016;
- Rwanda Natural Resources Authority, 2012. Empowering Women Through Land Tenure Reform: the Rwandan Experience, T. Hoza Ngoga;
- Enquête Intégrale sur les Conditions de Vie des Ménages ,2013/2014 ;
- Water for Growth, 2017. IWRM programme Rwanda, Gender Strategy, February 2017;
- MINIRENA: www.minirena.gov.rw;
- UNDP, 2006. IWRM Gender Resource guide;
- AGRIFOCUS, 2012. Gender in value chains: Practical toolkit to integrate a gender perspective in agricultural value chain development;
- IFPRI, 2012. Women's Empowerment in Agriculture Index (http://www.ifpri.org/publication/womens-empowerment-agriculture-index);
- Sachin Gathani and Dimitri Stoelinga (2013), Understanding Rwanda's Agribusiness and Manufacturing Sectors, IGC international CENTER;

- UN, 2014. Who is gaining from Trade Liberalisation in Rwanda: A Gender Perspective UNCTAD/DITC/2014/2 PUBLICATION;
- Gender Monitoring Office, 2016. Annual reports, 2015-2016;
- GMO, 2017. Gender profile in Agriculture Sector, 2017 ;
- CEDEAO, Intégrations du genre dans la gestion integree des ressources en eau en Afrique de l'Ouest, finance par le Royaume de Danemark ;
- Cleaver F., 2000. "Analyzing Gender roles in community Natural Resource Management Negotiation, Life courses and Social Inclusion". -IDS Bulletin, 31.2, Wailey Online Library;
- MINALOC, 2018. District Development Strategies, draft 2, January 2018;
- W4GR, National IWRM Gender Strategy, 2017, Rwanda Water and Forestry Authority.

Hyperlinks to useful sources regarding this catchment plan

- Global Water Partnership: www.gwp.org;
- http://climate.org/using-rwandas-indc-to-evaluate-projects-funded-by-climate-finance/;
- http://www.un.org/sustainabledevelopment/news/communications-material/;
- UNWATER: www.unwater.org;
- Waterportal.rwfa.rw;
- www.water.rw.

References to Water for Growth Rwanda publications

Table 21: Overview of W4GR Technical Reports

Number	Short title	Date	Status
TR01	Assessment of existing water MIS	August 2015	Final
TR02	Water Permit	September 2015	Final
TR03	Assessment of Institutional Frameworks	June 2016, October 2016 and final in February 2017	Draft – to be discussed with RWFA/IWRMD
TR04	Water Use Fees	March 2016	Final - Fee levels given are advisory only.
TR05	Water Resources Monitoring Assessment	November 2015	Final
TR06	M&E Strategy	June 2016	Final
TR07 Vol-I	Water Resources Monitoring Programme – Rehabilitation Plan (Vol 1 – Surface water / Suspended Sediment)	March 2016	Final
TR07 Vol-II	Water Resources Monitoring Programme – Rehabilitation Plan (Vol 2 – Groundwater)	April 2016	Final
TR07 Vol-III	Water Resources Monitoring Programme – Rehabilitation Plan (Vol 3 – Water quality)	March 2016	Final
TR08	Communications Strategy (and programme branding)	June 2016	Final
TR09	Capacity building assessment and plan	January 2017	Draft – to be discussed with RWFA/IWRMD
TR10	Gender Strategy	February 2017	Final

TR11	Investment Fund – Manual of Procedures	October 2016	Final and endorsed
TR12	Catchment Characterisation Report: Nyabarongo Demonstration Catchment	January 2016	Interim Working Document (Final)
TR13	Catchment Characterisation Report: Sebeya Demonstration Catchment	January 2016	Interim Working Document (Final)
TR14	Catchment Characterisation Report: Nyabugogo Demonstration Catchment	January 2016	Interim Working Document (Final)
TR15	Catchment Characterisation Report: Muvumba Demonstration Catchment	January 2016	Interim Working Document (Final)
TR16	Consistency Analysis	November 2016	Final
TR17	Catchment Characterisation and Vision - Sebeya	June 2016	Final
TR18	Catchment Characterisation and Vision– Upper Nyabarongo	June 2016	Final
TR19	Catchment Characterisation and Vision – Nyabugogo	June 2016	Final
TR20	Catchment Characterisation and Vision - Muvumba	June 2016	Final
TR21	Water Law Revision	October 2016	Final
TR22	Catchment Plan version 1.0 – Sebeya	March 2017	Approved by PSC, 5-4-2017
TR23	Catchment Plan version 1.0 – Upper Nyabarongo	March 2017	Approved by PSC, 5-4-2017
TR24	Catchment Plan version 1.0 – Nyabugogo	March 2017	Approved by PSC, 5-4-2017
TR25	Catchment Plan version 1.0 – Muvumba	March 2017	Approved by PSC, 5-4-2017
TR26	Volcanoes area flood management	Final	Final draft discussed in validation workshop with stakeholders in December 2016
TR27	Bilharzia control Lake Muhazi (Phase 1 – Desk Study)	January 2017	Final
TR28	Water Users' Survey	January 2017	Final
TR29	Water Balance and Allocation Modelling	March 2017	Final
TR30	Cost Benefit Analysis (Exploration phase)	March 2017	Model building, initial results.
TR31	Rainwater Harvesting Strategy	January 2017	Final
TR32	Reserved for water quality / pollution study	-	-
TR33	Lake Muhazi pre-feasibility studyy	July 2017	Final Draft
TR34	Masaka spatial development plan	Expected in 2019	-
TR35	Water permit system manual	Expected in 2018	(system now undergoing updates due to name change RWFA and ICT overhaul MINIRENA)
TR36	M&E report 2016	March 2017	Final
TR37	Multilateral Climate Change Adaptation & Mitigation Funding	March 2017	Final
TR38	Concept note EIP UNY01	January 2017	Final

TR39	Concept note EIP NY01 (Murama)	March 2017	Final
TR40	Concept note EIP NY02 (Muhazi)	June 2016	Final
TR41	Concept note EIP MUV02	March 2017	Final (replaced MUV01)
TR42	Concept note EIP SEB01	January 2016	Final
TR43	FS/DD EIP – Land husbandry measures in Muhanga and Ngororero	June 2016	Final
TR44	FS/DD EIP – Rehabilitation of Murama sub-catchment project in Nyabugogo	August 2017	Final; adaptations were introduced afterwards
TR45	FS/DD EIP – Rehabilitation works and monitoring on Muhazi Dam, Nyabugogo	October 2017	Final
TR46	FS/DD EIP – Landscape rehabilitation / soil conservation measures in Muvumba	August 2017	Final
TR47	FS/DD EIP – Landscape rehabilitation / soil conservation measures in Sebeya	June 2016	Final
TR48	IIF Strategic and Draft Operational Plan	September 2017	Draft
TR49	M&E Report up to 1 July 2017	September 2017	Draft
TR50	Gender mainstreaming Inception Report	August 2017	Final
TR51	Guidelines for catchment restoration, soil erosion protection, and land husbandry, with examples for Upper Nyabarongo	August 2017	Draft
TR52	Scoping workshop Sebeya	June 2016	Final
TR53	Scoping workshop Upper Nyabarongo	June 2016	Final
TR54	Scoping workshop Nyabugogo & Muvumba	June 2016	Final
TR55	WEAP catchment analysis Sebeya (version 06)	August 2017	Internal
TR56	WEAP catchment analysis Upper Nyabarongo (version 06)	August 2017	Internal
TR57	WEAP catchment analysis Nyabugogo (version 06)	August 2017	Internal
TR58	WEAP catchment analysis Muvumba (version 06)	August 2017	Internal
TR59	WEAP catchment analysis Sebeya (version 07)	November 2017	Internal
TR60	WEAP catchment analysis Upper Nyabarongo (version 07)	November 2017	Internal
TR61	WEAP catchment analysis Nyabugogo (version 07)	November 2017	Internal
TR62	WEAP catchment analysis Muvumba (version 07)	November 2017	Internal
TR63	Bilharzia control Lake Muhazi – Phase 2	Expected 2019	Research phase
TR64	CP-SEA workshop Oct 2016	October 2016	Final
TR65	Recommendations for collaboration on spatial information (by RCMRD)	September 2017	Final
TR66	Catchment Plan Sebeya 2018-2024 (version 2.0)	March 2018	Final Draft for PSC

TR67	Catchment Plan Upper Nyabarongo 2018-2024 (version 2.0)	March 2018	Final Draft for PSC
TR68	Catchment Plan Nyabugogo 2018-2024 (version 2.0)	March 2018	Final Draft for PSC
TR69	Catchment Plan Muvumba 2018-2024 (version 2.0)	March 2018	Final Draft for PSC
TR70	Catchment Plan 2018-2024 Sebeya (version 3.0)	July 2018	Approved by PSC
TR71	Catchment Plan 2018-2024 Upper Nyabarongo (version 3.0)	July 2018	Approved by PSC
TR72	Catchment Plan 2018-2024 Nyabugogo (version 3.0)	July 2018	Approved by PSC
TR73	Catchment Plan 2018-2024 Muvumba (version 3.0)	July 2018	Approved by PSC

Annex 1. The Water for Growth Rwanda Programme

In an effort to introduce integrated land and water management within hydrological units (catchments), the Government of Rwanda, through the Water for Growth Rwanda programme, has commenced the development of catchment plans, and this is one in a cyclical series of such for Rwanda. The programme is a platform to promote improved, integrated management of Rwanda's water resources (IWRM), financed by the Embassy of the Kingdom of the Netherlands. Over the course of 2015-2019 this platform receives technical assistance from an international IWRM support unit (ISU), cooperating with the Rwanda Water and Forestry Authority (RWFA).

Water for Growth Rwanda has five components and a number of cross-cutting themes (including climate change adaptation and gender), as visualised in Figure 26. The enabling environment for catchment planning is supported through Component 1 (enhancement of institutional frameworks for IWRM); Component 2 (capacity strengthening of staff at central, catchment, and district level); and Component 5 (knowledge management, including the development of water resources monitoring, the implementation of dedicated studies, surveys, and research, and the sustainable embedding of learning processes in the organisations involved in IWRM). Alongside the enabling environment, Component 3 focuses entirely on the introduction of catchment planning and management in four so-called demonstration catchments. And finally, the IWRM Investment Fund, supported in Component 4, is a basket fund that holds an initial contribution from the Embassy of the Kingdom of the Netherlands of 18 million Euro dedicated to the implementation of investment projects in the four demonstration catchments of Component 3.

Figure 26: Water for Growth Rwanda programme components

As mentioned above, Water for Growth Rwanda incorporates interventions in four demonstration catchments (
Figure 27), namely: Nyabugogo, Upper Nyabarongo, Muvumba, and Sebeya.

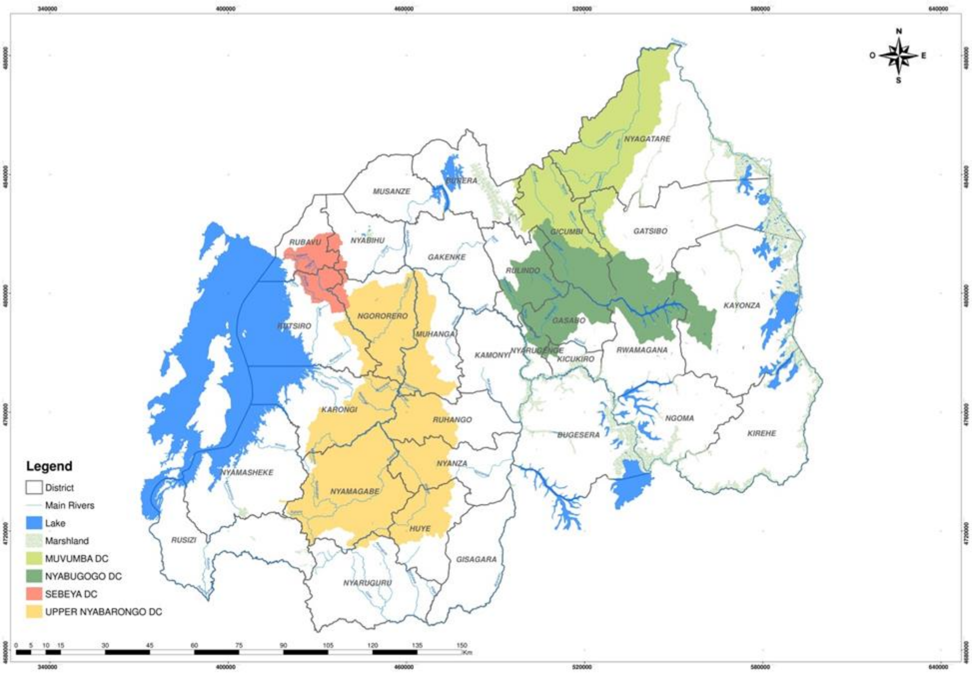


Figure 27: Demonstration catchments of Water for Growth Rwanda

The plan includes a broad Programme of Measures for the catchment, which is the result of an extensive alignment phase with other national and local strategic plans for the period 2018-2024, supporting all plan partners in an integrated response to Vision 2050 and the National Strategy for Transformation for 2017-2024 (NST1). Annual implementation plans will be developed by the plan partners, and jointly monitored.

This catchment plan provides an important instrument for the development of joint performance contracts between national level ministries, their agencies, and the districts in the catchment.

Annex 2. Glossary of terms

Catchment, Sub-catchment, and River Basin

A catchment, also called watershed, is any area of land where precipitation collects and drains off into a common outlet, such as a river, lake, or other body of water. A catchment contains all the surface water from rain runoff, and nearby streams that run downslope towards the shared outlet, as well as water stored in groundwater.

Catchments can be defined at a number of scales, depending on the number of branches in the system of watercourses. They can be hierarchically sub-divided into smaller catchments, or sub-catchments, micro-catchments and individual watercourses, as the number of branches in the system reduces.

Rwanda distinguishes four catchment levels in its National Water Resources Master Plan. The country comprises two basins: the Congo River basin (Congo Basin) in the west, fed by the Kivu and Rusizi level 1 catchments; and the River Nile basin (Nile Basin) in the east, fed by seven other level 1 catchments, namely: Upper Nyabarongo, Lower Nyabarongo, Mukungwa, Akanyaru, Upper Akagera, Lower Akagera, and Muvumba catchments. Within these nine level 1 catchments, 20 level 2 sub-catchments are distinguished, dozens of level 3, and hundreds of level 4 catchments. Within Water for Growth Rwanda, catchment plans have been developed for four, so called Demonstration Catchment Areas (DCA), consisting of two level 1 catchments (Upper Nyabarongo, Muvumba) and two level 2 sub-catchments (Sebeya, Nyabugogo).

Catchment Plan (CP)

A Catchment Plan is a spatial plan designed to implement common goals, co-developed by all relevant stakeholders within the catchment area itself, as well as by national ministries and agencies. The current catchment plan spans the period 2018-2024 (harmonised with NST-1, SSPs, DDS with the corresponding implementation period) and is subject to sexennial (six year) revision. The CP aims at implementation of integrated management of water, land, and related natural resources within the geographical boundary of a catchment or sub-catchment. Catchment plans facilitate coherent implementation of measures by several Districts. They integrate and align national and local laws, policies, plans, programmes, and projects. Catchment plans are developed using a participatory approach with all relevant stakeholders and the formulation process has also been designed in line with SEA requirements and methodologies.

Cost Benefit Analysis (CBA)

Cost Benefit Analysis (CBA) is a methodology to determine the monetarised costs and benefits of an intervention. There are two kinds of CBAs; financial CBA and economic CBA. Financial CBA relate to those costs and benefits for the funding party, whereas economic CBA relate to (avoided) costs and benefits to the wider (national) economy. Economic CBA is sometimes also referred to as Social CBA (SCBA) or Environmental CBA (ECBA) when it focusses on evaluating and monetarising social and environmental costs respectively. In all cases, all costs and benefits are monetarised, either using market prices for financial CBA or shadow prices for economic CBA. As such, CBA requires high levels of data availability, which are usually not available at initial project appraisal stage. CBA is therefore conducted at CPIP Feasibility Study stage, when a prioritisation of investments has been made.

Catchment Plan Implementation Project (CPIP)

Catchment Plan Implementation Projects (CPIPs) are water management projects that have a strong demonstration, replicability/scalability, and (preferably) innovation character, and/or may be directly linked to an IWRM related driver of socio-economic development. CPIPs may be developed as stand-alone projects, or in groups or packages of coherent and interdependent CPIPs. Packages may also stand alongside regular IPs and IP+s (see 'Implementation Project'), where different, but mutually supportive, interventions may require different implementers (see IWRM Package). CPIPs are eligible for co-funding by IIF.

Driver of socio-economic development

A driver of socio-economic development is defined as a major business activity, either by a company or companies in a sector or industry, for example agricultural value chain, tourism around a national park, or mining. Within the (sub-)catchment, a limited number of key drivers of socio-economic development can be identified, which have a link with water use (abstraction, pollution, as landscape element, etc). Through mainstreaming of IWRM the catchment plan aims to enhance water productivity and socio-economic development while protecting the water resources.

DPSIR Framework

DPSIR stands for Driving forces, Pressures, State, Responses, and Impacts (see schematic relationships in Figure 28 below). This causal framework describes the interactions between society and the environment (in or beyond the catchment) through driving forces, pressures, states, impacts, and responses. The DPSIR analysis supports the selection of responses to mitigate negative IWRM related impacts identified in the catchments. These responses may target causes, as well as effects, i.e. the Driving forces, Pressures, and/or Impacts, as originally found in the catchment. For each situation the optimal (mix of) responses is defined, to achieve sustainable solutions.

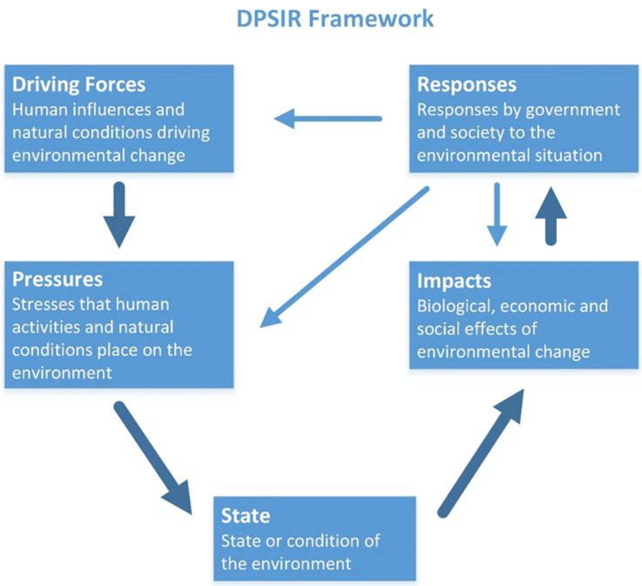


Figure 28: The DPSIR framework visualised

Feasibility Study and Detailed Design

A feasibility study is done after the approval of a concept note. A feasibility study is an analysis of how a project can be successfully completed, accounting for practical, technical, economical, legal, scheduling and other factors. A feasibility study is used to determine potential positive and negative outcomes of a project before investments are made in a detailed design study and eventual implementation. A feasibility study contains preliminary designs, technical specifications and an overview of the cost of implementation. Another component of a feasibility study is an Environmental Impact Assessment (EIA). The latter is the process of evaluating the likely positive and negative environmental impacts of a proposed CPIP and how these can be enhanced or mitigated. It also considers inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.

Groundwater bodies

Groundwater bodies, according to Article 2.12 of the European Water Framework Directive, are defined as "a distinct volume of groundwater within an aquifer or aquifers". They are units for the management of groundwater resources that are either exploited by man or support surface ecosystems

Implementation Project (IP)

An Implementation Project (IP) is an ongoing or planned project (in some cases a programme) in the catchment area. IPs are part of the Programme of Measures, and are implemented by e.g. public, private, or NGO implementing agencies. IPs are composed of infrastructure, capacity building, and/or institutional components. They can be stand-alone projects or programmes (e.g. Tourism Masterplan for Gishwati-Mukura national park), ranging in scope and size. An IP with add-ons related to IWRM, is called an IP+. For example, an existing or planned project for a new tea factory can be enhanced with water and energy efficiency and sustainable forest management measures, upon which it can be treated as an IP+, opening opportunities for joint funding between the public and private sectors.

Integrated Water Resources Management (IWRM) Package

A package of projects (CPIPs/IPs/IP+s) can form an integrated solution to a catchment management main goal or problem. These projects each cover a specific dimension of the targeted issue, preferably reinforcing each other's impacts and efficiency.

Infrastructure measures

The vast majority of measures in the catchment plan (IPs, IP+s, CPIPs) comprise of physical interventions in the catchment infrastructure, including green infrastructure like the catchment landscape itself, as main interventions. The more integrated CPIPs often contain institutional or knowledge components as additional elements.

Institutional measures

This is related to the coordination between existing, water-related actors for improved water governance, or the establishment of a new agency in the water sector. For better management of water resources, several institutional developments are proposed, such as installation of a Catchment Task Force to be institutionalised as Catchment Committee as proposed in the new Water Law.

Knowledge measures

This refers to the collection, storage, dissemination, and use of knowledge in and about a catchment. It can be a capacity building programme, including training activities, the set-up of a knowledge centre, studies and research, drafting of guidelines or best practice papers.

Logical Framework / Intervention Logic

A logical framework (log-frame), is a model or methodology to formalise intervention logic. It answers the questions: How do we address the objectives of a project, in terms of components, activities, under which assumptions and risks? And, how do we measure the success of the project in the M&E framework (Monitoring & Evaluation)?

Multi Criteria (Decision) Analysis (MC(D)A)

Multi Criteria (Decision) Analysis (MCDA or MCA) formalises the inclusion of non-monetary and qualitative factors into decision analysis and can be useful when information or analytical resources are limited, and when decision factors are mixed in terms of numerical and non-numerical types (semi-quantitative). Scores and weights are applied by stakeholders at all levels to environmental, social and economic/financial factors, reflecting their performance and importance on key factors. MCDA lends itself to prioritisation of projects through comparing relative costs and benefits and giving preference to those with highest scores.

Quantified indicators (for example relating to financial and economic performance) can also be included in MCDA. MCDA techniques are often used in expert or stakeholder groups to guide decision-making in complex processes.

Programme of Measures (PoM)

A Programme of Measures is a coherent and robust set of measures designed to achieve the objectives of a catchment plan. The PoM of this catchment plan, for example, comprises infrastructural, knowledge, and institutional measures. In line with IWRM, the catchment plan is a jointly created and owned plan of stakeholders from public and private sectors and civil society. Implementation of a PoM is done by the organisations and businesses according to its objectives within the scope of the catchment plan. The PoM for this CP has been developed for the period of 2018-2024. It follows the catchment plan strategies that have been defined to achieve the CP long-term vision. Prioritisation and implementation arrangements are elaborated in annual implementation plans.

Public-Private Partnership (PPP) / Public-Private Civil Society Partnership (PPSP)

Public-Private Partnership (PPP) is an arrangement between a public and private sector partner regarding sharing costs, responsibilities and risk in relation to an investment and the management of the facility. Rwanda has a PPP law that guides large-scale PPPs in energy and water supply. A variation is the Public-Private-Civil Society Partnership (PPSP). PPSP is a synergistically operational model used to achieve sustainable development in which the three parties jointly develop a business unit/service of mutual benefit and provide maximum benefit to the wider community.

Strategic Environmental Assessment (SEA)

'Strategic Environmental Assessment (SEA) is a systematic, ongoing process for evaluating at the earliest stage, the environmental quality and consequences of alternative visions and development intentions incorporated in policy, planning or programme initiatives, to ensure full integration of relevant biophysical, economic, social and political considerations.' (General Guidelines and Procedures for Strategic Environmental Assessment, REMA, 2011) Rwanda's Organic Law on the Environment (N04/2005), Chapter 4, Article 67, states:

1. Every project must be subjected to an initial environmental impact assessment (EIA) in order to obtain authorisation for its execution;
2. The same applies to programmes, plans and policies that may affect the environment (SEA).

Within Water for Growth Rwanda, the SEA process is entirely integrated into the development process of the catchment plan.

Nexus approach

The term 'Nexus' simply means that issues are interlinked. Hence there is a great number of sector combinations linked to a nexus approach.

1. The environment-economy nexus is the basic nexus in the catchment. A degraded catchment cannot support plants, animals and people. Contaminated water is bad for health and water treatment is costly and reduces the profitability of a business;
2. The water-energy-food security nexus (Figure 29) is the notion that water, energy, and food, are interdependent. Water is a key resource for energy and food security. In case of drought, energy supply becomes more erratic, food becomes scarce. The catchment plan therefore is a key instrument to help achieve water, energy, and food security in the catchment. A water-health-nutrition nexus is also often addressed in combination.

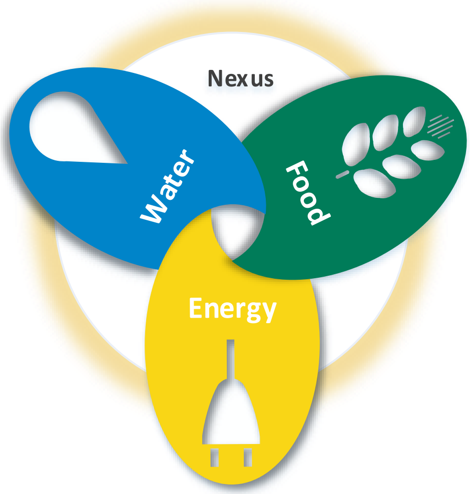


Figure 29: The water-energy-food security nexus

Total value or total impact

The challenge to redefine development metrics leads to holistic concepts as total value. This multi-criteria analysis framework values environmental and social returns next to financial returns. Total value takes into consideration long-term consequences, along entire value chains. It includes protection of the natural resource base and considers externalities, such as the cost that degradation of the environment, through emission of GHG, air and water pollution, causes to society. In recent years, progress has been made with methodologies to quantify externalities in private and public sectors to better compare different development alternatives.

Water productivity

The FAO defines water productivity as the biomass produced per cubic meter of water consumed (kg/m^3) often referred to as 'crop per drop'. From an economic perspective water productivity can be expressed as added value per volume of water (RWF/m^3). The productivity can be optimised at different levels, such as plant (as some varieties are more efficient in producing grain), farm (e.g. introducing an irrigation system), catchment or at national levels.

Water Evaluation and Planning (WEAP)

The software suite for Water Evaluation and Planning (WEAP), developed by the Stockholm Environment Institute (SEI), has been used to simulate the baseline situation (2015), as well as several future projections, and to compare different development alternatives that might be followed to achieve the catchment plan objectives with regard to sustainable water use.

Water footprint

A water footprint is an indicator of human appropriation of water resources. It measures the consumptive use of water from different sources, as well as the impact of pollution:

1. The blue water footprint is a measure of the consumption of surface and groundwater combined;
2. The green water footprint is a measure of the consumption of rainwater by crops and forests stored as soil moisture;
3. The grey water footprint is the amount of freshwater required to assimilate pollutants to meet specific water quality standards.

Water security and water stress

Water security is the capacity of a population to safeguard sustainable access to an adequate and acceptable quantity and quality of water. This means that there is enough, clean water to sustain livelihoods, human well-being, and socio-economic development, whilst ensuring protection against water-borne pollution and water-related disasters, and whilst promoting preservation of ecosystem services. The measure of water demand not met for this security is referred to as water stress.

Water risk

Water risk refers to the probability of an entity experiencing a harmful water-related event. Water risk is felt differently by every sector of society and the organisations within them, hence it is defined and interpreted differently (even when they experience the same degree of water scarcity or water stress). That notwithstanding, many water-related conditions, such as water scarcity, pollution, poor governance, inadequate infrastructure, climate change, and others, create risks for many different sectors and organisations simultaneously.

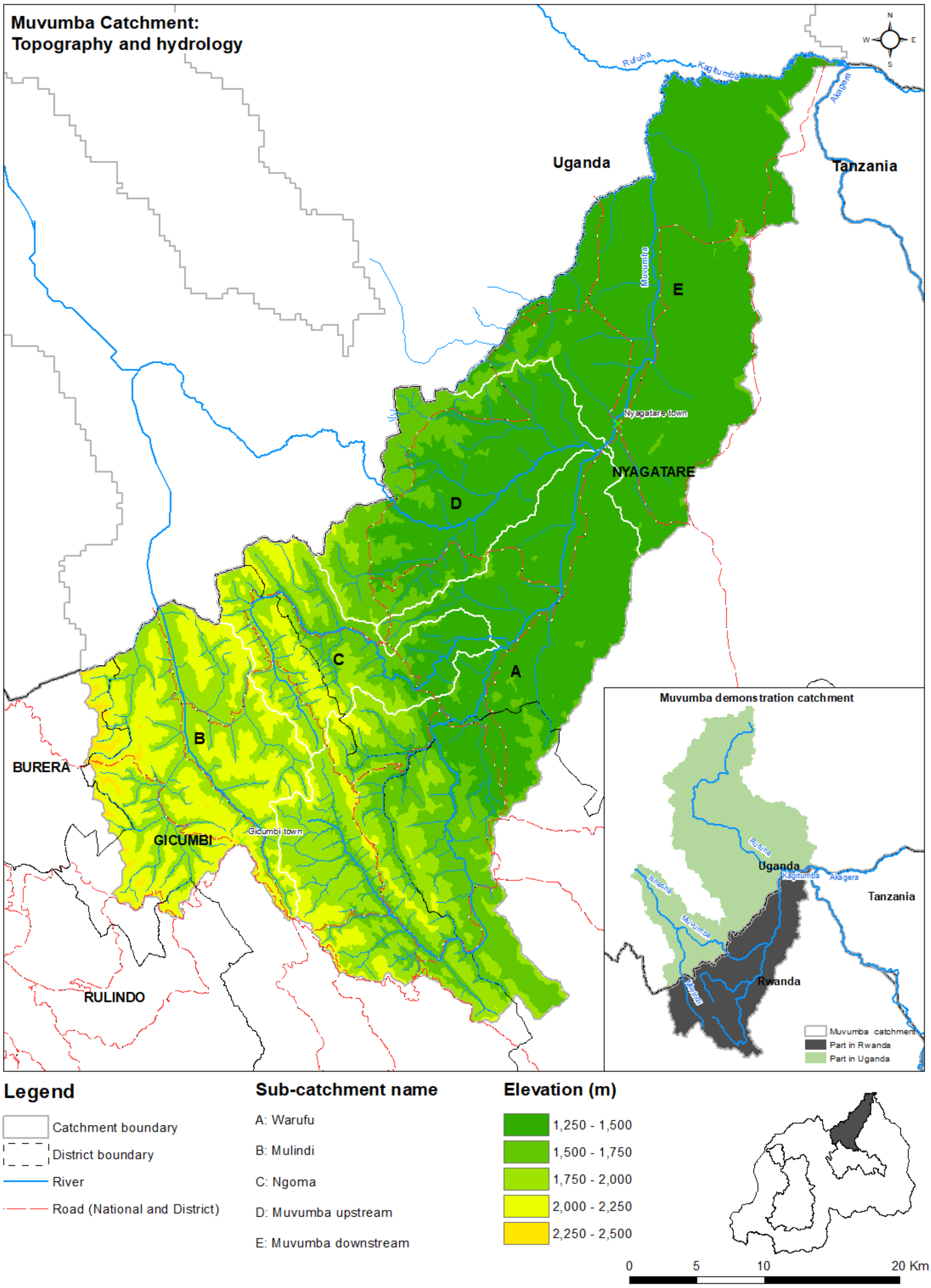


Figure 30: Muvumba catchment elevation, waterbodies and waterways

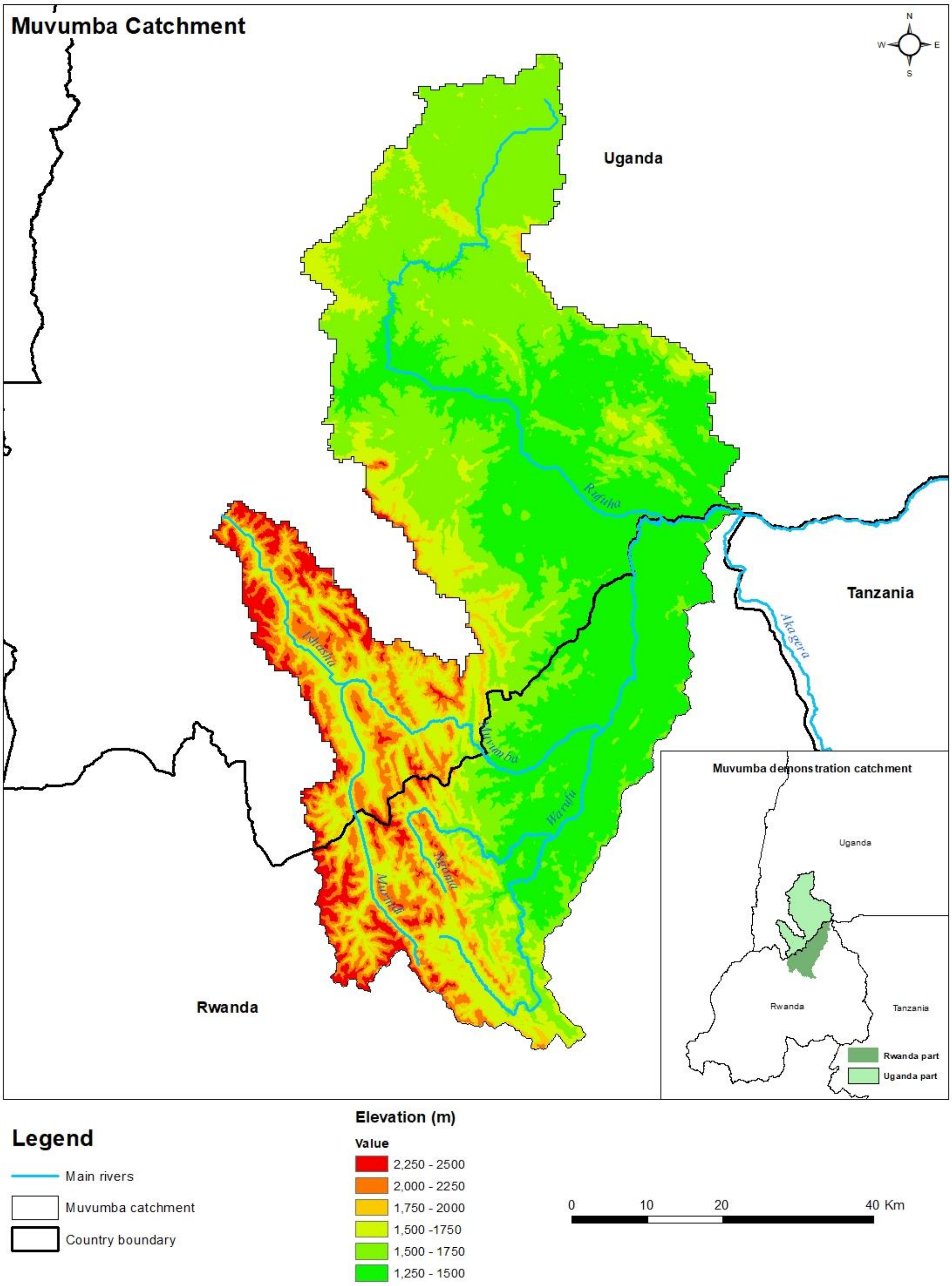


Figure 31: Muvumba catchment localisation in Rwanda and Uganda

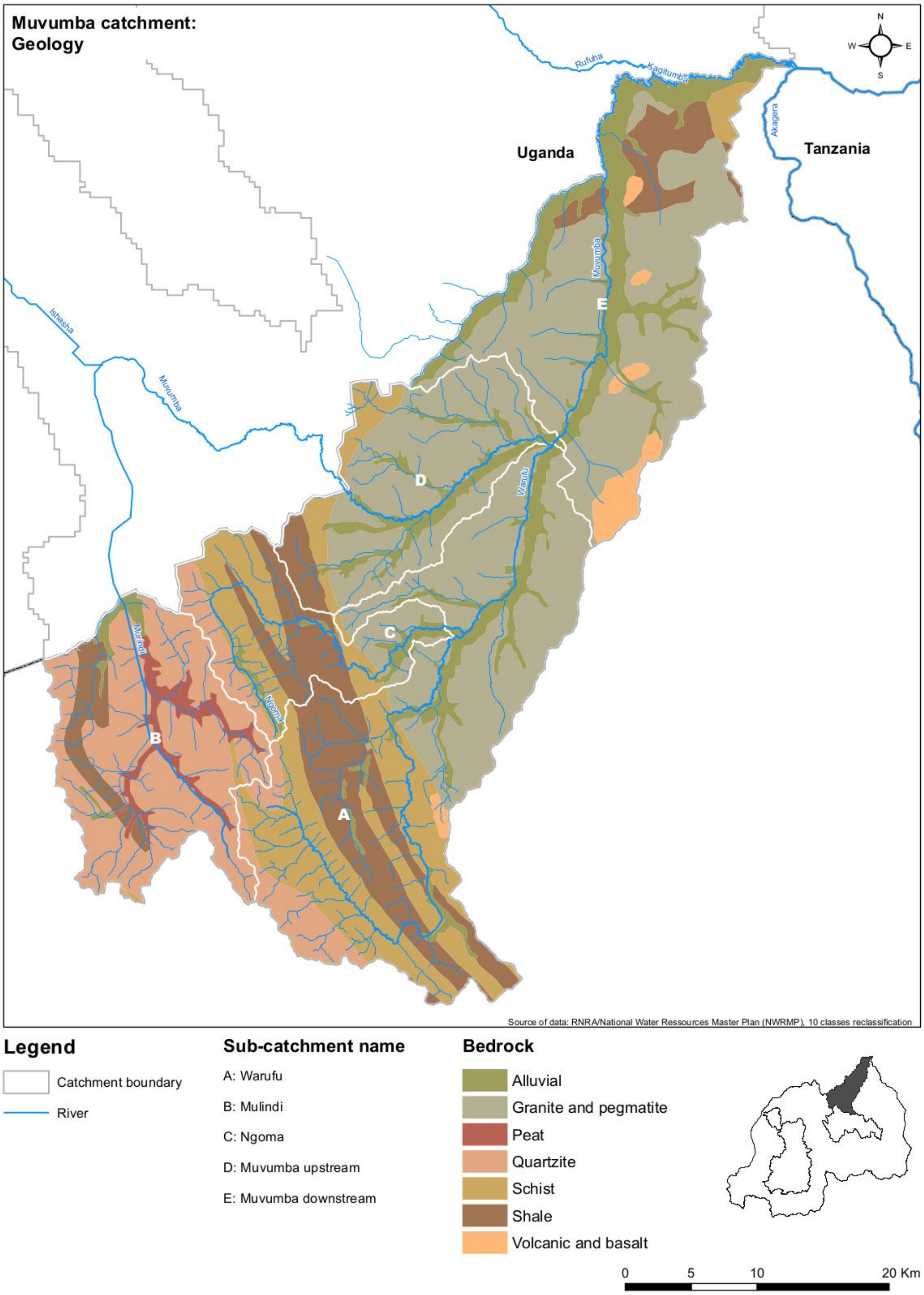


Figure 32: Geology of Muvumba catchment

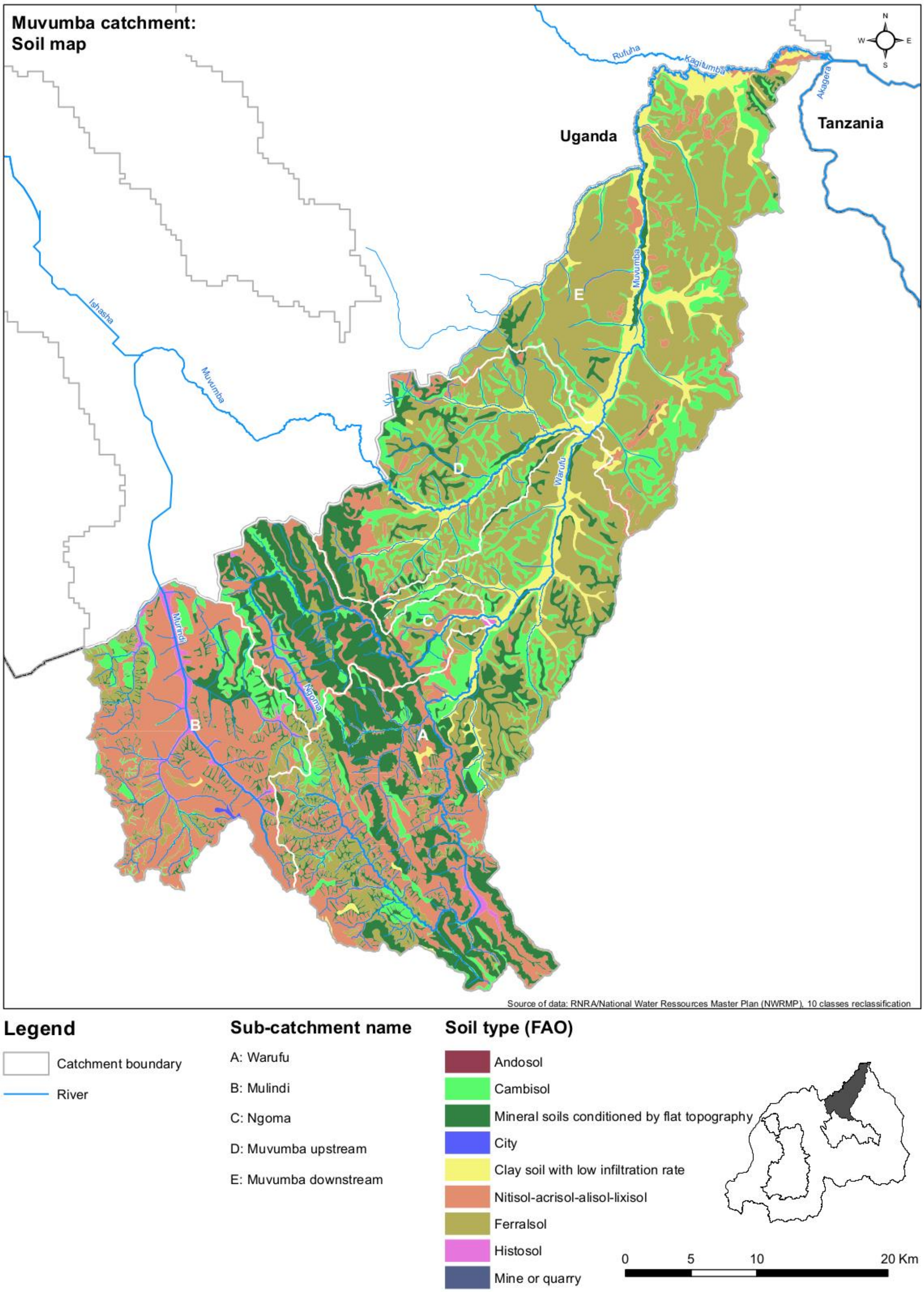


Figure 33: Soil types in Muvumba catchment

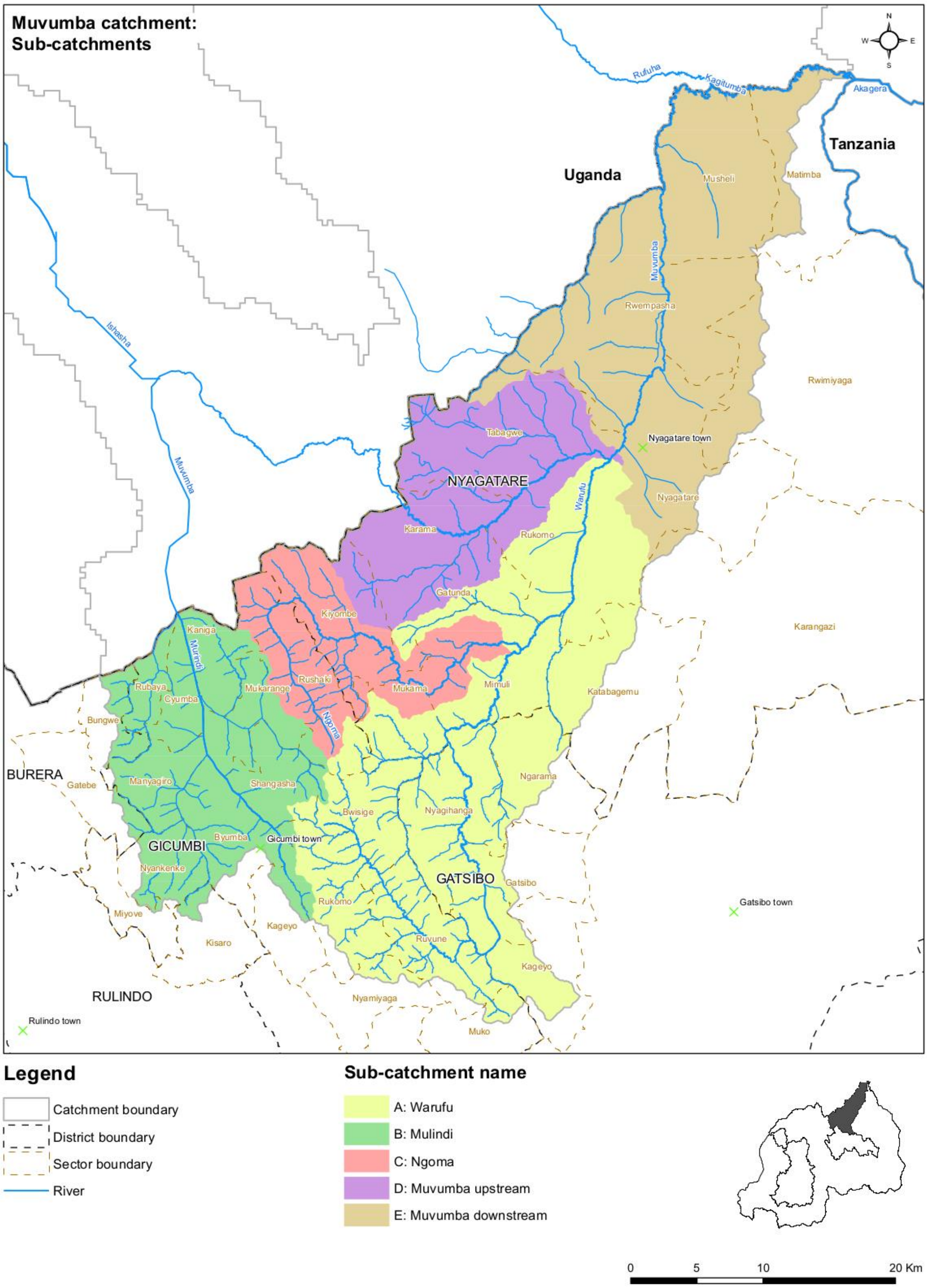


Figure 34: Sub-catchments map

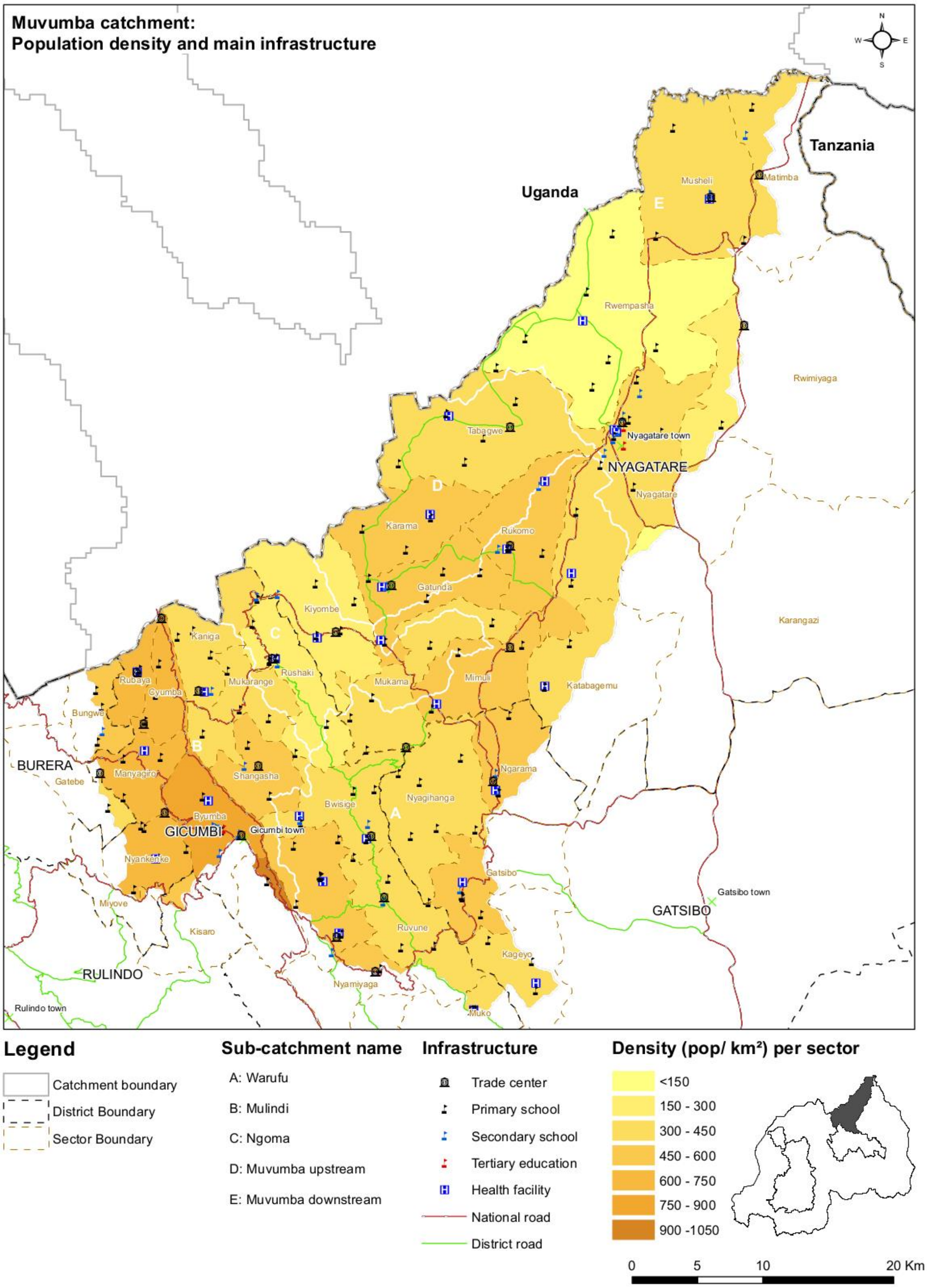


Figure 35: Muvumba catchment population density and key-infrastructure

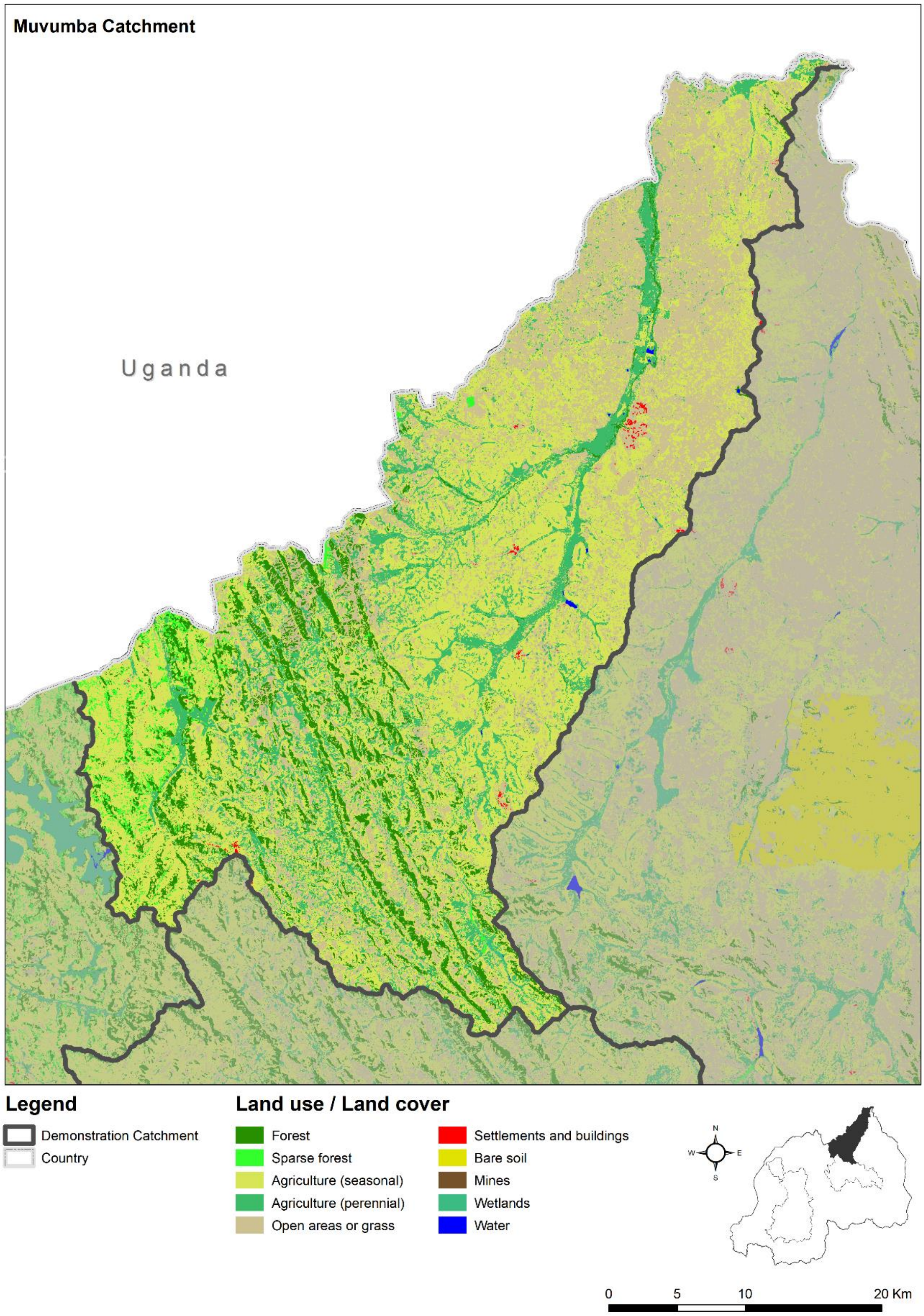


Figure 36: Land Use / Land Cover map (LULC) (W4GR 2018)

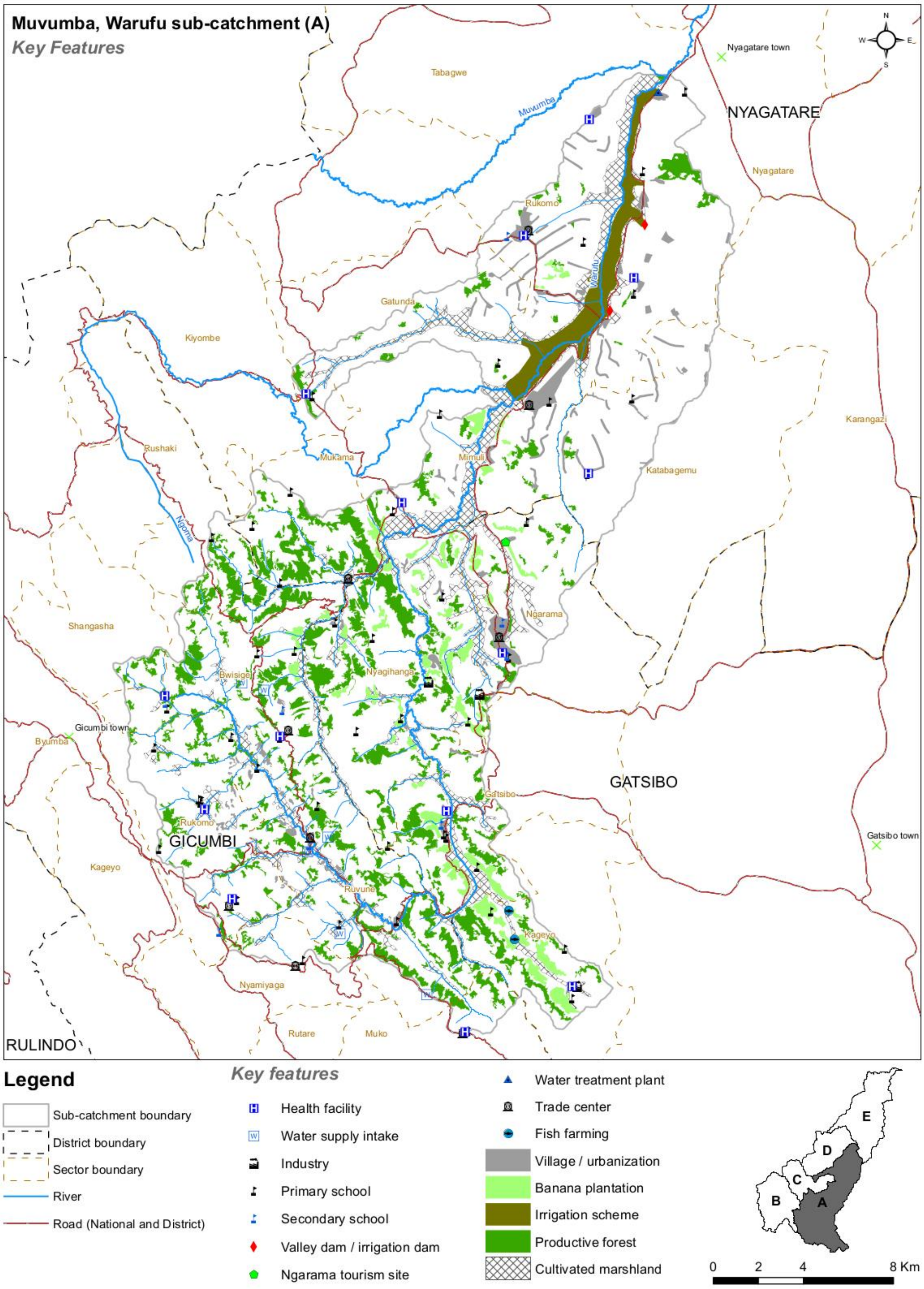


Figure 37: Key geographic features of the Warufu sub-catchment

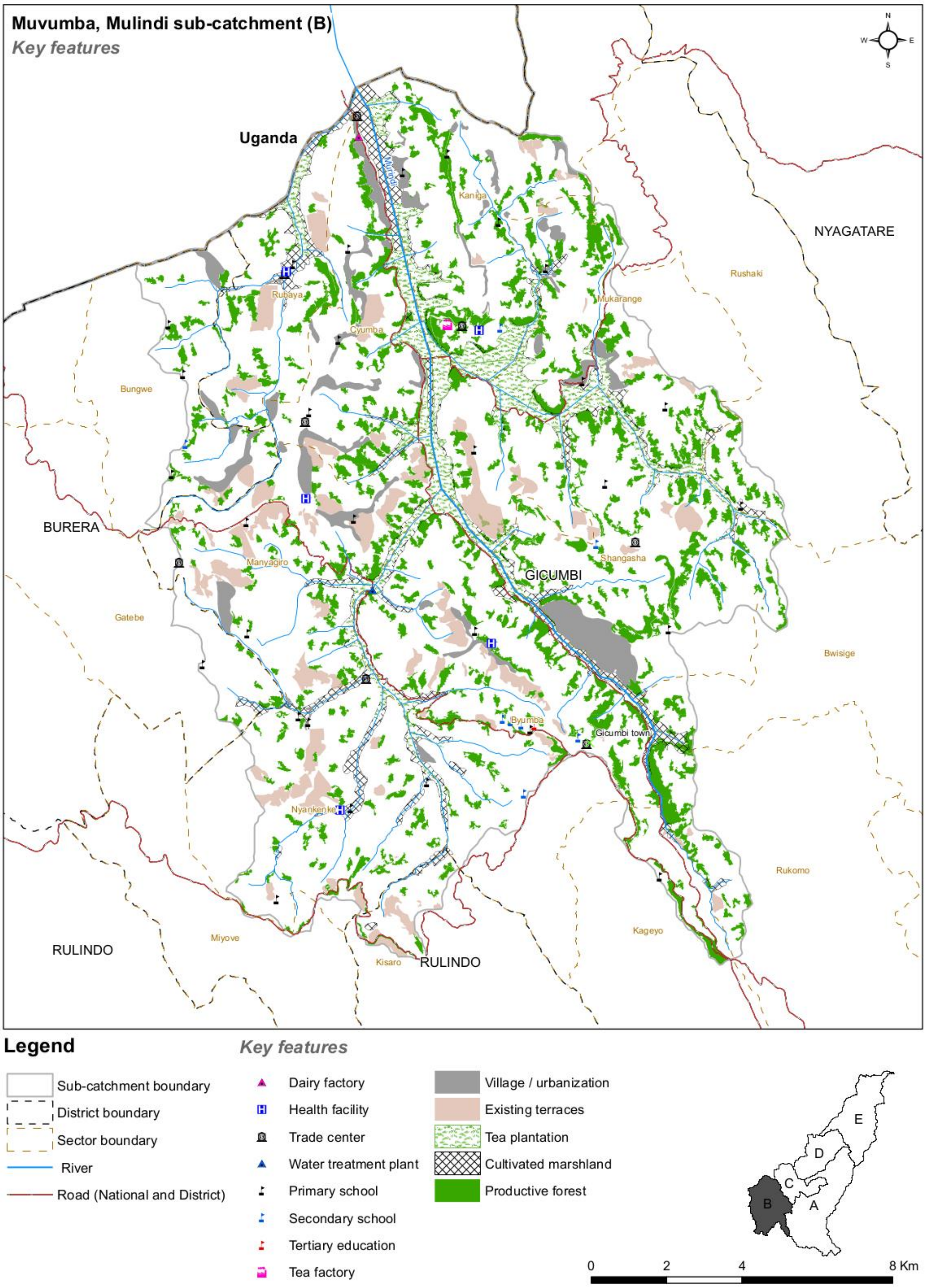


Figure 38: Key geographic features of the Mulindi sub-catchment

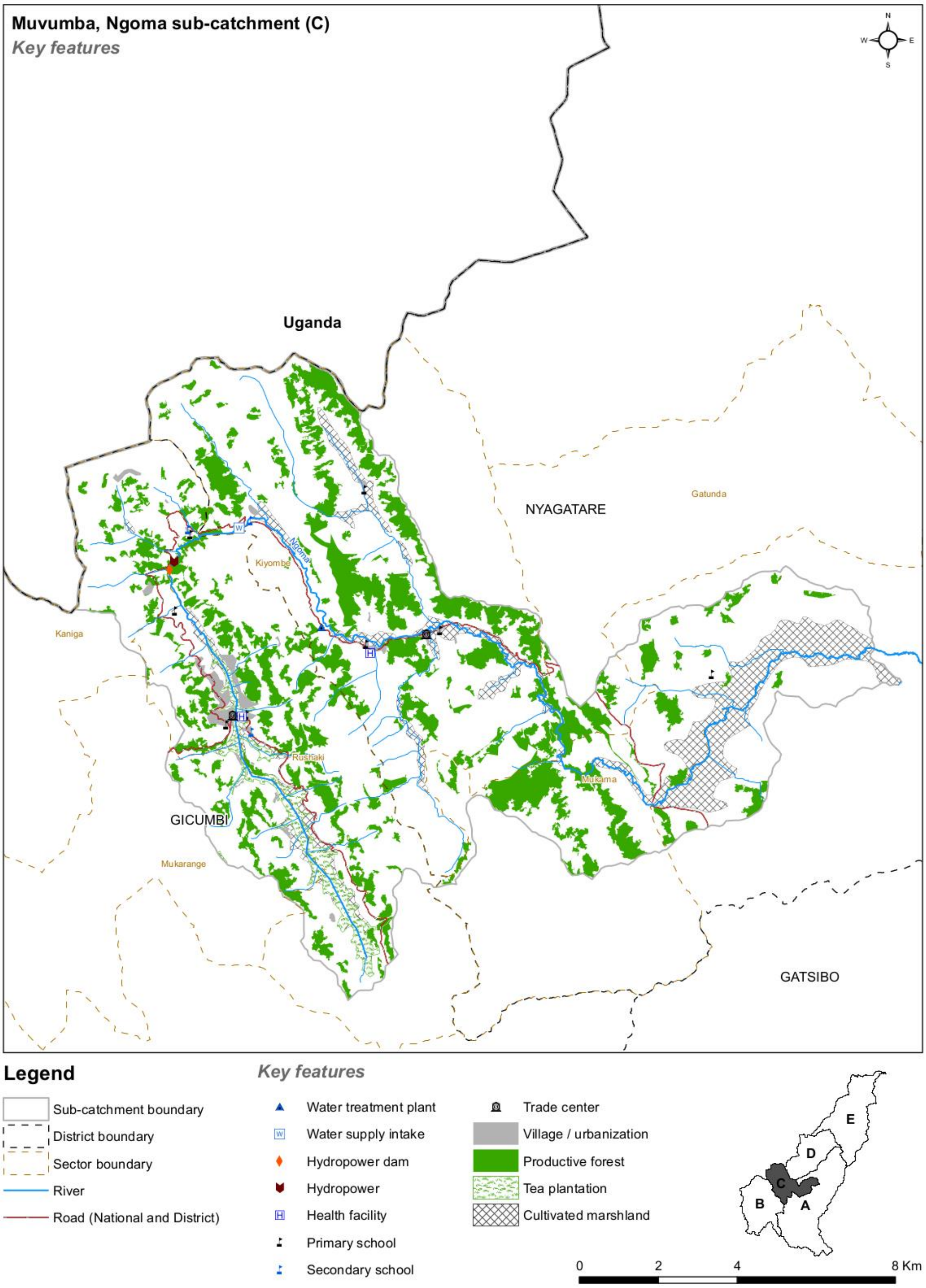


Figure 39: Key geographic features of the Ngoma sub-catchment

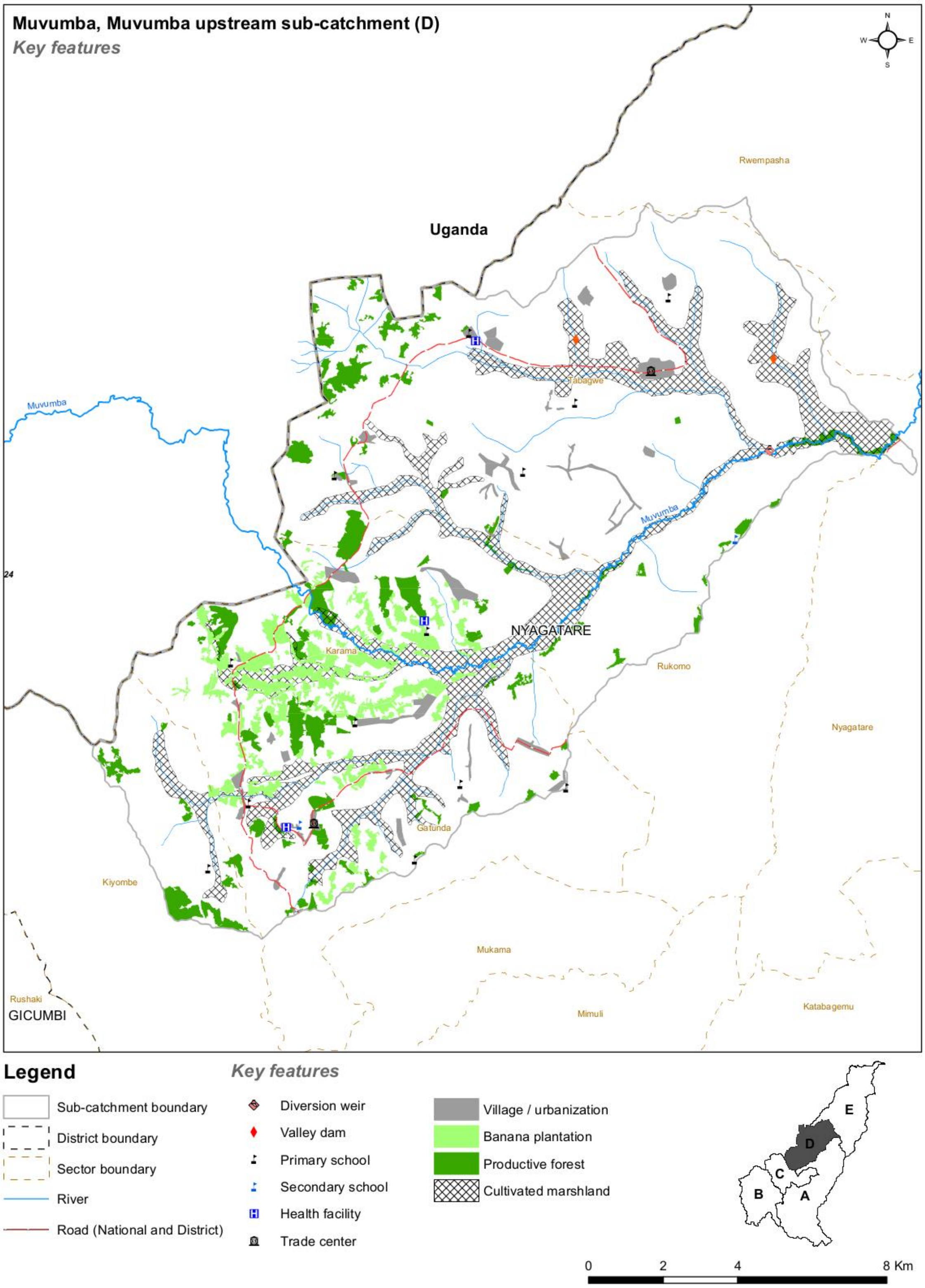


Figure 40: Key geographic features of the Muvumba Upstream sub-catchment

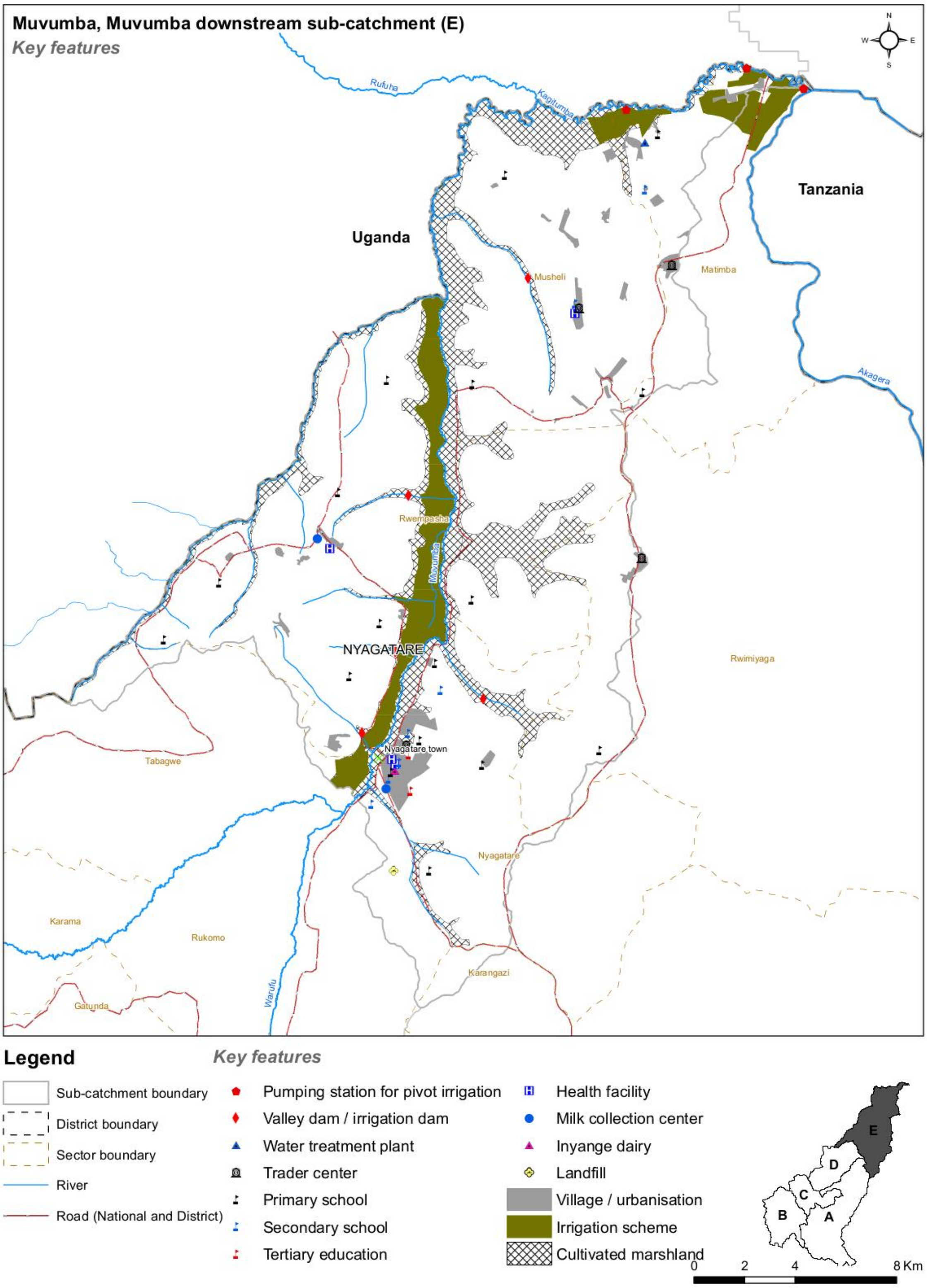


Figure 41: Key geographic features of the Muvumba Downstream Catchment

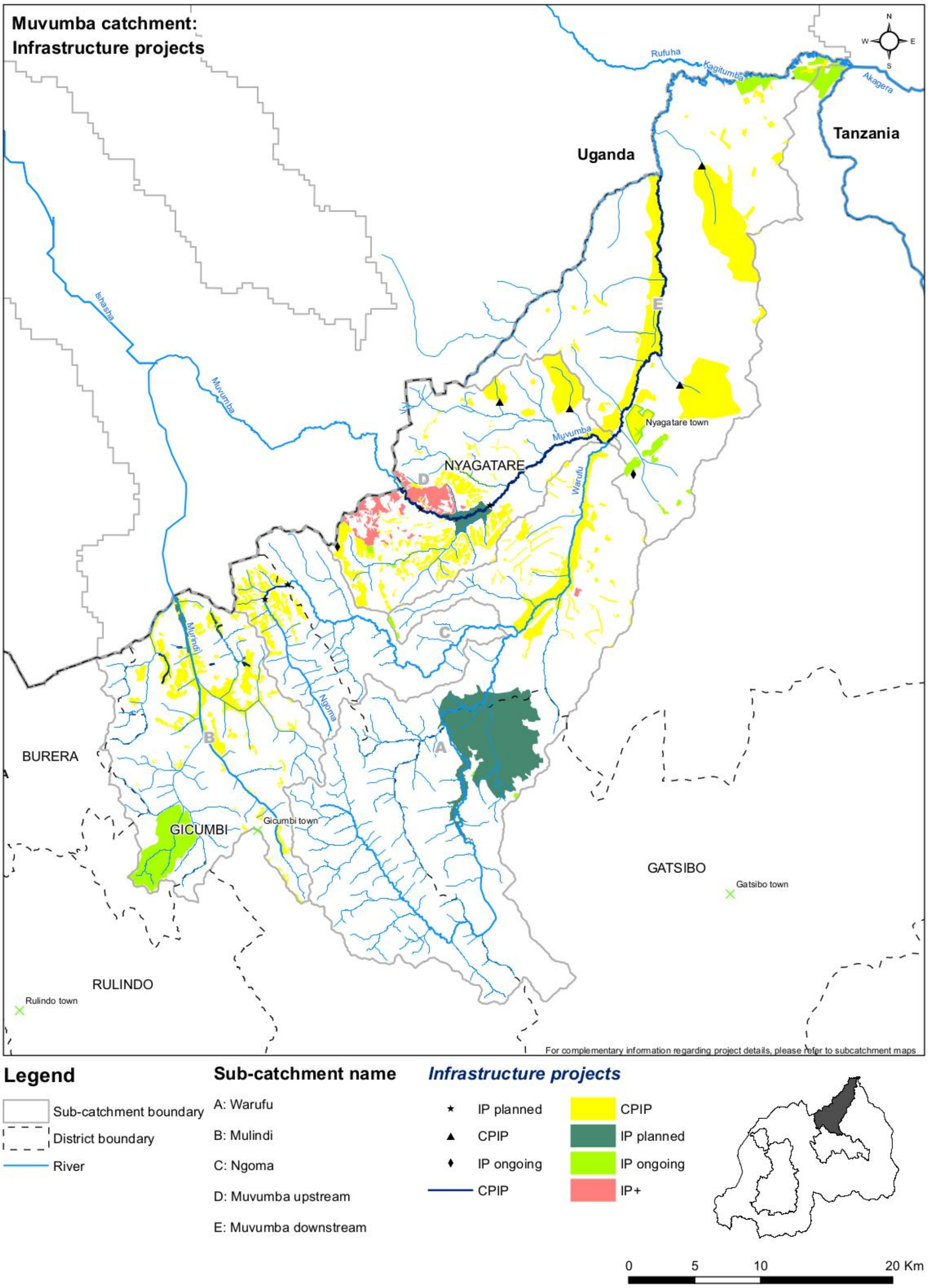


Figure 42: Infrastructure projects classified (IP/CPIP)

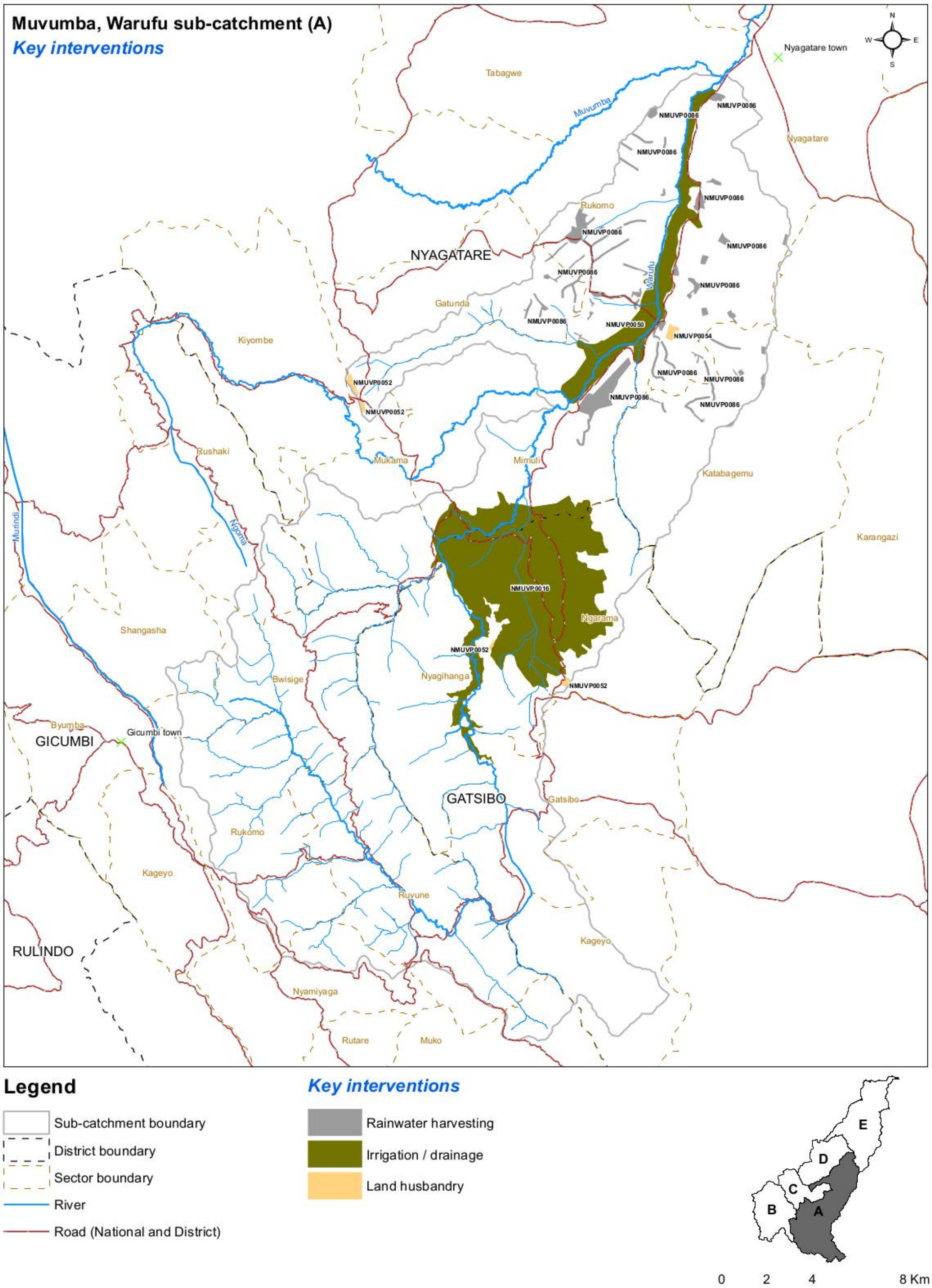


Figure 43: Key interventions in Warufu sub-catchment (interventions included only where spatial scope is known)

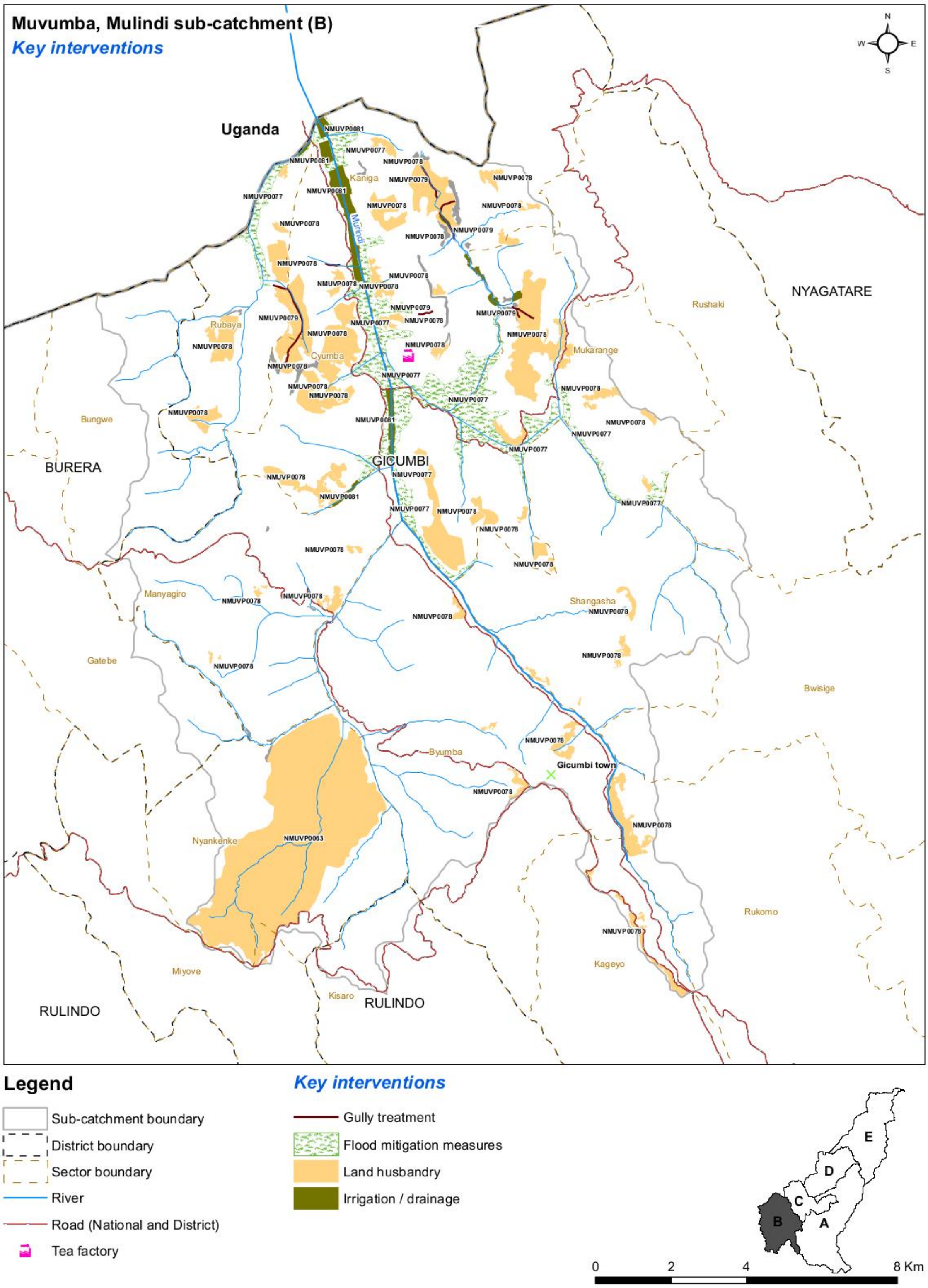


Figure 44: Key interventions in Mulindi sub-catchment (interventions included only where spatial scope is known)

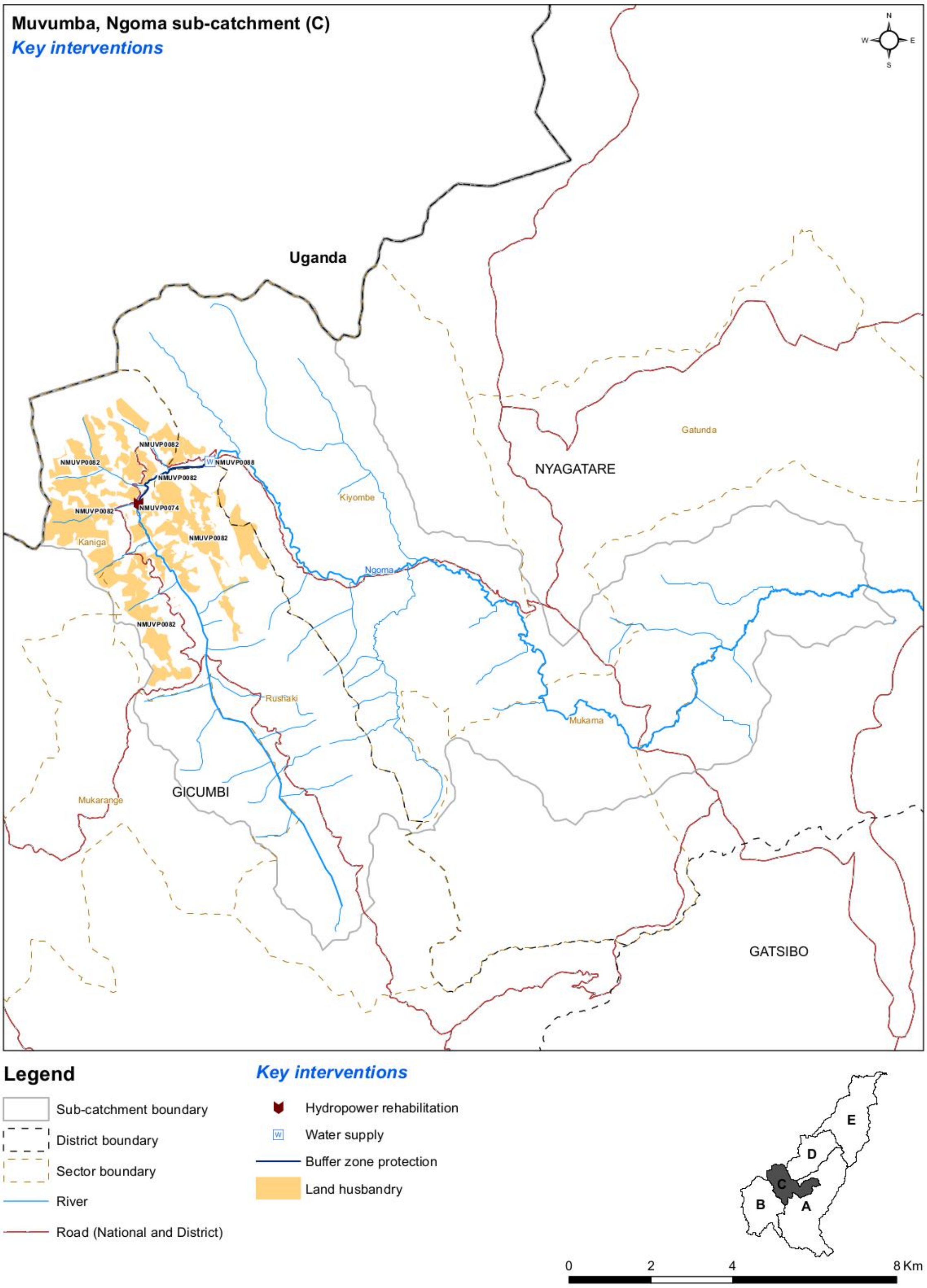


Figure 45: Key interventions in Ngoma sub-catchment (interventions included only where spatial scope is known)

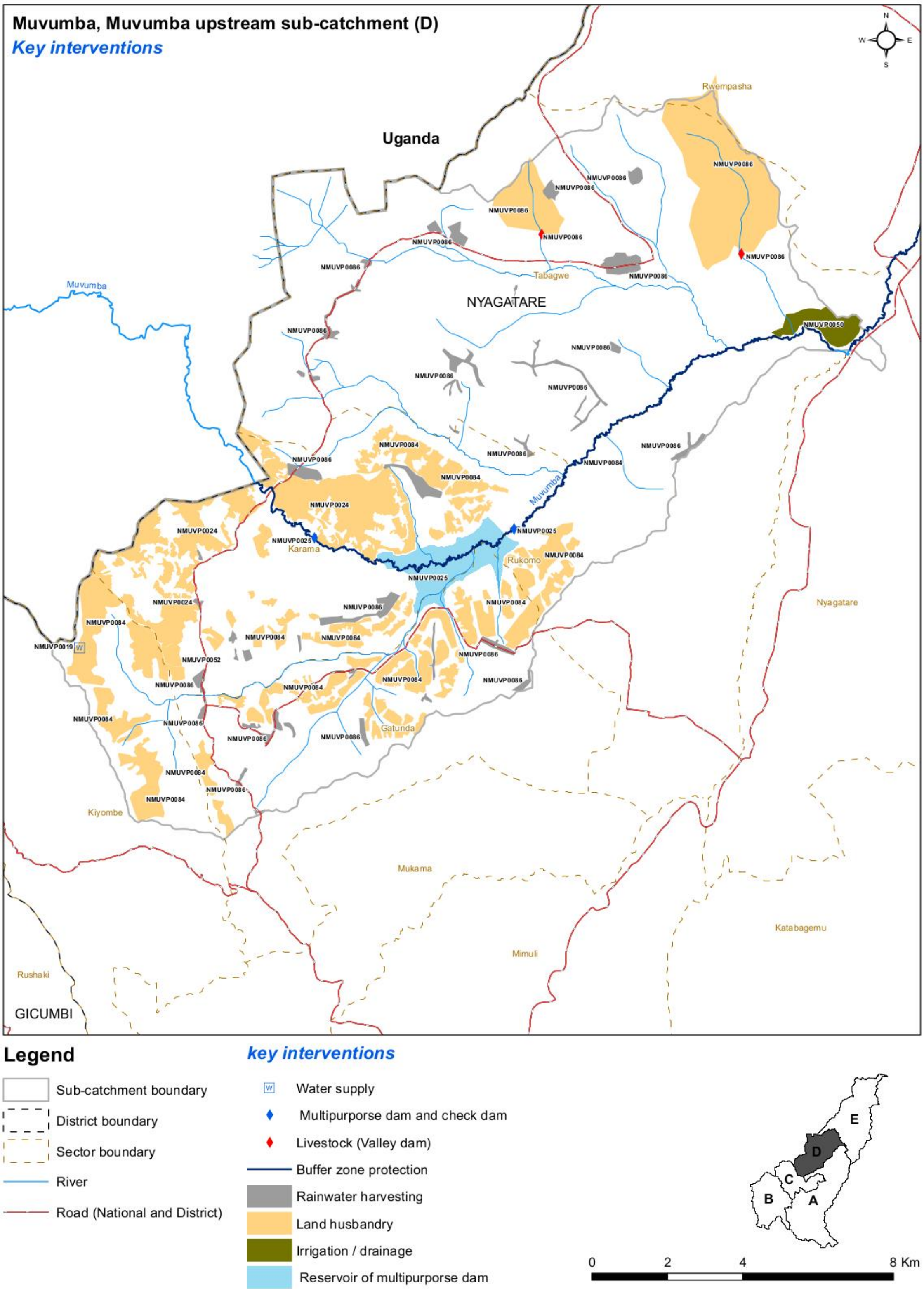


Figure 46: Key interventions in Muvumba Upstream sub-catchment (interventions included only where spatial scope is known)

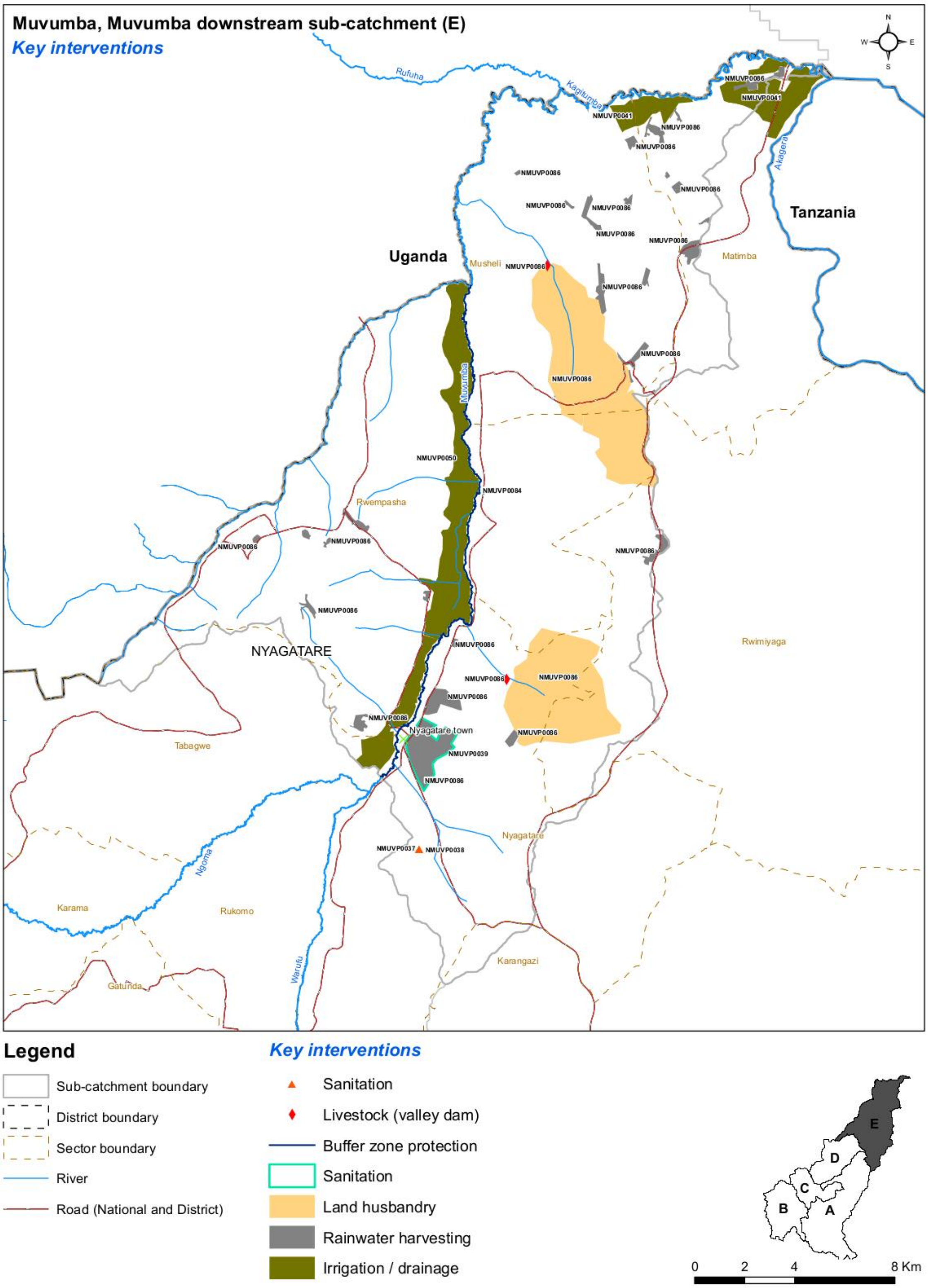


Figure 47: Key interventions Muvumba Downstream sub-catchment (interventions included only where spatial scope is known)

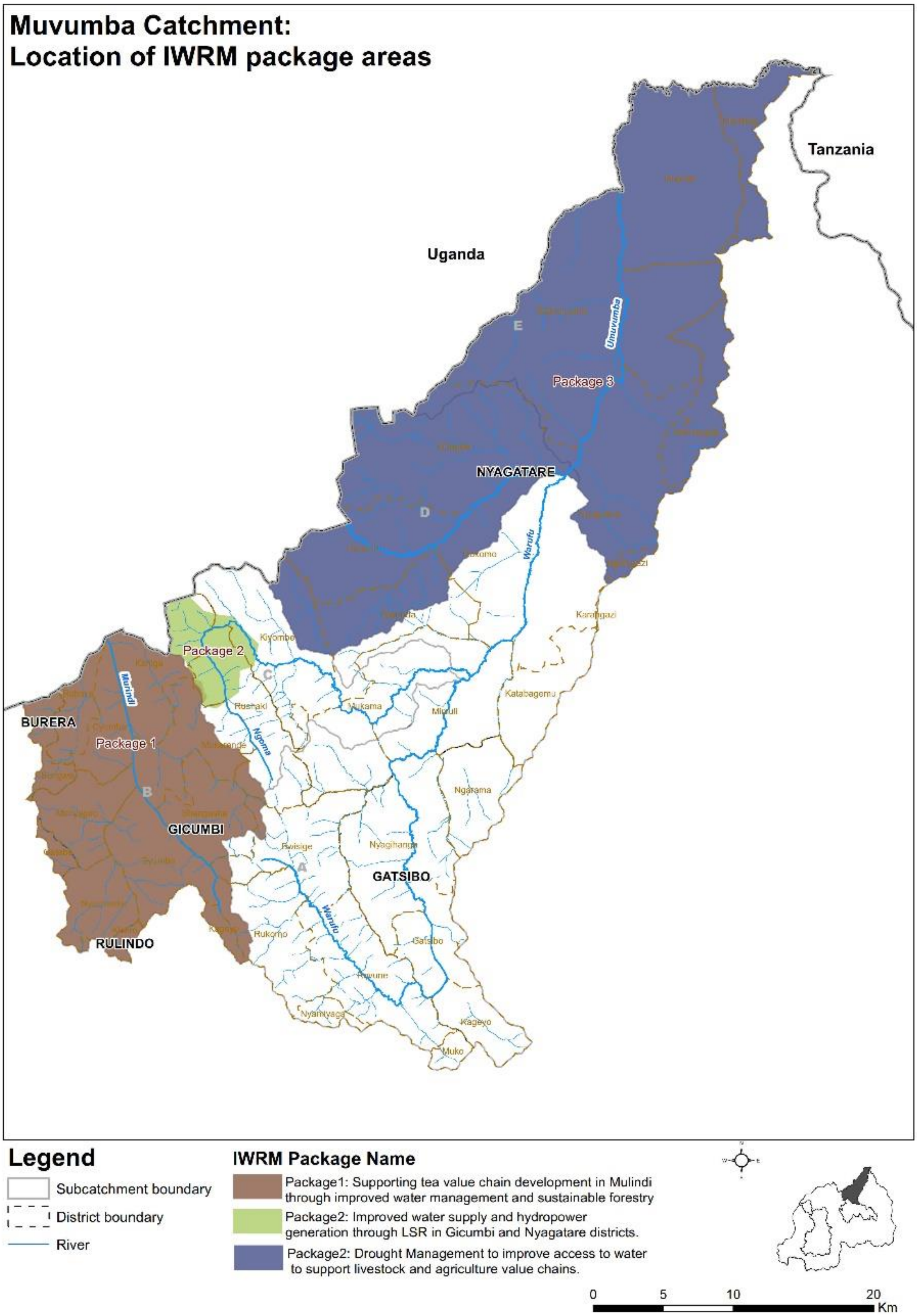


Figure 48: Key Overview of IWRM packages in the catchment, developed in February 2018

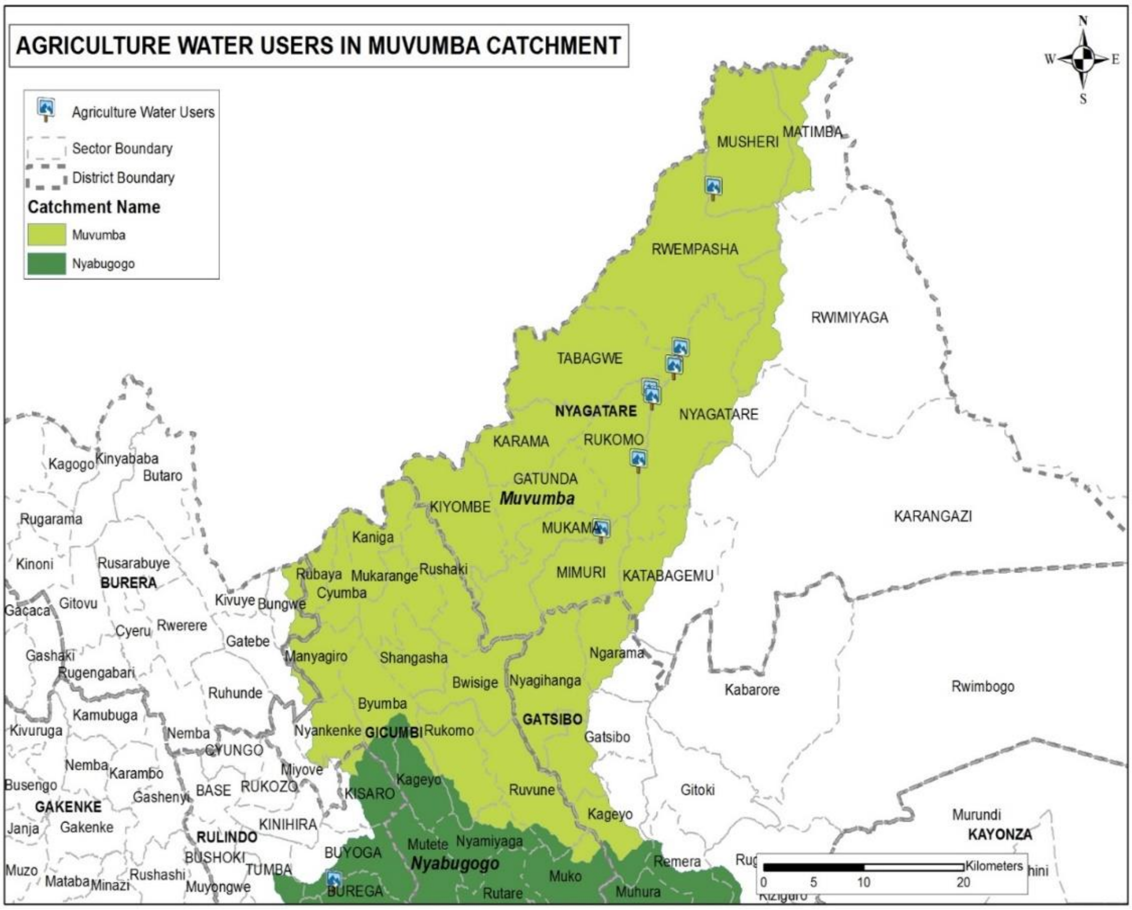


Figure 49: Water Users Survey – Agriculture water users in Muvumba catchment

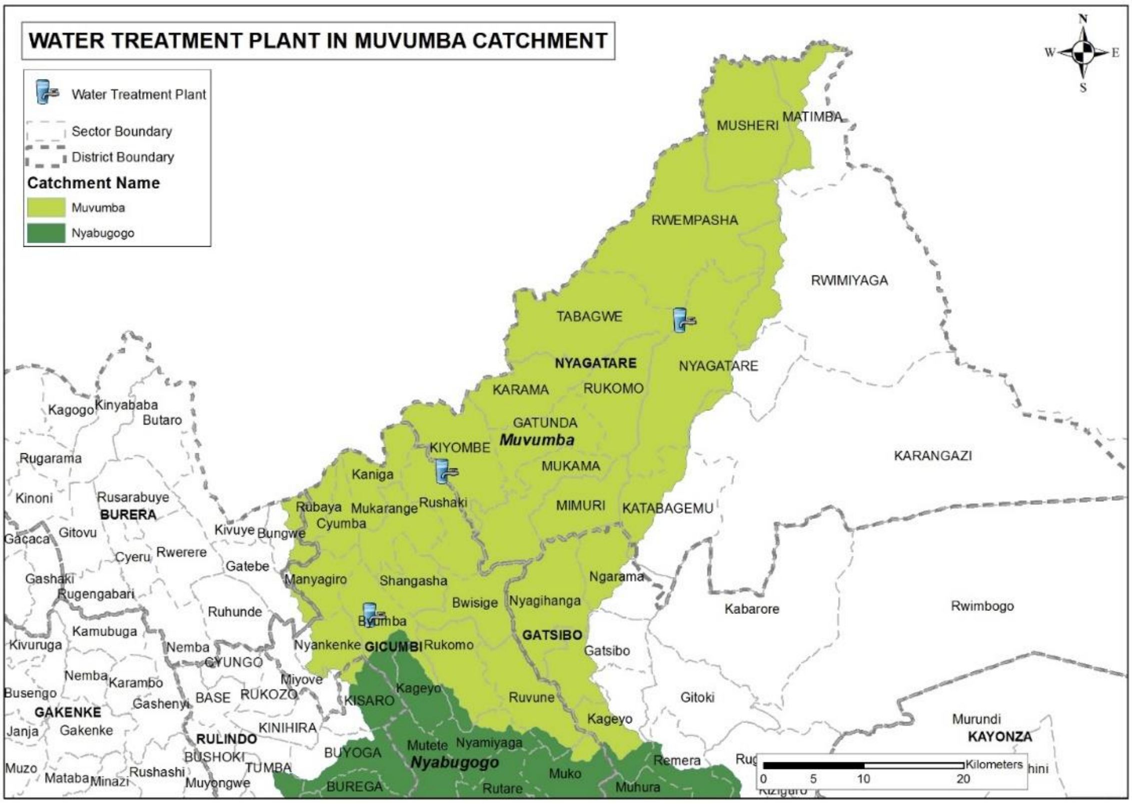


Figure 50: Water Users Survey – Water treatment plants in Muvumba catchment

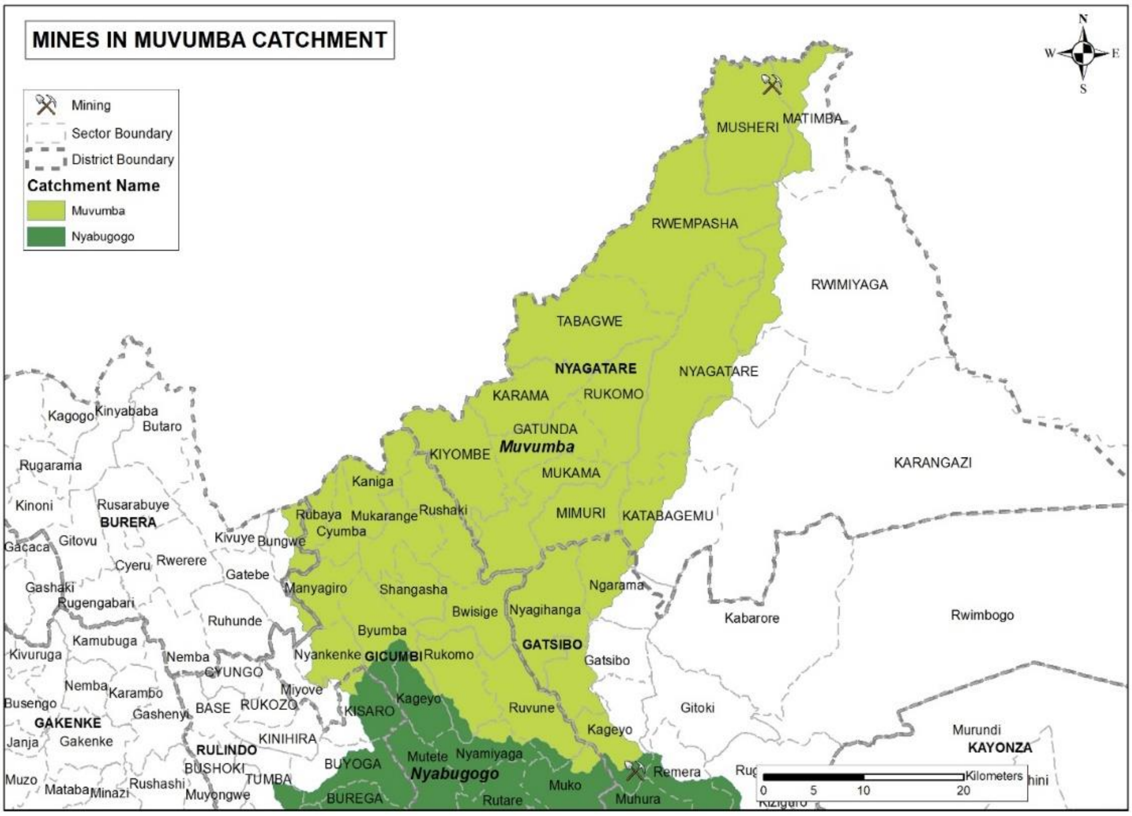


Figure 51: Water Users Survey – Mines in Muvumba catchment

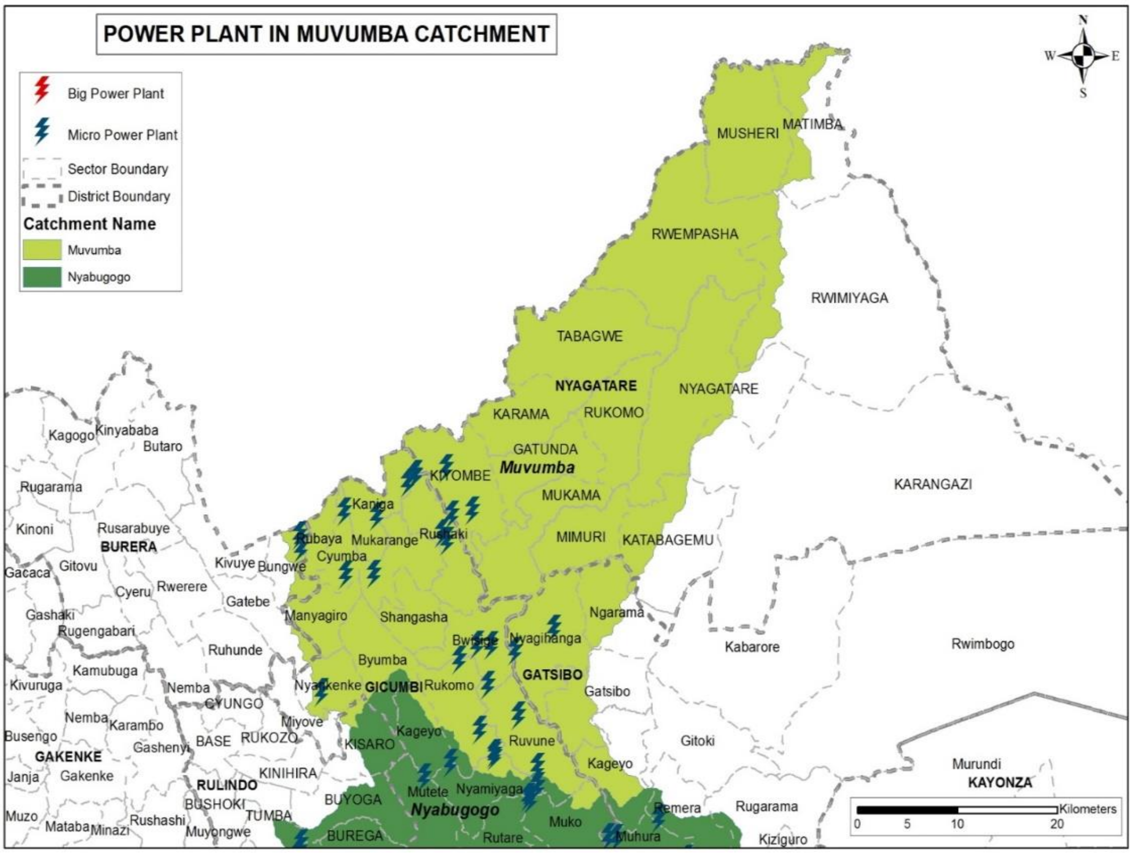


Figure 52: Water Users Survey – Hydro power plant sites in Muvumba catchment (existing and potential)

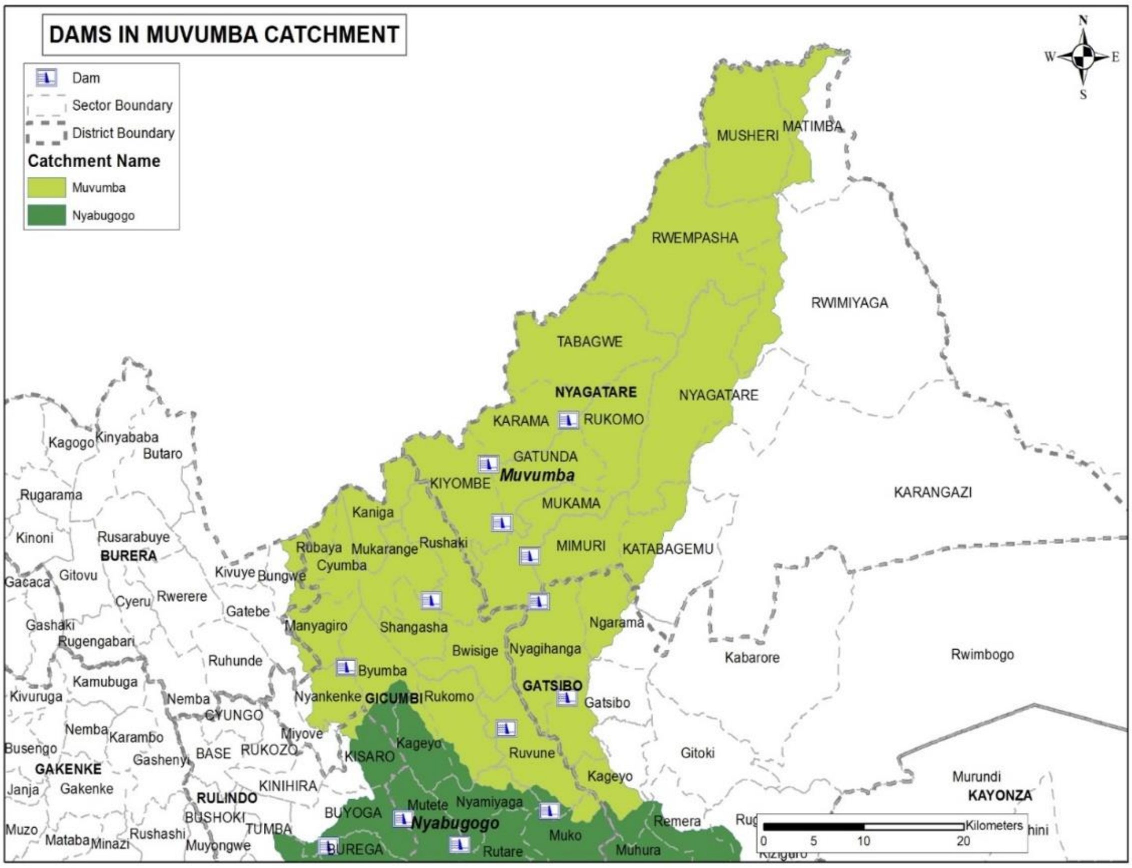


Figure 53: Water Users Survey – Dam sites in Muvumba catchment (existing and potential)

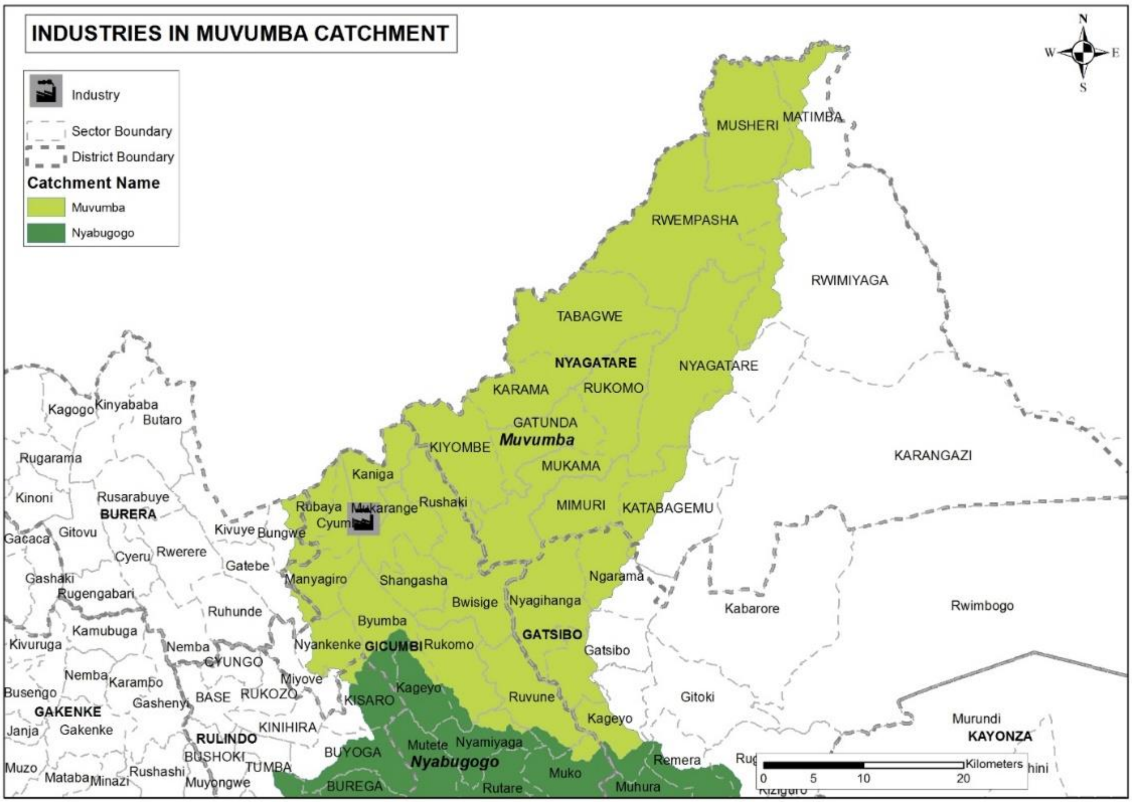


Figure 54: Water Users Survey – Industries in Muvumba catchment

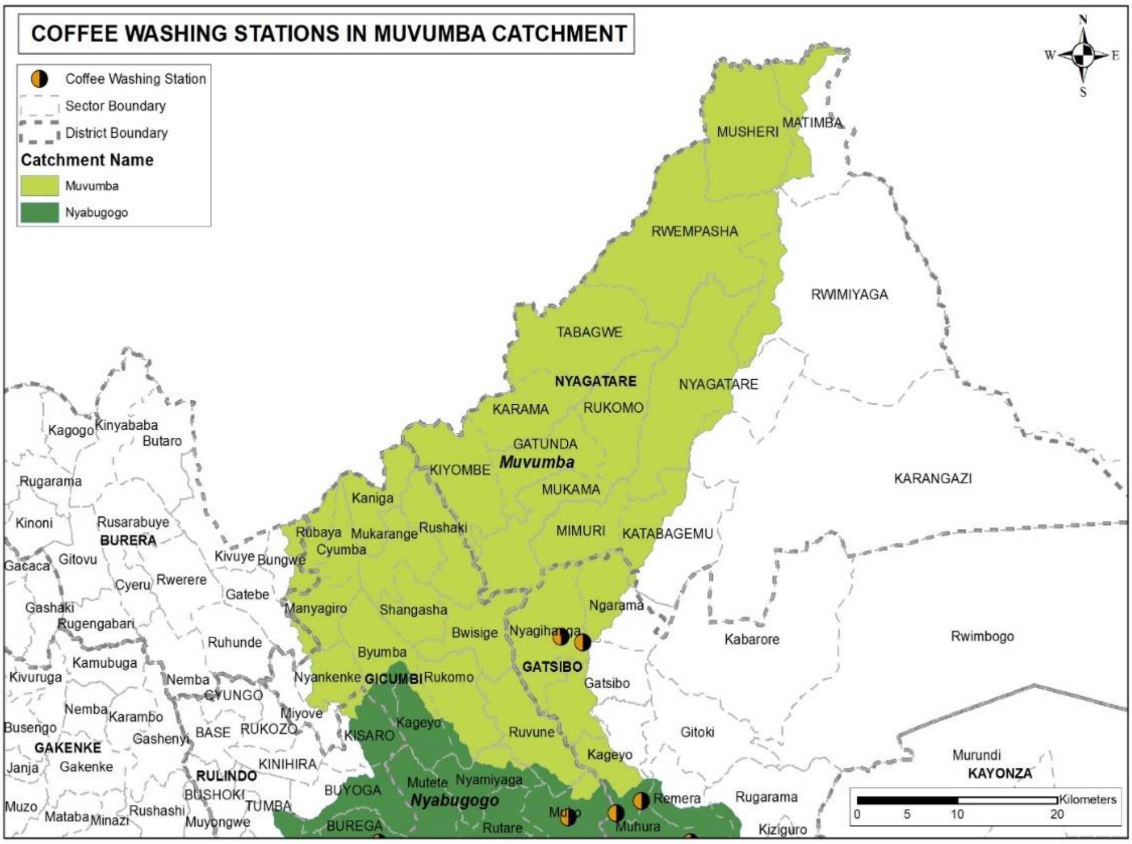


Figure 55: Water Users Survey – Coffee washing stations in Muvumba catchment

Annex 4. Consistency alignment

4.1 Introduction consistency alignment

The Catchment Plans and IWRM planning constitute a new and innovative approach for Rwanda. They are spatial plans that integrate land and water management in an area confined by the natural hydrological boundaries of a watershed. The boundary approach is appropriate for catchment management process and interventions, when, for example, physically restoring areas from upstream to downstream. Irrespective of this, catchment plans still need to be aligned with provincial and district development plans and programmes and sectoral plans. At the highest level, like any plan or strategy within Rwanda, they also need to comply with the overall strategic framework of the Government of Rwanda, as laid down in the Vision 2020 and the subsequent Vision 2050, as well as the implementation strategy 2017-2024 as laid down in the National Strategy for Transformation (NST1).

Based on the SEA approach, this chapter sets out the way in which the consistency between the catchment plan and the overall governmental planning framework is assured. It also explains consistency with local level strategies and eventually annual implementation plans, budgets, and Imihigos.

The SEA process started with a consistency analysis of existing laws, policies, regulations, and plans (W4GR TR16, 2016). A summary of this analysis is provided below. In addition, a high-level analysis was made on the plan's alignment with NST1 outcomes[36]. This concluded that implementation of the Catchment Plan would contribute to 78% of NST1 outcomes. In addition, those draft Sector Strategy Plans 2018-2024 that were available were also analysed for consistency with the catchment plan and provide more detail of how the Catchment Plan is aligned with, and contributes to, specific sectors.

In order to set things in context, sections 4.2, 4.3 and 4.4 introduce Rwanda's latest apex vision and strategy.

4.2 Consistency analysis of policies, legislation and regulation

The purpose of a consistency analysis of existing policies, plans and programmes with catchment plans is to check the degree of alignment between these with regard to possible interagency co-operation. Such an analysis requires an inventory of national, local and sector plans that may have influence on, or that may be influenced by, the catchment plan.

During consultative stakeholder meetings (with national stakeholders and the Catchment Task Force), a first analysis of existing policies, plans and programmes was undertaken to develop an overview of those that may have consequences for the catchment plan (see W4GR TR12 – TR15, 2016, for the results). The analysis identified those that might generate opportunities for the catchment plan, as well as those that set environmental and socio-economic conditions (criteria), and that potentially conflict with them. The analysis suggests how such conflicts might be resolved.

The actual analysis was undertaken by preparing an inventory of relevant policies etc that may influence IWRM, evaluating for each its goals to assess levels of consistency and determine whether they contained conflicts. Thereafter, a SWOT Analysis framework (Strengths, Weaknesses, Opportunities and Threats) was undertaken to assess inconsistencies and alignment issues. The results of the assessment are reported in W4GR TR16 (2016) and summarised in the sections below (Annex 0 to Annex 4.2.3).

[36] NST1 draft version of December 2017 was made available to the catchment planning team by MINECOFIN

4.2.1 Key strengths of existing policy instruments

The first key strength is that Rwanda subscribes to the principles of IWRM in the management of her water resources. This manifest itself in the availability of key policy and legislative frameworks related to IWRM. IWRM principles are integrated in an explicit manner in the national policy for water resources management, as well as the environmental policy, the green growth and climate resilience strategy and the national water resources master plan. Law No. 62/2008 lays out a general IWRM framework, including prevention of pollution, the user / polluter pays principle and the principle of users' associations for administrative management of water. It also calls for better, more integrated management, development, utilisation and protection of land and water resources at the catchment level.

Similarly, Organic Law No. 04/2005 determining the modalities of protection, conservation, and promotion of Rwanda's environment is also very relevant for IWRM and catchment plans. An important aspect of the legal context for catchment plans is that, according to Article 67, '*Every project shall be subjected to an Environmental Impact Assessment (EIA), before obtaining authorisation for its implementation*'. The article further mentions that '*…this applies to programs and policies that may likely affect the environment*'.

The principles of IWRM are also implicitly captured in Law No. 08/2005 determining the use and management of Rwanda's land. This was repealed and replaced in 2013 in order to strengthen the law's scope on gender equality, property right protection and environmental conservation and protection. Some of the other relevant pieces of legislation include: Law No. 58/2008 that determines organisation and management of aquaculture and fisheries; Law No. 30/2012 governing agrochemicals; Law No. 10/2012 governing urban planning and building, and; Law No. 55/2011 governing roads.

Rwanda's legislative and policy environment also acknowledges pressure on water resources and incorporates key dimensions of IWRM, such as water as a social and economic good; stakeholder participation, and; promotion of catchment relevant scales, e.g. basin, for planning and decision-making. Examples here include the national policy for water resources management; the revised vision 2020; the second economic development and poverty reduction strategy (EDPRSS 2); the seven-year government program; the decentralisation policy; the community development policy; the disaster management policy; the national strategy for community development, and; the local economic development.

In a similar fashion, the national rice policy calls for the development and management of water through a participatory approach, involving users, planners, and policy makers at all levels. Likewise, the gender policy sets out key objectives to ensure empowerment of women in various sectors, including environment protection and land use management. In terms of management of water resources at a watershed level, a key regulation is Law 62/2008, the law 'Putting in place the use, conservation, protection and management of water resources regulations'.

Policies on agriculture, environment, land, water resources management and infrastructure emphasise aspects of soil erosion protection and water conservation, and there is promotion of agro-forestry through the five-year strategic plan for the environment, the natural resources sub-sector, the national climate change and low carbon development strategy and the strategic plan for the transformation of agriculture (SPTA-3, 2013-2018) etc.

In addition, documents such as the national fertiliser policy, the irrigation policy, the Rwanda irrigation master plan, the master plan for development of fisheries and aquaculture in Rwanda, and the public policy and strategy for Rwanda all establish objectives and indicators directly relevant to sustainable environment and natural resources management. The national decentralisation policy, the community development policy and the national strategy for community development and local economic development are also all relevant as they establish responsibility for implementation of actions in the management of the environment, natural resources, agriculture and infrastructure at the local level. Decentralised entities (districts) have been given responsibility for "*efficient management of rivers, lakes, sources of water and underground water*", as well as for '*efficient management and effective use of swamps*'.

It is, therefore, clear from this analysis that many policy instruments are consistent with, and supportive of, each other and IWRM.

4.2.2 Key weaknesses of existing policy instruments

In addition to the strengths documented in Annex 4.2.1, there are also specific challenges and weaknesses in policy instruments that may hinder implementation of the IWRM approach. For example, some policy instruments lack specific provisions for IWRM, such as the environmental policy which is not specific in terms of the purpose of conserving wetlands. Instead, the policy acknowledges that traditional wetland use has been poorly conceived and lacks organisation or objective. It calls for elaboration of a formal wetlands policy and master plan, and a national wetlands inventory that distinguishes between protected and unprotected wetlands acceptable for human use, but provisions were not developed yet. There is limited uniform demarcation of mandates (and related to this: limited capacities) at decentralised level to promote watershed management, address soil erosion control, agro-forestry and other soil and water conservation measures. Many committees in various sectors e.g. environmental committees, agricultural water user committees, forestry management committees, Disaster Management Committees etc. often have similar or overlapping roles and responsibilities for natural resources management. Many farmers and other rural water users, especially women are illiterate. This poses a challenge for their involvement in training and service provision which are modelled to benefit literate farmers/water users. Policies and implementation programmes should be geared towards reaching these under-privileged target groups.

Article 22 of Rwanda's constitution (2003, amended 2015) states the right to a clean environment: "*Everyone has the right to live in a clean and healthy environment*". It does not explicitly, however, expound the principles of IWRM as a means to secure this, for example through universal water rights. It is though anticipated that the new water law will make such express provisions. With regard to land management, Ministerial Order No 14/11.30 (21/12/2010) states that land consolidation is designed to enable farmers to consolidate multiple parcels under one crop management program and thereby optimise agricultural productivity, as well as strengthen the connection between buyers and farmers. There is, however, no single clause on integrating the management of land, water and other terrestrial land and aquatic resources. Furthermore, the order does not provide for the active participation of local people; a fundamental principle of IWRM.

There are also serious gender gaps in institutional arrangements in the water sector. Despite women's clear role in day-to-day water management, women are underrepresented in ministries and departments that deal with water management (MINIRENA, including Rwanda Water and Forestry Authority/RWAFA, MININFRA, and MINALOC). At the community level, women are under-represented in decision-making related to agriculture, water and sanitation, for example, only one out of six members of one of the W4GR Catchment Task Forces is a woman, notably the National Women's Council District Coordinator (Ref 13976/16.03/RNRA/05). Most technical positions in districts and at RWFA are filled by men. Policy makers, managers and technicians in natural resource management have limited knowledge on how and why different situations and interests of men and women should be taken into consideration. There is also inadequate ability to identify issues where gender 'blind' planning has or can have a negative impact on the implementation of development initiatives.

Although women play a pivotal role as providers and users of water, as well as custodians of the environment, it is also surprising to note that in most policy instruments (e.g., the national water resources master plan; the five-year strategic plan for the environment and natural resources sector, the national agriculture policy, and; the third strategic plan for the transformation of agriculture in Rwanda), there are no guidelines on or for the role of women in the provision, management and safeguarding of water resources. Furthermore, integration and coordination between various policies and human activities (in particular, development of different economic sectors) are not clearly highlighted in most policy instruments.

Other weaknesses included conflicting objectives in the programmes for transformation of agriculture, for example objectives related to intensification in use of pesticides and fertilisers that conflict with objectives on improving water quality and objectives for the reclamation of marshland that are in conflict with objectives on wetlands protection). Soil use intensification measures are prioritised in agricultural mechanisation strategies, and in the national agriculture policy at the expense of the protection environment and natural resources management. Similarly, the national climate change and low carbon development strategy seeks to aggressively promote protection of environment which may be at odds with agriculture transformation and economic development. These potential conflicts have to be carefully examined at local sub-catchment level.

4.2.3 Effective Catchment Plan implementation

Given this complex policy environment, a key requirement for effective implementation of the catchment plan is to integrate relevant policies, programmes, plans and laws. This will ensure inclusive and accountable decision making and sustainable water resource management. Such integration should be reflected in the catchment plan and district development strategies, giving districts the necessary capacity to effectively implement policies at the local level.

In order to apply the principles of IWRM in catchment planning, it is necessary to have cross-sectoral cooperation at catchment scale, and to include both bottom-up and top-down participation, with emphasis on coordination across multiple scales. Cultivation of a network of partnerships is essential to ensure inclusion of a diverse array of stakeholders within a framework of collective decision-making. It is increasingly recognised that central government agencies cannot do everything and that some components of water and land management are better handled by other actors. The emergence of partnership networks has changed the centralised planning approach to an alternative, catchment-based planning approach with much greater stakeholder engagement (including the private sector) through definition and agreement of a common vision and shared understanding of water management issues.

It is, therefore, imperative to revise policy documents that have inconsistencies or weaknesses to ensure they are aligned with the principles of IWRM, as opposed to promulgating various fragmented policy and legal texts. Central government agencies such as MINIRENA, MINAGRI, REMA should coordinate better with local governments to integrate the activities of a comprehensive catchment plan, through a range of aligned district development programs for effective implementation at district level.

4.3 Vision 2020, Vision 2050, 7YGP and NST1

The implementation instrument for the remainder of Vision 2020 and the first four years of Vision 2050 will be the first National Strategy for Transformation (NST1). NST1 will integrate far sighted, long-range global and regional commitments by embracing:

- The Sustainable Development Goals (SDGs) which consist of 17 goals with around 170 targets and indicators, across a range of economic, social and environmental issues[37];
- The Africa Union Agenda (AUA) 2063 and its first 10-Year Implementation Plan 2014-2023, which is dedicated to building an integrated, prosperous and peaceful Africa by its own citizens and creating a dynamic force in the international arena. The AUA has eight pillars spanning social and economic development, integration, democratic governance and peace and security;
- The East African Community (EAC) Vision 2050. This focuses on initiatives for job creation and employment and uses development enablers that will create jobs that are integral to the long-term

[37] The SDGs also formed key input for the development of the vision and objectives for this catchment plan. The selection and formulation process are documented in the so-called Scoping Report, from May-June 2016, Water for Growth Rwanda. The resulting vision, overall objective, and specific objectives were subsequently formulated in their final form in the interim documents 'Catchment Plan (catchment name) – Characterisation and Vision (Water for Growth Rwanda TR17 – TR20, 30 June 2016).

transformation, value addition and acceleration of sustained growth. These include infrastructure, transport networks, energy and information technology, and industrialisation.

NST1 mainstreams these, and other obligations including the COP 21 Paris Agreement on Climate Change, but its prime influence is the aspirations of Vision 2050. Further, NST1 constitutes the Government of Rwanda's programme for 2017 - 2024 and combines the previous stand-alone 7YGP and the EDPRS into one plan. Vision 2020 catch-up plans will also be integrated under NST1.

The NST1 framework provides the basis for a series of Sector Strategy Plans (SSPs) for selected economic sectors, and for the development of District Development Strategies (DDSs), both for the period 2018-2024. NST1 also identifies a series of Cross Cutting Areas (CCAs) to ensure harmonisation across strategies, on a number of priority topics, again with key guidance for the period 2018-2024. NST1 demands alignment between SSPs, DDSs, and CCAs, and a joint translation into harmonised Annual Plans and Budgets, (joint) Imihigo and joint M&E. Catchment Plans, as a new instrument for integrated spatial planning, can be placed in the middle of this strategic alignment framework, as in Figure 2, chapter 1.)

An overview of the envisaged coherence between the catchment plans and sectoral/district implementation plans and budgets (operational plans) and strategies on the one hand, and annual implementation plans on the other, is provided in Figure 25, chapter 5. Catchment Plans bridge the strategy – operational gap. As such, catchment plans function as one of the pivotal instruments for Joint Imihigos and attaining Vision 2050.

4.3.1 Aspirations of Vision 2050

Vision 2050 aspires to take Rwanda beyond high income to high living standards by the middle of the century. It aims to attain upper, middle-income country status by 2035 and high-income status by 2050, with the intention of providing high quality livelihoods and living standards to its citizens by mid-century.

Vision 2050 focuses on five priorities that underpin the design, as well as the policies and actions, of NST1:

1. **High quality and standards of life**: Moving beyond meeting basic needs to ensure a high standard of living to transform the lives of households and individuals. The focus is on:
    a. Sustained food security and quality nutrition;
    b. Universal access to water and modern sanitation;
    c. Affordable, reliable and clean energy;
    d. Quality education and health care;
    e. Modern housing and settlements with environmentally friendly and climate resilient surroundings;
    f. Inclusive financial services;
    g. Adequate social security and safety nets;
    h. National and regional peace and security.
2. **Developing modern infrastructure and livelihoods**: Modernisation with smart green cities, towns and rural settlements, well designed transport facilities and services, efficient public and private services;
3. **Transformation for prosperity (developing high value and competitive jobs and sectors)**: Improved productivity and competitiveness through diversified tourism, manufacturing driven by competitive local industries, business and financial services, IT and technology, logistics and aviation, agro-processing, science and technology innovation, construction and extractive industries. All these will be underpinned by high quality services in public and private sectors;
4. **Values for Vision 2050**: The values underpinning economic and social progress are self-reliance and self-determination, dignity, unity and Rwandan identity, integrity, equity (including gender and youth), transparency and openness, participation in the global community, good governance and accountability, community participation, local innovation and national stability;

5. **International cooperation and positioning**: Rwanda will forge its own place in the world in the context of regional integration, multi- and bi-lateral cooperation, freedom from aid dependency, pan-Africanism and south-south cooperation.

4.3.2 The 7-year Government plan (NST1)

The National Strategy for Transformation (NST1) works towards the realisation of vision 2050 "*The Rwanda we want*" in the period of 2018-2024. It contains economic, social and governance pillars and the transformation agenda is designed to move Rwanda beyond the status of middle-income economy through identified private sector driven ICT, finance, tourism, creation of a knowledge-based economy, agricultural value chains and export growth, focused around mining and agriculture.

This chapter focusses on i) How the NST1 and its Sector Strategic Plans guide the catchment planning, ii) How catchment planning contributes to achieving the NST1 goals and can assist in its implementation, and iii) Important findings from catchment planning that are relevant for the NST1.

A high-level analysis was made on the degree of alignment of the 54 NST1 outcomes with catchment plan outcomes and impacts. The analysis determined that implementation of the catchment plan will contribute to 78% of NST1 outcomes (Figure 56), demonstrating the added value of catchment planning – as key IWRM instrument – to achieving national objectives and priorities.

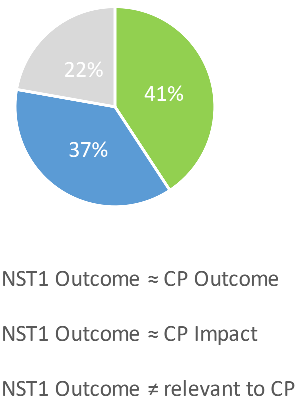


Figure 56: Overall CP alignment to NST1

Figure 57 shows that alignment is strongest in the NST1 economic (integrated urban development, sustainable mining, agriculture, environment and general green economic growth) and governance (decentralisation, capacity building, M&E system, multi-stakeholder approach) pillars / clusters, but is also present in the social (access to water and sanitation, health benefits) pillar / cluster. Examples of where there is no, or little alignment of outcomes relate to education and the health sector.

The catchment planning process aligns with that of the NST1 through joint planning and by allocating water resources to programmes to be implemented under the economic, social and governance pillars. Business and development activities in agriculture, energy, industries and urban sectors depend on water for their operation and produce waste flows that may affect others in the catchment. The second pillar of social inclusive development also depends on water. The goal of 100% access to water supply and sanitation and access to energy will determine priorities in allocating scarce water resources. Lastly, there is also a strong relation with the governance pillar through equitable allocation of water resources among the sectors to benefit the population.

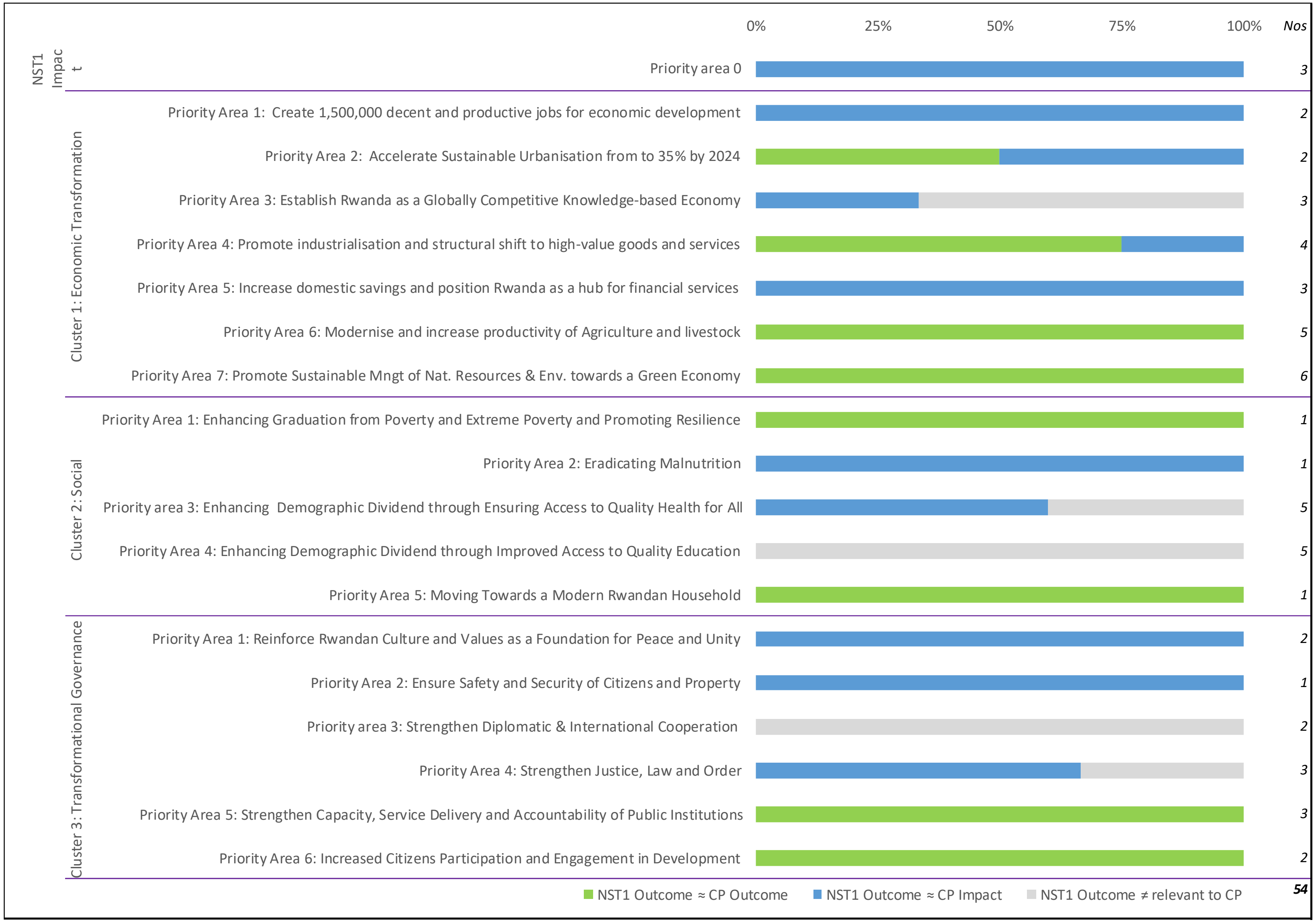


Figure 57: NST1 alignment with Catchment Plan based on NST1 Outcomes per Priority Area

One of the main objectives of catchment planning is to optimise long-term water productivity. Catchment plans therefore help to deliver the interlinked goals of the NST1 through translation into concrete interventions within areas defined by hydrological boundaries. Priority areas identified in the NST-1 are also first in line for water resource allocation at catchment level. Accelerated economic development, as proposed in NST1, will increase pressure on the environment and specifically on water resources. Dealing with this will require a cautious approach in allocation of water permits to users in order to optimise human well-being along with other areas and create higher levels of water security. Catchment planning helps to visualise and quantify the implications of the NST1, which in turn may guide decision-making on how to implement the strategy. This huge technological and organisational shift, coupled with increased water use / stress, requires effective water governance by catchment committees.

IWRM in the context of the catchment promotes a balanced approach to protection of natural capital, on the one hand, with optimising water allocation to social and economic priorities, on the other. The private sector, supported by the right incentives, can turn catchment management into business opportunities for a resilient economy and improved wellbeing of people.

NST1 → CP: NST1 guidance to catchment planning

NST1 establishes standards for high-quality life; this is aligned with overall and specific catchment plan objectives:

- Guiding the development of priorities for the allocation of water resources;
- Identifying key actions in the three transformation pillars, in line with the SSPs;
- Providing a vision for sustainable management of natural resources and the environment;
- Moving towards a carbon neutral economy;
- Promoting inclusive green growth based on private sector development/knowledge/natural resources;
- Setting a framework for homegrown values and solutions;
- Promoting a strategic shift to private-sector-driven economic development;
- Empowering youth and women through promoting entrepreneurship and access to finance;
- Promoting partnerships between government, the private sector, citizens, NGOs and FBOs.

CP → NST1: Catchment plan guidance to the implementation of NST1

Whereas NST1 has a strong top-down and sectoral approach to planning, catchment plans introduce a combination of top-down and bottom-up, decentralised spatial planning approach based on the natural resources available within the catchment:

- Water balance results show the water resources available for development;
- Goal setting for the protection of quality and quantity of water resources including groundwater;
- Georeferenced information for:
  - existing water users;
  - informing water allocation rules/priorities for NST1 implementation;
  - water related hazard risk management.
- Optimal locations for implementation measures, such as water harvesting or drought management;
- Interlinkages between water users through the water cycle;
- A framework for assessing and acting upon the interdependency between the environment and economic development;
- A spatial context for positive valorisation of water (economic, financial, social) and for responding to negative externalities or risks, such as drought, flooding, water contamination;
- A planning environment to improve livelihoods, build resilience, and local economic development;
- Information regarding the spatial valuation of natural capital and its protection;
- Information for the mainstreaming of IWRM in national policies and development interventions (combining IWRM with the existing SEIA and EIA methodologies);
- Monitoring of catchment health and water system.

4.4 Sector Strategic Plans (SSPs)

NST1 also consists of Sector Strategic Plans that provide more detail of how specific sectors are aligned with the Catchment Plan.

At the time of writing, eight separate drafts of 2018-2024 SSPs were available. A high-level assessment was undertaken to determine the extent to which respective SSP outcomes were aligned with catchment plan outcomes and impacts; the results being summarised in Figure 58. The assessment shows that, not only is the catchment plan highly relevant for traditional IWRM sectors, like environment and natural resources, forestry, governance and decentralisation, and water supply and sanitation, but also to agriculture, urbanisation and rural settlement, private sector development and energy. Only the health sector was less well aligned, although perhaps still more than might be expected.

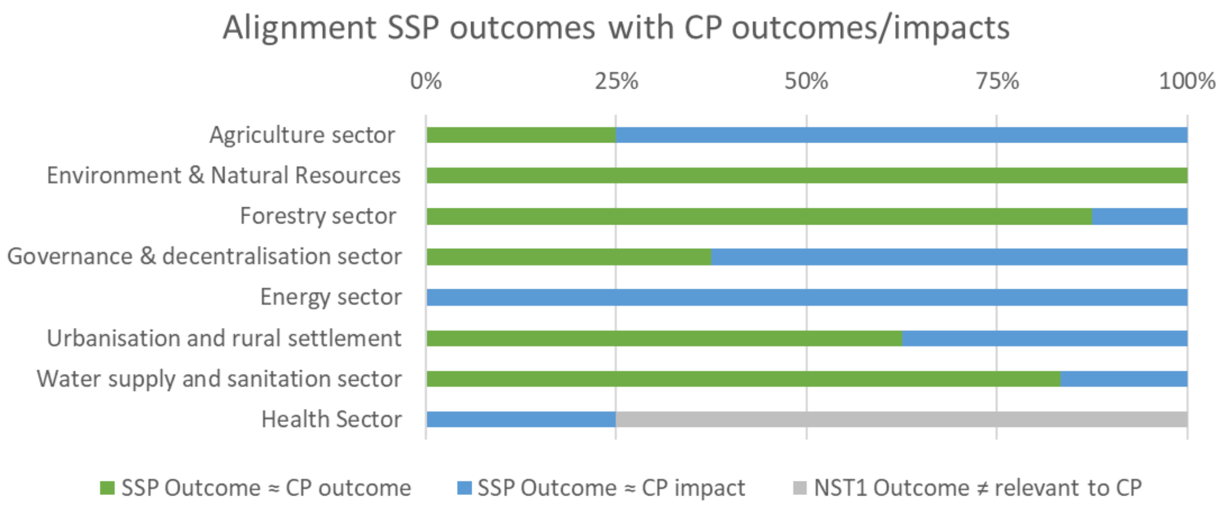


Figure 58: Draft SSP alignment overview

SSP Private Sector Development (PSD) and youth employment

Developing the private sector as the engine of economic growth is one of the six principles of NST1 2018-2024. The overarching objective of the economic transformation pillar is to accelerate inclusive economic growth and development founded on the private sector, knowledge and natural resources.

High level analysis of alignment between draft PSD, SSP outcomes with CP outcomes and impacts showed how catchment planning directly contributes to job creation and increased productivity, as well as to innovation in priority value chains (Figure 59). In addition, proper catchment planning reduces the risk profile of the agricultural sector (reduced flood threat, better and accessible water supply, etc.) and thus positively impacts the investment environment and export base diversification.

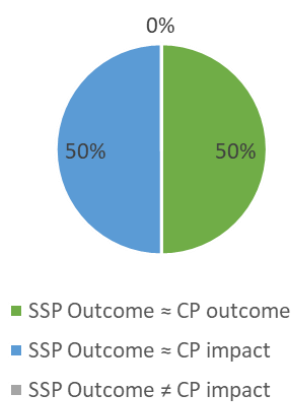


Figure 59: Alignment CP – PSD SSP

PSD is about increasing productivity and enhancing diversification of competitive value chains. By using the latest discoveries in resource efficient, low-carbon technology, and factoring in climate resilience and water efficient technologies, Rwanda can quickly transition itself to a modern society.

Mobilisation of resources from the private sector is also essential for the restoration and protection of the catchments. Private-sector resources will also undeniably grow the nation's economy. If the IIF is to be used most productively, it should be evident that the funds are encouraging public-private sector initiatives. This is simply about getting more-for-less.

The catchment plans identify a strong need for nature-based enterprises for managing natural infrastructure, whilst simultaneously creating value for the environment and the economy. A private sector led economy, based on entrepreneurship, is instrumental to achieving the objective of sustainable transformation. Seen from this viewpoint, there are many business opportunities for the private sector and inclusiveness and job opportunities for youth, women and disadvantaged groups can be built in at design phase of any given investment project.

PSD SSP → CP: Strategic plan for private sector development guidance to the catchment planning process

- Setting the agenda for inclusive economic growth and development founded on private sector, knowledge and natural resources;
- Selecting and prioritising competitive value chains to boost 'Made in Rwanda';
- Promoting the private sector as the engine for economic growth;
- Setting a goal to increase (from 5% (2017) to 80%) the proportion of public forest allocated to private operators by 2024;
- Defining the goal for the development of Special Economic Zones and business/industrial parks (one in Kigali, and eight more in the rest of Rwanda) and ensuring their IWRM proofing;
- Pushing for higher productivity and greater economic diversification.

CP → PSD SSP: Catchment Plans guide implementation of private sector transformation

- Creating opportunities for including water productivity as a design parameter;
- Mapping water related risks to business investment and private sector development;
- Planning for integrated flood and drought management;
- Rolling out IWRM tools to assist tea, sugar cane, rice, coffee and mining companies with investment decisions;
- Mainstreaming reduce, re-use and recycle approaches across industries and value chains;
- Providing spatial information for mobilising private finance for catchment restoration and protection;
- Enforcing of regulatory measures and feedback loops on 'what works' and 'what does not';
- Promoting multi-actor engagement between private, public and civic entities in the catchment;
- Promoting innovative public private partnerships (PPP) and nature-based enterprises;
- Sharing IWRM knowledge and tools among stakeholders.

SSP Agriculture

Rwanda's agricultural sector covers plant production, animal husbandry, fisheries and productive forests and contributes approximately 30% to the country's GDP, constitutes 50% of export and absorbs 70% of the labour force.

Agriculture is directly linked to water, the environment and other sectors in complex relationships and is the backbone for achieving food security, improved livelihoods, and socio-economic development, both for smallholders and the export sector (value chains of coffee, tea, horticulture and floriculture). If implemented, the Strategic Plan for Agricultural Transformation (PSTA4; MINAGRI, 2017) will substantially increase the water footprint, thereby increasing pressure on surface and groundwater resources in terms of quantity, quality and timing of availability.

High level analysis of alignment between draft PSTA4/SSP outcomes with CP outcomes and impacts re-emphasises the important role that catchment planning offers to agriculture strategy and *vice-versa* (Figure 60).

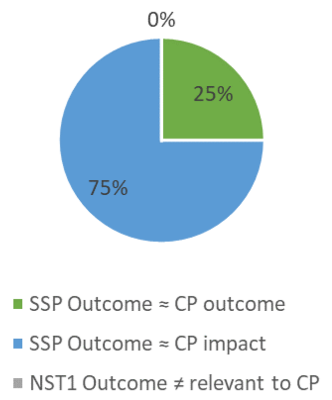


Figure 60: Alignment CP – Agriculture SSP

The catchment plan shows where water users are located and how they may be affected by the planned interventions in agriculture. The water balance can be used to test how projected interventions will affect existing water resources. IWRM measures, as identified in the catchment plan, will stimulate greater resource efficiency, reuse and recycling throughout the agricultural value chains.

Catchment planning, therefore, offers a suite of tools to develop the agricultural transformation strategy into feasible implementation plans at catchment level, assessing ideas for, e.g. new irrigation schemes, against competing land and water demands, and ensuring optimal allocation of water resources through the issuance of water permits to eligible water users. Close collaboration between MINAGRI/RAB, NAEB, RDB, RWFA-WRMD, and the CTF will ensure optimal alignment between the catchment plan and the local detailing of the Irrigation Master Plan. RAB, in close collaboration with RWFA/WRMD, is currently revising the Irrigation Master Plan, based on the WEAP results presented in W4GR TR29 (2017) and subsequent catchment specific WEAP reports (TR59 – TR 62, 2017), and in line with the water allocation plan presented in this Catchment Plan.

PSTA4 → CP: The strategic plan for agricultural transformation guidance to catchment planning

Agriculture, being the main water user and making the biggest claims on water resources in the coming seven years, will impact and put pressure on the entire hydrological system. Goals for 2024 include:

- Strategies;
- Doubling irrigation in marshlands and on hillsides to 102,284 ha[38];
- Putting wetlands under irrigation;
- Quadrupling fish production (a near-non-consumptive use of water, but with pollution risks);
- Doubling fertiliser inputs per hectare (which may lead to higher pollution levels in waterbodies);
- Doubling export of horticultural products (leading to higher export of virtual water);
- Rolling out support packages such as agroecology, integrated pest management, climate smart agriculture (CSA) and IWRM in irrigation to protect the environment and water quality while building climate resilience;
- Defining horticulture, floriculture, dairy and meat as priority agricultural value chains.

[38] The irrigation master plan will undergo a revision in 2018, incorporating water availability data from the catchment plans and national WEAP study, which may lead to a change in this figure.

CP → PSTA4: Catchment plan guidance to implementation of the strategic plan for agricultural transformation

The Water Evaluation and Planning (WEAP) model results reveal that, for unmet water demand to be reduced to zero (under a medium-term future projection scenario), the following measures are required in the agriculture sector:

- Agricultural use of water must increase its efficiency by 30%, for example through improved technology or adoption of different crops or varieties;
- Targets for the increase in the total area under flood irrigation should be reduced by 50%.

SSP Environment and Natural Resources (ENR)

Sustainable and climate resilient natural capital underwrites Rwanda's present and future prosperity. This underscores the value addition of the ENR sector to the medium-term goals of NSTP and longer-term goals of Vision 2050. The ENR sector constitutes the resource base of the economy and land degradation damages the economy of Rwanda with a cost of 3.5% of agricultural GDP. Economic development and the environment are, therefore, linked in many ways: Businesses use natural resources in processing, thereby valorising water resources in the production process. Droughts, floods, contamination by mines and other water related risks and shocks damage infrastructure, hamper business and threaten food security. These risks are multiplied by climate variability and change. Integrated flood and drought management approaches must be utilised to reduce the water related risks to doing business. Stopping degradation of catchments, through reforestation and catchment restoration, has been underway since 2011 in some catchments, with tangible results. This remains a priority in Rwanda.

Unsurprisingly, high level analysis of alignment between draft ENR SSP outcomes and CP outcomes and impacts, confirms complete congruity (Figure 61).

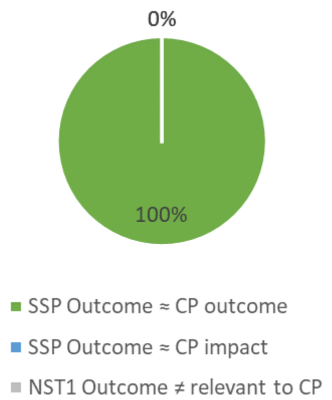


Figure 61: Alignment CP – ENR SSP

The overall objective of the ENR strategy is to promote, coordinate and enable the sustainable management of natural resources to safeguard green and climate resilient growth and achieve high standards of living across generations. Here, the ENR sector includes land, water, mines, forestry (the latter with its own sub sector strategy – see below), meteorology, and environmental management.

Ministries responsible for ENR will set up a comprehensive data management, regulation and enforcement mechanism to protect the natural resource base for long-term development. Catchment committees will be instrumental in governance of the water resources and will instil collaborative governance to monitor and identify issues among water users, for example to address the contamination from mining.

IWRM and catchment planning is also complementary to effective disaster management in that it addresses structural issues thereby reducing the risk of disaster. Improved water governance, combined with infrastructural improvements and behavioural changes, are part of the solution.

ENR SSP → CP: The Strategic plan for Natural Resources and Environment guidance to catchment planning

- Introducing the concept of natural capital as producer of the environmental services that underpin the economy;
- Promoting, coordinating and enabling the sustainable management of natural resources for green and climate resilient growth;
- Setting the goal of 100% of water users having water permits;
- All catchments having catchment committees and plans;
- Increasing water storage from 6.7 to 10 m^3 per person;
- Introducing market-based forestry;
- Double the area under agroforestry;
- Protecting and improving water quality;
- Defining land tenure and boundaries of properties;
- Planning for the restoration of catchments;
- Setting the goal of establishing 24 sustainable mining clusters.

CP → ENR SSP: Catchment plan guidance to implementation of ENR strategic plan

- All catchments having catchment committees and plans;
- Analysing water resources and using water balance to demonstrate the water resources available for development;
- Adopting goals for managing and protecting quality and quantity of groundwater;
- Providing georeferenced information on existing water users and thereby informing water allocation rules/priorities and the assignment of water use permits;
- Applying spatial valuation of natural capital and its protection;
- Identifying and strategising around managing water related risks;
- Operationalising water harvesting/drought management at catchment level;
- Proving linkages between water users through the water cycle: e.g. contamination from mines;
- Showing spatial options for strategies of water storage, RWH, and integrated flood management, climate resilience;
- "*Optimising and scaling-up sustainable and climate resilient management of natural capital resources to anchor and accelerate achievement of Rwandan prosperity*";
- Providing a framework for recognising and understanding environment and development interdependencies;
- Positive valorisation: livelihoods, resilience, economic development; Negative: externalities/ risks for public and private sector: drought, flooding, contamination;
- Providing a methodology to integrate IWRM in SEA/SEIA and EIA;
- Providing tools for joint planning and monitoring of Natural Capital and the water system.

SSP Forestry

Forestry contributes 21% of agricultural GDP. Trees and forests are central to catchment restoration and form an important part of the natural capital necessary for climate resilient green development. Besides, forestry is currently the mandatory land use form for slopes of 60% and above.

Forestry has its own sub-sector strategy within the ENR sector strategy and also has a sub-sub sector of agroforestry. Agroforestry delivers 27% of sustainable biomass and has the potential to supply as much as 40% of the national demand (National Forestry Inventory, 2015). Agroforestry strongly contributes to sustainable climate smart agriculture where trees serve as wind-breaks, act to recycle nutrients from deeper soil layers, reach water deeper in the soil, produce organic matter, and provide fodder, shade, firewood, poles, and fruits. Currently, agroforestry has around 25 trees per ha, but this should ideally be intensified to 50-100 trees per ha (National Forestry Inventory; 2015). Unsurprisingly, and like its ENR ‘parent’ strategy, high level analysis of alignment between the draft forestry SSP outcomes with CP outcomes and impacts confirms complete congruity (Figure 62).

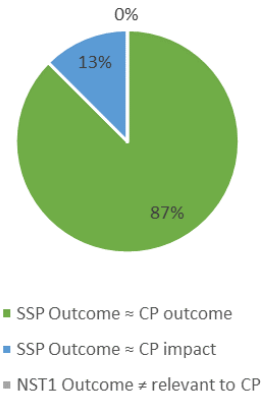


Figure 62: Alignment CP – Forestry SSP

The link between forestry and catchment management is very important. Forest management, (re)afforestation, and agroforestry are key elements of an integrated response to land degradation. Overlaps between the DDS, the District Forestry Master Plan (DFMP), the District Landscape Rehabilitation Plan (DLRP) and the Catchment Plan (CP) are shown in Figure 63.

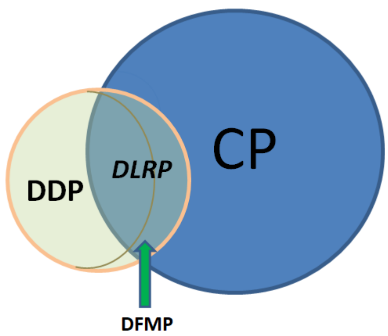


Figure 63: Coherence between district, forestry, and catchment planning (DDP, DLRP, DFMP, and CP)

There is a serious risk of further decrease and degradation of forest cover due to demands on wood for timber, sticks and poles, firewood, and charcoal production that may eventually exceed production. The current, projected development path of Rwanda will greatly increase demand for wood and thus put existing forests under pressure. When forests are degraded, the whole catchment degrades.

The strategic target in the NST1 is to increase the proportion of public forest (State and District owned) allocated to private operators, from 5% (2017) to 80% by 2024. It is also proposed that the proportion of private forest converted into productive forests and managed by forest owners’ associations will increase from 0% currently to 50% by 2024. This will be supported by an effective PPP model to be developed in the forest sector.

The agroforestry strategy contains practical information on agroforestry. It proposes contracting private operators to support farmer field schools (FFS) with planting and managing agroforestry plots for three years (supervised by extension workers). The agroforestry strategy also plans mapping of eroded soils in all agroecological zones, along with existing soil and water conservation measures. Agroforestry is then proposed as a measure for ameliorating eroded soils and to complement current soil and water conservation measures. The strategy highlights the need for marketing of agroforestry products and for facilitating access to private finance for agroforestry.

CP → DFMP: Aligning catchment planning and district forest management plans

The forestry sub-sector strategy, together with the National Forest Management Plan 2017 – 2024 and the District Forestry Management Plans (DFMP), gives official endorsements for private-sector-led commitments to forestry for expanded sustainable catchment restoration investments. DFMPs contain detailed maps with forest areas and identified Forest Management Units (FMUs) to align with (sub) catchments plans. Introduction of market-based forestry is a welcome innovation with a win-win for both parties in improved environmental protection, while boosting the forestry production with green job creation.

On the other hand, the catchment plan contains information about land degradation or abandoned mines to be forested and shows links between forest-driven environmental services and water supply, energy, and other sectoral users. Prioritisation of forestry management contracts should take into consideration the degradation pressure in relation to socio-economic development of the population. In case of firewood for a tea factory, the DFMP shows the location of forests, the area, the production capacity, owners, and a business model to create new green jobs, while at the same time enhancing sustainability of the catchment. The support modality in agroforestry through farmer field schools can be combined with training in smart-agriculture and protection of the environment.

SSP Governance and Decentralisation (G&D)

The overall objective of Governance and Decentralisation (G&D) Sector is to put the citizen at the centre of all development endeavours and to contribute to the realisation of NST1 and thus to Vision 2050 as enabler for economic and social transformation.

The specific objectives of the Sector are: to foster citizen participation and inclusiveness, to ensure quality service delivery by all citizens and institutions including online service delivery, and to promote best practices and home-grown solutions as well as Rwandan core values so as to sustain the envisaged sustainable development.

Catchment planning aims for transformational IWRM governance by transcending administrative and sectoral boundaries and involving all key stakeholders within the catchment. As such, catchment planning is a governance instrument. High level analysis of alignment between the draft G&D SSP outcomes with CP outcomes and impacts re-affirms this: all SSP outcomes benefit directly (37%) or indirectly (63%) from catchment plan implementation (Figure 64). The linkage between G&D SSP and CP is especially strong in their mutual objectives of increasing transparency and accountability that is enforced by public and non-public stakeholders, as well as self-reliant local government and capacitating stakeholders to participate in informed decision making.

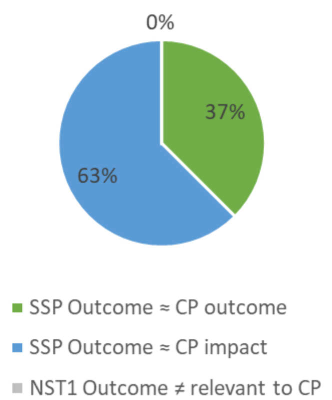


Figure 64: Alignment CP – Governance and Decentralisation SSP

SSP G&D → CP: The strategic plan for governance and decentralisation guidance to catchment planning

- Goal setting for transparency and accountability at individual and institutional level enforced by public and non-public stakeholders;
- Target self-reliant local government;
- Designing Capacity Development strategies to meet the transformation agenda;
- Strengthen the CP's ambition on transparency and accountability;
- Enhancing fiscal and financial decentralisation;
- Increasing transparency in budget execution reporting through benchmarking and performance analysis;
- Improving sectoral decentralisation.

CP → SSP G&D: Contributions of catchment planning to the strategic plan for governance and decentralisation

Catchment Planning, characterised through spatial planning and a participatory approach is almost by definition a strong tool for Joint-Imihigos, bringing together multiple government ministries, (sub)districts, private and non-governmental entities as well as local and downstream stakeholders:

- Boosting the participation of citizens in planning and budgeting;
- Building human resources capacity, especially relating to spatial planning and IWRM;
- Increasing gender diversity in (decentralised) decision making;
- M&E framework of catchment plan promotes transparency and accountability as well as knowledge sharing and capacity building;
- Catchment Committees constitute an entity of decentralised decision making or decision influencing, as per their mandate laid down in a Ministerial Order accompanying the new Water Law.

SSP Energy

Energy and electricity are a prerequisite for achieving socio-economic development. Currently, biomass generates 85% of the energy consumed in Rwanda. Electricity is generated by hydropower, solar, diesel, methane gas, and peat.

The water-energy-food securities nexus amplifies the impact of droughts, through food shortages and faltering energy supply, damaging business and undermining development, especially of vulnerable groups. Failing to implement intersectoral planning in catchments might result in ceased or reduced energy production due to a lack of sufficient quantity (flow) and quality (sediment) of water. Policy incentives to promote renewable energy (e.g. micro or pico-hydropower, solar) and energy-efficient products (for example improved cookstoves) reduce the pressure on forestry for biomass, which can slow or ultimately prevent further deforestation.

High level analysis of alignment between the draft energy SSP outcomes with CP outcomes and impacts shows how catchment planning indirectly fully supports energy sector objectives (Figure 65). Increased electricity generation capacity is, for example, supported through CP implementation by reducing sedimentation in rivers, thus allowing hydropower plants to attain higher load factors, energy efficiency and profitability.

The water-food-energy securities nexus implies that changes in energy consumption (will) affect the water cycle and food situation and *vice versa*. Energy generation requires water, while irrigation and water supply use energy for pumping and water treatment. Replacing biomass as the main source of energy (85% of energy in Rwanda) by cleaner (LPG instead of firewood) or renewable alternatives (biogas, off-grid solar) is necessary to halt deforestation. Hydropower is a clean renewable energy source that requires water whilst water can still be used for other purposes after passing turbines. Restoration of degraded catchments, together with other IWRM tools, can help hydropower installations to be more cost effective, since improved water quality will reduce turbine maintenance and operations costs of hydropower facilities.

Nexus interdependencies related to hydropower, peat exploitation and energy efficiency can better be dealt with in catchment planning.

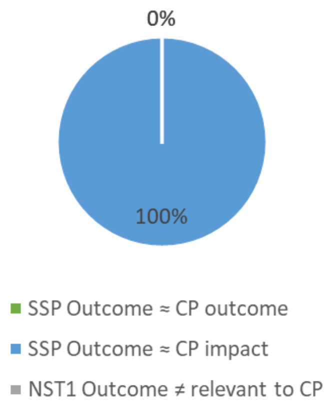


Figure 65: Alignment CP – Energy SSP

SSP Energy → CP: The strategic plan for energy guidance to catchment planning

- Setting a goal of 100% of the households with access to energy by 2024;
- Investing in national energy mix: hydropower, solar, peat, methane, biogas, geothermal, biomass;
- Promoting small scale, off-grid electricity solutions for remote communities;
- Setting a goal of 18% better energy efficiency;
- Setting the goals of 16% acceptation of improved cookstoves, 100% green charcoal, reduction of biomass as energy source, increasing renewables in electricity generation.

CP → Energy SSP: Catchment plans guidance to the implementation of the strategic plan for energy

- Visualising energy-water-food nexus interdependencies in the catchment;
- Identify hydropower, including its up and downstream relations (water quantity and quality and timing);
- Monitoring water flow in (sub)catchments;
- Mapping water related opportunities and risks and mitigation;
- Promoting operationalisation of renewable energy (biogas, pico hydro power, LPG) and energy efficiency (improved cookstoves, practices) to protect forest;
- Identify cross-sectoral solutions (e.g. use methane from lake Kivu for nitrogen-based fertiliser);
- Identify and promote options for waste to energy (bagasse, coffee pulp, rice husks).

SSP Urbanisation and Rural Settlements

The Urban and Rural Settlement plays a vital role in achieving ambitions under several NST1 priority areas. Most notably these include accelerating sustainable urbanisation from 17.3% (2013/2014) to 35% by 2024 (focus on developing secondary cities and an efficient and competitive construction industry), 'Moving towards a Modern Rwandan household' (focus on liveable rural and urban settlements, equitable and accessible housing) and 'Strengthen Capacity, Service delivery and Accountability of public institutions' (integrated planning and adherence).

IWRM planning is a cornerstone of urban and rural planning as the quantity and quality of water resources are one of the determining factors for quality of life. It is of no surprise therefore to see Urban and Rural Settlements SSP outcomes to be highly related to Catchment Planning (Figure 66). For the NST1 governance pillar, direct links include the need for integrated human settlement planning and coordination, where the catchment plan could be of crucial importance, and adherence and compliance to development regulatory frameworks (which includes the catchment plan). For the NST1 economic transformation pillar, direct links are especially strong where catchment planning provides an enabling environment for secondary cities to function as poles of economic growth. For the NST1 social pillar, direct links include well-managed rural and urban settlements allowing for liveable, well-serviced, connected, compact, green and productive settlements.

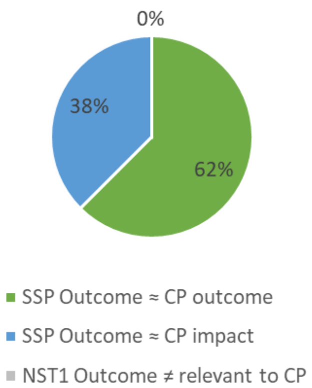


Figure 66: Alignment CP – Urbanisation and Rural Settlements

SSP U&RD → CP: The strategic plan for urbanisation and rural settlements guidance to catchment planning

- Planning liveable, well-serviced, connected, compact, green and productive urban and rural settlements with a cultural identity;
- Designating secondary cities as poles of socio economic growth;
- Integrating human settlement planning and coordination, raising awareness and making it inclusive;
- Facilitating development of affordable and social housing, and access to housing, by leveraging private investment with the help of government support schemes;
- Setting goals for upgrading of informal settlements;
- Enhancing efficiency and regional competitiveness of the private construction industry.

CP → SSP U&RD: Contributions of catchment planning to the strategic plan for urbanisation and rural settlements

- Localising urbanisation and settlements within (sub) catchments;
- Prioritising basic services and water services to new settlements;
- Assessing of IWRM relations;
- Identifying cost effective investments in water and waste related solutions;
- Supporting urban resilience with greening and water related solutions: rainwater harvesting, filtration in green areas, urban agriculture, decentralised waste management, water storage, groundwater recharge and use;
- Promoting resource efficiencies from onset;
- Developing and sharing knowledge among stakeholders.

SSP Water and Sanitation (WATSAN)

The WATSAN strategy is a sub-strategy of the infrastructure strategy. Water supply in urban and rural areas is expected to grow by almost 70% in terms of the volume of water abstracted in the period 2018-2024. On the other hand, there will be investments to improve operational efficiencies in water supply, semi-centralised sewerage systems, faecal sludge processing, and modern landfill.

High level analysis of alignment between the draft WATSAN SSP outcomes with CP outcomes and impacts shows how catchment planning is fully contributing to the main objectives of this sector (Figure 67).

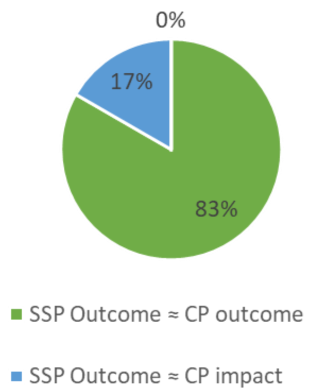


Figure 67: Alignment CP – WATSAN SSP

Access to safe, affordable water for all is a priority in all catchment plans and should under no circumstances be compromised by water demands from other users. Sanitation also depends on clean water. Storm water management and wastewater flows interact in many ways with catchment water resources. In addition, reducing water pollution through regulating solid and liquid waste disposal practices is a key focus of the catchment plan.

Provision of water for domestic consumption is the greatest priority water use in the catchment. By demanding an uninterrupted flow of high-quality water, water supply companies create a need to protect sources and ensure long-term security. Provision of a reliable supply of water helps build the 'social transformation pillar'. Good quality water is also important for health and nutrition. Supply of water can play a major role in water governance, by bringing stakeholders together around a common interest to protect water resources. Hygiene management at household level requires reducing the risk of contamination of drinking water, by preventing flooding of latrine pits or other contamination of the water supply intake.

Several factors can interrupt the safe supply of water, and catchment planning helps to identify and mitigate risks to this in relation to floods, droughts, contamination (e.g. by suspended sediments) and climate change. Such risks can be mitigated, for example by increasing storage, and/or by adding rainwater harvesting to provide water for uses other than human consumption. Mainstreaming operational efficiencies throughout the water supply network and reducing non-revenue water is also needed.

The impacts that water supply interventions have on the water resources, have been incorporated in the water allocation plans for each (sub) catchment. Collection of urban sewage and subsequent treatment of waste water before discharging into surface water, still is in its infancy in Rwanda. Modernisation in this sub-sector of WATSAN will lead to higher quantities of better quality return flows to replenish water resources.

SSP WATSAN → CP: The Strategic Plan for Water and Sanitation guidance to catchment planning

- The goal of universal access to safe and affordable water for all;
- Establishing drinking water as a priority in water allocation plans;
- Concern for the quality of water resources;
- Improving sustainable water supply service delivery through setting (consumption based) tariffs allowing for cost-recovery, capacitating managerial and technical staff, setting and monitoring design quality standards and better defining institutional responsibilities;
- Goals for safe management of solid and liquid waste;
- Promoting operational efficiencies in water supply, semi centralised sewerage systems, faecal sludge processing, and modern landfill;
- Improve storm water management in urban areas;
- Introducing Water Safety Plans as practical tool to apply IWRM in WASH;
- Promoting waste to energy, recycling nutrients and organic components from liquid and solid waste.

SSP WATSAN → CP: The Strategic Plan for Water and Sanitation guidance to catchment planning

- Giving water for domestic water supply and sanitation priority in allocating water permits;
- Imposing a target on water efficiency gains, expressed in (raw) water use per capita per day, requiring reduction of e.g. water losses as component of Non-Revenue Water (NRW);
- Matching water demand with water balance in specific (sub) catchments, to be integrated in water security plans of water suppliers;
- Operationalising urban storm water management in ways that prevent gully development, by combining rainwater harvesting, storage, and well-designed and implemented drains;
- Identifying risks from liquid and solid waste flows to contaminate the water resources;
- Integration of IWRM principles in project life cycle and rolling out IWRM tools in relation to WATSAN;
- Identifying and mitigating risks to water supply in relation to floods and droughts, contamination and climate change;
- Designing multi-use of water in rural areas, e.g. storage for consumption, irrigation of gardens and small livestock;
- Mapping of water sources for protection and contamination sources;
- Mainstreaming 'reduce, re-use, recycle across the water and sanitation chain;
- Promoting integrated thinking, e.g. through the nexus 'nutrition and water-sanitation-hygiene' (e.g. to reduce stunting) and the nexus water-energy-food security, and identify entry points for actions, such as the water-energy-food security nexus knowledge CPIP in the catchment plan programme of measures.

SSP Health

Good physical and mental health is a prerequisite for productivity and to realise one's potential. 16% of health centres are without water and 24% of health facilities are without appropriate waste management. The goal of the health sector is accessibility (in geographical and financial terms) of equitable and affordable quality health services (preventative, curative, rehabilitative and promotional services) for all.

Environmental health is related to the catchment with nature and green landscape also in urban areas. Human behaviour is key to management and protection of water resources at the household, community and catchment levels, primarily through hygiene aspects of WASH (see WATSAN SSP above) (see Figure 68) for the alignment between the CP and the health SSP).

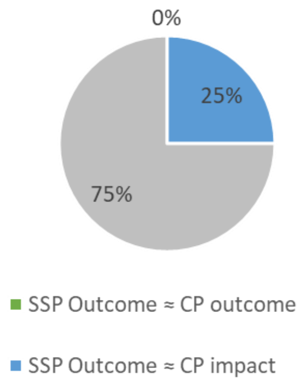


Figure 68: Alignment CP – Health SSP

SSP Health → CP: The strategic plan for Health guidance to catchment planning

- Setting a goal for universal accessibility of equitable and affordable quality health services (preventative, curative, rehabilitative and promotional services);
- Planning for roll out of health programs (improve demand, access and quality);
- Proposing stronger policies, with resources and better management for health;
- Planning to strengthen all levels of service delivery (organise the services effectively at all levels);

- Ensuring effective governance of the sector (strengthen de-centralisation, private sector coordination, aid effectiveness, and financial management);
- Planning to equip all health centres with basic services.

CP → Health SSP: Catchment plans guidance to the implementation of the Health Strategy

- Mapping and identify risks in relation to environmental sanitation: waste flows, contamination by animals, air, water in the territory;
- Offering a framework for action;
- Providing insights and programming around water-health-nutrition nexus issues;
- Prioritising water service provision and waste management of health centres;
- Providing water related environmental health risk analysis, monitoring and mitigation.

4.5 Cross-cutting area alignment

This section contains key alignment details for each relevant cross-cutting area (CCA) used in development of this catchment plan. Cross-cutting areas are also aligned with implementation strategies and translated into specific interventions 'on the ground' through master plans, programmes and projects. From vision, to policy, to strategy, to a plan with activities and assigned budgets is a continuum that ensures the realisation of said vision.

Traditionally within IWRM, and within the scope of Water for Growth Rwanda, two cross-cutting areas are considered of prime importance: Gender and climate change mainstreaming. These are among the CCAs listed in the NST1, and are briefly discussed alongside other catchment plan-relevant CCAs in sections below, and in more detail in Annex 10 and Annex 11.

4.5.1 Gender

A gender and family promotion approach are enshrined in the NST as a CCA to be mainstreamed in all sector strategies, policies and programmes. The CCA of gender is led by MIGEPROF. IWRM also identifies gender as a cross cutting theme of prime importance, women being 52.5% of the total Rwandan population and key actors in water usage, supply and management. The IWRM Gender strategy (W4GR TR10, 2017) recommends ensuring equal access and participation, control, women's empowerment and equitable benefits from the water resource programme of measures.

Four priority areas for informing gender mainstreaming in the catchment plan have been selected based on existing global commitments (Sustainable Development Goal 5 (SDG 5), CEDAW, Beijing PfA, regional (NEPAD, EAC 2050), and National medium and long-term strategies (especially the National Gender Policy and Strategy, Sector gender mainstreaming strategies in agriculture and infrastructure, the IWRM gender strategy and gender profile reports and NISR, EICV4 Thematic Report on Gender). The priority gender mainstreaming strategies in the catchment plan are:

- Strategies to enhance equal participation of women and men in planned measures;
- Strategies to enhance empowerment of women;
- Ensuring equitable benefits from water resource management and productivity;
- Gender transformative strategies to alleviate unequal power relations within households and for reduced unpaid work.

These priority areas were paralleled with the aspirations of the new Vision 2050 and in line with the NST1, to increase women's access to economic opportunities and valuing their unpaid work by ensuring that gender equality is mainstreamed in all productive sectors. In that regard, attention will be given to strategies so that they:

- Ensure women and men are full participants in IWRM measures and take part in water governance within the catchment;
- Equitably address strategic and practical gender needs of all water user's groups and special needs in catchment implementation plans and projects;

- Ensure effective implementation of actions under these priorities in Districts; this catchment plan will be aligned with District Development Strategies and SSP in terms of gender specific actions following key guidelines (Annex 10);
- Facilitate inclusion and support gender responsive land use planning and management processes for improved and sustainable land use;
- Improve access to hillside irrigation in dry areas for value chains that include a high number of women, reduce the number of households depending on firewood as a source of energy for cooking from 83.3% (2014) to 42% by 2024, promote rainwater harvesting and improve safe water supply and sanitation, promote alternative HH income sources in terms of off-farm projects and incentives for ecosystem services, gender sensitive training initiatives for increased farmer resilience to drought and climate change, affirmative actions on women headed households.
- Accountability for gender equality in CP will be enhanced through institutionalisation of sex disaggregated targets and results across key Sector Strategic Plans, harmonisation of gender budget statements (GBS) with IWRM gender strategy with the aim of achieving gender parity and equity across key IWRM sectors by 2024.

Gender mainstreaming in the catchment

The methodological approach has used the gender analysis of roles and social relations within the four catchments. In the assessment, at least two sub-catchments were sampled in each catchment, for qualitative data collection to support the analysis. The data collection included Focus Group Discussions (FGDs), consultation meetings, problem tree (participatory approach) work, and in-depth interviews with the water users and key stakeholders. This primary data was synchronised with a literature review and previous analyses of the gender equality situation in the water/agriculture and environment sectors in Rwanda. An overview of relevant gender literature is included in the references section of this report.

An overview of the results of focus group discussions with women and with men in the catchment (October 2017) is provided in Table 22.

Table 22: Results of women and men focus groups for gender mainstreaming

<table>
<tr><th colspan="2">Women’s group</th></tr>
<tr><th>Issues/constraints</th><th>Solutions</th></tr>
<tr><td>- Soil erosion impact: poverty and vulnerability affect women severely as they are primarily dependent on natural resources;
- Limited access to domestic/drinking water leads to health issues;
- Long distance from water sources in valleys presents challenges for livestock in zero grazing areas;
- Limited capacity to afford modern RWH tanks affects domestic water supply;
- High population density;
- Inadequate sanitation in households;
- Scarce firewood: 1500 Rwf/bag of wood, 6500 Rwf per bag of charcoal;
- High population density pressure on farmland and forest/water.</td><td>- Terracing;
- Create opportunities for off-farm jobs for small-scale women farmers;
- Improved water supply near households;
- Support farmers to afford the cost of RWH tanks;
- Housing in settled model villages, improved fuel saving cooking stoves and model sanitation;
- Address unequal division of unpaid labour in farm and water related activities;
- Gender and family planning as part of IWRM Farmer Field School (FFS) curriculum.</td></tr>
<tr><th colspan="2">Men’s group</th></tr>
<tr><th>Issues/constraints</th><th>Solutions</th></tr>
<tr><td>- Limited forest cover and wood resources;</td><td>- Increase number of tree nurseries per cell;
- Reforestation of degraded forests;</td></tr>
</table>

▪ Soil erosion impact on crop yield and water quality (rivers), Rutare; ▪ The water sources are very far from people's homes near the valleys and people mostly stay in the top hill area; this presents challenges for farming during dry seasons and an issue for livestock watering (Mwange); ▪ Low water productivity for agriculture due to drought (Muvumba U&L); ▪ These alternate with the floods in the tea plantations.	▪ Support for terracing; ▪ Improve clean water connectivity near villages; ▪ Support for improving locally made rainwater harvesting tanks (RWH); ▪ Hillside irrigation model; ▪ Alternative income source for adaptation; ▪ Small scale irrigation for value crop production, ponds and other methods; ▪ Support tea cooperatives to increase the green tea yields through flood mitigation.

The Muvumba catchment faces fierce seasonal droughts, leading to water conflicts between livestock and irrigation. The issue to be tackled here is the affordability of rainwater harvesting tanks or structures. Training water users in RWH taking into account their livelihood status and purchasing power will enhance access to domestic water and water for livestock, which is expected to bring leverage in the division of labour among spouses. Support to farmer cooperatives, inclusive of women, is needed for them to afford small-scale irrigation infrastructure and for efficient and increased water productivity, which contributes to a gender balanced approach to drought resilience.

In order to respond to these issues, the implementation of the Catchment Plan will be considerate of the gender dimension. Incentives for equal involvement of women and men in the implementation of the programme of measures are important. Women should take part in decision making within established water structures (WUA, CTF) (UNDP, 2006; W4GR TR10 and TR50, both 2017). Furthermore, skills transfer must use gender sensitive methods, in the form of learning by doing, e.g. at farmer field schools (FFS). Methods from the Gender Action Learning System (GALS) can be applied on topics of IWRM measures to include men but also women involved in unpaid employment (Cleaver F., 2000).

For equity purposes, business incubation for women and youth, and the inclusiveness of investment projects will also be required to guarantee equitable opportunities to raise, and benefit from, water productivity. Based on gender roles, the program of measures responds to different needs, therefore, the needs of groups with special needs will be addressed as indicated in the gender guidelines (Annex 10). The Catchment Plan Implementation M&E team will be equipped with the necessary knowledge for effective monitoring of gender indicators and collection of sex-disaggregated data, to allow measurement of the gender impact.

Gender mainstreaming proposed interventions in the catchment

The proposed gender-IWRM aligned implementation projects include, but are not limited to, a gender focused drought resilience project through small-scale irrigation demonstration. Besides, gender add-ons are mainstreamed in the Packages' concept notes and CPIPs for Muvumba catchment.

As the catchment includes a part located in the hills of Gicumbi, where erosion is a threat to livelihoods, incentives in the form of temporary paid jobs for catchment restoration, or permanent employment in catchment maintenance, will contribute to ensure resilience for landless families and small-holder farmers. In upstream and downstream Muvumba, livestock development and the milk value chain are key drivers. Watering livestock responds directly to the needs of men, as they have the responsibility to care for cattle ranches. Muvumba is characterised by larger farm sizes and has a high potential for market-oriented agriculture in mono-cropping (maize and banana and livestock). It is strategic to work with women's groups to empower them, but it is equally necessary to build actions that encourage both men and women to cross gender boundaries and overcome barriers which prevent their participation in IWRM measures as individual farmers, and which help them to better access the large agribusiness opportunities. The

Catchment Task Force (CTF) will be equipped with the necessary knowledge for effective monitoring of CP implementation of the gender perspective at household and community level.

4.5.2 Environment and climate change

Rwanda protects its environment through several environmental laws and regulations, captured under the Environmental Organic Law (2005), currently under revision. Climate change is addressed primarily in the Green Growth and Climate Resilience Strategy (GGCRS) (2011), and the Intended Nationally Determined Contributions (INDCs) that represent Rwanda's international efforts at combating climate change. Four priority areas for environment and climate change mainstreaming have been selected by the Government of Rwanda, based on existing global (Sustainable Development Goals (SDGs), Paris Agreement), regional (Agenda 2063, EAC 2050), and national medium and long-term strategies (especially INDC/GGCRS). Priority sectors are:

- Sustainable agriculture;
- Sustainable urbanisation;
- Sustainable industry, and;
- Sustainable Energy.

These priority areas will be developed in line with aspirations of the new Vision 2050 to improve quality of life by:

- Progressing mainstreaming of environment and climate change;
- Reducing vulnerability to climate change; and
- Preventing and controlling pollution.

In November 2015, Rwanda submitted its own INDC for COP21, presenting its vision and commitment on climate change adaptation: "Rwanda's long-term vision is to become a climate resilient economy, with strategic objectives to achieve Energy Security and a Low Carbon Energy Supply that supports the development of Green Industry and Services; Sustainable Land Use and Water Resource Management that result in Food Security, appropriate Urban Development and preservation of Biodiversity and Ecosystem Services, as well as to ensure Social Protection, Improved Health and Disaster Risk Reduction that reduces vulnerability to climate change impacts".[39]

Rwanda's INDC represents the most complete and comprehensive overview of actions to safeguard its environment against the effects of climate change; these intended contributions are also used to provide direction on climate mainstreaming in the Water for Growth Rwanda catchment plans. The following paragraphs provide some background on Rwanda's INDC, and the approach to mainstreaming of climate change in the catchment plans.

As Rwanda is not historically a large emitter of GHGs the approach described in the INDC focuses mainly on adaptation to, and development of resilience against climate change. The INDC consists of eight separate Programmes of Actions (PoAs), each with specific actions. The PoAs were first presented in the report 'Green Growth and Climate Resilience Strategy (GGCRS) (REMA, 2011). By mainstreaming these PoAs into Water for Growth's interventions (from feasibility study stage onwards), the programme attempts to practically assist with implementation of the INDC and help achieve its vision and commitment. An overview of Rwanda's INDC is presented in Annex 11, providing an overview on governmental focus regarding climate change.

[39] Rwanda's submitted INDC for COP21, Paris: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Rwanda/1/INDC_Rwanda_Nov.2015.pdf

4.5.3 Other cross-cutting areas

Capacity development

Capacity development is at the core of Water for Growth Rwanda's support to introduction of IWRM in Rwanda. Besides a series of technical trainings, such as in SEA and water balance modelling, the process of development of this catchment plan was largely a learning-by-doing exercise, in which the required capacities were developed gradually among the stakeholders involved in the process. The capacity development will also continue over the course of the years 2018-2024, during which the catchment plan will be implemented. Partly, this will continue to follow a process of learning-by-doing (often the most effective capacity building instrument), and partly by the implementation of several knowledge management interventions (referred to as *knowledge CPIPs* [40] later in this catchment plan). A detailed capacity building plan will be developed under W4GR, to address capacity needs of the catchment task force. Some trainings or other knowledge CPIPs can be funded from the knowledge management (including training) budgets of W4GR. Needs that cannot be met within the currently available budgets will be addressed within the overall approach to obtain funds for implementation of the entire Programme of Measures of this catchment plan. Chapter 5. (Implementation arrangements) of this catchment plan provides more details on the approach to be followed.

The CCA of Capacity Development's key strategies informing the catchment plan takes into account the domestic targets and indicators for international and regional organisations signed by Rwanda, such as the African Union agenda 2063, the East African Community 2050 goals, and the SDGs. The key element of this CCA is to identify skill gaps at sector/district level to be bridged through an employability skills development program.

The following specific actions are required to address those skill gaps, in order to enhance capacities in IWRM and catchment planning. Many of these will also benefit development in related fields:

- Enhance capacities in geo-information management and development of maps to support spatial planning through strong capacity (and best practice) development across the board in all central and local government institutions involved in any type of spatial planning;
- Improve catchment water balance modelling skills at central level, and introduce these at the level of catchment offices;
- Enhance hydrologic and hydraulic modelling and assessment skills among private sector and government;
- Enhance flood and drought risk assessment and management skills at national and catchment level;
- Develop skills and experience among private sector and the government, in developing applications for water permits and the assessment thereof, on hydrologic and hydraulic parameters;
- Continue to develop capacities for catchment planning and catchment management;
- Continue to improve and spread participatory and adaptive catchment planning;
- Introduce integrated nexus thinking and assessments, such as for the water-energy-food security nexus, the nexus ecosystem-economy, and the nexus water-health;
- Enhance capacities in the banking sector as well as private sector and the government, on financing interventions in the catchment, including nature-based innovative business models;
- Improve skills and tools for financial planning for catchment plan implementation and catchment management in general;
- Develop understanding of the scalability of IWRM concepts, from household or company level up to transboundary collaboration;
- Develop skills to assess, monitor, and improve water productivity;
- Enhance skills and improve willingness / attitudes across the Government of Rwanda, to adopt IWRM and catchment plans as multi-sector coordination and prioritisation instruments;

[40] CPIP: Catchment Plan Implementation Project. See Annex 2, Glossary of terms, and Chapter 4. , Programme of Measures.

- Enhance capacities of government and stakeholders to implement IWRM and catchment plans, through improvements in water governance and catchment governance regulations and institutions (e.g. through the new water law and establishment of the permanent Catchment Committee and Catchment Office / permanent catchment secretariat.

Several of the capacity needs mentioned above will be addressed in the W4GR capacity building plan for the catchment and national levels. Subject to available budgets and expertise, a selection of these will be implemented in 2018-2019. Remaining items may be incorporated in subsequent Annual Implementation Plans and budgets, as Knowledge CPIPs of this catchment plan.

ICT

A key cornerstone of capacity development in Rwanda is information and communication technology (ICT). ICT is at the core of modernisation in IWRM and catchment planning. Hardware such as smartphones, tablets and computers have innumerable options to boost information sharing and communication. Geographical information systems and knowledge portals are useful for planning, communicating and learning about IWRM in the catchment. Smartphones are used for geo-referenced socio-economic surveys. WhatsApp groups can be employed to share information on water use, floods and other water related disasters and otherwise informative messages on hygiene or markets, while apps can be used to track flooding patterns in the area. Furthermore, smartphones with geo-referenced information are revolutionising SME businesses, WASH management and agricultural value chains.

Spatial information about natural resources in maps gives insight into what is where. Updated satellite maps can give real time analysis of droughts, floods, deforestation or crop health. The data collection can be centrally monitored and collected for analysis. Rwanda's reliable energy and network coverage makes it possible to plan with ICT across the country.

Rwanda recognises that a "knowledge-based economy" requires high-quality production, distribution and use of knowledge and information. Although ICT is not listed at the CCA in the NST1, the ICT Policy and Smart Rwanda Masterplan as well as sector specific ICT strategic plans like the ICT 4 Agriculture Strategic Plan (2016-2020) underline the importance attached to ITC.

ICT in catchment planning is used for:

- monitoring (weather, climate, natural resources stocks and flows);
- modelling (climate scenarios, water balance and water allocation);
- data analysis and overlay of different thematic maps;
- electronic payment;
- information services;
- (social) marketing;
- social mobilisation for natural resources;
- optimising industrial processes and logistics.

Catchment planning and IWRM are data-driven processes. Automated measuring of water flows and quality renders real time data necessary to get a deeper understanding of the dynamics in water systems and to design appropriate actions (e.g. drainage). This is true for early warning systems, water balance models, water quality and specifically for groundwater.

Information is also essential for disaster management, agriculture, water and sanitation and natural resources in general. The costs of obtaining the information (satellite images) are relatively low and often lower than the costs of not having the information. However, upfront high investments are a barrier. ICT and disaster management are linked through insurance systems. For example, Rwanda Society Insurance (SORAS) Company had insured a total of 15,000 farmers (2013) through the Kilimo Salama (safe agriculture) weather index insurance project.

The use of maps, Google Earth, modelling and apps opens an exciting terrain for the officers in the field. At decentralised level, professionals often express their wish to learn more about using GIS, modelling and the use of Google Earth. During the catchment planning process, especially women have expressed the wish to access information portals to know more about water management.

As stated above, the CCA of Capacity Development's key strategies informing the Catchment Plan takes into account the domestic targets and indicators for international and regional organisations ratified by Rwanda, such as the AU agenda 2063, the EAC 2050 and the SDGs. Observations:

- It became apparent during the development of this plan, was that information management and development of maps to support spatial planning requires strong capacity and best practice development across the board in all central and local government institutions involved in any type of spatial planning.
- This observation on lack of common best practice in the development, use, and sharing of (thematic) maps holds importance for two of the NST1's sectors, namely that of ICT and of Education. The ICT sector should pay ample attention to the development of a skilled work force, capable of developing Management Information Systems, Spatial Data Infrastructure, and GIS applications. The maps and data analysis that would follow from these can in turn be used in the education sector, to enhance the knowledge levels of teachers, pupils, and students on the natural and social environment that they live in. This catchment plan makes a start for the inhabitants of the catchment, by providing a thorough characterisation of the catchment and its sub-catchments in maps, tables, and graphs. The key maps will moreover be made available at a larger scale in the Catchment Atlas. This can be used at schools and universities, in parallel with the daily utilisation by those involved in implementation of the catchment plan.

Regional integration

Rwanda is located upstream in the Congo and Nile river basins. Therefore, any changes in water use in Rwanda will be felt by water users downstream along the river. International water diplomacy deals with the water related issues in the international arena. Agreements about coordination around water resources, including joint ventures in large-scale investments, such as in hydro-power, will become more important due to population growth, climate change, and economic development in the river basin. The same holds for water quality; information increasingly needs to be shared internationally, e.g. for early warning in case of high levels of contamination flowing down the river system. This will allow downstream users lead time to temporarily shut down raw water abstractions for drinking water, or users that would be otherwise negatively affected.

The CCA of Regional integration key strategies informing the Catchment Plan are the following:

- Regional Integration in water management is institutionalised in the Nile Basin Initiative and supported by the programme NELSAP. The Environment and Natural Resources Strategy plans for functional governance frameworks in all cross-boundary catchments by the end of 2024;
- Strategic decisions about the regional economic specialisation can be expressed in a certain water footprint. The NST1 focuses on developing a service-based economy, including services in the field of tourism (including business tourism), finance, ICT, logistics, as well as a knowledge-based economy;
- The Strategic Plan for Agricultural Transformation PSTA 4 aims at increasing export and import of forestry and agricultural products. These trade flows will largely take place in the regional market and cross border trade. The embedded, or virtual, water that was used in the production and transportation of the imported or exported products needs to be considered when assessing and managing the national water footprint[41] and national and catchment scale water and food security (key elements of the water-energy-food security nexus).

[41] http://waterfootprint.org/en/

Disaster management

Disaster Risk Reduction and Management (DRM) is a CCA to be mainstreamed into all development sectors of NST1, including agriculture, infrastructure, environment and natural resources, energy, urbanisation, and social protection. The key document for this CCA is the National Disaster Management Policy (2012). The NST1 sectors will mainstream enforcement strategies and legislation to provide people-centred early warning systems, and effective disaster prevention, preparedness, and response mechanisms. This is specified in disaster management plans prepared by the Ministry of Disaster Management and Refugee Affairs (MIDIMAR). Catchment planning pays attention to prevention, by well-informed spatial planning, to minimise flood risk, landslides, drought-related risks, etc., and to knowledge management and institutional development to cater to early warning systems, preparedness, and response mechanisms. The catchment plan and its knowledge products can be used to enhance the capabilities of insurance companies to improve the insurance packages they can offer, to reduce the impacts of disasters on the livelihoods of people in the catchment.

The main natural hazards in Rwanda, identified by the National Disaster Management Policy (2012), are floods, landslides and mudflows, volcanic activity, drought, food insecurity, earthquakes, fires, and epidemics. Floods can be caused by river or flash floods and can have particularly high impact in built-up areas. Droughts and floods inflict high costs, and cause disruption of economic and social life. MIDIMAR tracks the damage of disasters. The policy seeks to establish the guiding principles and institutional architecture for disaster risk management. The goal is to increase the resilience of public and private sectors including vulnerable groups to disasters.

Flood and drought risk maps are an important input for catchment plans and guide the development of land use zoning plans. Where was the flood, when, what was the damage? Where do the water and sediment come from? What are the underlying causes? The data on the damage (physical and human) give an indication of the value of flood management interventions. Outbreaks of diseases are often related to water management issues in the catchment. The information can be analysed at catchment level and inform the design of an appropriate mix of activities.

Drought scenarios must take into consideration price effects due to failed harvests. Higher prices of basic commodities and agricultural products impact disproportionally on the most vulnerable population.

Hazard event maps developed by MIDIMAR offer rough indications of which areas suffer most from disasters. For flood protection, more detailed risk maps need to be prepared. The recommendation from the National Risk Atlas (2015) in relation to floods says: “The data needed are: (i) High temporal resolution (precipitation) data of a long period that can help the estimation of different intensities, durations, and frequency, (ii) High resolution data on land cover, (iii) Soil’s hydraulic properties, (iv) River profiles or sizes, and (v) Calibration data like discharges.”

Demographic pressure has led more people to live in flood plains or in areas prone to landslides. Poor land-use planning, environmental mismanagement and a lack of regulatory mechanisms increase the risk and exacerbate the effects of disaster. The data on Rwanda’s disaster situation of October 2017 showed that 128 ha of crops were destroyed in 2017. Catchment planning will therefore integrate preventive measures of disaster management like zoning and early warning through awareness campaigns to help build resilience among the population.

It is important to distinguish the difference between disaster management as practised by MIDIMAR and integrated flood management as promoted by IWRM in the framework of catchment planning. IWRM takes a more structural approach to integrated flood management, such as long-term planning of hard and soft interventions to reduce the flood risk to private and public property. As such, integrated flood management and disaster management complement each other.

IWRM

Catchment planning uses a holistic IWRM approach. That means that it looks at interaction between the different water users and at the resources availability and aims to match supply and demand for all users, including natural ecosystems and future inhabitants of the catchment and those upstream and downstream of the catchment, in a sustainable manner. IWRM has not (yet) been included in the NST1 Cross Cutting Areas, but it would be important to do so.

Tangible benefits of mainstreaming IWRM in the catchments are:

- Reduction in misallocation of funds;
- Reduction in stranded assets;
- Better protection of the precious water resources for long-term development;
- Optimisation of water productivity (higher added value per drop);
- Creation of synergy by planning for multipurpose projects;
- More actions to reduce water use; increase water retention; reuse; recycle; recharge;
- Reduce operational costs (e.g. for water treatment);
- Better protection of the water related nature / natural or green capital;
- Improvement in water quality;
- Reduction in disruption and related damages and loss of life (e.g. through water related disasters);
- Avoidance of conflicts between water users.

A draft IWRM mainstreaming guideline has been submitted to MINECOFIN for consideration in the near future.

4.6 District Development Strategies (DDSs)

Districts are obliged to align their development strategies with the strategic framework of NST1, and the SSPs and CCAs contained therein. DDSs provide a concretisation of sector strategies into tangible projects. Districts within Muvumba catchment should furthermore align their DDSs with the catchment plans and water related projects should be included in the CP programme of measures of the catchment plan, and vice versa.

All districts that jointly compose Muvumba catchment mention IWRM aligned strategies in their DDS. These are outlined under the cross-cutting area of “environment and climate change” and in other strategic priorities related to “increasing agriculture productivity” and “the Modern Rwandan household”, whereby all DDSs guarantee to achieve the national target of 100% HH access to clean water by 2024 (SSP Infrastructure target). Most water related interventions are under the priority component of the environment sector in the DDS, which is directly aligned to the NST1/SSP “Sustainable Management of Natural resources and environment to transition Rwanda toward a Carbon Neutral economy”. Some key IWRM/CP aligned interventions match with either outcomes, or outputs of DDS identified strategic priorities and conversely, DDSs integrate many of programme of measures in the catchment plan. The updated 3rd draft DDSs don’t, as yet, include IWRM as an individual cross-cutting area. Section 4.6.1 highlights interventions in the draft DDSs of Muvumba districts (Gicumbi, Nyagatare and Gatsibo)

4.6.1 DDS highlights

Highlights DDS Gicumbi

Gicumbi DDS mentions the IWRM among its key cross cutting areas, demonstrating a positive level of understanding about, and the importance of, IWRM by the district team. The district’s comparative advantages are strongly aligned to the CP/drivers identified by the DPSIR (section 2.2, chapter 2.).

Gicumbi DDS plans for the following priority interventions:

- Rain water harvesting by household tanks and dam storage construction;
- Sustainable land use for enhanced food security;

- Rehabilitation of 300 ha tea plantations in Rushaki, Kaniga, Mukarange, Shangasha, Byumba, Nyankenke, Rubaya, Manyagiro, Cyumba and Miyove sectors;
- Horticulture promotion on 360 ha;
- Recreation centre at Muhazi belt;
- Construct sewage and wastewater treatment systems;
- Introduction of hill slope farming technology that reduces erosion and flow of sediments in the surface water.

Again, this demonstrates that the Gicumbi DDS includes some of the same measures planned for Muvumba catchment, namely:
- Expand the area under terracing;
- Promote understanding of ecosystem changes and impacts (disasters, climate change, mitigation of impacts of land use changes and infrastructure development;
- Strengthen community education and awareness for conservation (using local media);
- Establish a good system of waste management;
- Effective private sector engagement;
- Tea value chain promotion, and;
- Rainwater harvesting by household tanks and establishment of dam storage.

Highlights DDS Nyagatara

Nyagatare DDS identifies among key development drivers' tea and livestock milk value chain which are identified by the DPSIR among key catchment drivers. Nyagatare is among the six secondary cities and therefore, District priorities include the development a green city urban master plan.

Nyagatare DDS plans for the following priority interventions:
- Rain water harvesting by household tanks and dam storage construction;
- Enforcement of proper land use and implementation of layout master plans;
- Feeder roads network rehabilitation and development;
- Development of Muvumba river side;
- Construction of processing plant at each mining site;
- Increase area under irrigation from 18 200 Ha to 27 200Ha (Karangazi, Rwemasha, and Nyagatare);
- Construction of 10 Valley Dams in Katabagemu and Rwimiyaga;
- Training and strengthening of Water Users Organisations in the irrigation schemes;
- Construction of a multipurpose dam;
- Modern irrigation;
- Akagera buffer zone development;
- Creating 3,000km of progressive terraces from 1,240Km;
- Rehabilitation of 1,240Km of progressive terraces;
- Creating 1,000Ha of radical terraces from 300Ha;
- Tree plantation;
- Resettlement of HH from high-risk zones to IDP model villages in Rwabiharamba sector; and,
- Mobilisation of heads of households to use cooking gas, cooking stoves, and biogas.

This demonstrates that the DDS includes some of the same measures planned for Muvumba catchment, namely:
- Expand area under irrigation;
- Effective private sector engagement;
- Capacity building of WUA; and
- Muvumba river bank protection etc.

Highlights DDS Gatsibo

Gatsibo DDS plans for the following priority interventions:

- Modernised mechanisms for combating erosion. This is treated as a cross-cutting program combined with the housing sector. For the latter, each building must have a core system of retaining rainwater, and ensuring environmental and natural resources management by increasing the number / area of radical terraces, ditches and area under forestry (increase of agro-forestry and forest);
- Hotels and other tourism activity around Muhazi Lake;
- Off-grid solutions, such as Solar PV and micro-hydropower;
- Increasing the availability, accessibility and affordability of improved cook stoves, like rondereza and canarumwe, that considerably reduce firewood use;
- Construction and rehabilitation of water supply system to ensure 100% access to clean water and sanitation by HHs, as well as improving the functionality of water supply systems;
- Adoption of land use planning and mapping specifically to develop the district land use master plan and training of district officials in GIS and Land Use Planning, and;
- Connection with the national Land Administration Information System (LAIS).

This demonstrates that the DDS includes some of the same measures planned for Muvumba catchment, namely:

- Expanding the area under Small Scale Irrigation (SSI);
- Effective private sector engagement;
- Improving exploitation of quarries to ensure that it is done in environmentally friendly manner;
- Expanding forest coverage;
- Mainstreaming Environmental Impact Assessment policy;
- Increasing awareness on / of environmental issues, and;
- Capacity building of male and female youth in entrepreneurship.

To achieve this, emphasis will be placed on implementation of Vocational Training Centres (VTCs), technical vocational education and training (TVET) and informal education centres.

Annex 5. NWRMP MUV observations and conclusions

The National Water Resources Master Plan (MINIRENA, 2014) identified a series of issues and observations for each level 1 catchment and translated these into conclusions and recommendations. These were used as input for this catchment plan in the scoping phase and reflected in the overview of issues and opportunities for the catchment, and in the DPSIR analyses. Priority recommendations were incorporated in the programme of measures and priority CPIPs for the first Annual Implementation Plan[42].

The main observations and conclusions on the Muvumba catchment were:

- There is a marked differentiation of land resources between the west and the east. The west has good, deeply weathered soils with rather high infiltration rates in narrow valleys with steep gradients. There is significant erosion, which is related to land use, in particularly agriculture. The east has poorer soils on undulating hills intersected by river valleys of the Muvumba River and its tributaries with much richer soils. The Muvumba River is rather small (5 to 10 m wide) in a large floodplain;
- Medium to high rainfall with a relatively short dry season in the west and significantly lower rainfall with more pronounced dry seasons in the east (Mutara);
- Significant surface flow generated from the Mulindi catchment (NMUV_1) in Rwanda, which then flows into Uganda for about 50 km, traversing significant extents of marshland near Kabale, to finally return as the Muvumba River in Rwanda. The upper reaches of the NMUV_2 catchment (Gicumbi district) also generate significant surface flow. The entire northern part of the catchment is transboundary with the Kizinga River and then the Muvumba forming the border between Rwanda and Uganda;
- Significant groundwater reserves that are accessible in the west (where it seems less needed) and from alluvial deposits in the main river valleys in the East;
- Population to double from 0.6 million to 1.3 million, urban population scheduled to grow from less than one hundred thousand to half a million;
- Difficult (east) to very difficult (west) accessibility outside of the main roads (axes - Kigali - Gicumbi - Gatuna and Kayonza - Gabiro - Nyagatare and Kagitumba plus some secondary roads linking Gicumbi with Nyagatare and Gabiro;
- Current level of water use is low (registered use at 5.5 percent of renewable resources which is the highest level for the country; current demand estimated at slightly above 12 percent);
- Adjusted water balance for the Muvumba catchment up to 2040 has been reduced as regards the irrigation from surface water because dry season resources are insufficient for that development by 2040. The current irrigation development in Musheli sector (400 ha) has been maintained. Other essential demand and presumably viable commercial ventures can be developed with occasional restrictions and minimising allocations for environmental requirements during less abundant hydrological years. It is further recommended that particularly water intensive industries be relocated and or develop in other catchments.

Necessary developments and recommendations are:

- Water supply services in the rural domain is still insufficient for a variety of reasons including poor planning, inadequate investment, limited exploitation and repair, resources decline, low population density and inadequate service solutions. The development of a catchment-based water supply plan is highly recommended. The study for the improvement of the Rural Water Supply in Rwanda by JICA (2008 - 2009) covered seven districts of the Eastern Province and therefore most of the upper and lower Akagera catchments and part of the Muvumba catchment. The report is very commendable and useful but as the title states, it is limited to i) district boundaries, which thwarts the finding of catchment based least cost solutions, and to ii) rural water supply which is only part of the water demand and reduces the perception on the optimum allocation of limited available resources. The recommended approach is based on exhaustive identification and assessment of demand areas and service volume (comprising rural, urban, industries, administration, and other known water demand), identification of supply

[42] Note for the summation below; where EWSA is mentioned its drinking water tasks have in the meantime been transferred to WASAC.

locations and zoning of adequate least cost services (spring - borehole - gravity pipeline - pumped pipeline - rainwater harvesting) considering exploitation and investment costs (in this order). The planning exercise should apply GIS software with DTM layer and automation of dynamic height from source. While the district is not a sound basis for water management planning, all districts of the catchment should be fully implicated in the development of the catchment water supply plan and they should derive from it for the formulation of their district development plans;

- Water supply services in the urban domain seems more or less satisfactory for most of the urban centres of the catchment. The district survey allowed to make a list of emerging urban areas with insufficient supply that need to upgrade to an 'urban' water supply status. With respect to planning, EWSA service is responsive but not yet proactive. The water supply planning for urban areas should be integrated in the catchment-based water supply plan specified above;
- Urban sanitation is a growth sector aiming at 50% of urban water supply being centrally collected and treated by 2040;
- Water requirements for industry, mining, coffee washing stations, livestock and non-hydropower power plants should be integrated in the catchment-based plan specified above (under rural demand). Any opportunity in these domains should be pursued making sure they are operated in a socially and environmentally sustainable manner. The application for a water permit at RFWA-IWRM for any significant intervention in the natural hydrological cycle in combination with an EIA study under control of the RDB and monitored for compliance by REMA, will further the aspired sustainability;
- Water supply for livestock can be viably generated from rainwater harvesting and is in that format ideally suited to complement the 'one cow - one family' concept. It is recommended that MINAGRI / RARDA investigates this option and promotes it. The cost for dedicated water supply systems for livestock watering in livestock intensification zones in the catchment is integrated in the catchment investment plan;
- Notwithstanding major investments in the irrigation sector, rain fed agriculture and livestock production remain the mainstay of the catchment's agricultural production. The protection of the catchment's land resources is a huge priority. Appropriate land-use (when needed by readjustment of land use), erosion protection by radical and bunch terraces and other protective measures must remain the focus for the future of the catchment;
- With respect to the irrigation sector, the renewable resources of the catchment are insufficient to support all possible commercially viable developments. For each irrigation mode the recommendations are specified below;
- Water supply from irrigation ponds is endorsed. Further research and additional training of farmers in the use of the ponds may raise the profitability at the family level;
- The catchments renewable resources are insufficient for the full development of the potential area of 26,000 ha for dry season marshland irrigation. The development of this domain is nevertheless supported on condition of the development of a series of 4 larger storage reservoirs with a combined storage capacity of 34 MCM that carry over surface flow from the wet to the subsequent dry season;
- The catchments renewable resources are insufficient for the development of hillside irrigation from surface water. The currently developed area of 400 ha in Musheli sector can be maintained if the Muvumba dry season flow is sufficiently regulated by storage capacity (see previous point);
- Irrigation from dams. This development allows to carry over resources from the wet season to the dry season and therefore not only supports irrigation, but also dry season environmental flow and it provides opportunity for reuse. All 9 dam sites in the catchment are endorsed. All dam development should be geared to the maximum inter seasonal storage capacity even when the command area to be irrigated may require less. The development of the two reservoirs in the Mulindi catchment has lower priority;
- Small hydropower is of interest for the catchment and a number of interesting sites is under study.

In order to manage the catchment adequately from its current condition (hardly any water use), to the 2040 situation (use of 25 % of the renewable resources), a number of miscellaneous measures are proposed:

- Monitoring of rainfall resource and general climate data;
- Monitoring of surface water quantity and quality;
- Monitoring of groundwater quantity and quality;
- Monitoring of users' interventions in the natural hydrological cycle;
- Development and use of a dedicated water management information system;
- Formulation and introduction of a permit system for water use interventions;
- Installation of a decentralised catchment water management office reliant on the RWFA-IWRM.

Annex 6. Infrastructure, institutional and knowledge measures

Table 23: Infrastructure measures

ID	Type[43]	Title	Scope	Sub-catchment	DPSIR[44] level	Lead & support entities
NMUVP0001	IP	Implementation of Land husbandry techniques	Land husbandry interventions.	A. Warufu	D P	MINAGRI, RAB, Nyagatare District
NMUVP0002	IP	Sustainable watershed Resources Management	Buffer zones restoration and protection along Muvumba & Warufu; Agroforestry and fruit seedlings plantation; Distribution of rainwater harvesting facilities to HH.	D. Muvumba Upstream	D P	RWFA, Gatsibo, Nyagatare Distrcts
NMUVP0003	IP	Expansion of marshlands irrigation development	Consider add-on IWRM principles.	Multiple	D P	MINAGRI, RAB and Nyagatare District
NMUVP0004	IP	Early warning capability for drought & food shortage	Mitigate climate change consequences, implement the programme of actions under the green growth and the climate resilience strategy.	Multiple	D P I	RWFA, MOE
NMUVP0005	IP	Upgrading, extension and rehabilitation of water & sanitation network in Nyagatare secondary city	Water supply and sanitation. Consider IWRM add-on.	Multiple (A. Warufu, C. Ngoma, D. Muvumba Upstream, E.	D P	MINIRENA, WASAC and Nyagatare District

[43] Types: IP/IP+/CPIP

[44] D = Driving forces; P = Pressures; S = States: I = Impacts; R = Responses

ID	Type[43]	Title	Scope	Sub-catchment	DPSIR[44] level	Lead & support entities
				Muvumba Downstream)		
NMUVP0006	IP	Buffer zones restoration and protection alongside the rivers	Buffer zones restoration and protection alongside Muvumba, Warufu and Mulindi and their tributaries; Agroforestry and fruit seedlings plantation; Distribution of rainwater harvesting facilities to HH.	Multiple	D P	MoE, RWFA, Gicumbi, Gatsibo and Nyagatare Districts
NMUVP0007	IP	Study ground water for domestic, livestock and SSI	Diversify the source of water.	Multiple	D P	RWFA, RAB, Nyagatare District
NMUVP0008	IP	Promote the use of alternative sources of energy (hydropower, biogas, solar, etc)	Reducing pressure on natural resources.	Multiple	D P I	RWFA, REMA, Gicumbi, Gatsibo and Nyagatare Districts
NMUVP0009	IP	Ruboroga1 (Kaniga) water supply system (pumping station, reservoirs, pipes network, power line, etc)	Increasing access rate to clean water; Consider IWRM add on.	B. Mulindi	D P	WASAC and Gicumbi District
NMUVP0010	IP	Increasing area under tea plantation	Business project. Consider IWRM add-on.	Tbd	D	Mulindi tea factory and NAEB
NMUVP0011	IP	Construction of industrial parks	Business project. Consider IWRM add-on.	B. Mulindi	D I	Gicumbi District
NMUVP0012	IP	Water for people /District/Rwungo-Manyagiro drinking water supply	Increasing access rate to clean water; Proposal Waste-WASH proposal received.	B. Mulindi	D P	Water for People, WASAC and

ID	Type[43]	Title	Scope	Sub-catchment	DPSIR[44] level	Lead & support entities
		system (intake, pumping station, reservoirs, power line)				Gicumbi District
NMUVP0013	IP	Land husbandry/soil conservation/soil erosion control	Soil erosion control.	Tbd	D P	RWFA, RAB, Gicumbi, Gatsibo and Nyagatare Districts
NMUVP0014	IP	GFI/TFI/Hillside irrigation development (pumping station, power line, dam sheet reservoir, sprinklers system, drip irrigation, center pivot, gravity system)	Hillsides irrigation to deal with climate change in the region.	Tbd	D P	MINAGRI and RAB
NMUVP0015	IP	RNRA/KOICA/Muvumba multipurpose dam 35 MCM	Irrigation (8 000 ha), water supply and hydro-power generation in Nyagatare district (Rukomo, Rwempasha, Musheli, Tabagwe and Nyagatare sectors.); Detailed study already completed. Now looking for funding, very expensive compared to added value.	Multiple (A. Warufu, D. Muvumba Upstream, E. Muvumba Downstream)	D P I	RWFA, MoE, MINAGRI, MININFRA, WASAC, REG
NMUVP0016	IP	Warufu multipurpose dam (25MCM)	Irrigation (2500 ha), water supply and hydro-power generation in Gatsibo district (Nyagihanga, Gatsibo and Ngarama sectors); Detailed study already completed. Now looking for funding, very expensive compared to added value.	A. Warufu	D P I	RAB
NMUVP0017	IP	Transport Sector Support Project, Phase 1: Improvement and Asphalting of 51.54 km: Base-	Improving roads.	B. Mulindi	P	RTDA and MININFRA

ID	Type[43]	Title	Scope	Sub-catchment	DPSIR[44] level	Lead & support entities
		Gicumbi-Rukomo section, funded by AfDB				
NMUVP0018	IP	Transport Sector Support Project, Phase 2: Improvement and Asphalting of 73 km Rukomo-Ngarama-Nyagatare section	Improving roads.	Multiple (A. Warufu, D. Muvumba Upstream, E. Muvumba Downstream)	P	RTDA and MININFRA
NMUVP0019	IP	Intake of water supply system for LVWTSAN for Nyagatare city (AfDB/EAC)	-	D. Muvumba Upstream	D P	LVWATSAN, AfDB/EAC
NMUVP0020	IP	Livestock water supply system (MINAGRI/AfDB)	Protecting source and avoidance of conflict of livestock holders; Water user association are set up but are unequipped for tasks. Additional training for maintenance of infrastructure may be required.	D. Muvumba Upstream	D P	MINAGRI, AfDB
NMUVP0021	CPIP	Technical solution to livestock water supply system	Technical solution to enhance water availability in dry times (enhanced infiltration, water storage, use of ground water -- linked to upstream catchment rehabilitation.	Tbd	D P	RAB
NMUVP0022	CPIP	Institutional solution to livestock water supply system	Institutional: Enhancing water user association as management platform & develop Communication plan.	D. Muvumba Upstream	D P	RAB
NMUVP0023	IP	Intake for irrigation scheme in Gitengure cell (Tabagwe sector)	Add-on required on soil and water conservation - rssp (World Bank).	D. Muvumba Upstream	D P	Nyagatare District, RSSP (World Bank)
NMUVP0024	IP	EIP Karama with W4GR	Gender mainstreaming required as add-on among others.	D. Muvumba Upstream	D P	RWFA / W4GR

ID	Type[43]	Title	Scope	Sub-catchment	DPSIR[44] level	Lead & support entities
NMUVP0025	IP	Multipurpose dam development (irrigation, domestic water use, electricity production)	-	D. Muvumba Upstream	D P I	RWFA, MoE, MINAGRI, MININFRA, WASAC, REG
NMUVP0026	IP	Landscape rehabilitation	Develop details later on.	D. Muvumba Upstream	-	RWFA and Nyagatare District
NMUVP0027	IP	Small Scale Irrigation development coupled with construction of livestock watering points	Develop details later on.	D. Muvumba Upstream	D P	RAB and Nyagatare District
NMUVP0028	IP	RWH (construction of multipurpose valley dams for livestock, irrigation & domestic)	Part of RWH project - Catchment methodology should be adhered to, otherwise evaporation will lead to water loss.	D. Muvumba Upstream	P I	Rab
NMUVP0029	IP	RWH (spectrum of RWH solutions on public buildings and households)	Component of RWH project.	D. Muvumba Upstream	P	RWFA
NMUVP0030	IP	IWRM on industrial zones, business parks and SEZ	-	E. Muvumba Downstream	D I	Nyagatare District
NMUVP0031	IP	Promote incentive initiatives to preserve forests (biogas digestors, improved stove cooking)	Solar not effective as cooking energy source. Charcoal making also an issue.	D. Muvumba Upstream	D P	MoE, REMA and RWFA
NMUVP0032	IP	Banana and coffee mulching	In Karama sector (Nyagatare district).	D. Muvumba Upstream	D P	RAB and Nyagatare District
NMUVP0033	IP	River bank protection (buffer zone restoration)	Programme of Interventions.	D. Muvumba Upstream	D P	RWFA
NMUVP0034	CPIP	Transboundary facilitation of catchment dialogue (Operational collaborative framework (between Gicumbi & Nyagatare districts	Should be a separate project / institutional + environmental aspect. Allows cooperation at lower administrative level. Uganda-Rwanda.	Multiple	D	MoE and RWFA

ID	Type[43]	Title	Scope	Sub-catchment	DPSIR[44] level	Lead & support entities
		(Rwanda) and Kabale & Ntungamo districts (Uganda)				
NMUVP0035	CPIP	Early warning capability for drought and food shortage in Nyagatare and Gatsibo district	Good demonstration project based on GIS and remote sensing, RMA and minagri. Food security as objective. Strong potential to involve private sector (ICT) to provide information at farm level. Radio may be used as well.	Multiple	D P S	RLMUA, RAB and RWFA
NMUVP0036	IP	Lake Victoria Water Sanitation Programme, (LVWTSP) Construction of water treatment plant, Faecal sludge treatment plant and landfill, urban drainage development and capacity building	Check name and inclusion of capacity building, gaps if any.	E. Muvumba Downstream	D P	LVWTSP
NMUVP0037	IP	Construction of water treatment plant	Component of Lake Victoria Water Sanitation Programme, (LVWTSP).	E. Muvumba Downstream	D P	LVWTSP
NMUVP0038	IP	Construction of Faecal sludge treatment plant and landfill	Component of Lake Victoria Water Sanitation Programme, (LVWTSP).	E. Muvumba Downstream	D P	LVWTSP
NMUVP0039	IP	Urban drainage development	Component of Lake Victoria Water Sanitation Programme, (LVWTSP).	E. Muvumba Downstream	D P	Tbd
NMUVP0040	CPIP	Rice irrigation schemes (1500 ha) (RSSP/funded by WB), Rwempasha, Musheri sectors end date 2013	Capacity building required for WUAs, on how to manage irrigation infrastructure. Second add-on: assess drainage water pollution and potential for treatment of effluent before it is discharged into the main river.	D. Muvumba Upstream	D P	RSSP / funded by WB
NMUVP0041	IP	Kagitumba Phase 2. 500 ha	Good project scope. No need for add-ons. 500 ha's of what?	E. Muvumba Downstream	D P	RAB

ID	Type[43]	Title	Scope	Sub-catchment	DPSIR[44] level	Lead & support entities
NMUVP0042	IP	Livestock watering system (LWS) for 627 farms implemented by Livestock Infrastructure Support Project (LISP) in Nyagatare district (Rwempasha, Musheli, Tabagwe, Rwimiyaga and Nyagatare sectors) funded by AfDB, end date 2015	Add-on: Protecting source and avoidance of conflict of livestock holders. Water user association are set up but are unequipped for tasks; Additional training for maintenance of infrastructure may be required. (Fred to check).	D. Muvumba Upstream	D P	Nyagatare District / funded by AfDB
NMUVP0043	CPIP	Develop guidelines for IWRM-proofing of buildings. Use rehabilitation of four slaughter houses in Nyagatare Sector as pilot subjects	Introduce IWRM approach including RWH as water, waste, and energy aspects. Fred to check more information on the slaughterhouses (in 6-year LED plan). Note: In Muvumba, if sufficient information on the slaughterhouses it will be a CPIP. Otherwise national level knowledge development project.	D. Muvumba Upstream	P	Tbd
NMUVP0044	IP	Construction of water supply system (27 km) in Musheri, Rwimiyaga, Karangazi and Rwempasha	Increasing access rate to clean water.	D. Muvumba Upstream	D P	WASAC
NMUVP0045	IP	Construction and rehabilitation of boreholes using solar energy (WASAC) in Karangazi sector	Add-on to assess how underground water could be used. WASAC might be informed by the W4GR groundwater study.	D. Muvumba Upstream	P	WASAC
NMUVP0046	IP	Construction of 15 MCCs in Karangazi and Rwimiyaga sectors	Consider IWRM add-on.	D. Muvumba Upstream	D I	Nyagatare District
NMUVP0047	IP	Construction of IDP Model Village - Rwabiharamba in Karangazi Sector	Add-ons rainwater harvesting.	D. Muvumba Upstream	P	Nyagatare District and Rwanda Housing Authority
NMUVP0048	IP	Transport Sector Support Project, Phase 2: Improvement and	Improve storm water drainage.	D. Muvumba Upstream	P	Tbd

ID	Type[43]	Title	Scope	Sub-catchment	DPSIR[44] level	Lead & support entities
		Asphalting of 73 km Rukomo-Ngarama-Nyagatare section, funded by Arab Bank				
NMUVP0049	IP	Construction of lined drainage of 2.2 km in Nyagatare city (Nyagatare Sector)	Too small for additions.	D. Muvumba Upstream	D P	Tbd
NMUVP0050	CPIP	Capacity building in irrigation and domestic water use efficiency (management of water and hydraulic infrastructure in irrigation, livestock and domestic use)	Capacity building required for WUAs, on how to manage irrigation infrastructure. Second add-on: assess drainage water pollution and potential for treatment of effluent before it is discharged into the main river.	D. Muvumba Upstream	D P	RWFA, RAB and Water for Growth
NMUVP0051	IP	Agroforestry (IUCN FLR interventions): 22 ha in Ngarama Sector and 34 ha in Nyagihanga sector	Soil & water conservation measures.	A. Warufu	D P	IUCN and RWFA
NMUVP0052	IP	Forest plantations (District/Reserve Force), (Mukama, Gatete, Gatete1 village)	Soil & water conservation measures. Ha?	A. Warufu	D P	Nyagatare District and RWFA
NMUVP0053	IP	Feeder roads through VUP/District 10km Kabungo-Mukama	Add-on: management of storm water from drainage system.	A. Warufu	P	Nyagatare District, RTDA and RWFA
NMUVP0054	IP+	Land scape rehabilitation 300 ha (radical terraces) around Cyabayaga dam (Gakirage, Cyabayaga cells) (LWH/RSSP/MINAGRI/WB)	Add-on: agroforestry, lime and manure on existing terraces.	A. Warufu	D P	LWH / RSSP / MINAGRI
NMUVP0055	IP+	Marshland irrigation development 690 ha	Add-on of strengthen of WUAs capacities in operating and managing irrigation water and infrastructure.	A. Warufu	D P	RAB

ID	Type[43]	Title	Scope	Sub-catchment	DPSIR[44] level	Lead & support entities
NMUVP0056	IP	Employ improved forest management for degraded forest resources	Forestry SSP / FBME project.	A. Warufu	D P	RWFA
NMUVP0057	IP+	Radical terraces which need agroforestry component the full IWRM package is not applied (no lime and manure in required quantities, no agroforestry, etc)	Add-on of agroforestry and drainage on existing radical terraces.	A. Warufu	D P	Tbd
NMUVP0058	CPIP	Landscape restoration (afforestation, progressive terraces, agroforestry, etc.)	Soils & water conservation.	A. Warufu	D P	RAB, RWFA and Nyagatare District
NMUVP0059	CPIP	Landscape rehabilitation (terracing, afforestation, agroforestry, etc.)	This is a part of landscape restoration.	A. Warufu	D P	RAB, RWFA and Nyagatare
NMUVP0060	CPIP	Management of storm water (road drainage)	This is a part of landscape restoration.	A. Warufu	P	RTDA, Gicumbi, Gastibo and Nyagatare Districts
NMUVP0061	CPIP	Landscape restoration (terracing, afforestation, agroforestry, gullies treatment, etc)	This is a part of landscape restoration.	A. Warufu	D P	Tbd
NMUVP0062	CPIP	Promote the use of organic manure from composting on existing terraces	This is a part of landscape restoration.	A. Warufu	P	RAB, REMA, Gicumbi, Gastibo and Nyagatare Districts

ID	Type[43]	Title	Scope	Sub-catchment	DPSIR[44] level	Lead & support entities
NMUVP0063	IP	Terraces	-	B. Mulindi	D P	Tbd
NMUVP0064	IP	Afforestation	-	B. Mulindi	D P	Tbd
NMUVP0065	IP	Water supply (intake, water treatment plant, etc.)	-	B. Mulindi	D P	WASAC
NMUVP0066	IP	Faecal sludge treatment plant (Rukomo, Kinyami cell)	-	B. Mulindi	D P	Water for People
NMUVP0067	CPIP	Business park in Byumba Sector	SEZ project.	B. Mulindi	D I	Gicumbi District
NMUVP0068	IP	District milk processing plant (Dairy) in partnership with private sector (PPP) in Byumba sector	-	B. Mulindi	D P I	Gicumbi District and PSF
NMUVP0069	CPIP	Watershed protection around Mulindi tea plantation (afforestation: 2 747 ha and agroforestry: 9 790 ha) in Rubaya, Kaniga, Mukarange, Shangasha, Cyumba, Byumba and Munyagiro sectors (IUCN)	Add-ons for protection and production of fire wood, with sustainable forest management plan.	B. Mulindi	D P	IUCN
NMUVP0070	IP	Radical terraces and agroforestry on 2500 ha in Rushaki, Mukarange, Shangasha and Kaniga sectors	-	B. Mulindi	D P	Gicumbi District
NMUVP0071	CPIP	Radical terraces which need agroforestry component the full IWRM package is not applied (no lime and manure in required quantities, no agroforestry, etc)	Add-on of agroforestry and drainage on existing radical terraces.	B. Mulindi	D P	Tbd

ID	Type[43]	Title	Scope	Sub-catchment	DPSIR[44] level	Lead & support entities
NMUVP0072	IP	Sustainable pest management techniques to control plant parasites and pathogens in tea plantations and other crops	IP, but advise on pollution / downstream water use aspects as criterion of sustainability. Investigate opportunities for production of organic tea at higher prices. Learn from e.g. Sorwathe.	B. Mulindi	D	RAB
NMUVP0073	IP	Water management including flood mitigation in valley tea plantations	Specific for Mulindi marshlands tea plantations (peat).	B. Mulindi	D	FONERWA
NMUVP0074	CPIP	Adjustment of infrastructure and regulation of water discharge and intake timing, Hydropower plant on Ngoma river	Upstream (Gicumbi) hydropower - downstream (Nyagatare) water supply intake conflicts, related to operational management of the HP plant and absence of storage facilities at intake for drinking water supply. Sediment loads in rainy season need to be taken into account (flushing). Intake on Ngoma river and on spring to supply water for livestock and human consumption in Nyagatare, Tabagwe, Rwempasha sectors. (WASAC and LISP/MINAGRI/AfDB).	C. Ngoma	P I	REG
NMUVP0075	IP	Forest plantations (District/Reserve Force), (Mukama, Gatete, Gatete1 village)	Land husbandry interventions.	C. Ngoma	D P	RWFA
NMUVP0076	IP	Feeder roads through VUP/District 10km Kabungo-Mukama	Transport.	C. Ngoma	P	Nyagatare District

Table 24: Institutional measures

ID	Title	Content	DPSIR [45] level	Potential implementing partners
1	New Water Law and related ministerial orders	For sustainability of the institutional collaboration framework, the draft new Water Law needs to be adopted and gazetted. The law will provide for catchment committees and their support structures, whose mandates will be stipulated in Ministerial Orders.	D	MINENV MINILAF MINALOC Districts
2	Establishment of permanent Catchment Committee (CC)	Transformation of Catchment Task Force into Catchment Committee, with adaptations as required, upon gazetting of new water law and ministerial order(s).	D	RWFA, districts
3	Establishment of permanent (technical) 'secretariats' of Catchment Committee	Permanent support structures with staff, as per ministerial order following the new water law; including implementation of Capacity Development Plan.	D	RWFA, districts
4	Development of National Wetlands Policy	Develop a National Wetlands policy to change the current trend of wetland loss and unsustainable use in Rwanda. Wetlands provide various ecosystem services that have significant economic, cultural, environmental and recreational value. Locations: Major Wetlands in Rwanda: Nyaborongo complex, Rugezi Burera Ruhondo complex, Akanyaru complex, Akagera complex.	D P I	REMA
5	Catchment Plan funding & investment round table	Organise a catchment plan implementation funding and investment meeting with development partners, charity organisation, development funds, institutional investors.	D	All development partners in Rwanda
6	Implementation of open data policy and promotion of data sharing	Promote, at high, middle, and low levels across the Government of Rwanda and other stakeholders, a culture of willingness, or even eagerness, to share (geo)data. Remove regulatory boundaries, develop clear mandates, but overall realise a culture shift, and involve private sector, by outsourcing tasks that are better and cheaper dealt with by professionals outside ministries.	D	NISR, RLMUA, RWFA, REMA, MINAGRI, MININFRA, MINICT, RCMRD, IUCN, ESRI Rwanda, Universities, CGIS, SEAD project
7	Enhancing capabilities for transboundary	Facilitate options for operational level collaboration on IWRM topics, including sharing of information and joint operational decision making, in transboundary catchments	D	RWFA, MINILAF, MINENV, MINAFFET, CTF

[45] D = Driving forces; P = Pressures; S = States: I = Impacts; R = Responses

ID	Title	Content	DPSIR [45] level	Potential implementing partners
	water management at catchment level	(e.g. Muvumba) and catchments with transboundary external water transfers (e.g. Sebeya).		

Table 25: Knowledge measures

ID	Title	Type [46]	Objective/Content	DPSIR [47] level	Output	Potential implementing partners
1	Special Economic Zones (SEZs) and IWRM	BP	Review policy and approach for development of SEZs and develop knowledge to make SEZs climate resilient and water smart (grey water reuse, rainwater harvesting, water recycling etc.). Protect SEZs from flooding/landslides, drought hazard and/or damage through water contamination.	P I	Policy review and recommendations	RWFA, IPRCs, Urban planning entities, RLMUA, MINICOM, WASAC, Districts, project developers, construction companies and architects
2	Mining and IWRM	BP	Review policy and approach for sustainable mining and include IWRM and LR measures. Include clean water and waste management processes with the aim to reduce sediment loads to rivers and reduce turbidity, reduce contamination, enhance water use efficiency and water recycling in mining operation and implement water permitting for mines (professional and artisanal).	P	Policy review and recommendations	Mining companies, Rwanda Mines, Gas and Petroleum Board, REMA, DFID Sustainable Development of Mining in Rwanda
3	Cattle and poultry value chain (among others Dairy) and IWRM	BP	Review and develop knowledge on opportunities for improved water points, increased water productivity and reduction of water pollution (*E. coli*) and trampling of riverbanks. Identify solutions for shortage of manure needed for new terraces.	D P	Policy review and recommendations	MINAGRI, cattle and poultry farmers, SNV
4	Contribute to optimisation of land rehabilitation /	R, BP, S	Review practises in socio-economic terms depending on geographical characteristics.	D	Recommendations for optimisation of guidelines	MINAGRI, MINLAF, MINEFOCFIN

[46] BP = Best Practice; R = Research; T = Training; TVET = Technical and Vocational Education and Training; S = Spatial / GIS / Remote Sensing; M/T = Models/Tools; Mon. = Monitoring

[47] D = Driving forces; P = Pressures; S = States: I = Impacts; R = Responses

ID	Title	Type [46]	Objective/Content	DPSIR [47] level	Output	Potential implementing partners
	catchment restoration guidelines					
5	Climate smart agricultural soils on progressive terraces	R, BP	Identify the most effective combinations of techniques, as proposed in Rwanda's INDC, that significantly improve water productivity and decrease soil erosion on progressive terraces, considering Rwanda's diverse geography. Location: Representative research plots for demonstration catchments of W4GR (Upper Nyabarongo, Nyabugogo, Sebeya, and Muvumba).	D P	Pilot study	Lead University (through tendering), W4GR
6	Drought risk assessment and management	R, BP, S	Seasonal weather forecast; drought preparedness measures; emergency water supply, information; mobile decentralised drinking water treatment infrastructure; water permit allocation leading to institutional measures. Location: Eastern Province.	D		RMA, Districts, MIDIMAR, RWFA/WRMD, WASAC
7	Carry out study into water-energy-food-securities nexus	R, S, M/T	Introduce integrated nexus thinking and assessments, such as for the water-energy-food security nexus, the nexus ecosystem – economy, and the nexus water – health. Location: National level, but down scalable to catchment, sub-catchment and household level.	D		Prime Minister's Office, MINENV, MINILAF, MININFRA, MINAGRI, MINISANTE, etc
9	Land cover map, soil erosion risk map, land degradation	S	Detailed, accurate, updated land cover, land degradation, land restoration and forestry cover maps. The land cover map forms the basis for all spatial planning in Rwanda and needs to be updated regularly as the other maps as well.	D	Maps	RWFA Forestry Department, RLMUA, NISR, BOSS, RCMRD

ID	Title	Type [46]	Objective/Content	DPSIR [47] level	Output	Potential implementing partners
	map, catchment restoration map					
10	Catchment atlas	S	W4GR GIS materials collected and developed available for wider use (spatial planning, education, consultants). CP first example of integrated spatial planning in Rwanda.	D	Catchment atlas	W4GR
11	Update hydropower potential atlas	S	Existing atlas from 2007/8 lacks economic analysis and needs to be updated based on new water use and plans. Location: Start with small demonstration area in one of the DCA to test usefulness of idea.	D	Hydropower potential atlas	SHER, SNV
12	Develop hydraulic design manual, for design hydraulic structures and water permit application, testing criteria), and water permit assessment	BP, M/T	Enhance hydrologic and hydraulic modelling and assessment skills among private sector and government. Develop skills and experience among private sector and the government, in developing applications for water permits and the assessment thereof, on hydrologic and hydraulic parameters.	D P I	Hydraulic design guidelines	RWFA WRMD, Universities, Consultants
13	Payments / Incentives for Ecosystem services (IES)	R, BP	Evaluate practise in Yanze sub-catchment and best practices in other areas. Research potential to develop regulations that use the fees for water permits as an admin fee that is used to support the WRMD / permitting body, and a water use fee that is channelled back to the catchment, as a PES scheme.	D	-	In cooperation with IUCN

ID	Title	Type [46]	Objective/Content	DPSIR [47] level	Output	Potential implementing partners
14	Development of IWRM training programme for local stakeholders and beneficiaries	BP, M/T	Capacity building plan for Catchment Committees, Catchment Offices / permanent secretariat to Catchment Committee, and other stakeholders and beneficiaries. Subjects include (but not limited to): ▪ Continue to develop capacities for catchment planning and catchment management; ▪ Improve and spread participatory and adaptive catchment planning; ▪ Develop understanding of the scalability of IWRM concepts, from household or company level up to transboundary collaboration. Develop skills to assess, monitor, and improve water productivity (e.g. WaPOR).	D	Capacity building plan Training	-
15	WEAP governance manual	M/T	A model governance plan will be developed to ensure the quality of WEAP models, their improvements, and their usage. This knowledge measure will be key to safeguarding the sustainability of model use and the relating knowledge within the WRM department and plan partners. Improve catchment water balance modelling skills at central level and introduce these at the level of catchment offices.	D	Model governance plan Training	RWFA (lead) W4GR
16	Regular updates of WEAP models	M/T	Continuously update water use data in WEAP models, develop new models for new areas of topics, and implement regular updates of existing models, according to guidelines in WEAP governance manual.	D	Updated and new decision support models and analysis reports	RWFA / WRMD W4GR
17	Support development of WEAP	M/T	Develop a critical mass for sustainable use of WEAP, by linking governmental, educational, and consultant users. The members of the group share information and experiences online or through (bi-) annual meetings and learn from each other.	D	Critical mass organised	SEI, COs, districts, universities, IPRCs, Consultants

ID	Title	Type [46]	Objective/Content	DPSIR [47] level	Output	Potential implementing partners
	community of practise					
18	Projects geo-database	S, M/T	A central, eventually online geodatabase of IPs and CPIPs that is accessible for plan partners, which can be used to prepare annual implementation plans and Imihigos. In line with the ICT agenda of Rwanda.	D	Projects geo-database	COs, districts, ministries
19	GIS training of central, district staff and catchment office staff (including hardware, software and datasets)	S, M/T	Enhance capacities in geo-information management and cartography / development of maps to support spatial planning, through strong capacity (and best practice) development across the board, in all central and local government institutions involved in any type of spatial planning, and stakeholder organisations.	D	Training, Better and more maps	COs, districts, W4GR, ESRI, RWFA, COs, districts, universities, IPRCs, ESRI Rwanda, Consultants
20	Support development of GIS community of practise	S, M/T	Develop a critical mass for sustainable use of GIS, by linking governmental, educational, and consultant users. The members of the group share information and experiences online or through (bi-) annual meetings and learn from each other.	D	Critical mass organised	-
21	Institutional capacity building in gender mainstreaming and gender budget statements	T	Capacity building among national and local government staff, to ensure resource allocation for IWRM related gender issues and to effectively demonstrate the approach and equip the Ministry and districts with skills to monitor the gender impact of CPIPs.	D	Training	-

ID	Title	Type [46]	Objective/Content	DPSIR [47] level	Output	Potential implementing partners
22	Catchment plan implementation funding and investment tools and training	M/T	Improve skills and tools for financial planning for catchment plan implementation and catchment management in general. Enhance capacities in the banking sector as well as private sector and the government, on financing interventions in the catchment.	D	Training Round table	MINECOFIN W4GR
23	FEWS	M/T	Flood Early Warning Systems. A combination of monitoring networks, rapid assessment models and tools, and information dissemination means to communicate warnings on time, to the intended recipients.	I	FEWS models, monitoring network, warning system	RWFA/IWRM REMA MINALOC MIDIMAR BRLi
24	MIDIMAR Flood and landslide risk knowledge base	R, S, M/T, Mon	Collate and analyse key hydro-meteorological data to respond to MIDIMAR's risk management policy. ▪ High temporal (and spatial) resolution (precipitation) data of a long period that can help the estimation of different intensities, durations, and frequency; ▪ High resolution data on land cover; ▪ Soil's hydraulic properties; ▪ River profiles or sizes; ▪ Calibration data like discharges.	D P I	Knowledge base for flood and landslide risk mapping and assessment	MIDIMAR RWFA/WRMD
25	Operationalise water permit system	S, M/T	Raise awareness among water users on the need to obtain water permits. Streamline the processing of permits (linked to K-CPIP 12) and maintain the system and its data.	D	Water permit system, with up-to-date data, and permits issued	RWFA/WRMD

ID	Title	Type [46]	Objective/Content	DPSIR [47] level	Output	Potential implementing partners
26	Sponge City Concept pilot	BP, R	To increase water storage in urban areas in construction and natural areas and align with worldwide initiatives.	D	Pilot projects	RWFA/WRMD, City of Kigali
27	Water storage strategy	M/T	To upgrade RWH strategy to a generic water storage analysis and strategy.	D	Analysis tool, strategy	RFWA/WRMD

7.1 SEA methodology

Why an SEA summary?
This Annex provides a general overview, and highlights significant details, of the Strategic Environmental Assessment (SEA) process that was followed in development of this catchment plan. The objective is to facilitate an assessment of the process by the authority mandated for such work, namely REMA.

SEA process steps
The Strategic Environmental Assessment (SEA) methodology that was used in development of this catchment plan followed international best practice. The process involves implementation of five main steps and nine sub-steps (see below and in Annex 7.2). Independent advice and coaching on the process was provided by Netherlands' Commission on Environmental Assessment (NCEA).

1. Screening:
    a. Reach consensus on the need for SEA and its link to planning;
    b. Find stakeholders and announce start of the plan process;
2. Scoping:
    a. Develop a shared vision on problems and opportunities, define plan objectives, and draft alternative ways to reach these objectives;
    b. Do a consistency analysis for relevant (national) policies that have consequences for each catchment;
    c. Set ToR for the technical assessment, based on scoping results;
3. Assessment:
    a. Assess the impacts of alternatives and document this;
    b. Review: organise (independent) quality assurance of documentation (preferably involving stakeholders);
4. Formal decision-making:
    a. Discuss with all stakeholders the alternative to prefer;
    b. Motivate the (political) decision in writing;
5. Monitoring: Monitor the implementation and discuss the results.

Integration of IWRM and SEA process steps
Both IWRM and SEA can be understood as participatory processes designed to create a well-developed plan with a broad support base. For the development of catchment plans in the framework of Water for Growth Rwanda, IWRM and SEA elements were combined into an integrated IWRM / SEA plan process.

The desire of the Governments of Rwanda and the Netherlands to integrate both processes were captured in an MoU between both countries, laying the foundations for the IWRM Programme, commonly referred to as Water for Growth Rwanda. In order to help shape the process, coaching was provided by the Netherlands Commission for Environmental Assessment (NCEA). The process steps of IWRM, as followed within Water for Growth Rwanda, are presented in Figure 1 (Chapter1.).

Table 26 links the process steps of IWRM and SEA to each other and Annex 7.2 provides a detailed report of activities for each of the official ten SEA steps to facilitate independent review by REMA. Annex 7.3 provides an overview of activities undertaken as part of the integrated IWRM / SEA process for development of this catchment plan. Annex 7.4 presents conclusions and lessons learnt.

Table 26: Combining process steps of IWRM and SEA

<table>
<tr><th>Steps in IWRM[48]</th><th>Elements</th><th>Phases in SEA[49]</th><th>Steps in SEA</th></tr>
<tr><td>N/a</td><td>N/a</td><td>Screening</td><td>1. Reach consensus on the need for SEA and its link to planning;
2. Find stakeholders and announce start of the plan process;</td></tr>
<tr><td>Situation analysis</td><td>Develop catchment characterisation report with analysis of important aspects of the catchment:
▪ Physical characteristics;
▪ Water resources characteristics;
▪ Socio-economic analysis;
▪ Stakeholders analysis (of SEA step 2).

Consistency analysis of existing policies, plans, programmes (SEA step 4).</td><td rowspan="2">Scoping</td><td rowspan="2">3. Develop a shared vision on challenges and opportunities, define plan objectives and draft alternative ways to reach these objectives;
4. Do a consistency analysis for relevant (national) policies that have consequences for each catchment;
5. Set ToR for the technical assessment, based on scoping results;</td></tr>
<tr><td>Vision development</td><td>Creating a vision for the medium to longer term future (SEA step 3) with Catchment Task Force, kicking off in a joint scoping workshop, and developing a ToR for the plan development and assessment (SEA step 5).</td></tr>
<tr><td rowspan="2">Integrated planning</td><td rowspan="2">Develop catchment plan considering competing land and water interests and comprising:
▪ water allocation;
▪ water resources protection / conservation;
▪ land use / catchment rehabilitation.

Assessment of development alternatives (SEA step 6).</td><td>Assessment</td><td>6. Assess the impacts of alternatives and document this;
7. Review: organise (independent) quality assurance of documentation (preferably involving stakeholders);</td></tr>
<tr><td>Formal decision making</td><td>8. Discuss with all stakeholders the alternative to prefer;
9. Motivate the (political) decision in writing;</td></tr>
</table>

[48] Source: Integrated Water Resources Management Programme Rwanda 2015 – 2019. Project document 15 October 2014.

[49] Source: Netherlands Commission for Environmental Assessment.

Steps in IWRM[48]	Elements	Phases in SEA[49]	Steps in SEA
	Independent quality assurance of documentation (for this version of the CP) by the FPG and Catchment Task Force (SEA step 7). A separate review of the whole process by REMA is planned in fiscal year 2018-2019, for learning purposes mainly. Participatory decision making involving local and central levels (SEA step 8). The resulting plan will include: ▪ a summary of the plan development process, assessment of alternatives, and motivation of decisions (SEA step 9); ▪ infrastructure development measures; ▪ governance measures (stakeholders' engagement, institutional framework); ▪ M&E plan (design of SEA step 10).		
Sector and agency planning	Planned activities assigned to implementing entities, often sector agencies or District administrations, and included in sectoral and district Imihigos and annual work plans; EIPs planned within the IWRM Programme.	N/a	N/a
Co-ordinated implementation	Implementation of sector and agency plans respecting time schedules and designs formulated in integrated catchment plan; EIPs implemented within the IWRM Programme.	N/a	N/a
Joint monitoring	Monitoring of implementation is assured by stakeholders in the catchment, together with regular monitoring procedures of implementing	Monitoring	10. Monitor the implementation and discuss the results

Steps in IWRM[48]	Elements	Phases in SEA[49]	Steps in SEA
	organisations, resulting in annual catchment plan implementation M&E reports (implementation of SEA step 10).		

7.2 SEA step results

A step by step account of the SEA process followed in the development of the catchment plan
As explained in Annex 7.1, this Annex serves to facilitate an independent assessment of the SEA process by REMA, the mandated authority for SEA in Rwanda. The process is described according to the official ten step SEA.

Screening step 1: Consensus on the need for SEA

Legal and institutional context for SEA
The Constitution of Rwanda (2003) makes provision for rights to a healthy environment for its inhabitants and this formed a basis for the Environmental Protection, Conservation, and Management Policy (2004). This was given effect by Organic Law No. 04/2005, which determined the modalities for protection, conservation, and promotion of environment in the country.

Organic Law No. 04/2005, and its regulations in the form of Ministerial Orders, are implemented through Law No. 16/2006, which established the Rwanda Environmental Management Authority (REMA) as the regulating agency and determined its organisation, functions, and responsibilities. Following its legal mandate, REMA has put in place environmental management tools and guidelines, including general and sector-specific guidelines for EIA.

Principle 1, Article 7, Organic Law 04/2005 stipulates precautionary measures informed by results of both environmental assessments of policies, plans, projects, and development activities and assessment of social wellbeing. Although legal provision for deployment of an SEA instrument appears to be present, only EIA is adequately treated in the law and in the general and sector-specific guidelines issued by REMA. REMA is currently in the process of finalising an official guideline for SEA in Rwanda[50] in order to establish SEA firmly in the Rwandan context. The SEA process, as developed and implemented in Water for Growth Rwanda with independent assistance from the Netherlands Commission for Environmental Assessment (NCEA), complied with the 'guidance-under-development', and incorporated best international practice, as well as local constraints and opportunities.

In an international legal and institutional context, SEA facilitates adherence to those international legal conventions to which Rwanda is a party, including:
- UN Convention on Biological Diversity (UNCBD) 1992;
- UN Framework Convention on Climate Change (UNFCCC) 1992;
- UN Convention to Combat Desertification (UNCCD) 1994;
- Basel Convention 2005;
- Convention on International Trade in Endangered Species (CITES) 1973;
- Kyoto Protocol 1998;
- RAMSAR Convention on Wetlands of International Importance 1971;
- Rotterdam Convention 2004;
- Stockholm Convention 2001;
- Vienna Convention 1985 and four related protocols; and the
- Cartagena Protocol 2000.

SEA contributes to achievement of the Sustainable Development Goals (SDGs) which played a leading role in the development of visions for the catchment plans within Water for Growth Rwanda.

[50] The majority of the text in this section is quoted literally from the 2011 'General Guidelines and Procedures for Strategic Environmental Assessment (SEA) developed by REMA in collaboration with United Nations Rwanda and UNDP.

Explanation of embedding SEA principles

SEAs are applied to policies, plans, and programmes with a broad and long-term strategic perspective (e.g. visionary or conceptual). SEA is focused on better decision-making pertaining to the policy, plan, or programme at hand, based on better quality information from a broader information base including stakeholders affected by the policy, plan, or programme[51]. A good SEA provides guidance for future decision-making for any projects that may come out of the PPP.

For a catchment plan, this firstly implies that an SEA is obligatory (hence the integration of SEA in the catchment planning process) and secondly, that the programme of measures, as a key element of the catchment plan, will be guided by decisions made at the planning level. Overall, integration of SEA into the catchment planning process led to a better catchment plan, with a broader support base, and local, as well as central, ownership, which strongly enhanced its implementation.

Having done an SEA for the catchment plan does not release subsequent implementation projects from the requirements vis-à-vis Environmental Impact Assessments (EIA). According to Rwandan law, an EIA is required for all specific and relatively short-term projects and their specifications. An EIA is geared toward obtaining relevant permits for project implementation and rarely generates feedback to considerations made in the PPP, whereas SEA is focused on decision-making.

Above all, by combining information, process, and procedures (Figure 69), SEA principles provide the catchment planning process with requirements for:

- Participation – by strengthening the role of stakeholders;
- Transparency – through an open and accountable process;
- Information – on priorities, alternatives, and impacts;
- Institutions – focusing on the plan implementation and enforcement capacity.

A catchment planning process incorporating SEA principles, such as the one followed here, will:

- Yield more attention to environmental impacts (positive or negative) of the plan;
- Provide better understanding of the cumulative impacts of the plan (rather than a list of individual impacts of a series of smaller projects that follow from it);
- Reduce the need for EIA discussions about strategic choices, e.g. regarding locations selected, or technologies proposed; and
- Facilitate implementation of downstream EIAs owing to the wealth of information collected in the plan development process.

In particular the geo-information collected and developed in the process, will be provided to plan partners at central and local level, in a quest to enhance the level of GIS-based spatial planning. Moreover, several shapefiles are already made available online, through government-owned web portals.

As described in Annex 7.1, from the onset of Water for Growth Rwanda, the intention has always been to integrate the SEA process as much as possible into the catchment plan development process. Based on discussions between the WRMD, the ISU, and the NCEA, a decision was made to also integrate justification of SEA into the catchment plan.

REMA was closely involved at the start of the process and participated in the NCEA training / kick-off workshop (NCEA, 2015) and in a face-to-face meeting between the plan owner (WRMD), the consultants of the ISU and representatives of the NCEA. This meeting laid the foundation for development of the detailed roadmap for catchment plan development incorporating the SEA process.

[51] In SEA terminology, commonly referred to as 'PPP'; not to be confused with Public Private Partnership.

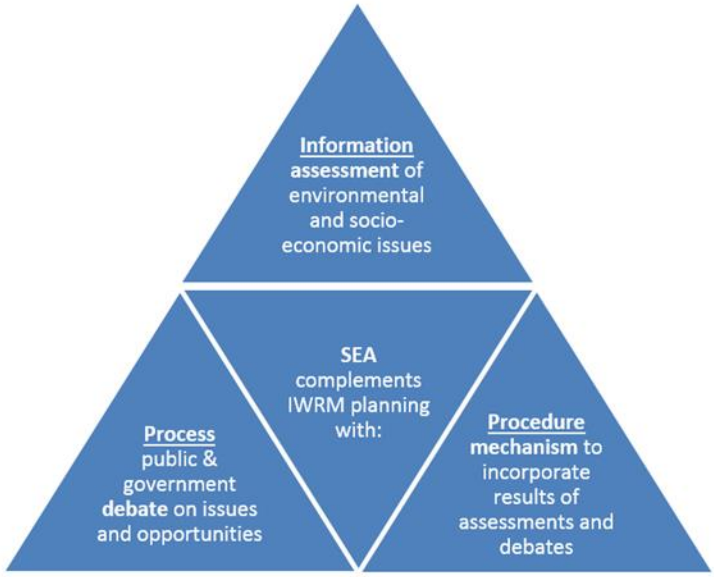


Figure 69: Added value of SEA to the catchment planning process, through information, process, and procedure[52]

Water for Growth Rwanda, also supported the SPIU of RWFA to implement a so-called 'Early Implementation Project'. This project was started as soon as possible, and in order for it to be 'visible in the field' was developed and implemented before completion and approval of the catchment plan. Its implementation did not therefore follow the overall SEA process.

The process for development of the EIP is described in the text box below.

Early Implementation Projects (EIPs)
In order to be visible in the field as soon as possible, rather than waiting for the catchment plan to be ready, Water for Growth Rwanda developed a so-called Early Implementation Project (EIP) for Muvumba. This was considered at the time as a no-regret measure that could be implemented fairly quickly and easily and show 'action on the ground'. From a series of concept notes, the Programme Steering Committee selected an EIP for the catchment (PSC meeting report 27/1/20-16). This selection process comprised a series of knock-out criteria, including suitability of the investment opportunity (urgency; no-regret; consistent with existing PPP) and feasibility expectations (technical, economic and social). Prioritisation criteria were also applied (sustainable solution; ease of technical implementation; poverty reduction potential; job creation potential; demonstration and learning value; relevance to IWRM and catchment context; NGO involvement; private sector involvement; connection to ongoing initiatives in the catchment; and lastly a group of criteria related to the status of preparations) clear analysis of problem and solution, and availability of feasibility study and/or detailed design) were also considered. Shortly after selection, feasibility studies and detailed designs were developed, including EIA requirements and, considering the scope of interventions and involvement of the local population in execution of the work, separate environment and social mitigation measures were not considered necessary.

Screening step 2: Find stakeholders and start the plan process

The key stakeholders for development of the catchment plan comprised representatives from the central level, as well as representatives from the (significant) relevant catchment districts (see Section 2.1.2). Start of the plan process was announced at national level by installation of the IWRM Programme Steering Committee and subsequent requests for assignment of technical focal points as representatives of the key

[52] Source: NCEA, the Netherlands Commission for Environmental Assessment, supported the Government of Rwanda and Water for Growth in the development of an integrated process for SEA and catchment plan development.

partner ministries in a Focal Points Group (FPG). The FPG was designed to assist the PSC in their decision-making. Composition of the PSC and FPG is as shown in Table 27 and Table 28 (situation as of January 2018). Composition of the catchment-based Catchment Task Force core team, elected by its members from the full CTF, is shown in Table 29. The core team was officially installed by letter from the DG of MINIRENA/RNRA, on 16 November 2016 (Ref. 13976/16.03/RNRA/05). Both the CTF core team and the FPG were instrumental in technical development of plan alternatives. Individual ministries, agencies, and districts were key providers of projects for development of the programme of measures.

Table 27: Composition of Programme Steering Committee (PSC)

Ministry / organisation	Name	Position	Role in PSC	Gender
MoE (Former MINIRENA)	MUKARUBIBI, Fatina	Permanent Secretary	Chair person	F
EKN	VLAAR, Jan	First Secretary 'Water'	Co-chair person	M
MINAGRI	TWAGIRIYEZU, Emmanuel	Specialist	Member	M
MINALOC	NINGABIRE, Yves Bernard	DG Planning, M&E	Member	M
MINECOFIN	NSENGIYAREMYE, Christophe	Director of planning	Member	M
MIDIMAR	NSENGIYUMVA, Jean Baptiste	Director of Risk Reduction	Member	M
MININFRA	MUZOLA, Aime	COO WASAC (ex-Programme manager at MININFRA)	Member	M
WATER AID	UWERA, Fiona	Head of Policy, Research and Advocacy	Member	F
RAB	MUHUTU, Jean Claude	Assistant researcher	Member	M

Table 28: Composition of the Focal Point Group (FPG)

Ministry / organisation	Name	Position	Gender
MINAGRI	TWAGIRAYEZU, Emmanuel	Specialist	M
MINECOFIN	NSENGIYAREMYE, Christophe	Director of planning	M
MINALOC	RUHAMYAMBUGA, Olivier	Planning specialist	M
MIDIMAR	HATEGEKIMANA, Deogratias	Flood Risk Management Engineer	M
MININFRA	HATEGEKIMANA, Emmanuel	Senior Engineer	M
WATER AID	UWERA, Fiona	Head of Policy, Research and Advocacy	F

Table 29: Composition of Catchment Task Force (CTF) core team

Ministry / organisation	Name	Position	Role in PSC	Gender
Gicumbi	MUHIZI, Jules Aimable	Vice Mayor	Chair	M
Nyagatare	KABERUKA, Grace	National Women Council	Vice Chair	F
Gatsibo	NAMUHORANYE, Sylvere	Forest & Natural Resources Officer	Secretary	M
Gicumbi	MUJYAMBERE, Mustapha	NGO Representative	Advisor	M
Nyagatare	MUTABARUKA, Fulgence	Agronomist	Advisor	M
Nyagatare	MUKESHIMANA, Djamilla	Private Sector Federation (PSF) Representative	Advisor	F

Table 30: Composition of Catchment Task Force

Ministry / organisation	Name	Position	Role in PSC	Gender
Gicumbi	MUHIZI, Jules Aimable	Vice Mayor for Economic Development	CTF core team member chairperson	M
Gicumbi	MAJYAMBERE, Mustapha	NGO representative	CTF core team member	M
Gicumbi	NZEYIMANA, Jean Chrysostome	District Agronomist	Member	M
Gicumbi	UWAMURERA, Olive	District representative of NWC	Member	F
Gicumbi	LUTAGIRA, Jackson	District Officer for Environment	Member	M
Gicumbi	NKORONKO, Francois	District representative of PSF	Member	M
Nyagatare	KAYITARE, Didas	Vice Mayor for Economic Development	Member	M
Nyagatare	BAYIGAMBA, Egide	District Officer for Environment	Member	M
Nyagatare	KABERUKA, Grace	District representative of NWC	CTF core team member	F
Nyagatare	MUKESHIMANA, Djamila	District representative of PSF	CTF core team member	F

Nyagatare	MUTABARUKA, Fulgence	District Agronomist	CTF core team member	M
Nyagatare	MBERABAGABO, Elie	District representative of NGOs	Member	M
Gatsibo	MANZI, Theogene	Vice Mayor for Economic Development	Member	M
Gatsibo	HABIMANA, Jean Claude	District Officer for Environment	Member	M
Gatsibo	NAMUHORANYE, Sylvere	District & Natural Resources	CTF core team member	M
Gatsibo	UDAHEMUKA, Bernard	District Agronomist	Member	M
Gatsibo	URUJENI, Consolee	District representative of NWC	Member	F
Gatsibo	NIYOMUGABO, Placide	District representative of NGOs	Member	M

In the first months of the process, a full stakeholder analysis and stakeholder engagement plan were developed for the central and local levels (summarised in Annex 12). Most interaction with the CTF was through the core team who were invited at crucial moments in the process. A full list of CTF meetings is provided in Table 32. It proved difficult to arrange for regular meetings with either the full or core CTF due to the requirement to obtain travel approval from MINALOC for district staff more than two weeks in advance of any event. This hampered the convening power of W4GR and translated into an institutional recommendation for development of a permanent catchment committee (the intended successor of the project-based CTF) in the future. The limited availability of the CTF was mitigated by more regular meetings with individual districts, and meetings with central level counterparts took place via bilateral visits to partner ministries and organisations and via official meetings with the Focal Points Group (Table 33). For national decision makers, PSC meetings are listed in Table 34.

The PSC is formally the only entity with official decision-making powers in the process with the CTF being a temporary entity with a limited mandate. Nevertheless, wherever a position from the local / catchment level was required, recommendations from the CTF were taken in to account, and regarded as equally important as the national recommendations from the FPG. In particular, for the MCA that will be used to prioritise IWRM packages for allocation of IIF funds, weights allocated to themes and criteria in the MCA tool by the CTF should be considered of equal importance to the weights assigned by the national PSC.

Scoping step 3: Develop a shared vision on problems, objectives and alternatives

Scoping workshops, developing vision and objectives

Having a common vision for the future is an important first step in developing a catchment plan and achieving this vision is the ultimate goal of the planning and subsequent implementation processes. It should define the "destination" that is desired. The "vision-oriented" approach starts by clearly defining the vision: "where we want to go". A catchment vision statement is the long-term aspiration of what the catchment might look like in the future, or a description of the desired state of affairs. Visioning involves prioritisation of water resources management issues through a lens of managing water for growth, development and sustainability. A vision statement was formulated so as to ensure that it is broad enough to allow for wider interpretation and buy-in from various stakeholders and general enough to give it a long lifespan and allow its constituent, medium-term plans to remain relevant in the long-term and to the plan's goal and objectives.

A scoping workshop was held with the entire catchment task force (Muvumba scoping workshop report, W4GR TR54, 2016) and the workshop was supported by experts from NCEA. This workshop resulted in an overview of issues and opportunities for the catchment, which were subsequently prioritised by the CTF members. Next, an initial overview of existing catchment PPPs was generated, and this constituted the start of a detailed consistency analysis (see Annex 4). Subsequently, the United Nations Sustainable Development Goals (UN SDGs) were used as inspiration for development of draft general and specific objectives (see Annex 8).

The draft vision and objectives were then further analysed, and wording was harmonised with that used for other catchments. The guiding values and principles listed below, and as derived from international IWRM literature, e.g. UNESCO (2013), River Basin planning: Principles, procedures, and approaches for strategic basin planning), and best practice from South Africa, were used to finetune the wording. The final version of the vision and objectives was reported in 'Catchment Plan Muvumba, Characterisation and Vision' (W4GR TR20, 2016) that was itself submitted for feedback to the CTF and the national focal points of partner ministries. As no issues were raised by the CTF or by focal points, the vision and objectives were deemed final and approved.

Guiding values and principles

The catchment planning process is guided by the content of national policy statements vis-à-vis water resources conservation, water allocation, policy legal and institutional frameworks, water resources, climate change resilience, capacity building, and other crosscutting issues. Hence the following guiding principles are taken into account in the process of formulating the catchment plan[53]:

- **Equity:** This principle requires that economic, social and environmental benefits accruing from management and development of catchment water and land resources are shared in a fair and equitable manner amongst different groups. Equity considerations may be appropriate between different districts, between upstream and downstream communities, between different livelihood groups, and between water use sectors (including the environment), as well as in protecting and promoting interests of vulnerable and socially marginalised groups;
- **Environmental protection or sustainability:** This principle relates to managing water and land resources to maintain ecological integrity while meeting the needs for social and economic development;
- **Economic efficiency:** Efficiency is one of the pillars in the Global Water Partnership's definition of integrated water resources management. Economic efficiency entails achieving the greatest benefit to for the largest possible number of beneficiaries within the available financial and water resources;
- **Balanced development:** This principle requires catchment planning to balance, in a fair and transparent manner, competing needs and interests from the diverse community of water users (such as between agricultural irrigation and hydropower generation, and between livestock grazing and forest conservation);
- **Cooperation and participation:** Cooperation and coordinated actions are the hallmarks of integrated planning. This principle recognises the need for fostering goodwill and promoting alignment and joint actions among institutions and groups with overlapping roles and mandates as a way of achieving sustainable results. The related principle of participation requires that the stakeholders of the Catchment, who stand to benefit or lose from the planned interventions of the plan, be given an opportunity to influence its development and outcomes.

Developing plan alternatives

Plan development in Rwanda normally follows a technocratic, usually centrally orchestrated, straightforward process towards a single set of measures, without broad stakeholder consultation.

[53] The principles have guided the thinking processes but have not been linked to individual interventions in the programme of measures. The intervention logic adheres to the specific objectives yet may need to be further developed to be harmonised with NST1 outcomes.

Development, and subsequent assessment, of plan alternatives by and with stakeholders and through consensus building was, therefore, new to all stakeholders, and possibly a first for Rwanda. The idea of developing and comparing truly different alternative development options to reach a predefined goal and objective ('plan alternatives') was introduced by SEA coaches from the NCEA. In doing this, several sensitivities had to be overcome, such as making a comparison between a 'business as usual' alternative versus a new alternative, e.g. an 'IWRM alternative'. This was difficult as preferring a new alternative over 'business as usual' might be perceived as criticism of existing governance of water and land resources. Naming of proposed alternative approaches also, therefore, proved to be more of an issue than their actual development, albeit that each alternative had to stay within the top-down guidance of existing major policies. The process of plan alternative development for this catchment plan was done in three phases.

Phase 1: Development of main alternatives

A first set of alternatives was developed among the W4GR partners of the IWRM Department and the ISU, based on a characterisation and vision report (W4GR TR20, 2016). Initially the alternatives were named 'Business as Usual' (BaU) and 'IWRM Alternative'. Their contents were developed in an internal workshop (Minutes of Meeting, 19 August 2016, available at W4GR) and defined as those projects that relate to the management or use of land and water resources and that have already, or that are very likely to, obtain(ed) finance within approximately the next three years. The IWRM alternative was developed in such a way that it optimally reflected the vision and objectives.

Phase 2: Model development and quantification of alternatives and sub-alternatives / variations

The alternatives were further detailed in WEAP models, to quantify effects on water balance. In this phase, two main alternatives were renamed to 'Planning by Administrative and Sectoral Boundaries' (PASB, referring to BaU) and Planning by Catchment Boundaries' (PCB, referring to IWRM) respectively. In WEAP, a further set of scenarios was developed to represent baseline and autonomous developments[54], based on the key driving forces of economic growth, climate change, and population growth, as well as different sub-alternatives or variations of the PCB main alternative. A full explanation of the process followed, alternatives and variations simulated, and of the results were provided in the report Water balance and allocation modelling in Rwanda (W4GR TR29, 2017).

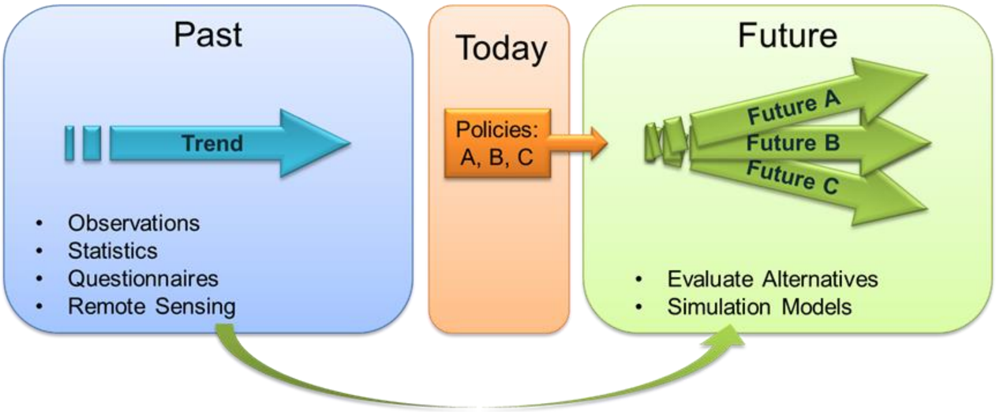


Figure 70: Approach to comparison of alternative future scenarios, based on modelling past, present, and future

In summary the following projections and alternatives were analysed within TR29:

- Baseline: Current status;
- Projections (each with a low, medium or high version):
  - Climate Change (temperature, precipitation and potential evaporation);

[54] Autonomous developments, or projections, are developments that occur beyond the influence of the catchment plan. In de models, the following autonomous developments were simulated for 2024, 2030, and 2050: economic development (based on national ambitions and forecasts), population growth (based on national forecasts), and climate change (based on national reports to the IPCC).

  - Population growth;
  - Macro-economic development;
  - Combined;
- Alternatives:
  - PASB: Planning by Administrative and Sectoral Boundaries (previously called: Business as Usual);
  - PCB: Planning by Catchment Boundaries (previously called: IWRM);
  - Variations of PCB with six6 options, namely:
    - investigating isolated effectiveness of measures in agriculture;
    - storage;
    - irrigation water savings;
    - industrial water savings;
    - domestic water savings; and
    - enhanced water productivity;
  - PCB+: Planning by Catchment Boundaries with enhanced catchment rehabilitation;
  - PCB-: Planning by Catchment Boundaries with water saving through reduced irrigation development.

Note that these scenarios (= generic name of a "projection" or "alternative") were evaluated for three-time horizons:
- 2024: To reflect results of the first implementation period 2018-2024;
- 2030: Target year for the Sustainable Development Goals;
- 2050: Distant planning horizon.

Combining all these projections, alternatives and time horizons led to a total of 67 scenarios that were analysed, and the full report of first model development and related results can be found in W4GR TR29 (W4GR, 2017). An overview of the entire modelling exercise for this catchment plan is provided here in Annex 6.

Results of the 67 model runs were summarised and their likely effects analysed by means of a set of hydrological key performance indicators.
- **Water demand**: Total demand for domestic, industry, livestock and irrigation (MCM/y);
- **Water shortage / unmet demand**: Water shortage (unmet demand) based on theoretical water demand for the specific scenario (MCM/y);
- **Water short months**: Number of months over 10 years where water shortage occurs (nr);
- **Evaporation demand**: Demand of entire catchment, including rainfed, excluding irrigation (MCM/y);
- **Evaporation shortage**: Shortage (MCM/y);
- **Average flow**: Average mean flow over 10 years leaving the basin (MCM/y);
- **Peak flow**: Highest flow over 10 years (MCM/y);
- **Low flow**: Lowest flow over 10 years (MCM/y);
- **Fast runoff**: Fast (surface) runoff (MCM/y);
- **Slow runoff**: Slow (base) flow (MCM/y);
- **Groundwater recharge**: Groundwater recharge (MCM/y).

A preliminary preferred alternative was selected by the catchment task force for catchment plan version 1.0, the assessment for which was based on model results of step 2 and W4GR expert judgement of alternatives on themes of ecosystem services, economic development, social development, and water governance & institutional development. PCB+ was selected as the preliminary preferred alternative and hydrological KPIs and maximum focus on sustainable catchment rehabilitation were considered the most important selection criteria. The preliminary preferred alternative was then confirmed by the FPG and endorsed by the W4GR PSC. Minutes of both meetings are available at Water for Growth Rwanda.

Phase 3: Refining models of integrated alternatives and variations

After selection of a preliminary preferred alternative for catchment plan version 1.0, focus shifted to improvement of initial models with a view to making them more realistic and easier to understand. This applied to both baseline and the future projections of autonomous developments, as well as to plan alternatives. Four new alternatives were developed, all based on alternatives of the previous phases, as show in Table 31.

Detailed results of this phase are presented in Section 7.3 of this Annex and the model results elaborated in Annex 9. A main conclusion of the model simulations was that the only alternative that came close to avoiding unmet water demand completely, was the RI+S+SLM+E alternative (i.e. the most ambitious alternative). The CTF was informed on this and a recommendation was given to consider this as the potential preferred alternative for the catchment. Subsequently, in meetings of the FPG (28 February 2018) and the PSC (14 March 2018), the selected alternative was endorsed, under the condition that unmet water demand would be completely avoided. This was subsequently achieved (for average to wet years) by finetuning the water allocation plan per sub-catchment, per month, and per time horizon 2024; 2030; 2050. The resulting water allocation plan is included in Annex 9 of this catchment plan.

Table 31: Refined alternatives for Catchment Plan 2018-2024

Alternative abbreviation	Alternative content
S	Increased water storage (not applicable in Sebeya, due to lack of opportunities).
S+SLM	Increased storage and sustainable land management practices.
S+SLM+E	Increased storage, sustainable land management practices, and enhanced water use efficiency.
RI+S+SLM+E	Reduced development of irrigation, increased storage, sustainable land management practices, and enhanced water use efficiency.

From preferred alternative to Programme of Measures

The preliminary preferred alternative from catchment plan version 1.0 (alternative PCB+) formed the starting point for listing relevant ongoing and planned interventions. The final preferred alternative (known as RI+S+SLM+E in WEAP, and further refined in the water allocation plan per sub-catchment (see Annex 9), as selected in the PSC meeting of 14 March 2018[55], forms the basis for the programme of measures in this catchment plan.

A series of tools and methods was used to arrive at a coherent, integrated programme of measures for the catchment plan. Figure 71 presents the content elements (inputs and outputs) alongside the tools and methodologies (process) that were used.

The preliminary programme of measures was analysed to assess whether it contained sufficient interventions to achieve the plan objectives, and whether the proposed projects in the PoM would singularly or jointly also help deliver the preferred alternative. The main conclusions of this assessment were:

- **Sustainable land management practices** are duly represented in the catchment rehabilitation plan and the knowledge CPIPs combined. Each individual catchment rehabilitation project that will be developed during the timeframe of the current and subsequent catchment plans needs to incorporate sufficient capacity strengthening measures, targeting the local beneficiary population;
- **Storage** development may normally be integrated into catchment rehabilitation projects, but for the Muvumba catchment the development of a multi-purpose dam is foreseen, as well as the rehabilitation, improvement, or development of a number of valley dams. Rainwater harvesting for houses and public buildings is recommended as local solution, albeit of limited significance for the catchment water balance;
- **Reduction of irrigation development** is covered aptly in the programme of measures: RAB and WRMD formed a joint task force to revise the Irrigation Master Plan to account for water availability (or lack of it) and adjust scheme location aspects at sub-catchment level;
- **Increase in water use efficiency** might be the most difficult target to reach, with targets for the next six years set at 5% efficiency enhancement in irrigation and industry, and 10% in domestic water supply. Industrial users (e.g. coffee washing stations and the tea factory) will need to develop water saving schemes. Savings in demand for / use of domestic water supply are on the agenda of WASAC and private operators, for example through their programmes targeting a broad reduction of Non-Revenue Water, in which many losses are represented. End-consumers should be made aware of the need to reduce water use in the long run, and they should be stimulated to act. This can be by fixing leaking taps and toilets, by reducing the use of tap water for non-essential purposes, and by promoting household rainwater harvesting.

[55] The W4GR Programme Steering Committee, in line with preferences from the Focal Point Group and the Catchment Task Force, selected the most ambitious alternative in terms of storage, sustainable landscape management, water use efficiency, and restricted development of new irrigation schemes, to arrive at sustainable water allocation in the catchment, in support of green growth. The PSC requested W4GR (the WRMD and ISU) to finetune the preferred alternative at sub-catchment level, in order to allow maximum irrigation development in sub-catchments with abundant water resources, and restrictions in sub-catchments with limited resources compared to total demand from all water users. This finetuned preferred alternative is incorporated in this catchment plan.

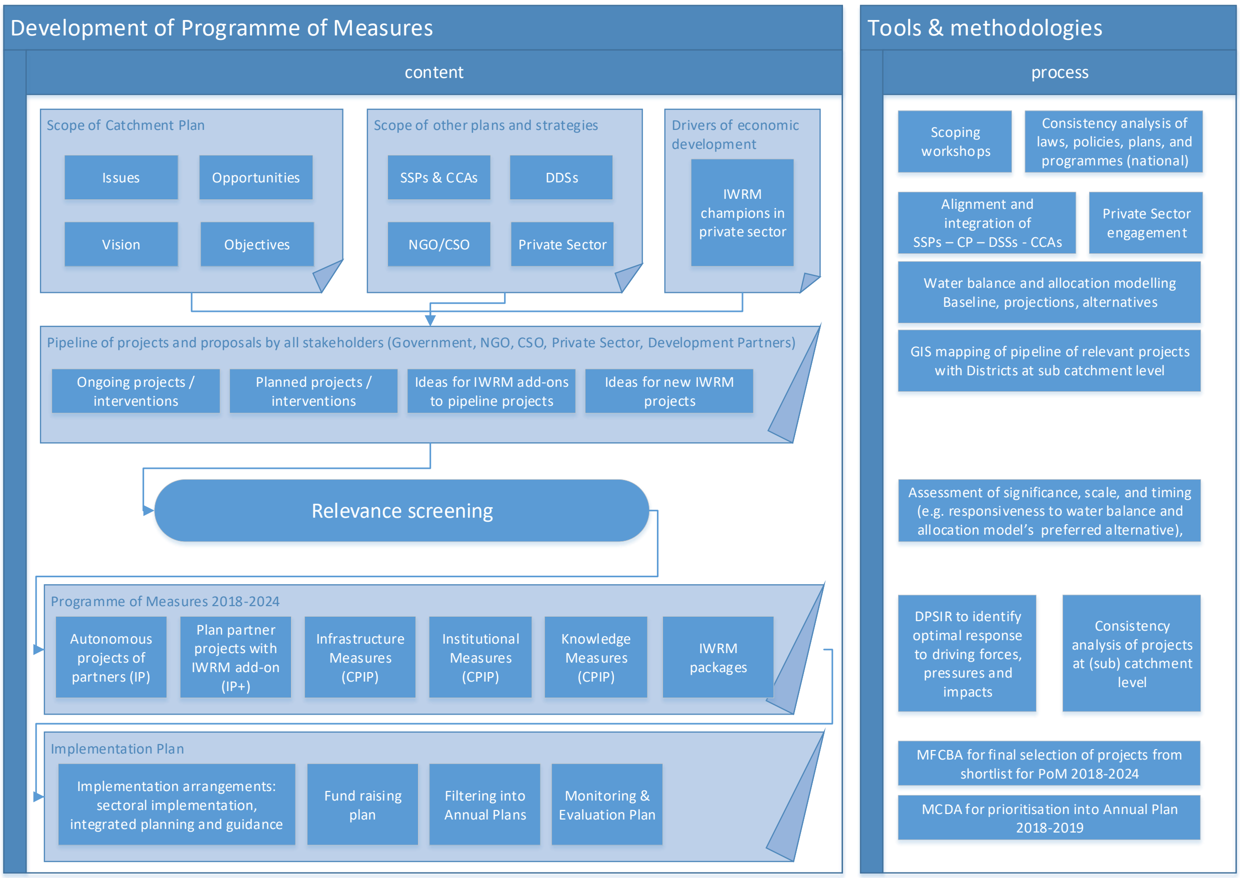


Figure 71: Development framework for catchment plan Programme of Measures

Integration of gender aspects in the catchment plan

The Dublin principles on IWRM stress the importance of incorporation of gender aspects in water management. Traditionally, men are often more involved in decision making on IWRM, whereas women often are the most important water users at household level. Gender aspects and processes adhered to in the catchment planning process are laid down in the Gender Strategy developed under Water for Growth[56]. In summary, the strategy explains that the involvement of women and men differs between subsequent stages of catchment plan development.

In the initial stages, the composition of the Catchment Task Force and of different stakeholder groups included women and their representatives (notably, the CTF includes a representative of the National Women Council). Many stakeholder groups are, however, composed of members as per their position (e.g. district environmental officers). Considering the fact that, in some positions in Rwanda, representation of women is either very low or very high in general, limited influence could be exerted on gender balance in each group related to development of the catchment plan, notably resulting in an under-representation of women in several fora and meetings. A recommendation related to this would be to increase the percentage of women in key positions relating to water management in governmental entities. During the situational analysis, and in so far as was possible, data collection was disaggregated between men and women. Women and men jointly developed the vision for the catchment and influenced the approach (terms of reference) for catchment plan development.

The current catchment plan 2018-2024 introduces gender mainstreaming guidelines for the development of implementation projects, and hands-on recommendations in the individual CPIP concept notes

[56] Water for Growth Rwanda, 2017, TR10 – Gender Strategy

presented in the plan. These guidelines are rooted in the assessments of gender needs and roles identified through participatory approaches conducted in the catchment area.

Integration of climate change in the catchment plan

Catchment planning needs to take into account the potential impacts of climate change and is an outstanding example of incorporation of both mitigation and adaptation measures in response. Measures like reforestation or agroforestry combine soil and water conservation (adapting the catchment to more erratic rainfall patterns and longer droughts) with carbon sequestration (reducing the level of greenhouse gas CO_2 in the atmosphere. In this catchment plan, climate change projections have been fully incorporated in the underlying water balance and allocation model that informed decision making between different plan alternatives. Moreover, climate change mitigation and adaptation measures have been mainstreamed in different ways in the programme of measures.

During the alignment phase, climate change considerations were fully integrated at a more detailed level, using Rwanda's Intended Nationally Determined Contribution (INDC), resulting in a final programme of measures that optimally supports Rwanda in its ambitions for sustainable development, while minimising adverse impacts of climate change. The INDC for Rwanda has been included in Annex 11.

Scoping step 4: Consistency analysis

A national level consistency analysis of laws, regulations, policies, and plans was carried out during the development of the Catchment Plan, the results of which are reported in TR16 – Consistency Analysis and summarised in Annex 4 of this catchment plan.

A pro-active consistency analysis, or consistency enhancement process, was further carried out in the alignment and integration phase. Here, the catchment plan was aligned with existing or planned national strategic plans for the same implementation period of 2018-2024, namely: the National Strategy for Transformation (NST1), the Sector Strategic Plans (SSPs), the Cross Cutting Areas (CCAs) (see Figure 2 for the position of catchment plans in the national and local strategic framework of Rwanda, and Annex 4 as a whole).

Subsequently, a consistency analysis at the level of the catchment and sub-catchments was carried out as part of the alignment and integration phase, during the development of the programme of measures. This entailed alignment of the plan with the District Development Strategies (DDSs) through a series of district alignment visits. During these visits, up-to-date information on ongoing and planned projects, including their physical location, as well as on key issues and opportunities, was obtained and mapped. District and W4GR staff jointly identified key options for development of CPIPs and for additions to planned IPs (IP+s). The results were digitised in GIS and a long list of IPs and potential IP+s and CPIPs also developed in Excel. A first analysis of the Programme of Measures was undertaken to determine potential measures and this list eventually formed the basis for the projects database that will be shared with the CTF and plan partners.

The final step was alignment of the catchment plan intervention logic with that of the NST1, SSPs (with embedded CCAs), and DDSs. A workshop, in which Directors of Planning from 11 districts, planners from MINAGRI, WASAC, and the Ministry of Environment, the DDS representative of MINALOC, and the vice chairpersons of two CTFs participated, was held to align the log frames of the NST1, SSPs, DDSs, and the CP. All workshop results and additional materials were subsequently analysed and summarised in a single, catchment plan log frame, aligned with NST1, SSPs, CCAs, and DDSs. This allowed for development of an optimally integrated Annual Implementation Plan and for monitoring and evaluation according to one single set of indicators that can be geographically aggregated from sub-catchment, to catchment, to district and eventually national level. This way, the contribution of catchment plans and catchment planning to NST1 can be documented (see for details chapter 4. and Annex 4), thus demonstrating the added value of an IWRM approach through catchment planning.

Scoping step 5: ToR for technical assessment

Developing criteria for the technical assessment of alternatives
The technical assessment of the plan alternatives followed the two phases of plan development. For Catchment Plan version 1.0, the following steps and tools were identified:

- Development of a first set of criteria for a few themes, namely: Economy, social, environment, and water governance and constituting a basic multi-criteria analysis (MCA);
- Selection of WEAP software for water balance and allocation simulation, recognising the fact that the catchment plan is the main and only plan to guide allocation of water and to safeguard a sustainable water balance in the long run;
- Selection of a set of hydrologic parameters, or key performance indicators (KPIs) in WEAP as criteria for assessment of water balance and allocation under different alternatives.

Use of the MCA approach proved not opportune for assessment of the first series of land and water-orientated alternatives as hydrological parameters were more concrete, more trusted, and provided more distinction than the water-use alternatives that were rather abstract and offered prescriptive, rather than descriptive, guidance on, for example water saving targets.

The assessment (in SEA terminology: terms of reference for assessment) of versions 2 and 3 of the Catchment Plan 2018-2024 uses the same WEAP KPIs to analyse updated catchment models and refined plan alternatives, and a more detailed set of criteria in a refined MCA, which was used to prioritise IWRM packages and CPIPs to be included in the first Annual Implementation Plan.

Assessment step 6: Assess impacts of alternatives

Assessment of the impact of different alternatives was done in two phases. Firstly, a set of alternatives was assessed on their hydrological performance with the best performing, in terms of limited unmet water demand, selected as the starting point for development of a new set of alternatives in a second phase. Development of the second set of alternatives coincided with quality improvements of the catchment model (for more details, see Annex 9 and W4GR TR62, 2017) within which simulations of baseline and autonomous development scenarios were slightly adapted, and new alternatives simulated against an updated, medium future projection. When this was done, one of the alternatives, namely RI+S+SLM+E[57], almost met the most important criterion, i.e. zero unmet water demand.

This alternative was adopted by the CTF, FPG, and PSC as the preferred alternative, under the condition that a refinement was made at sub-catchment level to minimise any required restrictions in the development of new irrigation schemes whilst still avoiding unmet water demand. This has been achieved in the final preferred alternative, which is a combination of S+SLM+E and RI+S+SLM+E, differentiated at sub-catchment level, as expressed in the water allocation plan presented here. The water allocation plan for Muvumba details the amount of water to be allocated to each water use category, including the environment, per sub-catchment and per month. The preferred water-use alternative and the water allocation plan also include targets for water saving in the domestic, industrial, and irrigation sectors. All plan partners, as well as private sector water users, need to join hands to achieve the targets for enhanced water use efficiency, for sustainable land management, and for a controlled growth or irrigated area.

In the alignment and integration phase that was implemented as part of the process to complete Catchment Plan 2018-2024, a second MCA tool was developed in Excel. Here, content experts (from W4GR) scored individual projects on their merits (including their expected contributions to the targets of the preferred alternative), and decision makers could then be assigned weights to themes and individual criteria. Lacking a formal decision-making body, because the new Water Law is not yet in place, CTF members and senior district planners provided weights as did the FPG. An assessment of the joint results

[57] Combination of sustainable land management, efficiency gains in irrigated agriculture, industry, and domestic water supply, with controlled / reduced development of new irrigation schemes (50% of the original IMP target)

of CTF and FPG weighting led to recommendations being made to the PSC meeting. The PSC recommended that W4G carryout a series of feasibility studies for the top ranked IWRM packages will subsequently decide which of these should receive IIF funds in the Annual Implementation Plan 2018-2019.

Assessment step 7: Quality assurance

This was a process to undertake quality assurance of the documentation used by decision makers in supporting the ultimate decision on the preferred alternative. The catchment plan and the SEA justification were combined into one document and the plan owner (RWFA) decided to submit it to the competent authority in Rwanda, i.e. MINENV/REMA, upon incorporation of any comments from the PSC.

The main description of the SEA process is found in this Annex; the outcomes of the process are included in the main text of the catchment plan and other background materials, as listed in this Annex and in the list of references of the plan, will be made available either online through the W4GR SharePoint website, or upon request.

Formal decision-making step 8: Discuss preferred alternative

The discussion on the preferred alternative was held in four forums; the CTF; the FPG; and the PSC. Refinement of the alternative then took place resulting in that presented in this catchment plan. This plan will again be submitted for approval to the PSC and subsequently endorsed in the Senior Management Meeting of MINENV. Subsequently, the plan will be submitted to the Prime Minister’s Office for ultimate endorsement and gazetting.

Formal decision-making step 9: Motivate the (political) decision in writing

The motivation of the political decision and any amendments or changes will be recorded in minutes of Cabinet and/or Parliament. The underlying motivation behind the strong focus on water allocation is reflected in the many occasions of water stress and drought in the country. The strong focus on catchment restoration is motivated by the high soil erosion rates in sloping areas, which reduces fertility and productivity of the land, and the related pollution of rivers with sediments, which leads to high costs of water treatment, as well as physical damage to intakes, and to regular flooding of downstream river sections.

Monitoring step 10: Monitor the implementation and discuss results

Since the catchment plan is a joint plan of multiple plan partners, at national and local level, and each has their own role and mandate, a joint monitoring approach is required. Chapter 5. which describes the overall approach to monitoring of plan implementation, including a log frame with a related M&E framework, provides a proposal for the establishment of a joint monitoring team. This should preferably be linked to the catchment management support team / Permanent Secretariat to the Catchment Committee and comprise catchment, as well as national, representatives. An institutional measure to establish such a monitoring team is provided for in Annex 6. An M&E Plan, based on the CP log frame and M&E framework, also needs to be developed by the joint monitoring team. This should include M&E elements of an Environmental and Social Management Plan (ESMP), which is an SEA tool, required to set the stage for subsequent EIAs / ESIAs for individual (infrastructural) implementation projects from the programme of measures.

7.3 Outputs summary of IWRM/SEA process

Whereas the previous sections addressed the ten SEA steps, Table 35 below provides an overview of the entire integrated IWRM / SEA process. Table 32 provides details of the locations etc. of meetings held with the CTF or with individual districts and Table 33 presents an overview of meetings of technical focal points of partner ministries. The latter group of experts provided feedback on the draft catchment plan and roadmap as well as recommendations to the PSC of W4GR. PSC meetings are listed in Table 62.

Table 32: Overview of catchment plan development workshops held with CTF and individual districts

Meeting	Date	Location	Participants	% women
Muvumba and Nyabugogo, catchment planning process scoping workshop	06/01/2016	Gicumbi	67	28
DHBC training Kayonza (Nyabugogo catchment) and Nyagatare (Muvumba catchment)	02/05/2016	Rwamagana	40	20
Muvumba catchment: validation workshop on alternatives and measures	07/02/2017	Gicumbi	12	17
Muvumba catchment committee meeting: implementation of the catchment plan, version 1.0	12/05/2017	Gicumbi	7	29
Alignment of Muvumba and Nyabugogo catchment plan to Gatsibo District plan	14/06/2017	Gatsibo	23	13
CP2.0 Mapping and alignment to DDS (Nyagatare District)	31/10/2017	Nyagatare	10	30
Alignment of Muvumba catchment plan to Gicumbi District plan	05/11/2017	Gicumbi	31	11
Alignment of Muvumba catchment plan to Nyagatare District plan	07/11/2017	Nyagatare	24	25
CP2.0 Mapping and alignment to DDS (Gicumbi district)	07/11/2017	Gicumbi	9	11
CP2.0 Mapping and alignment to DDS (Gatsibo district)	14/11/2017	Gatsibo	8	25

Table 33: Overview of W4GR Focal Point Group meetings

Meeting	Date	Participants	% women
Focal Point Group meeting (1st)	20/01/2016	6	0
Focal Point Group meeting (2nd)	21/06/2016	3	0
Focal Point Group meeting (3rd)	01/09/2016	3	0
Focal Point Group meeting (4th)	12/12/2017	3	0
Focal Point Group meeting (5th)	10/02/2017	10	10
Focal Point Group meeting (6th)	10/03/2017	9	11
Focal Point Group meeting (7th)	18/07/2017	8	13
Focal Point Group meeting (8th)	28/02/2018	FPG: 4 / CTF: 4	0 / 75

Table 34: Overview of W4GR Programme Steering Committee meetings

Meeting	Date	Participants	% women
PSC meeting (1st)	27/01/2016	12	17
PSC meeting (2nd)	31/03/2016	9	22

PSC meeting (3rd)	19/07/2016	6	50
PSC meeting (4th)	05/04/2017	11	27
PSC Meeting (5th)	03/10/2017	8	38
PSC Meeting (6th)	14/03/2018	PSC: 7 / CTF: 5	14 / 60

Table 35: Detailed catchment planning process, activities, and results, integrating IWRM and SEA principles

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
Start plan process	▪ Install Catchment Task Force and identify additional stakeholders at central and decentralised Government, NGOs, Civil Society Organisations, and private sector; ▪ Agree on roles, responsibilities and process structure.	▪ Instruction on formation (positions) and roles of CTF sent by MINIRENA to Districts (January 2016); ▪ Election of CTF core team by and from among CTF members in scoping workshop; ▪ Letter from Minister, establishing the core teams of CTF; ▪ Development of stakeholder analysis in CP1; ▪ Development of initial process structure; ▪ Subsequent regular updates of process structure.	▪ CTF established, including composition and roles/responsibilities; ▪ CTF core team established; ▪ Stakeholder analysis reported in CP1, and repeated in this catchment plan; ▪ First roadmap for development of catchment plan (January 2016); ▪ Updated roadmap in CP1 (March 2017); ▪ Several updates of roadmap, to align planning of CP development with (changes in) national planning process for NST1 / SSPs / DDSs.
Situation analysis	Characterisation of the catchment, in terms of land & water systems (technical, social, economic, gender and sustainability aspects).	▪ Based on NWRMP and underlying datasets, data were analysed in more detail, at catchment level; ▪ Production of spreadsheets and GIS maps, based on national statistics and other existing and available data, presenting catchment characteristics at district/sector/cell level.	▪ TR12-TR15, Catchment characterisation reports (initial drafts of catchment plans, January 2016); ▪ TR17-TR20, Catchment characterisation and vision reports (June 2016).
Stakeholder priorities	Identification of stakeholder issues and opportunities, and prioritisation of both.	▪ Stakeholder inventory developed during scoping workshop (June 2016);	Scoping report (June 2016), covering issues and opportunities,

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
		▪ Joint definition of stakeholder issues and opportunities with CTF (June 2016).	stakeholders, initial consistency analysis, and vision and objectives.
Vision development	▪ Development of catchment vision(s) and overall and specific objectives, addressing priority issues & opportunities; ▪ Definition of alternative pathways to reach the plan objectives.	▪ Vision and objectives developed during scoping workshop; ▪ Initial inputs were formulated during the scoping workshop, for subsequent development of alternatives; ▪ Alternatives were further developed during scoping workshops for Muvumba and Nyabugogo in June 2016.	▪ Scoping report for Muvumba and Nyabugogo (June 2016), covering issues and opportunities, stakeholders, initial consistency analysis, and vision and objectives; ▪ Two main alternatives: Business as Usual (Planning by Administrative and Sectoral Boundaries) versus IWRM approach (Planning by Catchment Boundaries).
Consistency analysis	▪ SWOT analysis of existing Policies, Plans, and Programmes; ▪ What other policies have constraining or win-win consequences for the catchment? ▪ Which feedback needs to be provided to existing PPPs, from a catchment plan point of view?	▪ Initial CTF consistency analysis of main policies during scoping workshop; ▪ National level consistency analysis op laws, regulations, policies and plans (July – September 2016); ▪ Paper based mapping and consistency scan of ongoing and planned projects at sub-catchment level during SEA-CP workshop (October 2016); ▪ Alignment & Integration process between NST1 / SSPs / CCAs / CPs / DDSs (July 2017 – January 2018) including meetings at all districts and participation in national level working group meetings (SWGs and TWGs) of key NST sectors and listing, mapping, and	▪ Scoping report (June 2016), covering issues and opportunities, stakeholders, initial consistency analysis, and vision and objectives; ▪ TR16 – Consistency Analysis report; ▪ TR64 – SEA-CP workshop report; ▪ Various inputs to SSPs and DDSs; ▪ Overview of key points from SSPs, CCAs, and DDSs and feedback to these documents, presented in this catchment plan; ▪ Programme of Measures, listing IP/IP+/CPIP (this catchment plan); ▪ Maps of IP/IP+/CPIP (this catchment plan);

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
		consistency assessment all projects (ongoing, planned, and new ideas (IP, IP+, CPIP) at sub-catchment level; ▪ W4GR national alignment workshop NST1-SSP-CP-DDS (Muhanga, 18-19 April).	▪ Alignment workshop report (April 2018).
Terms of Reference	Set ToR for detailed assessment of alternatives, including assessment criteria, and for ultimate plan development.	▪ Development of set of criteria during CP-SEA workshop (October 2016); ▪ Selection of WEAP software for water balance and allocation simulation; ▪ Selection of key parameters in WEAP as criteria for assessment of water balance and allocation under different alternatives.	▪ ToR for WEAP modelling exercise by FutureWater (the Netherlands); ▪ List of criteria in CP/SEA workshop report of October 2016 (TR64).
Planning & assessment	▪ Detailed studies for catchment planning, including a survey of water users and a study into water balance and water allocation under different alternatives and scenarios, incorporating remote sensing and modelling techniques; ▪ ↻ Iteration: design the alternative with maximum benefits and minimum negative impacts; ▪ Definition of programmes of measures (physical projects and institutional developments) for each of the plan alternatives;	▪ Water users survey was carried out (October-December 2016); ▪ Initial water balance and allocation modelling, using WEAP software (FutureWater, July 2016 – March 2017); ▪ Analysis of WEAP results at catchment and sub-catchment level (W4GR-ISU and RWFA-WRMD, April – August 2017); ▪ New water balance and allocation modelling (RWFA/WRMD, July – November 2017); ▪ Adapting roadmap to integrate the alignment phase into national strategic planning (NST1 / SSPs / CCAs / SSPs); ▪ District Development Strategy meetings were held at all districts in the catchment,	▪ TR28 – Water Users' Survey (March 2017) including spreadsheets and GIS maps of water users; ▪ TR29 – Water balance and allocation modelling in Rwanda (March 2017); ▪ TR58 – Water balance and allocation modelling, Muvumba catchment (August 2017); ▪ TR62 – Water balance and allocation modelling in Rwanda, Muvumba catchment draft final report (November 2017). Several subsequent versions of working versions of CP/SEA roadmap;

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
	▪ Definition of mitigation/compensation measures for remaining negative impacts in feasibility studies and detailed designs; ▪ Development of the catchment plan with technical annexes (3 main iterations, CP versions 1,2,3); ▪ Development of detailed water allocation plans in this catchment plan; ▪ Development of water governance plan in this catchment plan; ▪ Development of new Land Use Land Cover map covering 2017 remote sensing images, in this catchment plan; ▪ Development of Catchment Restoration Opportunities Map (in this catchment plan) and decision support tool for future use and regular updates and upgrades, with RWFA and RLMUA; ▪ Incorporate log frame and M&E framework (see alignment phase, below).	to identify ongoing and planned projects (IPs), to identify opportunities for upgrading IPs with elements of the preferred alternative and/or to integrate mitigation / compensation measures, to IP+; and to develop new IWRM measures (CPIP) to arrive at comprehensive Programme of Measures (PoM) in line with the preferred alternative (October – December 2017); ▪ IP/IP+/CPIP locations/areas were digitised, and GIS maps developed to allow for integrated assessment (November-December 2017); ▪ PoM sessions were held to develop coherent IWRM packages and to select best early CPIP candidates for IIF co-funding (November 2017 – January 2018); ▪ Development of this catchment plan for the period 2018-2024, in line with NST1 and other strategic plans of Rwanda.	▪ Long list of measures (IP/IP+/CPIP); ▪ GIS maps with digitised areas of issue and opportunities; ▪ GIS maps with digitised intervention areas of IP/IP+/CPIP; ▪ This catchment plan (versions in January 2017, March 2018, May 2018); ▪ LULC; ▪ CROM maps; ▪ CROM DSS tool; ▪ FS/DD for EIPs (2016-2018); ▪ FS for CPIPs / IWRM packages (June 2018).
Decision making on version 1.0	▪ Discuss with catchment task force and key additional stakeholders the alternatives and select the preferred alternative as starting point for the alignment process;	▪ Meeting with the CTF held on 7 February 2017, in which MCA was carried out to select preferred alternative (PCB+);	▪ Meeting report CTF 7 February 2017; ▪ Minutes of Meeting / Action & Decision list of PSC meeting 5 April 2017;

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
	▪ Support decision making on the catchment plan version 1.0 by the Water for Growth Rwanda Programme Steering Committee (PSC); ▪ Identify urgent and no-regret Catchment Plan Implementation Projects that can be supported using readily available funds, including the IWRM Investment Fund.	▪ PSC meeting of 5 April 2017 approved CP version 1 and the plan for the alignment phase towards CP2018-2024; ▪ PSC meeting of 5 April 2017 assigned areas in Murama (Nyabugogo) and Upper Muvumba for CPIP development.	▪ Draft concept notes for CPIPs Murama and Upper Muvumba.
Review	Quality assurance of documentation (by REMA as competent authority, and preferably involving stakeholders).	▪ REMA was requested to provide feedback on CP version 1.0, but no response was obtained (SEA reviews were not included in REMA plans up to FY 2018-2019); ▪ MINIRENA requested partner ministries to provide feedback on CP version 1.0, and to incorporate its findings in the sectoral strategy plans under development; ▪ The Embassy of the Kingdom of the Netherlands (EKN) requested an unofficial, yet independent review of CP version 1.0 from the Netherlands Committee for Environmental Assessment (NCEA); ▪ CP version 2.0 was used in joint SEA review training by REMA and WRMD (2018); ▪ CP version 3.0 (the current plan) will be submitted to REMA for official review.	▪ Letter by DG MINIRENA/RNRA to REMA, requesting review of CP1; ▪ Letter by PS MINIRENA to partner ministries, requesting feedback and follow up on the CPs version1.0; ▪ Letter with review from NCEA, October 2017; ▪ Response letter to NCEA, via EKN (28 November 2017, internal document); ▪ Actual response: enhanced narratives on implementation of SEA in this catchment plan 2018-2024, in particular in current Annex.

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
Alignment process	Originally planned process: ▪ Conduct sector dialogues to align the catchment plan and sectoral ministries' 5-year strategic plans as well as plans of private sector, NGOs/CSOs, and development partners in the key sectors; ▪ Conduct district dialogues to align the catchment plan and district 5-year strategic plans, as well as the private sector, NGOs/CSOs, and development partners in the district; ▪ Develop joint programmes of measures to be implemented in the 5-year period 2018-2023; ▪ Develop joint performance contracts to guarantee implementation of the joint programmes of measures; ▪ Update the catchment plan version 1.0 with the results of this step, to arrive at version 2.0; Adapted process: ▪ Provide input to 'projections' for Vision 2050, NST1; ▪ Align with key water using economic sectors via participation in Sector Workings Groups, Thematic Working	▪ Inputs were given to the development of the Vision 2050 and NST1, through the Director of Planning of MINIRENA; ▪ Participated in several SWGs/TWGs, notably those for agriculture and WASH; ▪ Feedback was given to several draft SSPs and CCAs, notably for agriculture, WASH, gender, climate change; ▪ An IWRM mainstreaming checklist was prepared, along the existing ones for e.g. gender, and provided to MINECOFIN for review / distribution / inclusion in the CCAs. To date (May 2018), IWRM has not yet made it to the level of CCA; key IWRM elements like gender, climate change, and environment, have a different status; ▪ Participated in several meetings at district level: JADF meetings, Imihigo meetings, and DDS development meetings, as well as the PoM meetings; ▪ Alignment workshop NST1-SSPs-CCAs-CPs-DDSs held 18-19 April 2018; ▪ CP log frame aligned with NST1-SSPs-DDSs. CCAs do not have their own log frames or strategies, but are incorporated throughout NST1, SSPs, DDSs, and CPs;	▪ General remark: Water for Growth Rwanda, the programme that developed this catchment plan, got to be regarded as a programme of talkers, whereas traditional donor-funded projects usually proceed towards implementation projects rapidly. The alignment process was adapted to reduce the interaction with the CTF and partner ministries. Whereas the new integration into the national processes around Vision 2050, NST1, SSPs, CCAs, and DDSs has its merits, this has had ramifications on the level of integration and alignment at catchment level, and delayed the development of concrete programmes of measures; ▪ Several short meeting reports of meetings with districts; ▪ Contributions to several SSPs and CCAs; ▪ Contributions to NST1 and MINECOFIN mainstreaming guidelines are pending;

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
	Groups, and support the development of Sector Strategy Plans; ▪ Align with Cross Cutting Areas of NST1; ▪ Align with District Development Strategies and Imihigos through regular meetings, focusing on sub-catchments with overlays in the districts; ▪ Align with private sector initiatives or opportunities on ad-hoc basis, promoting innovators / early adapters as drivers of economic development.	▪ A small number of private sector initiatives was selected and worked out to the level of CPIP, to act as catalysts and best practise examples within and outside the catchment.	▪ The overall result is the programme of measures in this catchment plan.
Formal decision making on version 2.0 and 3.0	▪ Support decision making on version 2.0 by the sequence of CTF-FPG-PSC; ▪ Incorporate feedback from PSC in version 3.0; ▪ Support decision making on version 3.0 by the sequence of CTF-FPG-PSC; ▪ Support WRMD in obtaining approval from Senior Management Meeting MoE; ▪ If required, assist WRMD / RWFA / MoE in motivating the draft (political) decision in writing; ▪ Alternatively, the motivation is recorded in minutes of Cabinet	▪ Meetings with the CTF (planned for January 2018) to discuss PoM and CPIPs and to obtain endorsement for the catchment plan; ▪ Meeting with W4GR Focal Group to prepare for PSC meeting; ▪ Meeting with W4GR PSC to approve or comment on the draft catchment plans; ▪ Development of final catchment plans; ▪ Submission of catchment plans to Prime Minister's Office, by MoE; ▪ Endorsement of catchment plans by Cabinet / Parliament as per national regulations.	▪ Minutes of Meeting of CTF; ▪ Minutes of Meeting of FG; ▪ Minutes of Meeting of PSC; ▪ Minutes of Meeting of Cabinet; ▪ Minutes of sessions of Parliament; ▪ Gazette.

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
	meetings and/or sessions of Parliament.		
Sector and agency planning	▪ Help PSC and CP partners in selection of IP/IP+/CPIP for upcoming fiscal year; ▪ Assign tasks to implementing district administrations or sector agencies; ▪ Develop Annual Implementation Plans.	Assist plan partners in development of first Annual Implementation Plan 2018-2019.	Approved Annual Implementation Plan (every fiscal year between 2018 and 2024).
Coordinated implementation	▪ Implementation by competent authorities, within boundaries set by catchment plan; ▪ Regular meetings of catchment task force representatives and central and district level implementing authorities to oversee plan implementation.	▪ Assign representatives of implementing partners and CTF to CP implementation oversight committee; ▪ Support 'permanent secretariat'/ catchment management support team; ▪ Support regular meetings, aligned with national and district planning calendar.	▪ Letters of assignment by implementing partners and from CTF chair person, supported by letters from mayors of districts; ▪ Minutes of meetings.
Joint monitoring	▪ Monitoring and Evaluation of plan effectiveness, positive and negative impacts, by stakeholders in catchment and regular monitoring organisations; ▪ Formulation of lessons learnt (for continuous learning and development of knowledge base on catchment planning) and transfer of information into the next round of catchment planning.	▪ Develop M&E plan; ▪ Assign representatives of plan partners to carry out M&E plan; ▪ Develop annual M&E reports, which include lessons learnt; ▪ Present M&E report and lessons learnt to CTF (or Catchment Committee) annually.	▪ ME& plan chapter in this catchment plan; ▪ Full M&E plan including roles, responsibilities, timing, and methodologies, in 2018-2019; ▪ Annual M&E reports from July 2019 onwards; ▪ Minutes of Meeting of Annual general meetings of CTF/CC.

7.4 Conclusions and lessons learned from IWRM/SEA process

Innovations, lessons learned and recommendations from IWRM-cum-SEA process

This catchment plan is one of the first to be produced in a truly participatory manner in Rwanda. Many innovations were involved in developing both the process and the content and a major process innovation (even at a global level) was integration of the SEA process into IWRM-based catchment planning. Another process or institutional innovation was the development of inter-district collaboration around natural resources, based on catchment boundaries, and by establishing a catchment task force comprising district vice mayors, district technical staff, and representatives of NGOs, National Women Council, and Private Sector Federation.

Innovations were also made at the technical level. GIS was used to map spatial information that is normally only shared through text and tables (information on key features, issues, opportunities, projects, etc.), and surveys were held to collect geo-referenced data on water users. In a parallel process under W4GR, water monitoring systems were rehabilitated and further developed to provide more and better information to support catchment planning and operational IWRM in the future. A beta version of a projects database has been developed, as well as a new national land cover / land use map, and catchment restoration opportunities maps (CROM) and a CROM decision support system (a tool for future use by RWFA, RLMUA, MINAGRI, and partners) has also been developed.

A key objective of W4GR has been to learn by doing, to raise awareness, and to develop recommendations for future improvements of the process and its individual technical tasks by capturing lessons learned. An overview of the key lessons learned, and associated recommendations is provided below:

1. **Lesson**: IWRM and SEA are both often referred to as participatory processes. A key difference between them is that IWRM may be regarded as an abstract framework of technical water related concepts and social processes, whereas SEA is strictly focused on a structured process, regardless of the content; both are equally valuable in shaping the participatory process used. The nature of the SEA approach means that it can take a long time before decisions are made. It does, however, provide quality and efficiency gains in the development and approval of catchment plans and has the potential to enhance buy-in of stakeholders at an early stage. International experience and best practice value the SEA process in enhancing implementation of plans by reducing opposition of stakeholders through including them at an early stage.

   Recommendation: Continue using the integrated approach of IWRM and SEA in the development of catchment plans.

2. **Lesson**: The structured process allowed for plan development in a participatory manner, with representatives of national and local government, and of NGOs, the National Women Council, and the Private Sector, with the local level brought together in the catchment task force. Furthermore, primary beneficiaries (the population and businesses in the catchment) participated at field level in the areas where EIPs were planned and implemented, and where CPIPs were / are being prepared. At all levels, the opportunity to participate from the earliest stages of plan and project development was appreciated by stakeholders.

   Recommendation: Continue to involve stakeholders at all levels and start every new process (plan or project development) with mapping out stakeholders and developing a stakeholder engagement plan, assuring gender integration from the start.

3. **Lesson**: Organisation of participatory processes takes time and effort and requires adequate financial resources. Government regulations also require up-front travel approval and mission orders for government staff. In particular MINALOC requires two weeks prior notice in the form of a formal request. This has at times hampered operations under a project setting, in which meetings cannot always be planned well in advance. But it equally requires attention once catchment

planning and catchment plan implementation are institutionalised completely in the Government of Rwanda.

Recommendation: In the institutionalisation of catchment planning, regulations, Ministerial Orders, and operational plans need to incorporate financial means, organisational capacity for planning regular meetings, and ideally standardised approvals for primarily district staff to attend meetings outside their own district.

4. **Lesson**: The CTF did not have their own financial or administrative means.

   Recommendation: Provide a budget to the CTF or its proposed successor, the catchment committee (CC). In addition, the president of the CTF / CC should have the power to convene, avoiding the requirement to obtain prior approval from MINALOC.

5. **Lesson**: The instrument of multi-criteria analysis (MCA) was new to many stakeholders; new tools were developed, and their functions explained. The concept of MCA to support decision making was appreciated.

   Recommendation: Continue use of the current MCA tool, and develop additional MCAs (based on the template, or from scratch) where needed. Take into account different roles in MCA, certainly in an SEA setting. Expert assessment is used to score on individual criteria, where opportune with stakeholder participation. Decision-making roles need to be allocated to mandated decision makers / politicians, or other stakeholders. The division of roles is just as important as the tool itself.

6. **Lesson**: SEA legislation in Rwanda is not yet implemented and draft SEA regulations require development of an Environmental and Social Management Plan (ESMP) for strategic plans such as this catchment plan. In an ESMP, SEA results are linked to subsequent Environmental (and Social) Impact Assessments (EIAs and ESIAs), which may be required for project implementation. An ESMP is designed to addresses relations between identified adverse impacts and (mitigating) measures for those, as well as the required budget, timing, responsible parties, and indicators to measure progress.

   Recommendation: Subject to formalisation of SEA regulations, in the first years of catchment plan implementation, a generic ESMP could be developed for the catchment plan, in a learning by doing setting, and as basis for subsequent project level assessments.

7. **Lesson**: The use of GIS and map development is still limited, certainly at district level. Many data are only available in tabular or textual form or can only be obtained verbally or even on-site. Sharing of (spatial) information is not formalised, and in practice often tedious and incomplete. For integrated spatial planning, such as catchment planning, this is, however, a prerequisite.

   Recommendation: Continue developing GIS skills and providing GIS hard- and software to plan partners, and certainly to districts. Formalise and develop a practice of data sharing, in line with the ambitions of Rwanda in terms of ICT and as a prerequisite to attain the development targets and potential of the country.

8.1 Catchment planning and alignment to SDGs

The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

The 17 goals build on the successes of the Millennium Development Goals, while including new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities. The goals are often interconnected and thus the key to succeeding on one will involve tackling issues more commonly associated with another.

Water is central to human wellbeing and welfare and is hence a central part of the SDGs: *"Water connects public health, food security, liveable cities, energy for all, environmental wellbeing, and climate action. Water and sanitation are necessary for human dignity and economic growth. Yet, as the SDGs make clear, the world needs to transform the way it manages its water resources, as well as improve water and sanitation related services…"* (UN-HLPW, 2017).

Figure 72 shows how other SDGs directly and indirectly relate to water through SDG goal 6 (clean water and sanitation) and how there is a clear need to connect the goals around the water cycle. The SDGs, therefore, form a strong justification for catchment planning based on Integrated Water Resources Management (IWRM).

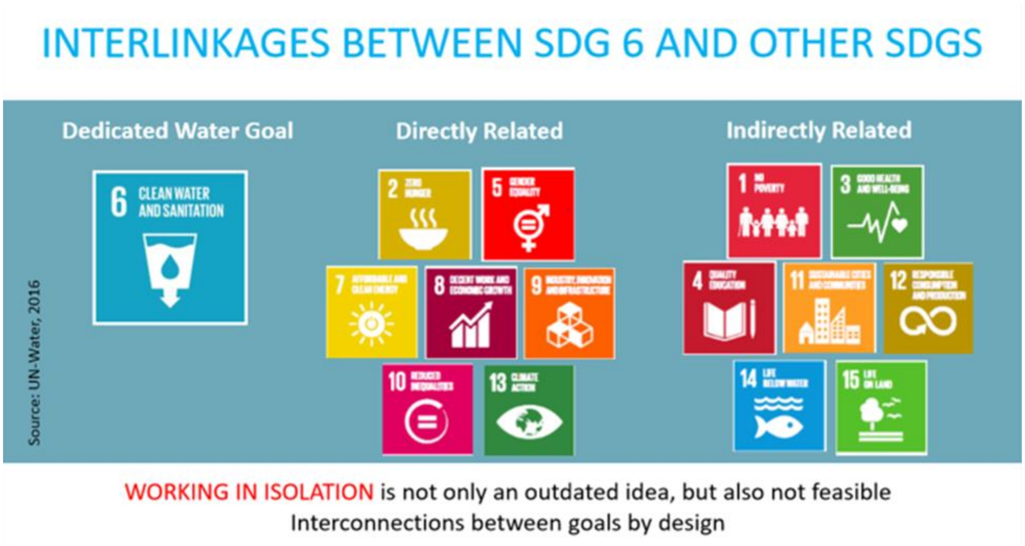


Figure 72: Interlinkages between SDG 6 and other SDGs

Each goal and project proposed in the catchment plan is linked to one or more of the 17 SDGs. Such strategic alignment is not only beneficial in achieving the global goals, it also increases Rwanda's access to green, climate and social development finance from multi-lateral institutions. In addition, strategic alignment to the SDGs also shows how IWRM allows private sector investors to create value by investing in catchment management. Many companies try to enhance their public image of being 'sustainable'. The fact that catchment plans are regarded as instruments of sustainable development makes corporate investment in catchment plan implementation attractive to the private sector.

SDG 6 and links to other SDGs

The majority of SDG target 6 supports implementation of other SDG targets and *vice versa*. The role of water is evident in:

- Poverty reduction (SDG 1.1-1.7);
- Food production to reduce malnutrition (SDG 2.2);
- Sustainable food production systems (SDG 2.4);

- Reducing waterborne diseases to fight neonatal mortality (SDG 3.2);
- Combating waterborne diseases (SDG 3.3);
- Supporting education targets (SDG 4.1-4.5);
- Gender inequality (SDG 5.1, 5.2, 5.4, 5.5);
- Establishing a productive workforce (SDG 8.5, 8.8);
- Reducing the number of deaths, the number of people affected, and economic losses caused by disasters, including water-related disasters (SDG 11.5).

The immediate link between water and SDGs 5.1, 5.2, 5.4, 5.5 and 4.1-4.5 may not be clear, but water is particularly important for women and girls as they are often tasked with fetching water. For girls of school going age, this means that they cannot attend school and fall behind in their education. Furthermore, schools need specific hygiene facilities for girls, hygiene education and awareness raising to stop stigmatisation for girls to fully develop their potential in and out of school. Schools without proper access to water and sanitation can also be a source for spreading waterborne diseases. On the other hand, schools are also one of the key places to instil appropriate basic hygiene and environmental sanitation behaviour among children.

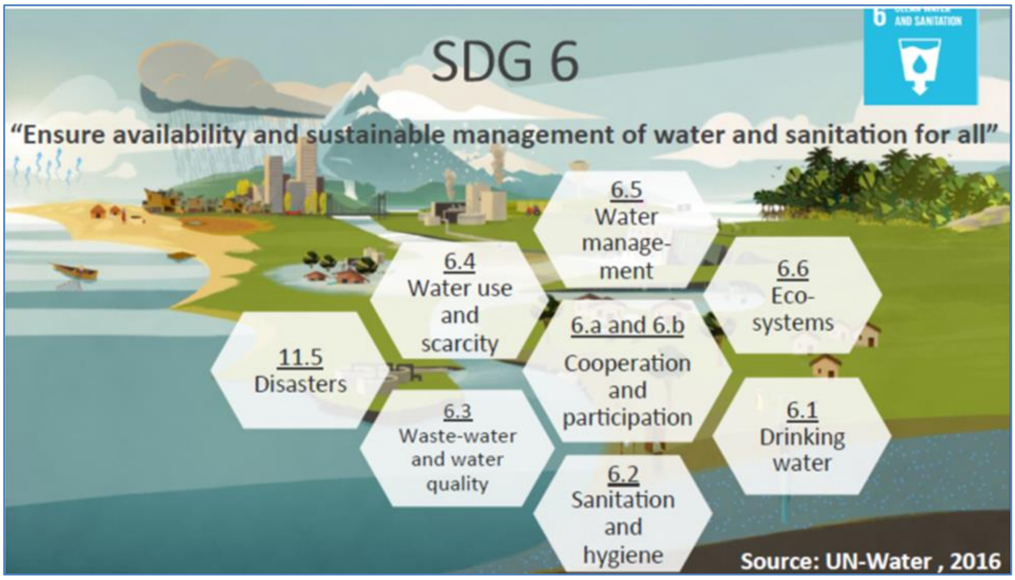


Figure 73: Target areas of SDG 6 and SDG11.5 (for water related disasters)

Catchment planning and alignment to SDGs

Realisation of Rwanda's National Strategy for Transformation 1 (2018-2024) suggests that water demand will likely double in the coming seven years. The agricultural sector is the biggest water user by far and is schedule to grow along with increased demands for water by industry, potable water sources, urbanisation and hydropower.

Matching different sectoral goals into one holistic catchment plan based on IWRM is a great challenge in water governance and the Catchment Task Force faced a steep learning curve before they could play a meaningful role as representative and advisory body at catchment level. The SDG framework was useful in this respect and was used in different stages of the catchment planning process to:

- Support understanding of the importance and interlinkages of water in the achievement of the 17 goals;
- Define the specific objectives for the catchment plan;
- Orient thinking in monitoring catchment plan implementation and define specific targets to be monitored.

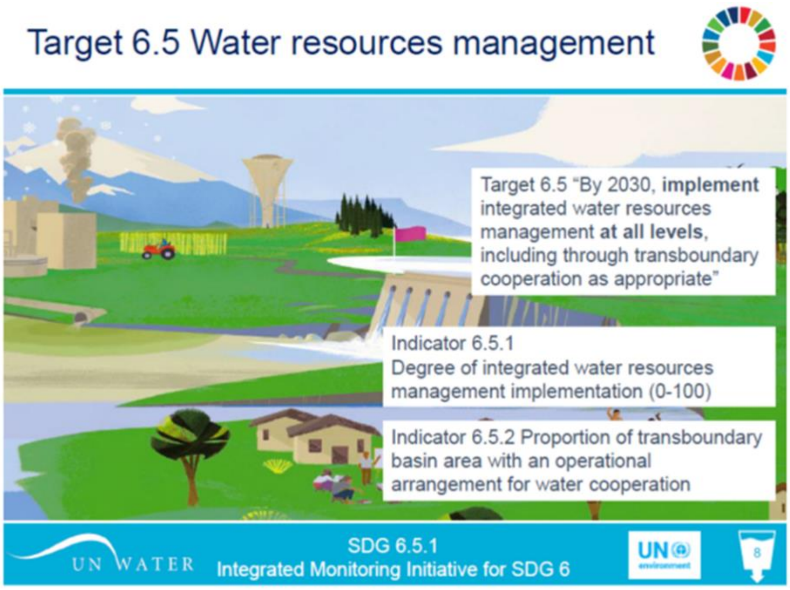


Figure 74: Monitoring of SDG 6.5 – Target and indicators

Scoping workshops held in 2016 led to the following statements used in development of Catchment Plan vision and objectives:

- SDG 15: Ecosystems protection, combating desertification and reverse of biodiversity loss: 31 scores;
- SDG 6: Ensure availability and sustainable management of water and sanitation for all: 29 scores;
- SDG 2: End hunger, achieve food security improved nutrition, and promote sustainable agriculture: 13 scores;
- SDG 5: Achieve gender equality and Empower all women and girls: 9 scores;
- SDG 11: Make cities and Human settlement inclusive, safe, resilient and sustainable: 8 scores;
- SDG 16: Promote peaceful and inclusive societies for sustainable development and inclusive institutions at all levels: 6 scores;
- SDG 13: Take urgent action to combat climate change and its impacts: 5 scores.

Muvumba catchment stakeholders prioritised the following SDGs:

- SDG 15: Ecosystems protection, combating desertification and reverse of biodiversity loss;
- SDG 6: Ensure availability and sustainable management of water and sanitation for all;
- SDG 2: End hunger, achieve food security improved nutrition, and promote sustainable agriculture.

Participants considered the value of ecosystem and biodiversity management as most important for achievement of the catchment vision and issues such as soil erosion caused by poor agriculture practices and lack of anti-erosion measures, deforestation caused by wood energy use and land use change for settlements, as well as flooding and landslides all need to be addressed. Sustainable management of water and sanitation for all and food security were also identified as important issues but not as important as the value of ecosystem protection.

It was felt that government, the private sector, and civil society must move together 'hand-in-hand' in order to achieve the goals. This would occur by government creating the right policies and regulations to enable private sector to make achievement of goals part of their business models and to integrate social goals into their business strategies and models, and by civil society in bringing about behaviour change to care for the environment as a natural capital for future generations.

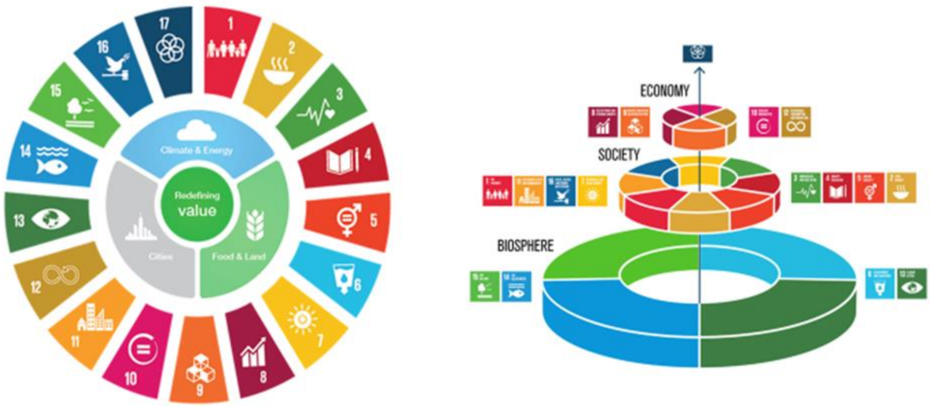


Figure 75: Creating value through catchment planning

8.2 Priority SDGs key messages

SDG 6 – Clean water and sanitation

Clean water and sanitation is the foundation of Rwanda's development. Access to clean water and improved sanitation is a right. Unsafe water and lack of sanitation causes sickness (DALYs) and children do not fully physically or mentally develop (stunting). Business cannot thrive without water and sanitation.

Catchment plans show water resource and environmental sanitation risks. Protection of water sources for drinking water is prioritised and pollution sources of liquid and solid waste are identified and mapped from mining to agriculture, as well as urban and specific industrial waste. Knowing the sources and streams of organic, plastic and electronic waste helps addressing related risks and identifying (business) opportunities to process and recycle waste.

SDG 12 – Responsible consumption and production

Droughts and floods cause famine and stress on natural resources. Famine disturbs education which reduces long-term food security.

Catchment management enhances resilience by increasing water storage, ensuring higher water productivity and water for nutritional value, as well as off-farm income to increase food security.

SDG 2 – Zero hunger

Clustering of housing and industries has disadvantages due to concentrated consumption and pollution.

Catchment planning maps hotspots of human settlements and offers spatial solutions to manage water, energy and waste flows and respond to disasters. Agglomeration has the advantage of scale for investments in resource efficiency, waste management and recycling.

SDG 11 – Sustainable cities and communities

Food waste and waste from packaging grows with population increase in a consumerist society.

Catchments are the places to instil awareness and belonging, as well as habits for responsible consumption and production. Water-wise, permaculture, and agro-ecology principles, as well as recycling measures are designed and located in the catchment.

SDG 15 – Life on land
Human life depends on land as much as oceans for sustenance and livelihoods. Increased degradation of the environment threatens lives and opportunities for development.

Catchment planning acknowledges the strong interdependency between nature and economy, through concepts of natural resources or natural capital, and ecosystem services. Investment in restoration and protection of natural capital, as well as allocation of water to environmental flows are all crucial.

SDG 13 – Climate action
Global climate change finally plays out in specific catchments where people experience the destructive effects of droughts and floods.

Catchment planning builds on scenarios that take climate variability into consideration. Adaptation, mitigation and resilience are translated into concrete measures and an adaptive catchment management.

SDG 16 – Peace and justice, strong institutions
Strong institutions, rule of law, clarity about land and water rights are essential for effective catchment management.

Catchment planning and IWRM reduce the risk of conflict, promote peoples' right on water and land use and strengthens the institutions around water resources.

9.1 Baseline and alternative development modelling

Water balance and allocation simulation software was used to assess the effectiveness and impacts of different water resources development scenarios, or in SEA terminology, management 'alternatives'[58]. A detailed account of the development of alternatives is provided in Annex 7. The main instrument to compare different alternatives was a catchment water balance and allocation model, in a dedicated simulation software package called WEAP (Water Evaluation and Planning system), developed by the Stockholm Environment Institute.

Staff of the IWRM Department were trained and assumed full ownership of the models. They made a detailed analysis of the inputs and outputs of the models developed for catchment plan version 1 and incorporated a number of improvements of several parameters for the model description. Moreover, several improvements and refinements were introduced in the alternatives. For Muvumba, the improvements and results are described in W4GR TR62 (2017) and summarised hereunder.

9.2 CP 2018-2024 WEAP models

Key assumptions in the models included the following:

- Realistic and transparent water usage (m^3/d) per user category (livestock, industries, irrigation, tea factories / other industries), linked to water use units (heads of cattle, industrial sites, etc.);
- Projections of water demand sectors development based on NWRMP projections;
- Inter-catchment transfers used e.g. for drinking water supply in one catchment, using water resources from another catchment;
- Accessibility of allocated water assumed to be 100% (water users are considered to have proper infrastructure to exercise their water rights).

Details of water usage per user category are provided in Table 36. Typical usage figures have been taken from MINIRENA, (2017) 'Baseline study on water users and water-use in level 2 catchments in Rwanda'. Information on actual water users (the entities using water in the catchment) was taken from W4GR TR28, (2017) 'Water Users' Survey'.

Table 36: Key model assumptions for typical water use per unit in each category

Water use category	Typical use per unit
Marshland irrigation	800 mm/year
Hillside irrigation	700 mm/year
Domestic water use (urban)	100 l/cap/day
Domestic water use (rural)	80 l/cap/day
Livestock	50 l/head/day
Mining	16.81 m^3/site/day
Coffee Washing Stations	139.65 m^3/site/day
Other industries, including tea factories	21 m^3/site/day

Details of the latest model versions were described in W4GR/WRMD internal reports on WEAP updates v.07, with Muvumba covered in TR62. Each alternative name was a combination of codes representing the building blocks of that alternative. An overview of alternative names (codes) and their content is provided in Table 37.

[58] An 'alternative' is a term commonly used in SEA to describe a programme of measures that could be taken to implement the plan that is being analysed; in SEA, multiple alternatives are compared to each other, and the preferred alternative is translated into the final programme of measures of the plan.

Table 37: Codes and content of new alternatives for Muvumba in WEAP model version 07

Alternative	Key approach
S	Development of new Storage
S+ SLM+E	Development of new Storage, Sustainable Land Management, and water use Efficiency
RI+S+SLM+E	Reduced Irrigation, development of new Storage, Sustainable Land Management, and water use Efficiency

The values for the building blocks or measures in each alternative, and for each planning horizon, are provided in Table 38.

Table 38: Details of new alternatives

Alternative	Storage per capita (m^3/cap)	Irrigation (IMP implementation rate, %)	Irrigation water use efficiency increase (%)	Domestic water use efficiency increase (%)	Industrial water use efficiency increase (%)
1. Autonomous development	2024: 1.2 2030: 1.2 2050: 1.2	24: 50% 30: 100% 50: 100%	BAU[59]	BAU	BAU
2. Development of new storage	2024: 1.2 2030: 20.0 2050: 35.0				
3. Development of new storage, sustainable land management[60] and water use efficiency	As (2)	As (1)	24: 5% 30: 15% 50: 30%	24: 10% 30: 15% 50: 20%	24: 5% 30: 10% 50: 20%
4. Reduced irrigation, development of new storage, sustainable land management*and water use efficiency	As (3)	23: 50% 30: 50% 50: 50%	As (3)	As (3)	As (3)

The most important result of the water allocation models is the quantity (in million m^3 per year or per month) of unmet water demand, or, in other words, the extent to which a prescribed development alternative over a defined planning horizon results in a situation with a water shortage. The goal of an effective water allocation plan should always be to avoid such a situation under 'normal circumstances[61]'.

Assuming average rainfall and evaporation figures in modelling implies that in wetter years more water will be available and in drier years less. This has particular implications for irrigation schemes (the largest water user) because, if scheme developers require 'guarantees' that they will have enough water to ensure a desired profitability or return on investment; they should plan their schemes so that they can continue to function even in moderately dry years. This means staying well within the amount of water allocated for

[59] BAU = Business as Usual.

[60] Several soil/water parameters are changed to simulate sustainable land management, see W4GR TR62 (2017).

[61] Defined as an average precipitation / evaporation pattern from a period of ten years (2006-2015), projected along a medium expected scenario for climate change, economic development, and population growth.

an average year and not planning to use it all. Developers of irrigation schemes, therefore, need to undertake scheme-specific assessments of water security and not just rely on average figures provided in these water allocation plans.

Quantities of water demand modelled for baseline and 2024, 2030, and the 2050-time horizons are presented in Figure 76[62] and this shows that total water demand increases exponentially, due to concomitant growth of demand in each individual projection (climate change, economic development, and population growth). From 2030 onwards, modelled developments, combined with unchanged water resources management, lead to a situation with growing unmet water demand. This situation calls for the implementation of mitigating measures, such as the ones proposed in the management alternatives. The effectiveness of implementation of these alternatives at catchment scale is shown in Figure 77 and Table 39, and show a clear need for a combination of sustainable land management and enhanced efficiency in water use in all sectors. It also shows that development of additional irrigation schemes, as currently planned in the Irrigation Master Plan (IMP, MINAGRI, 2010), is not feasible and will need to be revised.

A more detailed assessment at sub-catchment level (reported on in W4GR TR62 (2017) and presented in following sections) reveals that, apart for the Mulindi sub-catchment, restriction on development of irrigation schemes is required in all sub-catchments. The development of the Muvumba multi-purpose dam will, however, help to reduce the need for restrictions on irrigation development in the Muvumba 'Upstream' and 'Downstream' sub-catchments.

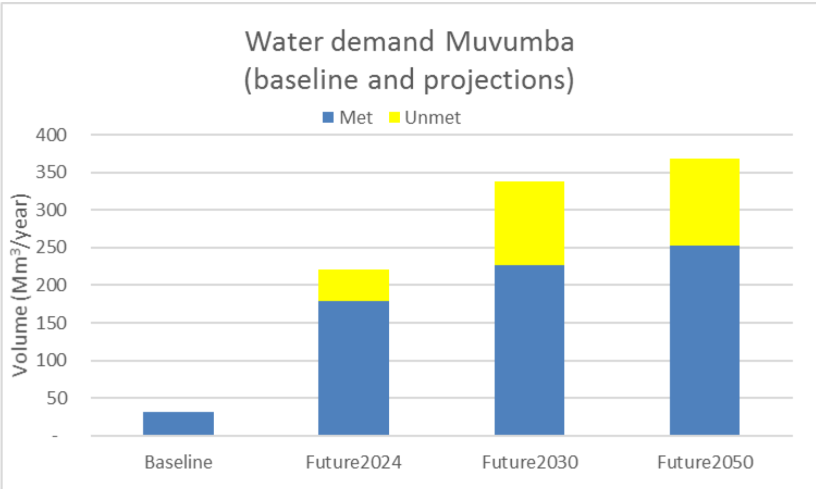


Figure 76: Total annual water demand (met/unmet) baseline and projections

[62] The approach is described in detail in W4GR TR29 (2017).

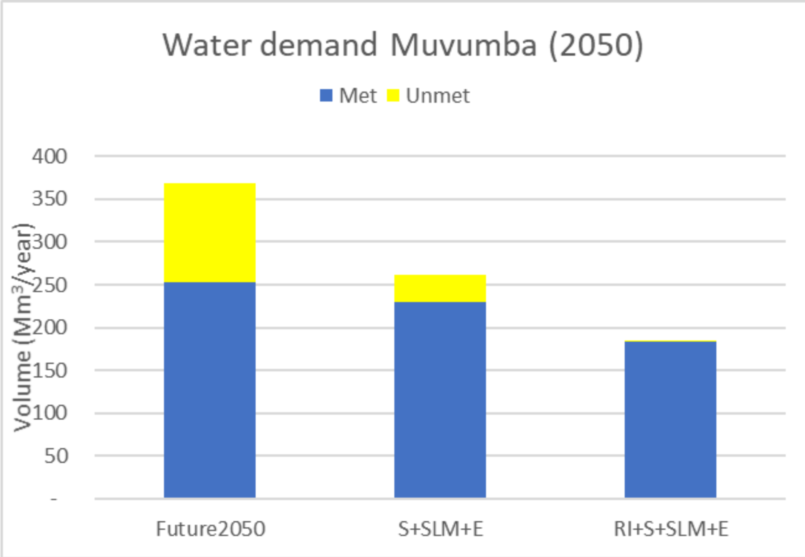


Figure 77: Total annual water demand in Muvumba by 2050 (met and unmet) under different alternatives

Table 39: Water demand (met/unmet) by 2050, new alternatives

Alternative	Met demand (2050) (MCM/y)	Unmet demand (2050) (MCM/y)
Future 2050	253	116
S+SLM+E	230	32
RI+S+SLM+E	183	0

An analysis of monthly water demand for Muvumba catchment as a whole for 2024 under the medium projection is shown in Figure 79 (see Figure 78 for the baseline). Demand by domestic, livestock, and industrial users is constant, and relatively low and environmental flow is set at 20% of the monthly blue water availability. Peak demands in dry months are related to irrigation schemes.

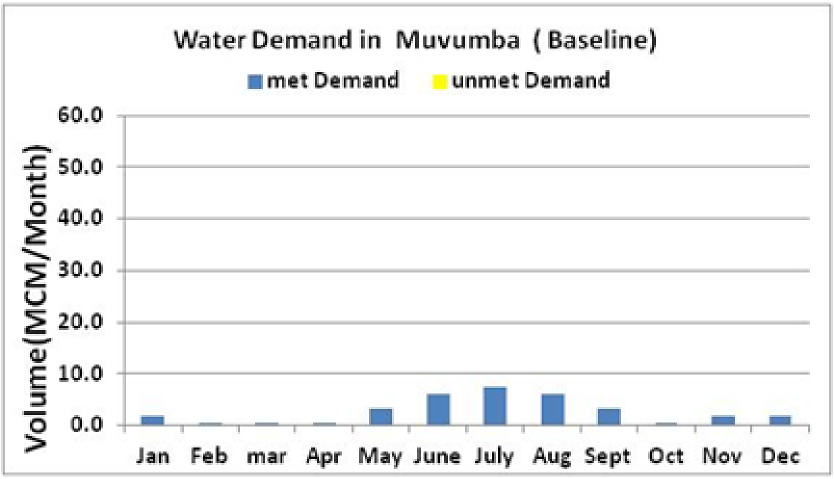


Figure 78: Monthly water demand (manageable or 'blue' water) for the whole catchment (baseline)

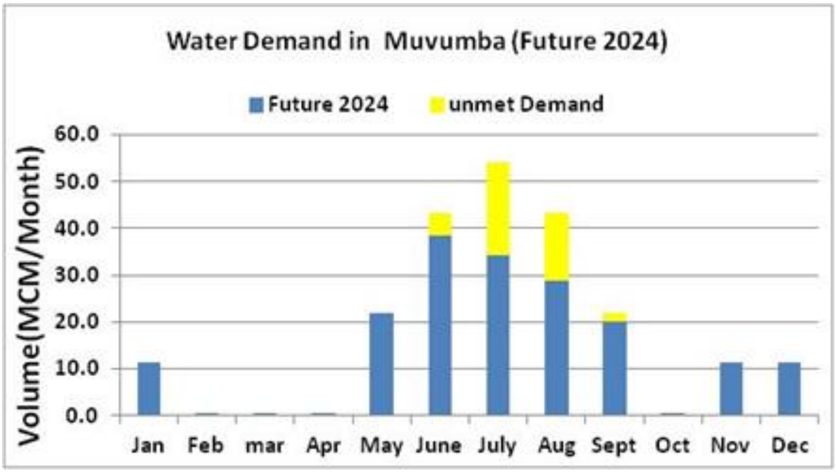


Figure 79: Monthly water demand (manageable or 'blue' water) for the whole catchment (projection for 2024)

A detailed analysis of similar water demand figures per sub-catchment and for different alternatives can be found in W4GR TR62 (2017). Water shortages in the dry season (June to September) have been addressed in the water allocation tables, by imposing water allocation restrictions to irrigation in sub-catchments with insufficient water resources, to a level that no unmet water demand remains. The implications on potential development of additional irrigation schemes in these sub-catchments will be assessed by the task force of RAB and WRMD.

Conclusions

- Growing water demand results in water stress by 2024;
- Only implementation of a combination of reduced irrigation, development of new storage, sustainable land management, and greater water use efficiency (the RI+S+SLM+E alternative) will result in zero unmet water demand by 2050. RI+S+SLM+E is, therefore, the preferred alternative;
- Finetuning of the preferred alternative at the level of sub-catchments allows for maximum development of irrigation schemes in those sub-catchments where water availability allows for more than 50% of IMP targets;
- The catchment plan's programme of measures, including IWRM packages and CPIPs, needs to assist in implementation of the preferred alternative, i.e.:
  - Develop large and small-medium scale storage throughout the catchment, including the Muvumba multipurpose dam;
  - Restricted yet optimal development of new irrigation within boundaries set by water availability;
  - Enhance water use efficiency by irrigation (30%), domestic (20%), and industrial (20%) users by 2050, or sooner;
  - Enhance catchment rehabilitation and soil moisture management, e.g. by agroforestry, terracing, live hedges, etc.

9.3 Water allocation plan

Water allocation plans have been devised for each sub-catchment and for each water user, including an environmental flow allocation[63], for the current (baseline) situation, as well as three planning horizons (2024 - the end of this catchment plan; 2030 – target year for achievement of the Sustainable Development Goals, and; 2050 – target year for achieving Vision 2050).

By developing an allocation plan per sub-catchment, the preferred alternative can be finetuned for each sub-catchment. Analysis shows that when demands articulated in the Irrigation Master Plan (IMP) compared with resources in sub-catchments with ample supply, the IMP can be developed (almost) in full. Conversely, in sub-catchments with lower overall supply, and/or with more competing users, development of new irrigation schemes will have to be restricted by more than 50% compared. Based on this analysis, optimum water-based economic development and food security can be combined with meeting the needs for domestic, livestock and industrial users, as well as the environment. In the currently proposed water allocation, irrigation has already been reduced, to avoid over-development of irrigated area and resulting water shortages. In situations of extreme water scarcity, i.e. in dry years, the volume of water allocated to all users would have to be further reduced. Under such circumstances, RAB and WRMD would need to jointly adjust allocations to irrigation systems and promote uptake of extra water saving technologies and further adjust cropping patterns in each season, e.g. by shutting down compartments of irrigation schemes, or by planting crops with higher drought tolerance. Timely seasonal forecasts by RMA are needed to allow for timely preparations.

Simulations of future scenarios become less accurate the further away the time horizon and so model results for 2024 are more reliable than those for 2030 or 2050. The current water allocation plans for 2030 and 2050 will, therefore, need to be updated in the future and any actual water demand developments (e.g. issuance of water permits, greater climate change impacts, new economic developments and any adjustments to population growth forecasts) incorporated into subsequent model runs.

[63] Set at 20% of monthly blue water availability in all alternatives and for all planning horizons. It should be noted that Environmental flow allocation also provides water to unplanned uses and users downstream as well as the environment *per se.*

Warufu sub-catchment water allocation plan

Table 40: Warufu sub-catchment water balance (existing conditions)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	9,969	56	20	1,994	5	200	2,275	7,694
Feb	9,383	51	18	1,877	4	0	1,950	7,433
Mar	10,347	56	20	2,069	5	0	2,150	8,196
Apr	11,909	54	19	2,382	5	0	2,460	9,449
May	12,718	56	20	2,544	5	400	3,024	9,693
Jun	10,193	54	19	2,039	5	800	2,917	7,276
Jul	7,729	56	20	1,546	5	1,000	2,627	5,103
Aug	6,779	56	20	1,356	5	800	2,237	4,542
Sep	7,223	54	19	1,445	5	400	1,923	5,300
Oct	8,735	56	20	1,747	5	0	1,828	6,907
Nov	10,607	54	19	2,121	5	200	2,400	8,208
Dec	11,639	56	20	2,328	5	200	2,609	9,030

Table 41: Warufu sub-catchment water balance (2024 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	7,805	116	43	1,561	8	2,806	4,534	3,271
Feb	7,696	106	39	1,539	8	0	1,692	6,004
Mar	8,278	116	43	1,656	8	0	1,823	6,455
Apr	9,015	112	42	1,803	8	0	1,965	7,049
May	9,442	116	43	1,888	8	5,611	7,667	1,775
Jun	9,617	112	42	1,923	8	7,532	9,617	0
Jul	8,893	116	43	1,779	8	6,947	8,893	0
Aug	8,188	116	43	1,638	8	6,383	8,188	0
Sep	7,330	112	42	1,466	8	5,611	7,239	91
Oct	6,924	116	43	1,385	8	0	1,553	5,372
Nov	8,070	112	42	1,614	8	2,806	4,582	3,488
Dec	8,930	116	43	1,786	8	2,806	4,759	4,171

Table 42: Warufu sub-catchment water balance (2030 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	7,598	187	81	1,520	14	4,850	6,652	945
Feb	6,700	170	74	1,340	13	0	1,597	5,103
Mar	7,686	187	81	1,537	14	0	1,820	5,866
Apr	8,423	181	79	1,685	13	0	1,958	6,465
May	11,218	187	81	2,244	14	8,692	11,218	0
Jun	11,407	181	79	2,281	13	8,852	11,407	0
Jul	9,635	187	81	1,927	14	7,425	9,635	0
Aug	8,609	187	81	1,722	14	6,604	8,609	0
Sep	7,370	181	79	1,474	13	5,623	7,370	0
Oct	5,079	187	81	1,016	14	0	1,298	3,780
Nov	7,852	181	79	1,570	13	4,850	6,694	1,158
Dec	8,668	187	81	1,734	14	4,850	6,867	1,802

Table 43: Warufu sub-catchment water balance (2050 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	8,233	538	290	1,647	41	3,994	4,864	3,370
Feb	7,021	490	264	1,404	37	0	791	6,230
Mar	8,222	538	290	1,644	41	0	869	7,353
Apr	9,372	521	281	1,874	40	0	841	8,531
May	10,980	538	290	2,196	41	7,989	8,858	2,122
Jun	13,482	521	281	2,696	40	12,641	13,482	0
Jul	11,144	538	290	2,229	41	10,275	11,144	0
Aug	8,227	538	290	1,645	41	7,358	8,227	0
Sep	7,048	521	281	1,410	40	6,207	7,048	0
Oct	5,241	538	290	1,048	41	0	869	4,372
Nov	7,695	521	281	1,539	40	3,994	4,836	2,859
Dec	9,316	538	290	1,863	41	3,994	4,864	4,453

Ngoma sub-catchment water allocation plan

Table 44: Ngoma sub-catchment water balance (existing conditions)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	2,417	18	5	483	2	0	509	1,908
Feb	2,380	17	5	476	2	0	500	1,881
Mar	2,701	18	5	540	2	0	566	2,135
Apr	3,129	18	5	626	2	0	651	2,478
May	3,333	18	5	667	2	0	692	2,640
Jun	2,654	18	5	531	2	0	556	2,098
Jul	1,998	18	5	400	2	0	426	1,572
Aug	1,668	18	5	334	2	0	360	1,309
Sep	1,715	18	5	343	2	0	368	1,347
Oct	2,111	18	5	422	2	0	448	1,663
Nov	2,587	18	5	517	2	0	543	2,044
Dec	2,735	18	5	547	2	0	573	2,162

Table 45: Ngoma sub-catchment water balance (2024 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	2,057	38	12	411	4	865	1,330	727
Feb	1,871	35	11	374	3	0	423	1,448
Mar	2,035	38	12	407	4	0	460	1,575
Apr	2,208	37	11	442	3	0	493	1,715
May	2,724	38	12	545	4	1,730	2,328	396
Jun	2,831	37	11	566	3	2,213	2,831	0
Jul	2,642	38	12	528	4	2,060	2,642	0
Aug	2,392	38	12	478	4	1,860	2,392	0
Sep	2,138	37	11	428	3	1,659	2,138	0
Oct	1,669	38	12	334	4	0	387	1,282
Nov	2,133	37	11	427	3	865	1,343	789
Dec	2,241	38	12	448	4	865	1,367	875

Table 46: Ngoma sub-catchment water balance (2030 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	**2,111**	27	22	422	6	1,548	**2,024**	87
Feb	**1,633**	19	20	327	5	0	**371**	1,262
Mar	**1,796**	21	22	359	6	0	**408**	1,388
Apr	**1,957**	20	21	391	5	0	**439**	1,519
May	**3,154**	21	22	631	6	2,474	**3,154**	0
Jun	**2,882**	20	21	576	5	2,259	**2,882**	0
Jul	**2,715**	21	22	543	6	2,123	**2,715**	0
Aug	**2,389**	21	22	478	6	1,862	**2,389**	0
Sep	**1,991**	20	21	398	5	1,546	**1,991**	0
Oct	**1,383**	21	22	277	6	0	**325**	1,057
Nov	**2,154**	20	21	431	5	1,548	**2,026**	128
Dec	**2,303**	21	22	461	6	1,548	**2,057**	246

Table 47: Ngoma sub-catchment water balance (2050 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	**2,115**	176	79	423	13	1,275	**1,543**	572
Feb	**1,889**	160	72	378	12	0	**244**	1,645
Mar	**2,065**	176	79	413	13	0	**268**	1,797
Apr	**2,488**	170	76	498	13	0	**259**	2,228
May	**3,390**	176	79	678	13	2,549	**2,817**	573
Jun	**3,686**	170	76	737	13	3,427	**3,686**	0
Jul	**2,526**	176	79	505	13	2,258	**2,526**	0
Aug	**2,051**	176	79	410	13	1,783	**2,051**	0
Sep	**1,680**	170	76	336	13	1,421	**1,680**	0
Oct	**1,543**	176	79	309	13	0	**268**	1,275
Nov	**2,145**	170	76	429	13	1,275	**1,534**	611
Dec	**2,295**	176	79	459	13	1,275	**1,543**	753

Mulindi sub-catchment water allocation plan

Table 48: Mulindi sub-catchment water balance (existing conditions)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	**4,346**	44	13	869	9	0	**935**	3,411
Feb	**4,104**	40	12	821	8	0	**880**	3,224
Mar	**4,464**	44	13	893	9	0	**958**	3,506
Apr	**5,060**	42	13	1,012	8	0	**1,075**	3,984
May	**5,329**	44	13	1,066	9	0	**1,131**	4,198
Jun	**4,564**	42	13	913	8	0	**976**	3,588
Jul	**3,561**	44	13	712	9	0	**778**	2,783
Aug	**3,048**	44	13	610	9	0	**675**	2,373
Sep	**3,101**	42	13	620	8	0	**684**	2,418
Oct	**3,707**	44	13	741	9	0	**807**	2,900
Nov	**4,460**	42	13	892	8	0	**956**	3,505
Dec	**4,781**	44	13	956	9	0	**1,022**	3,759

Table 49: Mulindi sub-catchment water balance (2024 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	**3,696**	90	28	739	24	55	**937**	2,760
Feb	**3,662**	82	26	732	21	0	**862**	2,800
Mar	**3,815**	90	28	763	24	0	**905**	2,909
Apr	**4,010**	88	27	802	23	0	**940**	3,070
May	**4,100**	90	28	820	24	110	**1,072**	3,028
Jun	**3,885**	88	27	777	23	220	**1,135**	2,750
Jul	**3,610**	90	28	722	24	275	**1,139**	2,471
Aug	**3,401**	90	28	680	24	220	**1,043**	2,358
Sep	**3,305**	88	27	661	23	110	**909**	2,396
Oct	**3,421**	90	28	684	24	0	**827**	2,594
Nov	**3,660**	88	27	732	23	55	**925**	2,735
Dec	**3,819**	90	28	764	24	55	**961**	2,858

Table 50: Mulindi sub-catchment water balance (2030 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	**3,801**	146	53	760	58	98	**1,115**	2,685
Feb	**3,769**	133	48	754	53	0	**987**	2,781
Mar	**3,944**	146	53	789	58	0	**1,046**	2,899
Apr	**4,147**	141	51	829	56	0	**1,078**	3,069
May	**4,255**	146	53	851	58	197	**1,305**	2,951
Jun	**4,046**	141	51	809	56	394	**1,452**	2,594
Jul	**3,836**	146	53	767	58	492	**1,516**	2,320
Aug	**3,490**	146	53	698	58	394	**1,349**	2,141
Sep	**3,426**	141	51	685	56	197	**1,131**	2,295
Oct	**3,457**	146	53	691	58	0	**948**	2,508
Nov	**3,707**	141	51	741	56	98	**1,089**	2,619
Dec	**3,907**	146	53	781	58	98	**1,137**	2,771

Table 51: Mulindi sub-catchment water balance (2050 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	**4,312**	419	190	862	306	81	**996**	3,316
Feb	**4,310**	381	172	862	278	0	**832**	3,478
Mar	**4,561**	419	190	912	306	0	**915**	3,646
Apr	**4,780**	406	183	956	296	0	**885**	3,895
May	**4,853**	419	190	971	306	162	**1,077**	3,776
Jun	**4,569**	406	183	914	296	324	**1,210**	3,359
Jul	**4,382**	419	190	876	306	405	**1,320**	3,062
Aug	**4,059**	419	190	812	306	324	**1,239**	2,820
Sep	**3,804**	406	183	761	296	162	**1,047**	2,756
Oct	**3,806**	419	190	761	306	0	**915**	2,891
Nov	**4,049**	406	183	810	296	81	**966**	3,082
Dec	**4,374**	419	190	875	306	81	**996**	3,378

Muvumba Downstream sub-catchment water allocation plan

Table 52: Muvumba Downstream sub-catchment water balance (existing conditions)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	31,450	23	11	6,290	0	1,229	7,554	23,896
Feb	31,404	21	10	6,281	0	0	6,313	25,091
Mar	39,156	23	11	7,831	0	0	7,866	31,290
Apr	55,277	23	11	11,055	0	0	11,089	44,188
May	63,745	23	11	12,749	0	2,458	15,242	48,503
Jun	32,083	23	11	6,417	0	4,916	11,367	20,716
Jul	22,136	23	11	4,427	0	6,146	10,608	11,528
Aug	21,052	23	11	4,210	0	4,916	9,162	11,890
Sep	25,556	23	11	5,111	0	2,458	7,603	17,953
Oct	33,077	23	11	6,615	0	0	6,650	26,426
Nov	40,446	23	11	8,089	0	1,229	9,352	31,094
Dec	38,678	23	11	7,736	0	1,229	9,000	29,678

Table 53: Muvumba Downstream sub-catchment water balance (2024 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	30,757	48	24	6,151	1	4,604	10,830	19,928
Feb	33,577	44	22	6,715	1	0	6,783	26,794
Mar	39,415	48	24	7,883	1	0	7,957	31,458
Apr	52,325	47	24	10,465	1	0	10,537	41,789
May	53,690	48	24	10,738	1	9,209	20,021	33,670
Jun	29,140	47	24	5,828	1	18,417	24,317	4,823
Jul	24,204	48	24	4,841	1	18,966	23,880	324
Aug	20,976	48	24	4,195	1	16,448	20,717	259
Sep	21,000	47	24	4,200	1	9,209	13,480	7,519
Oct	31,067	48	24	6,213	1	0	6,287	24,780
Nov	34,426	47	24	6,885	1	4,604	11,561	22,865
Dec	34,835	48	24	6,967	1	4,604	11,645	23,190

Table 54: Muvumba Downstream sub-catchment water balance (2030 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	24,521	78	45	4,904	3	4,120	9,150	15,371
Feb	23,836	71	41	4,767	3	0	4,882	18,953
Mar	28,696	78	45	5,739	3	0	5,866	22,831
Apr	40,189	76	44	8,038	3	0	8,160	32,029
May	48,336	78	45	9,667	3	8,239	18,033	30,303
Jun	28,171	76	44	5,634	3	16,479	22,235	5,936
Jul	27,779	78	45	5,556	3	20,598	26,281	1,499
Aug	15,470	78	45	3,094	3	12,249	15,470	0
Sep	17,049	76	44	3,410	3	8,239	11,771	5,277
Oct	22,743	78	45	4,549	3	0	4,675	18,068
Nov	28,433	76	44	5,687	3	4,120	9,929	18,504
Dec	26,906	78	45	5,381	3	4,120	9,627	17,279

Table 55: Muvumba Downstream sub-catchment water balance (2050 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	**24,599**	225	163	4,920	15	3,393	**8,714**	15,885
Feb	**26,927**	204	148	5,385	13	0	**5,751**	21,176
Mar	**31,910**	225	163	6,382	15	0	**6,784**	25,126
Apr	**43,790**	217	157	8,758	14	0	**9,147**	34,644
May	**46,978**	225	163	9,396	15	6,785	**16,583**	30,395
Jun	**23,110**	217	157	4,622	14	13,571	**18,581**	4,528
Jul	**18,356**	225	163	3,671	15	14,283	**18,356**	0
Aug	**16,379**	225	163	3,276	15	12,701	**16,379**	0
Sep	**14,270**	217	157	2,854	14	6,785	**10,028**	4,242
Oct	**21,421**	225	163	4,284	15	0	**4,686**	16,735
Nov	**25,202**	217	157	5,040	14	3,393	**8,822**	16,380
Dec	**26,627**	225	163	5,325	15	3,393	**9,120**	17,507

Muvumba Upstream sub-catchment water allocation plan

Table 56: Muvumba Upstream sub-catchment water balance (existing conditions)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	**19,016**	22	6	3,803	0	0	**3,831**	15,185
Feb	**17,717**	20	5	3,543	0	0	**3,569**	14,148
Mar	**21,110**	22	6	4,222	0	0	**4,250**	16,860
Apr	**30,032**	21	6	6,006	0	0	**6,033**	23,998
May	**37,121**	22	6	7,424	0	0	**7,452**	29,669
Jun	**19,415**	21	6	3,883	0	0	**3,910**	15,505
Jul	**13,033**	22	6	2,607	0	0	**2,635**	10,399
Aug	**12,573**	22	6	2,515	0	0	**2,543**	10,031
Sep	**15,844**	21	6	3,169	0	0	**3,196**	12,648
Oct	**19,707**	22	6	3,941	0	0	**3,969**	15,738
Nov	**23,365**	21	6	4,673	0	0	**4,700**	18,665
Dec	**21,211**	22	6	4,242	0	0	**4,270**	16,941

Table 57: Muvumba Upstream sub-catchment water balance (2024 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	**18,890**	46	13	3,778	0	1,828	**5,664**	13,226
Feb	**17,135**	42	12	3,427	0	0	**3,480**	13,655
Mar	**19,899**	46	13	3,980	0	0	**4,038**	15,861
Apr	**28,193**	44	12	5,639	0	0	**5,695**	22,498
May	**35,997**	46	13	7,199	0	3,655	**10,913**	25,084
Jun	**20,376**	44	12	4,075	0	7,311	**11,443**	8,933
Jul	**16,234**	46	13	3,247	0	9,139	**12,444**	3,790
Aug	**14,765**	46	13	2,953	0	7,311	**10,322**	4,443
Sep	**16,024**	44	12	3,205	0	3,655	**6,917**	9,107
Oct	**18,605**	46	13	3,721	0	0	**3,779**	14,825
Nov	**22,029**	44	12	4,406	0	1,828	**6,290**	15,739
Dec	**20,385**	46	13	4,077	0	1,828	**5,963**	14,422

Table 58: Muvumba Upstream sub-catchment water balance (2030 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	18,749	74	24	3,750	0	3,271	7,118	11,631
Feb	16,693	67	22	3,339	0	0	3,427	13,266
Mar	19,432	74	24	3,886	0	0	3,984	15,449
Apr	27,726	71	23	5,545	0	0	5,639	22,087
May	36,140	74	24	7,228	0	6,541	13,867	22,274
Jun	21,307	71	23	4,261	0	13,083	17,438	3,869
Jul	22,611	74	24	4,522	0	16,353	20,973	1,638
Aug	12,024	74	24	2,405	0	9,521	12,024	0
Sep	13,821	71	23	2,764	0	6,541	9,400	4,421
Oct	19,083	74	24	3,817	0	0	3,914	15,169
Nov	23,162	71	23	4,632	0	3,271	7,997	15,165
Dec	20,257	74	24	4,051	0	3,271	7,419	12,837

Table 59: Muvumba Upstream sub-catchment water balance (2050 preferred alternative)

Months	(Blue) Water Availability (1,000m3/month)	Water Allocation per sector (1,000m3/month)						
		Domestic	Livestock	E.flow	Industrial	Irrigation	Total	Surplus outflow
Jan	19,008	212	85	3,802	0	2,693	6,791	12,217
Feb	17,440	193	77	3,488	0	0	3,757	13,682
Mar	20,201	212	85	4,040	0	0	4,336	15,864
Apr	28,604	205	82	5,721	0	0	6,008	22,596
May	36,150	212	85	7,230	0	5,387	12,913	23,236
Jun	20,725	205	82	4,145	0	10,774	15,206	5,519
Jul	18,823	212	85	3,765	0	13,467	17,528	1,295
Aug	17,363	212	85	3,473	0	10,774	14,543	2,820
Sep	13,962	205	82	2,792	0	5,387	8,466	5,496
Oct	18,671	212	85	3,734	0	0	4,031	14,641
Nov	21,790	205	82	4,358	0	2,693	7,338	14,452
Dec	20,510	212	85	4,102	0	2,693	7,092	13,418

Catchment Plan implementation alignment with National Gender Policy

Water for Growth Rwanda is developing IWRM Packages and CPIPs as implementation means for the four demonstration catchments. Gender is one of the cross-cutting areas for the IWRM programme Rwanda (Water for Growth Rwanda) and within NST1, therefore, a gender strategy has been developed (W4GR TR10, 2017). This annex introduces a gender mainstreaming checklist, developed for better integration of gender sensitive actions in the catchment plans and its implementation projects, and highlights the key actions based on national commitments on gender equality from the national Visions for 2020 and 2050, NST1, and other key strategies for environment and natural resources management. Key actions are identified for informing gender action plans in implementation plans.

The actions presented in the checklist below are based on the National Gender Policy (2010) and further elaborated on the basis of gender analysis of proposed implementation projects in each catchment. These consider issues of social inclusion, empowerment, and the needs of men and women as users for equitable management of water resources. The checklist includes three sections: Gender strategy mainstreaming guidelines, Hands on guidelines for planning and implementation of IWRM packages, IPs, CPIPs and Strategic actions and recommendations.

Table 60: Gender mainstreaming guidelines rationale

Rationale	
Rationale and contribution of gender mainstreaming in IWRM	The gender equality principle is key to sustainable management of natural resources and IWRM approaches. However, evidence continues to manifest huge gender gaps between women and men, contributed to by socio-cultural differences in literacy levels, health, productive skills and access to information on employment and business opportunities. There is disproportionate access, control and decision power over water and land resources. Women are key actors in water usage, supply and management but are under-represented in decision making structures. Gender strategy in IWRM is expected to ensure equal access, control and equitable benefits in water resource management projects.
National Gender Policy vision and goals	
Vision	Rwanda's long-term vision is to set the Rwandan society free from all forms of gender-based discrimination and see both men and women participate fully and enjoy equitably from the development processes.
Sector goal	The overall goal is to promote gender equality and equity in Rwanda through a clearly defined process for mainstreaming gender needs and concerns across all sectors of development.

Implementation Plan Gender checklist

The checklist in Table 61 is to be used in the assessment of all actions / implementation projects (IP/IP+/CPIP) in the catchment, in order to mainstream gender equality in water resources management at all scales (from government down to households).

Table 61: Gender mainstreaming checklist for catchment plan implementation projects

Programme of Action	Actions[64]	Situation analysis summary	Added value on gender output/outcome
Topic: Agriculture			
1. Integrated Water Resource Management and Planning	1.1. Facilitate access to safe and clean water and promote the involvement of women and men in the decision-making process for the provision and management of safe and clean water, and improvement of sanitation facilities in both urban and rural areas.	Access to improved water sources in Rwanda by male and female headed households is almost equal, with 84.4% and 85.9% (EICV4 2012). Regarding the involvement of women and men in the decision-making process for the provision and management of safe and clean water, the data on Catchment Task Force established in four demonstration catchments show 28% representation of women (W4GR TR10, 2017). Therefore, efforts to strive toward parity are needed. The proportion of women headed households (HHs) with access to improved sanitation facilities is 76.6% while that of male HHs is 85.7%.	Increased access to safe and clean water by women and men Improved sanitation facilities in both urban and rural areas.
	1.2. Enhance rainwater harvesting to enhance water supply, human health and environment.	In Rwanda traditional roofing materials are rapidly replaced by modern materials. Only 2.2% of HHs still uses traditional options, (2.6% of women HHs, 2.0% of men HHs (EICV4, 2012). Therefore, rainwater harvesting is possible in almost all HHs and is a good IWRM practice to increase water availability at HH level for domestic and productive use.	Reduced time and burden for women in water collection for use in household chores.
	1.3. To increase number of women trained in various disciplines that ensure their participation in the productive/commercial use of water.	Women's reproductive role hinders their participation in extension and training programs. However, the (FAO, 2016) Gender Assessment of Rwanda Agri Policy revealed that 48% of total trained farmers in farmer field schools (FFSs) are women, 52% are men.	Built capacity of women and men for enhanced inclusion in IWRM through FFS.
Topic: Agriculture and land husbandry			

[64] National Gender Policy (2010), Agriculture Gender Strategy (2010) and Gender Profile in Agriculture sector (GMO, 2016), MINIRENA, 5YR SSP, (2013)

Programme of Action	Actions[64]	Situation analysis summary	Added value on gender output/outcome
Topic: Agriculture			
2. Sustainable, resilient and diversified production and productivity	2.1. Ensure equal rights between men and women in the area of rural development and engage them in the planning, implementation and monitoring of all development activities.	Evidence shows a dominant position of men in decision making within the agricultural sector, which contrasts with the existence of enabling legal and institutional frameworks for gender equality. Therefore, sustainable and resilient agricultural practices require actions that do not reinforce the dominance of men. A strategy of mainstreaming gender in IWRM policies, programs, projects, and activities forms a foundation for equal rights and equal opportunities for women and men in the agricultural sector and rural development.	Equal rights to water and land for agricultural production, social inclusion and participation enhanced in rural development projects. Non-stereotypical position for women in farm production cooperatives.
	2.2. Undertake gender sensitive measures aimed at transforming subsistence agriculture into market-oriented agriculture and empower the farmers especially women with appropriate knowledge and skills for food production and processing.	67. 6% of the total Rwandan population are involved in agricultural activities. Females are more involved in agriculture than males and most of them are in subsistence agriculture. Sustainable farm practices and efficient irrigation for commercial crop commodities are male-dominated because women own less land. This adds to their limited control over the land resource.	Equal benefits from productive use of land resources, livestock in marketable commodities and improved nutrition.
	2.4. Ensure that women's unpaid work in rural areas is valued and monetised[65].	Most of the farm tasks are culturally carried out by women, from ploughing to harvesting, mulching, weeding, etc. This type of work is not necessarily paid for or considered in food pricing for independent farmers. The farm work is only paid for in case of wage and self-employed farmers. The pay gap aggravates gender inequalities beyond the reproductive role of women.	Equity in division of labour, and gender pay gap addressed.

[65] Protocol to the African Charter on Human and People's Rights on the Rights of Women in Africa (2003)

Programme of Action	Actions[64]	Situation analysis summary	Added value on gender output/outcome
Topic: Agriculture			
		Females are more involved in subsistence agriculture than males. Independent farmers – F: 71.9% and M: 49.4%. Wage farm earners – F: 9.7 and M: 10.2%.	
	2.5. Promote gender in agriculture through promoting gender responsive climate smart agricultural technologies and information, and women's access and control to farm inputs for climate smart agriculture[66].	The gender profile in infrastructure (Gender Monitoring Office (GMO), 2017) recommends devising measures to improve women's access to alternative and reliable energy sources for cooking and to energy saving cooking stoves, especially those in rural areas and HHs headed by poor women. This would generate a positive impact on forest rehabilitation and reduce climate change issues. Disparities exist between women's and men's access to training and information. Despite the increased number of women and men owning a mobile phone, access to climate and IWRM information is a persisting issue.	Gender-inclusive projects that promote resilient and climate smart farming practices.
3. Promoting Intra-sector dialogue	3.1. To develop and coordinate partnerships and collaborative mechanisms amongst government institutions, CSOs, private sector and development partners and integrate appropriate actions to respond to practical and strategic gender needs in the agricultural sector.	The MINIRENA sector working group allows for coordinated effort from various partners, including government, and development partners. GBS are also planned every fiscal year. However, a gender subsector working group is not yet established in MINIRENA for combined action and monitoring of the progress in gender equality in the water sector. The MINAGRI sector working group is established and operational but emphasises equal access to agricultural services and may not focus on sustainable water and land management.	Joint implementation for gender sensitive projects in IWRM measures.

[66] NEPAD Gender, Climate change and Agriculture Support Program Report, August 2014

Programme of Action	Actions[64]	Situation analysis summary	Added value on gender output/outcome
Topic: Agriculture			
4. Productive and Inclusive Markets and Value Addition	4.1. Help females to organise self-help groups and cooperatives in order to obtain equal access with males to economic opportunities through employment or self-employment.	Membership of cooperatives in Rwanda doesn't show a very big disparity, however, women are under-represented in cooperative committees. Cooperative memberships – 2015: 42% are women and 58% are men. Women represent 45% of the nationwide leadership in cooperatives. Women are most likely to take subordinate and stereotypical posts such a secretariat and advisory roles. This has a negative influence on their level of access to, and negotiation power for, economic opportunities.	Strengthened women council, women self-help groups and cooperatives for equal access to economic opportunities. Promote the road market points or selling points to enhance access to markets for local food producers.
	4.2. To increase number of women trained in various disciplines that ensure their participation in commercial/productive land use.	Women's reproductive role hinders their participation in agricultural extension and training programs taking into consideration the factor of their inclusion in trainings.	Enhanced knowledge and skills through training and education.
Topic: Environment and catchment rehabilitation			
5. Sustainable environmental protection and natural resources	5.1. Undertake measures to ensure effective participation of women and men in all environmental protection and natural resources programmes and ensure effective dissemination and enforcement of the Land law.	The law governing land in Rwanda (2013) guarantees equal rights on land access, ownership and utilisation for both males and females. However, the traditional patriarchy of Rwandan society results in unequal power of decision over land use in households.	Gender-inclusive projects.
	5.2. To facilitate and support gender responsive land use	Women in Rwanda enjoy the same land rights as men. According to the law governing land in Rwanda, land owners are required to	Strategic Needs and interest of women and men considered in

Programme of Action	Actions[64]	Situation analysis summary	Added value on gender output/outcome
Topic: Agriculture			
	planning and management processes for improved and sustainable land use (MIGEPROF, NGP, 2010 & Agr Gender Strategy, 2010).	undertake protective and sustainable catchment measures on the land. However, women continue to have less control and don't take decisions on land use within the household and the community. The access to land by both spouses is at 54%. 18% are owned by just men, 26% earned by just women, and 2% by others (EICV4 2013/2014).	planning and management process.
	5.3. To increase the number of women: - benefiting from training to manage forestry, water resources, mining and land related businesses sustainably at the rate of 30%; - being employed at the same rate as men; - involved in environmental impact assessment, gender budgeting training, and monitoring and evaluation (MINIRENA, 5YR SSP, 2013).	One of the entry points for enhancing the role of women in the IWRM programme is to increase the number of women benefiting from training and to increase the number of women professionals involved in environmental management at sector and district level.	Promote women's participation in training and education.
	5.4. Ensure that 50% of the people involved in watershed management are women and ensure that women comprise at least 30% of the membership of local watershed management	Currently, the gender targets set by guidelines and sector strategy in terms of women's and men's participation and representation in water governance are not necessarily respected. This can be seen as a weakness that needs to be addressed.	Promoted participation of women in watershed management.

Programme of Action	Actions[64]	Situation analysis summary	Added value on gender output/outcome
Topic: Agriculture			
	committees (MINIRENA, 5YR SSP, 2013).		Women represented in local catchment task forces, water user organisations.
Topic: Other			
6. Access to finance	6.1. Establish mechanisms to remove barriers that constrain women's access to and control over productive resources such as commercial, industrial, finance and appropriate technology for a better participation in the private sector.	45.7% of all Rwandan HH income is derived from agriculture (EICV4, 2012, GMO, agri prof. 2017). But GMO, 2017 and agri profile reports emphasise that access to agriculture credit is low for men and women and the biggest share of credits/loans disbursed in agriculture is disbursed to male farmers: 2013 – M: 74.6%, F: 25.4%; 2014 – M: 83.6%, F: 16.4%; 2015 – M: 74.5%, F: 25.5%.	Reduced socio-cultural barriers to enhance women's entrepreneurship and participation in the private sector.
	6.2. Facilitate and support women and youth friendly credit schemes through VSL and MFI.	There is a partnership established for implementing access of women and youth to finance strategy which includes MINEACOM, MINECOFIN, MIGEPROF, RCA, Ministry of Youth (operating mostly through Business Development Fund (BDF) and SACCO.	Increased access for women and youth to finance.
7. Agri-market infrastructure development	7.1. Facilitate rural transport used in different localities, especially by women and institute appropriate intervention measures to facilitate access to energy to reduce the household energy burden on women.	Currently there is a big share of public investments going into rural infrastructure development, including feeder roads. Construction works employ women and men through VUP public works. The increased linkage of farmers to markets is ensured sustainably if community ownership is enhanced for maintenance and water collection structures. Firewood is used (and overexploited) in rural areas more than in urban areas. The distribution (%) of HHs using wood as the main type of cooking fuel is: urban: 29.3% and rural: 94.4%. The number of women involved in charcoal cooperatives has	Access to technology and alternative energy source to reduce the household energy burden and less forest degradation for cooking energy.

Programme of Action	Actions[64]	Situation analysis summary	Added value on gender output/outcome
Topic: Agriculture			
		increased and the number of men involved has decreased in 2014 compared to 2012: 54% for women and 46% for men. Energy saving cooking stoves (ESCS). ESCS are more popular in rural areas (38%) than in urban areas (20%). They are used more by MHHs (35%) than FHHs (32%) (Source: EICV 2012).	
	7.2. Encourage and support private initiatives aimed at facilitating access to ICT facilities especially for rural women and men.	The high increase in the population owning mobile phones and radios, and the improved access and connectivity to the electricity grid provide good opportunities for ICT business projects in rural areas.	Promoted gender-inclusive business projects through ICT.

Hands-on guidelines for gender mainstreaming in the development and implementation of IWRM packages/EIPs/IPs/CPIPs

1. Propose activities that combine people's domestic and food production water needs in catchments;
2. Propose actions that combine water needs for hygiene and food production especially for irrigation in horticulture;
3. Propose actions (add-ons) that empower women to take part in decisions on water governance and reduce the burden of carrying out home tasks;
4. Propose projects that enhance job creation, access to finance and allow women and men to move up the value chain;
5. Propose inclusive projects for sustainable ecosystem management, using a gender-balanced intense workforce;
6. Use gender sensitive and participatory training approaches that ensure participation by men and women: Farmer Field Schools (FFS) and Gender Action Learning System (GALS) methodology to transfer IWRM skills to water users;
7. Propose, where relevant, upgrades of IPs to IP+s which ensure equal access to IWRM related information by men and women water user categories in the catchment;
8. Propose IP upgrades to IP+ which educate men in vocational technical skills (off-mining and model mining) to address unemployment in mining probe sub-catchments;
9. Downscale key IWRM measures to HH level, to enhance access, family ownership and reduced cost (through a family performance book of IWRM aligned Imihigo). Each HH in the catchment can record its own household level progress made on rehabilitation measures of the sub-catchment or watershed in which they live (related to Catchment Plan or Imihigo), e.g. terrace maintenance, rainwater harvesting, kitchen gardens, tree nurseries, agroforestry trees planted, etc.;
10. Provide business development incubators for women and their moving up in the value chains;
11. Support innovative businesses that incentivise water users to plant key species for buffer zone protection (bamboo-based business, IES, beekeeping, small livestock) as drought resilience approach;
12. Propose add-ons that enhance women's positive role in IWRM, forest preservation and in increasing the water balance (RWH, improved cooking stoves, climate smart agriculture);
13. Propose actions that greatly include women by scaling up the IWRM measures at household level: Family agroforestry tree nurseries, kitchen gardens, etc.

Strategic actions and recommendations for effective and sustained gender equality considerations in the Catchment Plan

Enhanced institutional capacity for joint and coordinated agency in gender strategy implementation:

1. Initiate and operationalise a gender sub-sector working group at Ministry level bringing together multiple stakeholders;
2. Implement new partnerships (MoU) with gender related institutions: MIGEPROF, NWC for women empowerment and GMO for enhancing and monitoring gender accountability;
3. Conduct bi-annual joint planning workshops and development and update of gender responsive programming at catchment level;
4. Align and integrate water related gender issues in catchment area with Ministry's Gender budget statements (GBS) and allocate adequate budget to address them;

5. Participate in annual gender accountability day organised by GMO in one district within the catchment.

Knowledge management: Inclusive capacity building in IWRM measures and empowerment

1. Train the staff (districts, catchment offices, stakeholders, water users) on gender and IWRM and conduct national study tours for water users for targeted men and women for effective monitoring of CP;
2. Promote gender aware micro level approaches: Initiate pilot Gender Action Learning System tools for household level and Farmer Field Schools;
3. Mainstream gender in climate resilience measures to adapt to droughts and water related disasters or shocks: non-water consumptive business skill promotion such as beekeeping, bamboo handcraft, mushroom production; ecotourism;
4. Organise awareness campaign on protection of the catchment, agro-ecological practices and renewable energy.

Monitoring and evaluation and impact reporting

1. Integrate gender sensitive outputs and outcome indicators in M&E system;
2. Support W4GR IMS to track the progress including sex-disaggregated data in the catchment area hosted by the W4GR/RWFA to inform future analysis and decision making;
3. Conduct gender impact assessment of the W4GR programme and disseminate lessons learnt to stakeholders.

Annex 11. Rwanda’s INDC on climate change

Table 62: Rwanda’s Intended Nationally Determined Contribution (INDC)

Adaptation contribution	
Rationale and process for adaptation contribution	Rwanda is highly vulnerable to climate change, as it is strongly reliant on rain-fed agriculture both for rural livelihoods and for exports of mainly tea and coffee. With the highest population density in Africa, adaptation concerns are central to the INDC. In recent years, extreme weather events in Rwanda increased in frequency and magnitude what, in some parts of the country, led to significant losses including human lives. Floods and landslides were increasingly reported in the high altitude Western and Northern Provinces, whereas droughts made severe damages in the Eastern Province.
Summary of climate change trends, impacts and vulnerabilities	Rwanda has experienced a temperature increase of 1.4°C since 1970, higher than the global average, and can expect an increase in temperature of up to 2.0°C by the 2030s from 1970. Rainfall is highly variable in Rwanda, but average annual rainfall may increase by up to 5-10% by the 2030s from 1970. This is expected to lead to increasing rainfall intensity, leading to a higher frequency of floods and storms resulting in landslides, crop losses, health risks, and damage to infrastructure, as well as an increase in temperatures resulting in proliferation of diseases, crop decline and reduced land availability that impacts on food security and export earnings.
Adaptation vision and goals	
Vision for adaptation	Rwanda's long-term vision is to become a climate resilient economy, with strategic objectives to achieve Energy Security and a Low Carbon Energy Supply that supports the development of Green Industry and Services; Sustainable Land Use and Water Resource Management that result in Food Security, appropriate Urban Development and preservation of Biodiversity and Ecosystem Services, as well as to ensure Social Protection, Improved Health and Disaster Risk Reduction that reduces vulnerability to climate change impacts
Sector goals	The priority adaptation actions have been identified in Rwanda's Green Growth and Climate Resilient Strategy (2011), are on-going and will be partially or fully achieved by 2050. Many of the actions specified under the sectors programmes have both mitigation and adaptation benefits.

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
1. Sustainable intensification of agriculture	1.1. Mainstreaming agroecology techniques using spatial plant stacking as in agroforestry, kitchen gardens, nutrient recycling, and water conservation to maximise sustainable food production;	Seasonal shortages of food supply as a result of poor harvests caused by droughts and flooding and soil erosion are among the most significant signs of how the agriculture sector is vulnerable to climate change in Rwanda. In order to adapt to this situation, Rwanda intends to mainstream agroecology technologies in its current agriculture intensification programme and other natural resource-based livelihood programmes. **100% of the households involved in agriculture production will be implementing agroforestry sustainable food production by 2030.**	Reduced GHG emissions from land use change
	1.2. Utilising resource recovery and reuse through organic waste composting and wastewater irrigation;	The steep nature of Rwanda's topography coupled with very high population density (415 inhabitants / km2)11 leads to several pressures on natural resources, including land, and this remains the main reason for land degradation. Arable lands also show little tolerance when it comes to climate change effects like heavy rains and draughts. In fact, heavy rains lead to soil erosion resulting in fertility decline and low productivity. Rwanda intends to promote recovery and reuse of both organic waste and wastewater in order to restore and maintain soil fertility. **Organic waste use through composting, currently used at a small scale, will be implemented to reach 100% of the households involved in agriculture production countrywide by 2030. Waste water irrigation, mainly practiced in correction centres under national prisons services will be implemented countrywide by 2030.**	Reduction of methane emissions from landfills
	1.3. Using fertiliser enriched compost	Rwanda relies on imported inorganic fertilisers for its agriculture intensification activities. For instance, 36000 Mt of these were imported in 2014 and these importations are likely to increase in the near future. Although good at increasing yields, intensive use of inorganic fertilisers has adverse impacts to the environment in general and climate change in particular. In contrast, the use of organic fertilisers by composting has many environmental benefits whereby it provides an excellent way to manage the huge volume	Reduce GHG emissions from fertiliser manufacturing processes

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
		of organic waste and utilise it in a productive manner. The effectiveness of composted organic waste can be further improved by enriching and blending it with nutrients (Nitrogen phosphorus). This technique ensures a more efficient use of inorganic fertilisers, and adds valuable organic matter to soils, which also maximises terrestrial carbon in farm soils. **Rwanda intends to ensure the use of fertiliser enriched compost and shift from using pure inorganic fertilisers by 2030.**	
	1.4. Mainstreaming sustainable pest management techniques to control plant parasites and pathogens	Increasing average temperatures, changes in precipitation and water shortage are seen as climate change aspects that result in pests and diseases proliferation. In order to adapt to this, **Rwanda intends to promote sustainable pest management techniques that incorporates a cropping system based on producing multiple crop and fodder yields, but which is also designed to control plant parasites and pathogens such as stemborers and striga weed. Rwanda also intends to implement push-pull system using Napier grass and desmodium legume to manage pests under maize, sorghum, millets and rain-fed rice plantations.** The main adaptation benefits of the push-pull system are the increase of yields, soil fertility improvement through nitrogen fixation and provision of a continuous supply of fodder to cattle from the harvest of Napier grass and desmodium. This improves milk yields of cattle while reducing methane emissions as a result of improved fodder regimes.	Reduced GHG emissions from enteric fermentation
	1.5. Soil conservation and land husbandry	90% of Rwanda's crop land is on slopes ranging from 5 to 50% which makes it vulnerable to climate change impacts like soil erosion leading to permanent fertility loss. **Rwanda intends to expand its soil conservation and land husbandry programmes trough: Installation of land protection structures like radical and progressive terraces where these structures will be installed on 100% of the relevant area by 2030; Development and implementation of an intensive agroforestry programme with a target of covering 100% of arable land by 2030.**	Reduced GHG emissions from farm land and increased carbon sink through agroforestry practices
	1.6. Irrigation and water management	The Rwandan agriculture mainly rain fed which makes it vulnerable to weather shocks. Rwanda intends to increase investment in irrigated agriculture to increase production,	Efficient use of irrigation water

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
		harness fresh water resources while ensuring food security to its population. Under this action, district irrigation master plans will be designed, and small-scale schemes will be developed where possible based on water catchments, and farmer organisations trained in their development. **Agricultural land fitted with operational irrigation infrastructure was estimated at 4% of the total land with irrigation potential in 2012. The overall target of the new irrigation programme is to reach 11% by 2030.**	reduces nitrogen losses including nitrous oxide emissions.
2. Agricultural diversity in local and export markets	2.1. Add value to agricultural products through processing to meet its own market demand for food stuffs;	Food stuff distribution faces challenges when it comes to rural community market places where traded commodities can be damaged under extreme weather conditions. Rwanda intends to expand local markets by constructing market infrastructure, including roofed market facilities, serviceable road, and transport networks, developing decentralised village-based agricultural processing centres that incorporate low-carbon sources of energy, such as biogas-digesters and solar driers, and decentralised compost plants. This forms a conduit for agricultural-based trade based on less food miles for regionally and internationally imported food products. Strengthening local markets will also build economic resilience in rural areas that is less dependent on linear commodity flows of raw goods leaving rural areas unprocessed and without added value. **Group based organisations involved in agriculture production and running agro processing facilities were estimated at 10% of the total operating group-based organisations in 2014. The target is for this percentage to increase by up to 90% by 2030. Also, the installed capacity of agro processing installations is to reach 1,200,000 MT by 2030 from 400,000 MT12 in 2014. In addition, Rwanda targets to have 100% of farmers with access to services for post-harvest treatment and storage of food crops and reduce post-harvest losses to at least 1% by 2030 from 10.4%, 27.4% and 8.3% in 2014 for maize, beans, and rice respectively. The use of solar energy in warehouses will be actively promoted.**	Reduced GHG emissions as a result of using low carbon energy sources and reduced transport distance.
3. Sustainable Forestry,	3.1. Promote afforestation/reforestation of designated areas	The Rwandan forestry sector provides the main part of the primary energy needs (97% of cooking energy) to the population. Since 2002, there have been consistent gap in wood products supply and demand with deficits reaching 12 million cubic meters in 2009. This	Reduced GHG emissions through sequestration

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
Agroforestry, and Biomass Energy	through enhanced germplasm and technical practices in planting and post-planting processes;	deficit shows how the forest sector is and likely to remain under pressure. In order to deal with this main issue, Rwanda intends to improve the management of its forest resources by increasing efforts in using quality germplasm, planting trees at the right time (rain season) and improving post-planting care. Furthermore, the country intends to use mixed-species approaches which contribute greatly to the achievement of both mitigation objectives and adaptation benefits of ecosystem resilience and biodiversity. **Through this strategic action, the country's target is to achieve an overall 30% sustained forest cover of the total national land surface by 2030 from 28.8% in 2013.**	
	3.2. Employ Improved Forest Management for degraded forest resources;	Land scarcity is a primary constraint to the expansion of Rwanda's forest resources. Rwanda should maximise the productivity of its many degraded forest plantations which present an opportunity to increase biomass supply without converting additional land. **By 2030, Rwanda will implement public private partnerships to sustainably managing all forestry plantations through multiyear contracts with forests operators (in cooperatives) who will plant and maintain young plantations until they reach their commercial size.**	Reduced GHG emissions through sequestration
4. Ecotourism, Conservation, and Payment for Ecosystem Services Promotion in	4.1. Maximise business tourism (the largest source of export revenues) through strategic conference management in order maximise the distribution and volume of business travellers throughout the year	Rwanda will promote business conferences in efforts to maximise the distribution and volume of business travellers throughout the year. These efforts will result in increased bed occupancy at available hotels and lodges within Kigali, and subsequent visitation to its surroundings including Volcanoes National Park (VNP), Nyungwe forest and Akagera National Park. **Through this strategic action, Rwanda expects business and leisure tourists to increase from 545,000 people in 2012 to 1,262,000 people in 2030.**	Unspecified

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
Protected Areas			
5. Integrated Water Resource Management and Planning	5.1. Establish a national integrated water resource management framework that incorporates district and community-based catchment management;	Rwanda will integrate management of water resources at the district and community levels, define catchment wide responsibilities, cluster catchment partner-districts according to sub-catchment regions, and improve understanding of water users within districts and catchments. **The national framework for IWRM will be cascaded down to district and catchment levels. To this end, catchments committees and water users' associations (WUAs) will be established and trained at district level to cover all the 30 districts by 2030. Also, detailed catchment management plans have will be developed and implemented for all the nine identified main catchments areas by 2030.**	IWRM is expected to result in improved water resources in both quality and quantity. This will increase opportunities for hydropower development thus reducing emissions from fossil fuels used for electrical power generation.
	5.2. Develop water resource models, improved meteorological services, water quality testing, and improved hydro-related information management;	To allow precise planning of water resources and improved allocation, Rwanda will develop water balances at district and catchment levels, supported by hydrological models, improved rainfall monitoring, and a better understanding of agro-meteorology and water quality testing. **The important national water datasets will be identified to enable monitoring of the water balance, model abstraction and future demand. Furthermore, assessments will be undertaken of water resources under a range of climate change scenarios. In this regard, surface water quality monitoring will be carried out on selected sites of main rivers. All the existing 53 gauging stations will be upgraded to automated real time data stations by 2030.**	Unspecified
	5.3. Develop a National Water Security Plan to employ water storage	Rwanda will establish a comprehensive National Water Security Plan to expand water storage and irrigation infrastructure, rainwater harvesting, water conservation and water efficiency practices. This strategic action brings together the national policies and	Unspecified

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
	and rain water harvesting, water conservation practices, efficient irrigation, and other water efficient technologies.	strategies for irrigation, water supply and sanitation, IWRM and energy. **In this regard, an assessment of the current water storage capacity will be carried out and the improved water storage will be the main outcome of the assessment with reference to the IWRM subsector strategic plan. Rwanda will also implement the water resources master plan which identified potential sites for multipurpose dam construction countrywide for improved water storage. In addition to the detailed design for one of the identified, others will be initiated and finished by 2030. Rainwater harvesting will also be mandatory and will be made an integral part building codes by 2030.**	
6. Integrated approach to Sustainable Land Use Planning and Management	6.1. Employ an integrated approach to planning and sustainable land use management;	Given the size of the country and its very high demographic pressure, competition for land will continue to grow with increasing pressures from agriculture and livestock making land resources more vulnerable to climate change impacts. Encroachment on sensitive areas will persist until land reforms are completed. **Rwanda will implement rigorous planning and zoning regulatory framework to manage the changing demands on land. In addition to initiatives like systematic land registration and implementation of land tenure regularisation reform. Rwanda intends to reduce the plot size for single family houses from current 600 m2 to 300 m2 by 2016 and to 225 m2 by 2030.**	Combined actions under this programme will result in availing more land space which might be converted to others uses such as new forest plantations thus serving as carbon sink.
	6.2. Improve spatial data by harnessing ICT and GIS (Geographic Information System) technology;	Rwanda will develop National Spatial Data Infrastructure (SDI) to manage the nation's land information resources and to identify the fundamental datasets required to manage land and water resources, monitor land use and environmental change, support economic development, and enable Rwanda to better plan, monitor, and respond to the impacts of climate change. **It is planned that the establishment of the National Spatial Data Infrastructure will be operational by 2030.**	This strategic action will result in better estimations of GHG emissions from land use, land use change and forestry thus improving planning and implementation

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
			of specific mitigation actions for the same sector.
7. Disaster Management	7.1. Conduct risk assessments and vulnerability mapping	Specific risk and vulnerability assessments are key for better planning and implementation of relevant adaptation actions. In addition to the countrywide vulnerability index that was completed recently, Rwanda will conduct risk assessments and initiate vulnerability mapping to develop effective disaster management systems. **Risk assessments will be conducted and completed countrywide by 2030.** **Every five years, Rwanda will be updating the recently developed climate change vulnerability index as to reflect the real situation of vulnerability to Climate change at any given time in the country. In addition, other assessments (such as national communication) with a vulnerability assessment will be conducted periodically.**	Unspecified
	7.2. Establish an integrated early-warning system, and disaster response plans	Rwanda is exposed to climate related disasters like droughts, floods and landslides. In addition to existing disaster management initiatives mainly focusing on preparedness, assessment, mitigation and disaster reduction, **Rwanda will establish and early-warning system in order to prevent the impact of natural climate disasters on humans. Rwanda will also improve its capacity in disaster preparedness and mobilisation and distribution of relief to populations affected by specific disaster events.**	Unspecified
8.Climate data and projections	8.1 Employ community-based disaster risk reduction (DRR) programmes designed around local environmental and economic conditions, to mobilise local capacity in emergency response,	**Rwanda will implement the following community based DRR activities: improved farming techniques that mitigate flood and landslide impacts; first aid training; and environmental and public health awareness for disease prevention, particularly following flood and storm episodes. In order to reduce locally-specific hazards, relocation from high risk zones is considered as one of the strategic actions. In addition to households previously relocated from high risk zones, Rwanda will relocate additional 30 000 households by 2030.**	Unspecified

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
	and to reduce locally-specific hazards		
	8.2 Improve observation facilities to provide all climate information necessary for future monitoring, climate trend detection, management of climate variability, early warning and disaster management	**Rwanda will establish of additional observations in order to provide climate information necessary for future monitoring, climate trend detection, management of climate variability, early warning and disaster management by upgrading and maintenance of existing stations and calibration of meteorological instruments including weather radar.**	Unspecified

Annex 12. MCA methodology

A multi-criteria analysis was conducted for the selection of IWRM packages. This annex introduces the methodology in detail. A tool was developed in Microsoft Excel and used by the catchment task forces and the focal point group. The tool has been made available for future use by plan partners, e.g. for the development of additional catchment plans and for the selection of implementation projects in annual implementation plans.

Table 63: MCA criteria explained

Theme	Criteria	Explanation
1. Environment	Adaptation or Mitigation to climate change	This relates directly to the influence of the intervention on the resilience to effects of drought or excessive rain (and other climate change related impacts like increased unpredictability of rainy seasons), as well as effects on climate change mitigation e.g. carbon sequestration.
	Ecosystems quality and integrity	This looks at the area of the catchment in a non-degraded status, capable of providing catchment priority ecosystem services, by sustaining natural biodiversity and habitats (relates to W4GR indicators 25 and 26).
	Water quality improvement	The key water quality parameter in the period 2018-2024 is the sediment load; decreased sediment loads lead to reductions in unit costs of drinking water treatment by water service providers and to reductions in downtime of intakes for drinking water and hydropower.
	Water quantity improvement	This relates to the volume of water storage per capita (RWFA/WRMD KPI).
2. Economic	Contribution to rapid growth and economic transformation	This relates to the internal economic development in the catchment, e.g. by addressing local key drivers of economic development, but also relates to the volume and value of increased production. High scores reflect increased land and water productivity.
	Investment per unit area or per person	This examines the amount invested in the project in relation to the number of people benefiting from the project (e.g. water supply project or irrigation project) or the area covered by the project - compared to other projects aimed at resolving the issue at hand.
	Contribution to rural development	This relates to a shift from subsistence farming to commercial farming for markets, and to sustainable agriculture (including forward and backward linkages of agricultural value chains).
	Contribution to basic infrastructure development	This relates to the overall infrastructure that is needed to support a market-based economy, including accessibility to sufficient quantities and qualities of water, electricity, road network, etc.
	Contribution to sustainable, direct long-term jobs creation	This looks at the direct total number of jobs created (Full Time Employment), away from traditional agriculture and artisanal mining.

Theme	Criteria	Explanation
	Direct jobs for women, youth, and vulnerable groups	The percentage of women, youth, and people from vulnerable groups that receive sustainable employment out of the total number of new jobs (Full Time Employment) as outcome of the project.
3. Social	Contribution to poverty reduction	This relates to the number of households, benefitting from the investment project (W4GR indicator 24), and to the proportion of the local population benefiting directly from the project, especially women-headed households, youth, and vulnerable groups. Social inclusiveness is likely to increase their incomes and GDP per capita (EDPRS/NST1, W4GR indicator).
	Equitable allocation of water resources	This relates to water availability and accessibility for all users, and the allocation of significant amounts of water to eligible users via water permits. Water for industrial purposes is equitably shared with water for irrigation of both cash and seasonal crops.
	Contribution to health improvement	This relates to the quality, availability and accessibility of potable water at household level, the prevalence of improved sanitation facilities and hygiene practices, ultimately reflected in the incidence of epidemics and waterborne diseases, as well as infant mortality and morbidity rates.
	Need for population resettlement	This examines whether people will have to be permanently relocated in order for the project can take place. If available, it is assessed whether or not the land acquisition and resettlement plan ensure that incomes and living standards of project-affected persons will be restored at pre-project levels. (N.B., it is assumed that one household contains 7 people.).
4. Governance	IWRM demonstration value	The relates to the extent to which the project is of demonstration value (scalability / replicability elsewhere in or beyond the catchment) and its degree of integration, e.g. the participation of different stakeholders, the inclusion of multiple NST1 sectors, and the inclusion of CCAs.
	Stakeholder commitment	This relates to the degree to which the project has existing priority, e.g. by inclusion already in DDSs and Imihigos, government or development partners budgets, private sector commitments, as well as local stakeholder non-financial support.
	Gender equity in decision making and technical positions	This relates to the % of men and women participating in major decision-making processes and in technical positions (within districts, catchment task forces / catchment committees, and among their support staff), or the involvement by beneficiary women/youth/vulnerable groups in small-scale, local, decision-making processes to detail infrastructure projects.
	Provision for operation and maintenance	This looks at the need for, and availability of, sustainable recurrent funding and means (skilled workers, materials) for operation & maintenance (O&M).

Theme	Criteria	Explanation
	Technical feasibility	This looks at the ease of implementation from a technical perspective. High readiness means that FS/DD are available, as well as skilled contractors to carry out the work.

Table 64: MCA scoring rules per criterion

Theme	Criteria	Criteria scoring rules
1. Environment	Adaptation or Mitigation to climate change	**90%** is positive impact on climate resilience; **70%** is no change; **50%** is reduced resilience to climate excesses; **30%** is high reduction of resilience; **0%** is extreme reduction of resilience;
	Ecosystems quality and integrity	**90%** is positive; **70%** is no change; **50%** is slightly negative; **30%** is very negative;
	Water quality improvement	**90%** Positive impact - water quality improves; **70%** No impact; **50%** Negative impact – slight decline in water quality over limited area (5-10% of project area); **20%** Negative impact - moderate decline in water quality over large area (10-25%); **0%** Serious impact (significant decline in water quality >25% of project area);
	Water quantity improvement	**90%** is increase; **70%** is no change; **50%** is decrease; **30%** is large decrease;
2. Economic	Contribution to rapid growth and economic transformation	**90%** is increase; **70%** is no change; **50%** is decrease; **30%** is large decrease;
	Investment per unit area or per person	**90%** Positive – investment per unit area or per person is very low; **70%** Positive - investment per unit area or per person is low; **60%** Negative - investment per unit area or per person is relatively high; **50%** Negative - investment per unit area or per person is high; **40%** Negative - investment per unit area or per person is very high; **30%** Negative - investment per unit area or per person is extremely high;
	Contribution to rural development	**90%** is increase of rural economy; **70%** is no change; **50%** is decrease of rural economy; **30%** is large decrease rural economy;

Theme	Criteria	Criteria scoring rules
	Contribution to basic infrastructure development	**90%** is increase; **70%** is no change; **50%** is decrease; **30%** is large decrease;
	Contribution to sustainable, direct long-term jobs creation	**90%** is increase; **70%** is no change; **50%** is decrease; **30%** is large decrease;
	Direct jobs for women, youth, and vulnerable groups	**90%** is High; **70%** is Average; **50%** is Low; **30%** is Very low; **0%** is no vulnerable groups FTEs;
3. Social	Contribution to poverty reduction	**90%** is increase; **70%** is no change; **50%** is decrease; **30%** is large decrease;
	Equitable allocation of water resources	**90%** is increase; **70%** is no change; **50%** is decrease; **30%** is large decrease;
	Contribution to health improvement	**90%** is increase; **70%** is no change; **50%** is decrease; **30%** is large decrease;
	Need for population resettlement	**70%** No or little impact (for large-scale projects <10 households; for small-scale projects <1% of the population in the project area); **60%** Negative impact – some resettlement required (for large-scale projects 10-200 households; for small-scale projects 1-2% of the population in the project area); **50%** Negative impact - for large-scale projects 200-2500 households need to be resettled; for small-scale projects 3-4% of the population; **30%** Negative impact - for large-scale projects 2500-5000 households need to be resettled; for small-scale project 5-6% of the population; **20%** Negative impact – moderate resettlement required (large-scale projects 5000-10000 households; small-scale projects 7-10% of the population of the project area); **10%** Serious impact – unacceptable resettlement required (for large-scale projects >10000 households; for small-scale projects >10% of the population of project area);
4. Governance	IWRM demonstration value	**90%** is scalable and integrated; **70%** is scalable and water related; **50%** is single project, business as usual; no integrated approach;

Theme	Criteria	Criteria scoring rules
		30% is negative influence of up/down stream users/other stakeholders; **10%** is very negative influence on up/down stream users;
	Stakeholder commitment	**100%** is stakeholders fully support and there are committed funds from government/NGO/IFIs/private sector; **70%** is priority project for certain stakeholders (government/private sector etc) but no commitments made; **50%** is stakeholders are for project but no commitments from national/international level; **30%** is stakeholders with serious concerns on the project, this could be remediated; **0%** stakeholders are against this project;
	Gender equity in decision making and technical positions	**90%** is majority decision makers and/or assigned technical positions are women; **70%** is equal percentage of women and men involved in decision making / assigned technical positions; **50%** is unequal percentage of women and men involved in decision making / assigned technical positions;
	Provisions for Operation and Maintenance	**90%** Institutions/structures already in place for managing O&M (e.g. traditional irrigation scheme which will be rehabilitated); **50%** Negative impact - new scheme, no institutions/structures in place, but workable plan for O&M; **20%** Serious impact – new scheme, no institutions/structures in place, unrealistic plan for O&M;
	Technical feasibility	**90%** is FS/DD are available and skilled contractors are available; **70%** is skilled contractors are available but FS/DD still to be made; **50%** is FS/DD are unavailable and skilled contractors are unavailable.

Annex 13. Concept notes of IWRM packages

The IWRM package concept notes included in this catchment plan are:

- MUV01 – Support to sustainable water supply and hydropower generation through catchment restoration in Ngoma sub catchment;
- MUV02 – Drought management to improve access to water for supporting livestock and agriculture value chains; and
- MUV03 – Support improvements in sustainable water and catchment management (floods and sediments mitigation) through developing the tea and forestry value chains in Mulindi.

The concept notes of the IWRM packages are presented on the following pages.

IWRM Package:

1. Support improvements in sustainable water and landscape management (floods and sediments mitigation) through developing the tea and forestry value chains in Mulindi.

Main socio-economic driver:

Mulindi valley tea plantations & tea factory

Main issue:

Flooding in wet season and drought in dry season that affects green tea production; and insufficient sustainable fire wood which negatively impacts on local tea productivity.

Implementing partners: **RWFA**, TWFA, COOPTHE and COOTHEVM

Pacages rational

Tea is cultivated in Mulindi marshlands since 1959. The first factory was established in 1962 and was run by the Government of Rwanda until 2012 when it was privatized.

The Wood Foundation Africa (TWFA) within the East African Tea Investment (EATI) currently owns 55% of the factory whereas the tea grower cooperatives own the remaining 45%.

The Wood Foundation Africa (TWFA) provides technical assistance to the two tea leaf supplier co-ops: COOPTHE and COOPTHEVM to improve yields of the green tea and organizational advice. TWFA also provides 'best practices' information and seedlings to increase the productivity of the Co-ops. COOPTHE is exploiting 694 ha of tea in the valley marshland and COOTHEVM is exploiting 1015 ha in the marshland and on the hillsides. The cooperatives have 4,940 farmers members (71% of men and 29% of women).

The objective of TWFA is to support the development of the tea value chain and production in Mulindi as well as the upgrading of the factory with new more efficient technologies. After finishing the modernization of the factory and strengthened cooperatives, all the shares owned by the TWFA will be handed over to the Cooperatives. The management of the Tea Factory will then be taken over by the cooperatives.

The main challenges faced by the Mulindi tea plantations and factory are:

1.The impact of climate change and demographic pressure:

Recent change in rainfall patterns in the region are affecting the tea production. Although the average annual rainfall remains the same, the distribution is characterized by intense rainfall creating flash floods and dry spells which threaten the peat valley bio-system. Development of villages (imidugudu) and agriculture on steep slopes in the watersheds are also contributing to flash floods which have opened big gullies in the hills surrounding the tea plantation as well as in the marshlands themselves.

The gullies are unstable and quickly progress in loose peat soils. Sand and mud brought by floods tend to cover tea plantations causing important maintenance costs and even loss of entire tea plots. This is a substantial threat for tea production and livelihoods.

1.Water management in tea plantations:

Tea production is negatively impacted by water logging (high rainfall and poor drainage of the marshlands) and by drought (low rainfall or excess drainage during dry season). Tea productivity among the cooperative farmers varies significantly according to hydraulic condition in water dependent peat soils: in these marshlands, during the rainy season, the high water table impedes the development of the root system, while the shallow root system also suffers from a lack of water during the dry season. The water level in drains must therefore be carefully managed.

Drains should be deep enough to allow an appropriate drainage during the wet season but check dams are necessary to raise the water level up to the root system during the dry season. The drainage system in the tea plantation is composed of about 210 km of main drains and 1,220 km of secondary drains.

These need regular maintenance since they regularly receive sediments from the surrounding hills. Recent floods (10/2017) destroyed about 44 ha of tea plantations, covered by sand, gravel and even boulders. A drought occurred in 2017 and impacted 392 ha of tea of which 128 ha was severely damaged. Gullies are often created by runoff from settlements and roads on top of the hills. RWH can reduce the runoff and well protected drains using replicable low cost bioengineering technology can help control and reduce the creation of gullies.

Downstream, near the Ugandan boarder, around 200 ha of marshland tea plots have been abandoned since 1994 because of poor drainage and a collapse in the peat biosystem. Water works are needed to restore the drainage and favourable conditions to reinstall tea. The two cooperatives are already implementing maintenance works on the Ugandan territory but through informal cooperation. This activity could be more effective when implemented through formal transboundary cooperation involving local leaders from Rwanda and Uganda.

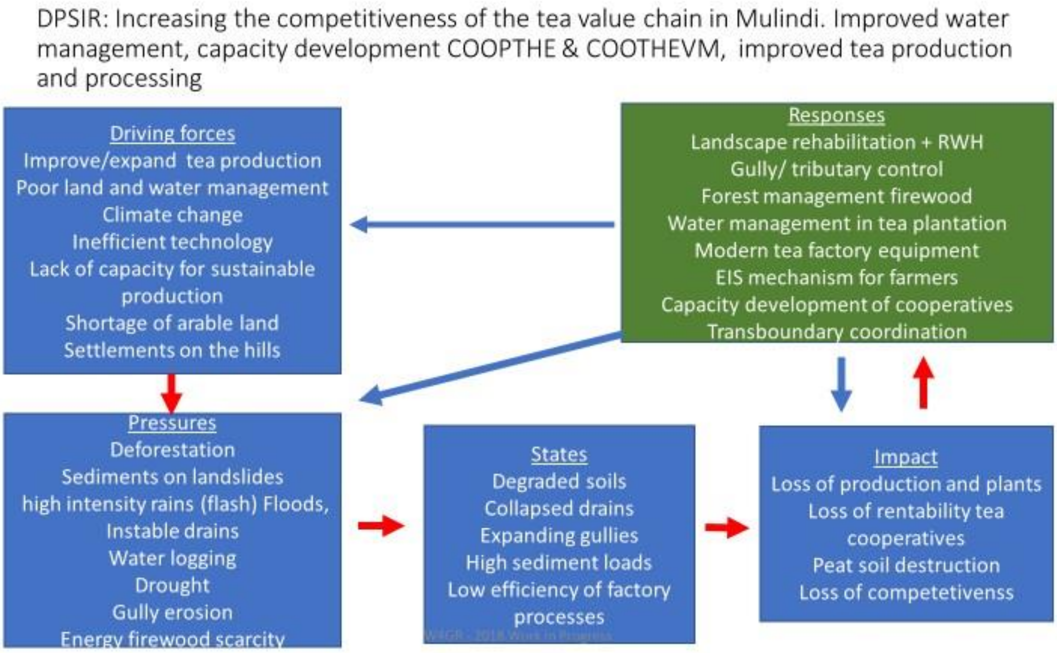
1.Tea factory – resource use of water and energy:

water used in the factory comes from 2 springs (pumping and gravity). Rainwater harvesting is planned. Waste water (from cleaning equipment only) is limited, only 10 m^3 per week. Treatment is done with lagoon and infiltration. 12,000 m^3 of firewood per year is needed for curing of the tea leaves. The factory owns 284 ha of forests covering presently about 40% of its energy needs. Additional firewood is bought from farmers with private woodlots, and eventually from District owned forests.

The DPSIR - Driving Forces, Pressures, State, Impact, Responses - in a nutshell:

Tea is the important economic driver in the Mulindi sub-catchment providing work and income to 4.000 families. The tea value chain consists of tea plantations, transport of leaves to the factory, forest to supply the firewood and the factory. Changes in weather patterns, lack of maintenance and damage by floods and erosion threaten the productive capacity of the plantations and the livelihoods of Mulindi inhabitants. Before the involvement of TWFA, costs were increasing while productivity was decreasing putting at risk the survival of the tea business. To reverse this trend several responses have been designed that include modernizing the

factory, protecting the catchment and improving water management in the plantations in the marshland.
Through a coordinated effort between the GoR, the TWFA, W4GR and the cooperatives, the tea value chain will regain its competitiveness and continue to improve the livelihoods of thousands of families in Mulindi and Ngoma sub catchmen



Objectives

The general objective is to *improve and sustain tea production and productivity to improve the livelihoods of the population involved in tea production in the area*.

The specific objectives are:

- The Improvement of water management in the tea plantation established in peat marshlands;
- The mitigation of floods and sediments impacts in the marshland tea plantation
- The establishment of a transboundary IWRM collaboration on drain maintenance to re-develop 200 ha in the downstream part of the tea plantations:
- The adoption of more efficient technology in tea processing

The spescifique activities for the project linked to packages

As shown in the DPSIR figure above, all development activities presented below are interlinked and contribute to the IWRM objective:

- **IP$^+$ - Improvement of water management in the tea plantation (peat marshland)**
  - Restore and improve the drainage network in the marshland and rehabilitate productive plantation areas;
  - Install check dam structures to regulate the water level in the drains during dry season;
  - Install foothill ring drains all along the marshlands to manage the inflow from the uphill aquifers.

- **CPIP#1 - Flood and sediment mitigation through Land Scape Restoration and Rain Water Harvesting:**
    - Landscape **(LR)** restoration in the hillsides and tributaries around the Mulindi marshlands to reduce the negative impact of flash floods and sediment deposition in the marshlands: terraces, agroforestry, afforestation, trenches, etc.;
    - Roof tank RWH in villages (settlement sites) and public buildings (schools, hospitals, etc..). The highest subsidy and support will go to vulnerable and women headed households;
    - Stabilise important gullies by installation of check dams with gabions and eventually other low cost replicable bio-engineering measures - 9 gullies with a total length of about 5000 m have been identified in Rubaya, Mukarange, Cyumba Sectors;
    - Support the district with sustainable forest development and management;
    - Incentive for Ecosystem Services (IES): to ensure the sustainability of the erosion control measures implemented around the tea plantation areas, an IES mechanism will be put in place between the tea growers' Co-ops and the land owners (farmers) in the hillside;
    - Capacity building in climate smart agriculture and in maintenance of antierosive measures put in place.
- **IP at national level with small local component - Transboundary IWRM collaboration on drain maintenance to re-develop 200 ha in the downstream part of the tea plantations:** There are 200 ha in the downstream part of the Mulindi tea plantations which have been abandoned since 1994 due to poor drainage conditions. The two Cooperatives are currently implementing drainage works in the downstream part in Ugandan territory using informal ways of cooperation with Ugandan part. A formal transboundary collaboration framework between Gicumbi district authorities and their counter parts in Uganda is proposed to overcome the reclamation of the downstream part of the tea plantation.

- **IP by TWFA - Modernization of the tea factory adopting more efficient technology.** TWFA is implementing a programme consisting of upgrading the factory with investments in new and more efficient technologies. Capacity building of the cooperatives in tea production and processing as well as in management and governance of the factory and the tea business. At the end the cooperatives will be able to take full ownership and control of the management of the Tea Factory.
- **IP by TWFA support the district in forest management**: TWFA is in discussions with the district to enter a co-management agreement for over 500 ha of Eucalyptus.

Beneficiaries and impact

This package will directly benefit COOPTHE and COOTHEVM tea grower cooperatives and their members as well as independent land owners in the hillside, through the assumption that erosion, flood and sediment mitigation will maintain fertility on their land and increase and sustain green leaf production throughout the year. Additionally, the population in the area will benefit from social benefits brought by the package and better living conditions in a safer environment.

The main expected impacts are:

1. Tea production and productivity will be increased.
2. Increased incomes for tea growers' farmers (men and women).
3. The supply of firewood to the tea factory will be sustained since the District will be able to supply additional firewood quantities needed by the factory, and the District's forestry out-growers will get additional incomes.
4. Transboundary cooperation mechanism with Uganda is promoted and as a concrete result, 200 ha of tea plantation will be redeveloped;
5. The contribution to the sustainable maintenance of the new infrastructures put in place in the framework of the landscape restoration projects through an IES mechanism between the tea growers' co-ops and the land owners (the farmers) in the hillside;
6. Increased resilience to floods and droughts.
7. Temporary job creation for local people including women and youth during the projects implementation.

Package Management

Implementation modalities will be defined at feasibility / detailed design stage according to specificities of each activity. In order to guarantee the added value of the IWRM approach, the implementation of each activity will be planned to maximise its impact, create economies of scale and optimise an efficient usage of resources from the different implementing entities.

For project/package management purposes the catchment task force (CTF) will oversee and advise on the project implementation. The CTF will be supported by technicians from the beneficiary Districts, the implementing entities, RWFA representatives and W4GR experts.

A monitoring system will be put in place based on the indicators from the log frame matrix defined at feasibility/design stages. As an example, gauging stations should be installed at strategic locations to measure the reduction of sediments and the increase of base flows as a result of erosion control on hillside and river banks.

During the implementation, regular participatory reviews should identify potential new investments based on the identified driving forces and to exploit existing opportunities aiming at maximizing the water productivity in the catchment.

On the long term, after project implementation, maintenance works, specifically in landscape and gullies rehabilitation will have to be managed by beneficiary districts. The project will ensure the capacity building of sector technicians in monitoring key parameters such as the trend in soil fertility and productivity, as well as maintenance of drains and bio-engineering works (vegetal check dams, cleaning sediments, etc.).

Funding and budget estimation

Estimated budget

No	Description	Unit	Quantity	Unit cost (Rwf)	Total cost (Rwf)
IP+	**Improvement of water management in the tea plantation**				
1	Recalibration of primary (210,000m)	m^3	315,000	2 500	787,500,000
2	Recalibration of secondary drains (1,220,000 m)	m^3	915,000	2,500	2,287,500,000
3	Installation of water regulation structure in concrete with metallic gate in the drains to raise the water level during dry season	nbr	14,300	100,000	1,430,000,000
Sub-Total IP+					**4,505,000,000**
No	**Description**	**Unit**	**Quantity**	**Unit cost (Rwf)**	**Total cost (Rwf)**
CPIP#1	**Floods and sediments mitigation through LSR and roof tank RWH in the watersheds surrounding the tea plantation valleys**				
1	Terraces on steep slopes+ agroforestry and manure	ha	670	2,430,000	1,628,100,000
2	Terraces on moderate slopes + agroforestry + manure	ha	100	633,000	63,300,000
3	Afforestation + trenches	ha	347	750,000	260,250,000
4	Restoration of old forests	ha	269	800,000	215,200,000
5	Agroforestry in existing radical terraces + cut off drains	ha	1613	300,000	483,900,000
6	Roof tanks RWH in settlement sites (Imidugudu) and public buildings (schools, health centres, etc.)	LS	1	80,000,000	80,000,000
7	Gullies treatment (5000 m)	LS	1	500,000,000	500,000,000

8	Incentive for ecosystem services (IES)	LS	1	50,000,000	50,000,000
9	Capacity building to farmers to sustain infrastructure put in place	Ls	1	50,000,000	50,000,000
Total CPIP#1					**3,330,750,000**

2.Support to sustainable water supply and hydropower generation through Landscape restoration in Ngoma sub catchment

Main socio-economic drivers:

Micro-hydropower plant (HPP) (upstream in Gicumbi) and WASAC intake for the water treatment plant (WTP) (downstream in Nyagatare).

Main issue: In the dry season, the flow in Ngoma river is drastically reduced: the HPP plant stops for 7 hours/day and the WTP is only working at half of its capacity. During rainy season, sediment transport hinders the normal operation of the HPP and the WTP.

Implementing partners: **RWFA**, RAB, W4GR, District

Package rational

The Ngoma sub-catchment of Muvumba falls administratively into 2 districts Gicumbi (Rushaki sector) and Nyagatare (Kiyombe, Mukama and Mimuri sectors). It is the smallest subcatchment with 9% of the whole catchment area which covers 145 km². The Ngoma river feeds the Karungeli river before it joins Muvumba river. The Ngoma sub-catchment constitutes an important source of water supply for human and livestock consumption for many areas (sectors) of Nyagatare District.

A micro hydropower plant (HPP) has been constructed in 2007 on the Ngoma river. This 50 kW HPP is managed by the district and supplies electricity locally to Kaniga sector serving about 250 households. The HPP is fed by a small reservoir with a dam built on the Ngoma river, which raises the water level by about 4 m.

Downstream to the HPP, WASAC has placed an intake on the Ngoma river with a maximum capacity of 70 l/s – 6000 m^3/day to supply a drinking water treatment plant (WTP) equipped with 2 units of 2400 m^3/day. Separate slow sand filtration units with a capacity of 1200 m^3/day are fed by a spring. The WTP provides drinking water to 4400 households in Nyagatare district in 10 sectors out of 14.

The reduced flow in the dry season in the Ngoma river is presently less than the 50 l/s needed by the HPP and the WTP. During rainy season, sediment transport hinders the normal operation of the HPP and the WTP.

The HPP and the WTP face problems that require investment on intake infrastructure to better manage sediments. These investments make sense in coordination with wider improvements of water management in the catchment.

The DPSIR - Driving Forces, Pressures, State, Impact, Responses - in a nutshell:
The economic development in the area has led to investment in hydro power generation and new water treatment plant both depending on water from the Ngoma river. The installations are underperforming due to low discharges during the dry season and faced with higher operating and maintenance costs due to high level of sediments. The pressure from erosion and low discharge is caused by inappropriate agricultural practices on the steep slopes upstream in the catchment.

A systemic approach to address the different issues simultaneously is needed. Landscape restoration will reduce the erosion and regulate the water flow to have more regular discharge throughout the year. These circumstances will allow the HPP to invest in repair and adjustment of the spillway design and the WTP to invest in a new, improved water intake. Stakeholder coordination will enable smooth implementation and operation of the facilities to optimize benefits from sharing the same stream and catchment.

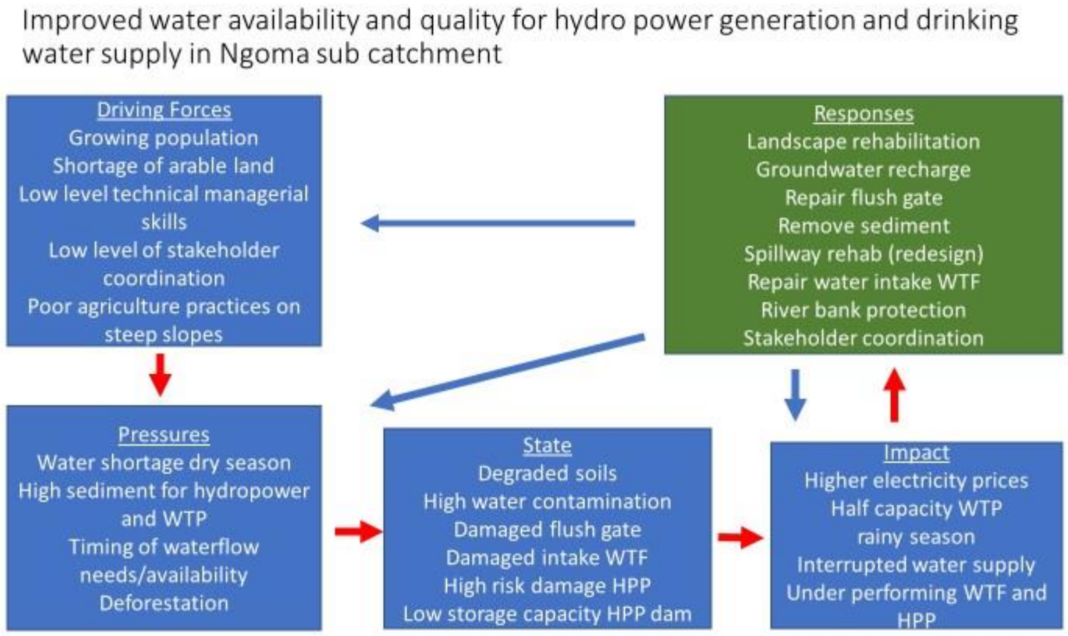


Figure 1 DPSIR hydro power and Water Treatment Plant Ngoma

Objectives and outputs

The general objective is **to secure the water availability in the Ngoma river and improve its quality to sustain energy generation and water supply production.**

The specific objectives are:

- The Watershed protection upstream of the HHP and the WASAC intake;
- The sustainable operation of the HPP through the rehabilitation of the dam and WASAC intake;
- The sustainable operation of the WTP through the reconstruction of the intake on Ngoma river.

Activities specific for project linkage to wider catchment intervation

- **CPIP #1: Watershed protection around the HHP and the WASAC intake:**
  - Ngoma catchment landscape restoration (terraces, trenches, afforestation). By restoring the landscape, it is expected that the surface runoff during the rainy season will decrease as well as the sediment load in the Ngoma river. Ground water recharge will help increasing the base flow during the dry season.

Terraces will be implemented on steep and moderate slopes with agroforestry and fertility management (i.e. extra application of manure and lime to restore soil structure and fertility) on about 1000 ha.
Afforestation will be implemented on 115 ha. Ditches will be installed to retain and safely drain runoff, reduce erosion and enhance ground water recharge.

- Ngoma river banks protection: the buffer zone limit is not respected by farmers who are cultivating up to the water course. Sediment from hills are transported by runoff to the river and banks are unstable and prone to erosion.
  The buffer zone will be demarcated according to the law, will be protected by planting suitable tree species, fodder shrubs and grasses on an area covering about 45 ha in the reach on the Ngoma river between the HPP and the WTP.
- Capacity building to farmers in climate smart agriculture and maintenance of erosion control measures to sustain the erosion control infrastructure put in place.
- Coordination between water users (HPP and WTP) for optimizing benefits of shared water resources. A water users forum will be installed for the duration of the project. The objective is to learn about coordinated stakeholder action to improve water management in the sub catchment that benefits the different water users.

• **HPP rehabilitation by removing the sediments in the dam, repairing the flushing gate repair and redesign & repairing the spillway (IP by Gicumbi District).**
• **Rehabilitation of water supply intake in Cyondo cell by WASAC (IP by WASAC).**

Beneficiaries and impacts

The implementation of this package will have the following impacts:

1. Groundwater recharge and dry season water flows are increased which improves operation of the HPP and WTP.
2. Sedimentation/siltation in surface water bodies (river and reservoir) is reduced and therefore operation of HHP and WTP is improved in the rainy season.
3. Erosion is reduced due to the implementation of landscape measures and improved soil fertility.
4. Increased agriculture production, enhanced food security and increased household incomes which can be invested in off-farm income generating activities.
5. Knowledge and best practices in IWRM are continuously documented and shared With lessons learned document at the end of the project to inform similar interventions elsewhere in Rwanda.
6. Temporary job creation for local people during project implementation.

Package management

Implementation modalities will be defined at feasibility / detailed design stage according to specificities of each activity. In order to guarantee the added value of the IWRM approach, the implementation of each activity will be planned to maximise its impact, create economies of scale and optimise an efficient usage of resources from the different implementing entities.

For project/package management purposes the catchment task force (CTF) will oversee and advise on the project implementation. The CTF will be supported by technicians from the beneficiary Districts, the implementing entities, RWFA representatives and W4GR experts.

A monitoring system will be put in place based on the indicators from the log-frame matrix defined at feasibility/design stages. As an example, gauging stations should be installed at strategic locations to measure the reduction of sediments and the increase of base flows as a result of erosion control on hillside and river banks.

During the implementation, regular participatory reviews should identify potential new investments based on the identified driving forces and to exploit existing opportunities aiming at maximizing the water productivity in the catchment.

On the long term, after project implementation, maintenance works, specifically in landscape and gullies rehabilitation will have to be managed by beneficiary districts. The project will ensure the capacity building of sector technicians in monitoring key parameters such as the trend in soil fertility and productivity, as well as maintenance of drains and bio-engineering works (vegetal check dams, cleaning sediments, etc.).

Fundind and budget estimate

Estimated budget

No	Description	Unit	Qty	Unit cost (Rwf)	Total cost (Rwf0
CPIP #1	**Watershed rehabilitation to sustain the HPP in Gicumbi and the WTP in Nyagatare**				
1	Terraces + agro forestry, manure and lime on steep slopes	ha	800	2,430,000	1,944,000,000
2	Terraces on moderate slopes	ha	200	633,000	126,600,000
3	Afforestation	ha	115	750,000	86,250,000
3	Ngoma river buffer zone/banks protection	ha	45	236,000	10,620,000
4	Capacity building to farmers	LS	1	50,000,000	50,000,000
5	Water users forum (facilitated by IWRM expert) Joint field visits in the area and 1 exchange visit /stakeholder tbd	Ls	1	5,000,000	5,000,000
Total CPIP #1					**2,222,470,000**

3.Drought Management to improve access to water for supporting livestock and agriculture value chains.

Implementing partners: **RWFA**, W4GR, RAB

Packages rationale

The Muvumba Upstream (D) and downstream (E) sub-catchments are located administratively in Nyagatare district and cover entirely or partially Matimba, Musheli, Rwempasha, Rwimiyaga, Nyagatare, Karangazi, Karama, Gatunda and Tabagwe sectors.

The two sub-catchments are characterized by sloping undulating land with high potential for livestock production and high demand for a number of competing uses especially irrigation and livestock production with complex shared transboundary river systems.

Natural forests, gallery forests along Muvumba river and natural vegetation, which covered a big part of the sub-catchments area, have been cleared for crop production, cattle ranches, construction wood and firewood. Most of the ranches are poorly managed, as a result of overgrazing and poor farming methods, grass cover is nearly depleted and soil compaction is common. Most of the soils have developed a hard pan, lost their water retention capacity, experienced excessive surface water run-off resulting in soil erosion and reduced groundwater recharge. So far, almost 95% of river banks and watersheds are used for agriculture, releasing chemicals and sediments into the river. During prolonged dry spells and drought periods the flow of the Muvumba river reduces substantially causing water crisis for livestock, plants and humans.

To reduce silting and chemical pollution in the Muvumba river, the project seeks to install or restore buffer zone on about 80 km alongside the Muvumba river and its tributaries. This protected area will be planted with different useful trees and fodder grass species (bamboo, agroforestry, elephant grass, etc.) to stabilize river banks and to prevent the river against pollution.

The planned Muvumba multi-purpose dam needs to be protected against sediments carried by surface runoff. That is why, it is planned to implement landscape restoration measures in the dam watershed, comprising afforestation on steep slopes and progressive terraces with agroforestry in the moderate slopes.

Frequently, the eastern part of Rwanda including the subcatchments area suffered long and recurrent droughts and water shortages are likely to worsen in the future (this has been shown by WEAP simulation results applied in the selected sub-catchments).
During dry periods, competition for the scarce water resources between different uses especially livestock and irrigation have been observed.

The key issue in Upper & Lower Muvumba sub-catchments is the water scarcity leading to conflictive situations between water uses (irrigation, livestock and domestic water use). More productive and more resilient agriculture requires a major shift in the way land and water are managed to ensure that these resources are used more efficiently while keeping social peace.

Land fragmentation and high population density, constitute major reasons to explore new farming systems to increase agricultural productivity and water efficiency. To achieve this objective, new crop varieties with higher economic value and less intensive water use should be introduced. New irrigation water saving technologies, should also be introduced such as drip irrigation, etc. Farmers in the considered areas within the existing irrigation schemes, need to be trained in efficient irrigation water delivery and scheduling and in maintenance of irrigation facilities with the target to meet the full crop water demand.

To date MINAGRI/RAB has been supporting small scale irrigation technology (SSIT) development, by providing farmers equipment (hose, motor and treadle pumps, sheet lining for small uphill reservoirs). The expanded farmer based small scale technology has been discussed and adopted in various forums including the Irrigation Forum and various Districts and farmer consultations and through demonstrations.

The SSIT approach has the advantage that it does not require complex pump stations nor buried pipe network and it is entirely portable and has reduced costs per hectare making it attractive to individual and small farmers.

Most of the efforts and investments made in Rwanda, for irrigation development have focused on water resources development and very few in on-farm water use improvement. The application of improved irrigation methods and techniques on small farms should be addressed in response to the increasing needs for higher irrigation efficiency, improved utilization of water and intensification and diversification of production through pressured piped systems.

Regarding WUA's capacity building in existing irrigation schemes (mainly rice irrigation) in water management, farmers are neither familiar with efficient water use, nor they are sufficiently sensitized to potential health problems and pollution of water bodies by pesticides and chemical fertilizers used on their crops.

Nyagatare district intends to develop livestock for milk and meat production, through intensive farming. This implies minimizing as much as possible the distance for access to water and producing of high quality fodder. Rainwater harvesting through small scale water storage infrastructure (e.g valley dams) development is one of the measures to achieve this objective. The district recommends prioritizing the rehabilitation of existing valley dams. Unfortunately, the existing valley dams are facing many challenges :

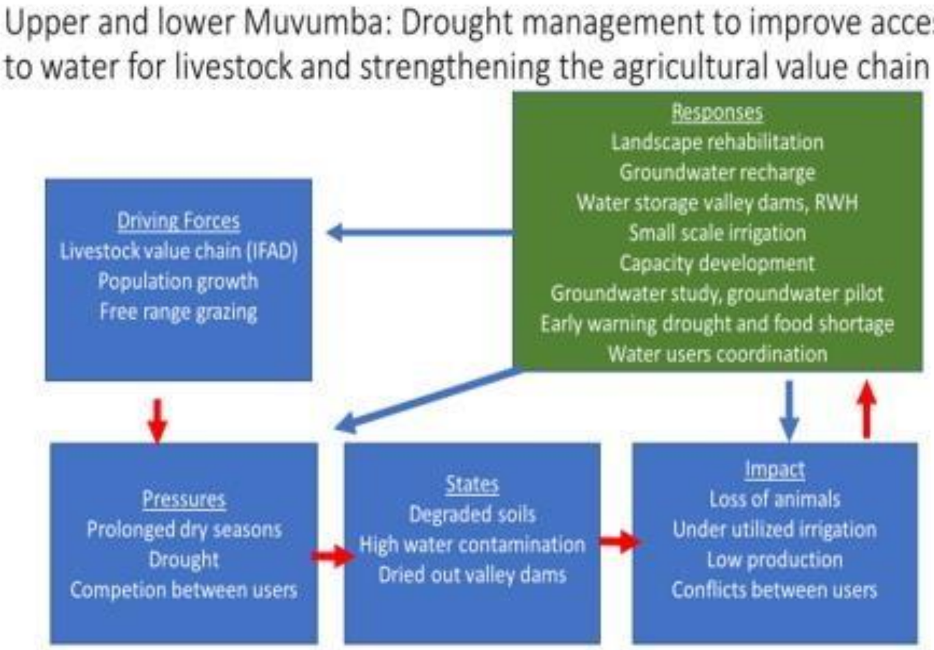
- Most of the reservoirs are rapidly drying out after the rainy season;
- Poor maintenance;
- Inexistence of WUA to manage the infrastructure.

In the package area, the only source of water is the Muvumba river and its main tributary Warufu stream. People who are living far away from Muvumba and Warufu rivers do not have any other source of water. To contribute to tackle this issue, a deep assessment on underground water resources availability and how it could be used shall be conducted.

The DPSIR - Driving Forces, Pressures, State, Impact, Responses - in a nutshell:

Upper and Lower Muvumba sub catchments are home of the largest livestock population in the country. The cows and with less importance goats are the bases for dairy, meat and hides value chains. Together with the large-scale irrigation along the Muvumba river, these are the main economic drivers. Overgrazing by cattle has degraded the soil in some parts reducing the water holding capacity and increasing runoff.

The impoverished soil can maintain even less cattle head. Irrigators and cattle owners and other users compete in dry season around the –cattle and agro-chemicals- contaminated river water. The situation is conflictive and there is risk of losing cattle in years of drought. The response is to increase water storage, improve cattle ranching practices, and water use efficiency. Rehabilitating new water resources outside the river for cattle, people and small-scale irrigation. Studies have to prove the viability of boreholes and restoration and improvement of valley dams. Multipurpose dam could increase water availability in the river during the dry months. An early warning system for drought coordinated with Uganda can help planning of prioritization of water users. The set-up of water user's forum is important to avoid conflicts and jointly learn about managing the limited water resources. For example, water can be allocated to the survival of cattle at expense of smaller area with irrigated rice. In time the processing and other elements of the cattle products value chain needs to be addressed to deal with contamination of slaughter houses.



Objectives and Out puts

The overall objective of the IWRM package is to support long-term economic development and livelihood of the population in the Upper & Downstream Muvumba sub-catchments, by reducing soil erosion, improving water quality, enhancing surface water storage and assess underground water availability, for different water uses and users.

The specific objectives are:

- To upscale and sustain the conservation and management of natural resources by reducing soil erosion, enhance the resilience to climate change and diversity livelihood in Upper and Lower Muvumba sub-catchments (D & E).
- To promote improved irrigation methods and techniques, in response to the increasing needs for higher irrigation efficiency, improving water utilization and diversification of agricultural production through localized irrigation.
- To define and develop optimized water resources mobilisation solutions such as surface water storage and ground water recharge for a long term sustainable availability of water for human and livestock.

Activities specific for projects linkage to a package

The package is composed of the following CPIPs:

- **CPIP#1 - Landscape rehabilitation in catchment and around the future multipurpose dam**
  - Progressive terraces (trenches +agroforestry) on moderate slopes;
  - Afforestation and cut off drains on steep slopes;
  - Gullies treatment;
  - River buffer zone/river banks protection;
  - Capacity building in climate smart agriculture and in maintenance of anti-erosive measures in order to sustain all the measures described above.

- **CPIP#2 - Support the development of efficient irrigation water use techniques**
  - Develop a pilot SSI project demonstrating the practicality of efficient, water saving localised irrigation techniques which could be adopted by small farmers and later on could be replicated in other similar areas within the two sub-catchments and in the country;
  - Provide capacity building to WUA members in existing irrigation schemes, on how to operate and to maintain irrigation facilities in order to reduce water losses in the context of water scarcity leading to conflict between various users. Farmers need to acquire (or improve) necessary skills in water management such as water-saving irrigation techniques, equitable water distribution, on time and on demand irrigation, maintenance of the infrastructure, etc.
- **CPIP#3 - Surface water storage and use of ground water.**
  - Optimization of valley dams use in cooperation with RAB and the District and ground water use pilot projects. Depending on particular conditions of each site, specific solutions will be emphasized such as increasing the volume/area ratio of the reservoirs through additional excavation, lining of the reservoirs (compacted clay), development of boreholes equipped with tanks and solar pumps;
  - Watershed rehabilitation around the valley dams. Landscape restoration needs in the watersheds will be evaluated taking into account current and future land use.
  - Support installation of roof tanks on households in settlement sites and in public buildings.

Beneficiaries and impacts

This package will directly benefit to the different categories of water users in the area: farmers using irrigation water and cattle raisers through a less competition on and better access to water, as well as farmers in the hillside through the assumption that erosion, flood and sediment mitigation will maintain fertility on their land. Additionally, the population in the area will benefit from social benefits brought by the package and better living conditions in a safer environment.

The main expected impacts are:

1. Conflicts between the main water users in the sub-catchments are decreased;
2. Area prone to erosion is reduced due to the implementation of landscape measures and improved soil fertility leading to increased agriculture production and enhanced food security and increased household incomes which can be invested in off farm income generating activities;
3. Annual groundwater recharge is increased
4. Sedimentation/siltation in surface water bodies (rivers and reservoirs) is reduced.
5. Efficient small scale irrigation practices are adopted
6. Water productivity and revenues from the vegetable and cattle products value chains (milk and meat) are increased;
7. Knowledge and best practices in IWRM are continuously documented and shared;
8. Transboundary cooperation with Uganda is effective;
9. Temporary job creation for local people inclusive of women and youth, during the projects implementation.

Package management

Implementation modalities will be defined at feasibility / detailed design stage according to specificities of each activity. In order to guarantee the added value of the IWRM approach, the implementation of each activity will be planned to maximise its impact, create economies of scale and optimise an efficient usage of resources from the different implementing entities.

For project/package management purposes the catchment task force (CTF) will oversee and advise on the project implementation. The CTF will be supported by technicians from the beneficiary Districts, the implementing entities, RWFA representatives and W4GR experts.

A monitoring system will be put in place based on the indicators from the log-frame matrix defined at feasibility/design stages. As an example, gauging stations should be installed at strategic locations to measure the reduction of sediments and the increase of base flows as a result of erosion control on hillside and river banks.

During the implementation, regular participatory reviews should identify potential new investments based on the identified driving forces and to exploit existing opportunities aiming at maximizing the water productivity in the catchment.

On the long term, after project implementation, maintenance works, specifically in landscape and gullies rehabilitation will have to be managed by beneficiary districts. The project will ensure the capacity building of sector technicians in monitoring key parameters such as the trend in soil fertility and productivity, as well as maintenance of drains and bio-engineering works (vegetal check dams, cleaning sediments, etc.).

Funding and budget estimates

Budget estimation

No	Item description	Unit	Qty	Unit cost (Rwf)	Total cost (Rwf)
I	**Landscape rehabilitation in catchment and around the future multipurpose dam**				
I.1	Progressive terraces (trenches + agroforestry)	ha	1236	633,000	782,388,000
I.2	Afforestation	ha	250	750,000	187,500,000
I.4	Buffer zone/river banks protection (80 km)	ha	120	236,000	28,320,000
1.5	Gullies treatment	LS	1	3,000,000	3,000,000
1.6	Capacity building to sustain LSR measures	LS	1	50,000,000	50,000,000
Sub-total I					**1,051,208,000**
II	**Support the development of efficient irrigation water use techniques**				

II.1	Develop pilot project which demonstrates high efficient water use rate in SSI	ha	6	4,000,000	24,000,000
II.2	WUAs capacity building	LS	1	50,000,000	50,000,000
Sub-total II					**74,000,000**
III	**Surface water storage and use of ground water**				
III.1	Optimization of valley dam use in cooperation with RAB and the district	Nbr	2	250,000,000	500,000,000
III.2	Water shed rehabilitation around the valley dams	ha	200	633,000	126,600,000
III.3	Support installation of roof tank on HHs, public building and trading centres	LS	1	80,000,000	80,000,000
III.3	Ground water use pilot projects	LS	1	125,000,000	125,000,000
Sub-total III					**831,600,000**
Grand Total (I+II+III)					**1,956,808,000**

14.1 Forestry and agroforestry

Forestry and agroforestry are part of Catchment Restoration interventions, which are core to the catchment plans. Forestry is the mandatory land use form for slopes of 60% and above.

Natural and production forests and trees are:
- Are a good protection against erosion and landslides and positively influence the water cycle in the catchment;
- Are part of the Natural Capital necessary for climate resilient green development; and
- Contribute to healthy catchments and healthy people.

Covering near to 30%[67] of the surface of Rwanda, forest substantially contributes to the environmental services such as: biodiversity, soil, clean water, hydrological regulation (flood protection, drought mitigation), clean air, carbon sequestration, climate regulation. Natural forest has a great intrinsic natural and ecological value but also represents financial value through generating cash flow from tourism. Production forest has less environmental value and more financial and social value through the exploitation of wood for timber, poles, firewood, charcoal and other non-timber products.

Due to inappropriate management, the quality and production of the forest is often poor. Newly planted forests suffer from high outfall rates, and from early felling of trees, improper pruning, cutting, and felling techniques, as well as blanket deforestation of entire plots. This all leads to sub-optimal forest productivity (and land and water productivity), elevated levels of soil erosion and regular destruction of biodiversity.

The risk of a further decrease and degradation of forest is present due to demand exceeding production for timber, service wood of sticks and poles and firewood. Rwanda's development will increase wood demand and thus pressurise existing forests. When forests are degraded, the whole catchment degrades and with it the ecological services that sustain society.

On sloping agricultural land, agroforestry is proposed, in combination with terraces, as necessary to reduce soil erosion and increase infiltration. Agroforestry supports food security and more sustainable agricultural production. Where households choose trees for fuel, beautification, shade, improvement of soil fertility, windbreaks or fruit production, agroforestry can play an important role in the reduction of poverty while protecting the environment sustainably.

A core intervention of Catchment Restoration is the intensification and diversification of agroforestry techniques; this involves extending the diversity and intensity of agroforestry trees already used to stabilise the slopes of terraces and improve soil fertility, promotion of perennials and tree-crops (including tea, shade coffee, fruit trees, etc), intercropping, planting of in-field trees, shelter-belts or live-fences. Species are to be selected in relation to the local conditions in coordination with farmers to adapt to their needs. A good approach would be to plant local species such as *Podocarpus, Polyscias fulva, Entandophragma, Croton megalocarpus, Markhamia Lutea, Vernonia Amygdalina Mytragyna,* and *Syzygium* to enhance biodiversity, in addition to exotic commercial species like *Alnus Acuminata, Acacia Agustima* and *Acacia melanoxylon* to generate revenues. Bamboo is also a crop that can be used in agroforestry. In Farmer Field Schools (FFS), farmers learn how trees are best managed to maximise benefits.

Private sector led forestry management

Forestry contributes 21% of the GDP generated by the agriculture sub-sector. The products include food, fruits, fodder, honey, medicines, construction materials, biodiversity and cultural/recreational services.

[67] GoR plans to increase forest from 29,7 (baseline; 2017) to 30% of Rwanda, restoring 2 million ha degraded forest by 2020, with a policy focused on a sustainable business-based forestry and wood industry (MINIRENA; 2017).

The increasing demand for wood in Rwanda and the regions also points to the solution: Sustainable Commercial Forestry. With a forestry management plan tree density in forest plantations can increase from 145 to 400-600 trees per ha and productivity levels can easily double. With green charcoal and improved cook stoves there is a way to provide the much-needed biomass energy while limiting negative trade-offs to environment- and health. Of the forests in Rwanda, 27% are State property, 2% are owned by the Districts, 68% are Private woodlots, and 3% are in institutional hands (National Forestry Inventory; 2015).

The strategic target in the NST1 is to increase the percentage of public forest (State and District owned) allocated to private operators from 5% (2017) to 80% by 2024. The percentage of private forest converted into productive forests and managed by Forest Owners Associations will increase from 0% currently to 50% by 2024. This will be supported by an effective PPP model to be developed in the forest sector (NST1 draft December 2017).

Forest Management Units (FMU) of 200 ha and above comprise of varying sized forest lots. The FMUs of District and State forests are defined in the District Forestry Management Plans. A private operator can, through competitive bidding, be awarded a management contract for one or more FMUs. The FMU can also include riverside and roadside plantations and allow for customary use arrangements of the people living in the area. Private forests, managed by Forest Owners Associations, can increase productivity by following the same model.

Forestry has its own sub-sector strategy within the Ministry of Environment and Natural Resources. Subsequently Forestry has a sub-sub-sector of agroforestry. Agroforestry delivers 27% of the sustainable biomass and has the potential to supply even 40% of the national demand (National Forestry Inventory; 2015). Agroforestry strongly contributes to climate smart agriculture. It serves as wind-break, recycles nutrients from deeper soil layers back in the arable layer, can reach water deeper in the soil, and produces organic matter, fodder, shade, firewood, poles and fruits. Agroforestry in Rwanda has around 25 trees per ha; ideally this could be intensified to 50-100 trees per ha (National Forestry Inventory; 2015).

The agroforestry strategy contains practical information on agroforestry. It proposes contracting private operators to support FFS with planting and managing the agroforestry for three years (supervised by extension workers). The agroforestry strategy also wants to map eroded soils in all agroecological zones and existing soil and water conservation measures. Agroforestry is proposed on the eroded soils to complement the soil and water conservation measures. The strategy highlights the need for marketing of agroforestry products and attracting private finance for agroforestry.

Aligning Catchment Planning and District Forest Management Plans

The Forestry sub-sector strategy together with the National Forest Management Plan 2017 – 2024 and the District Forestry Management Plans (DFMP) gives official endorsements for private-sector-led commitments to forestry for expanded sustainable Catchment Restoration investments. DFMPs contain detailed maps with forest areas and the identified FMUs need to be aligned with catchments plans. The introduction of market-based forestry is a welcome innovation with a win-win for both parties, leading to improved environmental protection while boosting the forestry production with green jobs creation.

On the other hand, the catchment plan contains information about land degradation or abandoned mines to be forested and shows links between forest-driven environmental services and water supply, energy and other sectoral users. Prioritisation of forestry management contracts should take into consideration degradation pressure in relation to socio-economic development of the population. In case of firewood for a tea factory, the DFMP shows the forests areas, and production capacity. Entrepreneurs can use this information to create new green jobs, while at the same time enhancing sustainability of the catchment. A few examples of commercial involvement in forestry-based catchment management are provided in the text boxes below. The support modality in agroforestry through Farmer Field Schools can be combined with training in smart-agriculture and protection of the environment.[68]

New Forests Company + Out-growers
In 2011 the government of Rwanda signed a 49-year concession agreement with the New Forest Company (NFC) to manage, develop and make productive the buffer zone around the Nyungwe National Park. The company produces: electric poles mainly for Rwanda Energy Group (REG); sawn timber for the growing Rwandan construction and furniture industry and charcoal. Saw dust and wood waste materials provide industrial charcoal to near resident and commercial markets.

NFC also buys wood from out-growers and local farmers encouraging them to plant trees. New Forests Organization (NFO), a registered NGO born as a Corporate Social Responsibility (CSR) programme of NFC, works closely with the out-growers and communities with potential for forestry. The NFO facilitates income generating activities, like tree seedling nurseries, timber products and bee-keeping. NFO has distributed more than 1.4 million seedlings that have covered over 1150 ha. NFO also supported communities with water supply, schools and connections to the electricity network.

NFOs has recently become independent of NFC with a non-state organisation philosophy to promote economic growth, social development and environmental protection. The first question is always: "how a profitable business will benefit the maximum number of stakeholders while protecting the environment."[69]

Alternatives for Firewood
Firewood and charcoal are the main energy source for cooking in Rwanda. W4GR-RWFA will liaise with NGOs/companies for introducing improved cooking stoves (ICS) and green charcoal. ICS and charcoal are standard incentives proposes in the IWRM projects where deforestation is an issue.

Improved Cooking Stoves (ICS)
Traditional cooking stoves are inefficient and the air contamination they generate is bad for health. Improved stoves combined with improved cooking practices can reduce the demand for firewood.

Green Charcoal
Improved charring techniques are more efficient and cleaner. Green charcoal in four main charcoal producing Districts (Nyaruguru, Nyamagabe, Nyamasheke and Karongi) would significantly reduce the pressure on forest.

Biogas
Rwanda has experience with household and institutional biogas. Farms with at least two cows and access to water can apply for biogas installation which produces gas for cooking and lighting. The by-product of the slurry is valuable fertiliser.

Bottled methane gas from Lake Kivu
Due to the higher price of bottled gas, GoR is promoting the use of LPG in the urban area.

Sustainable wood biomass
(Fire) wood from (agro)foresty is possible under sustainable forestry management. Using (rest) wood from (agro)forestry and buffer zones can be part of nature-based business proposals.[70]

---

[68] Sources: National Forestry Inventory; 2015: District Forestry Management Plans 2017; Forestry policy 2017; National Forest Management Plan 2017-2024.

[69] Source: NFC Newsletter 2017 and personal communication.

[70] Sources: MINIFRA, Saferrwanda.org; Inyenyeri.com; delagua.org; Nots.nl; SNV.org; GIZ.de

Mining

Mining is the second largest exporting sector in the Rwandan economy, generating about $210.6 Million of foreign exchange in 2014. Private mining companies that have access to technology and finance, need to be encouraged to invest in their operations. Small-scale (artisanal) mining, however, represents around 80% of all mining activity and this group struggles to access finance and technology. Cooperative miners work as individuals, or in groups typically numbering 50-100 people. Illegal mining is common.

The mining sector provides income and employment to approximately 50,000 people (16% of which are women). All catchments have some form of mining activity (minerals, sand, clay, gravel and stone for construction) within their boundaries. A new draft mining and minerals policy was developed (2015). The focus of the new policy is on environmental protection, social-inclusion, growth, employment and improved sector performance/ productivity.

Mining activity cannot be looked at in isolation from other activities in the catchments. Mining affects the water cycle through the water it uses and pollutes. Mining also results in a loss of forest cover, damages riverbeds and river courses. It affects catchments by increasing erosion and contaminating the water with mineral discharges and chemicals used in the processing of minerals. Environmental costs should be included in any economic analysis, especially as contamination can extend far beyond the life of the mine. Long-term environmental costs become public costs for taxpayers when the original mining company has ceased operations, or perhaps no longer exists.

Mitigation plans for environmental costs should be factored in at the design stage of both the business case and the production of a Life of Mine Plan (LOMP). LOMPs are supposed to cover catchment restoration activities and the return of land to productive use; however, this aspect of licensing is not fully implemented let alone enforced.

Mountain mining has different characteristics from riverbed exploitation, open cast mining or quarrying which should be addressed by differentiation in monitoring and enforcement requirements. With artisanal and small-scale business mining comprising the bulk of all mining activity in the country, as well as being the most damaging to the environment, this sector of mining activity requires a different strategy for supporting its development and regulation.

Sustainable mining: Towards model mines

Model mining is a concept coming from the EDPRS: there are currently two mines functioning as model mines and 25 more mine operations are engaged in trying to achieve this status. Model mining includes elements of Corporate Social Responsibility, environmental protection, and the achievement of improved work conditions for miners. Supporting the artisanal mining sector can improve the water quality of the catchment, but Government policy is not yet clear how the sector can be encouraged to comply with environmental regulation.

There is some experience of organising artisanal miners into cooperatives allowing the miners access to loans and better technology and skills (ref. Forest of Hope initiative in Gishwati Forest). Mining cooperatives, however, lack the conditions to access commercial funding that might encourage investment. The Rwanda Mining Board (RMB) supported by the DFID sponsored Sustainable Development of Mining in Rwanda (SDMR) initiative (2017-2020) is looking for new ways to develop the artisanal mining sector.

Ongoing initiatives to support mining

- DFID's SDMR initiative seeks to support the development of the economical and environmentally sustainable growth of Rwanda's mining sector. The project seeks to improve the livelihoods of poor miners and increase the contribution of the artisanal and small-scale mining sector to the economy by addressing key market failures facing the mining industry. This project should directly benefit 5,000 artisanal miners and their families. The project contributes towards Rwanda's SDGs by reducing poverty. SDMR will support the establishment of an enabling environment for private sector investment in

Rwandan mining and pilot new mining services aggregation centers. The idea is to group mines together into so-called mining districts (hubs) to facilitate joint investments in equipment for processing;

- GIZ supports the mining sector at national level and with policy development. They sponsor trainings. Activities are part of a regional GIZ programme;
- The World Bank has a special investment fund to support the development of the mining sector and this is accessible for mining companies.

Water and Mining – Managing Finite Resources for the Benefit of Rwanda
SDMR and W4GR are exploring the opportunity to collaborate in two areas of activity: 1) a research project **"Mines and their Contribution to River Sediments in Upper Nyabarongo Catchment"**; and 2) in the identification and elaboration of a **'Pilot' Mining Services Aggregation Centre** project that will test an innovative hub-based approach to more efficiently manage both ore extraction and water and waste management techniques in a more sustainable manner.

A proposed pilot could be located in the Ngororero-Muhanga Districts in the Upper Nyabarongo W4GR demo catchment. The selection of the site for the 'pilot', the participating mining companies or cooperative partners, and the scope of the project are being explored as of February 2018. The proposed pilot may focus on water-specific aspects of mining and mineral processing activities, developing the means to integrate the protection and maximisation of water resources used in the day-to-day activities undertaken by mining companies and cooperatives. It is expected that the pilot will demonstrate an approach to mining operations that can be scaled-up throughout the country and ultimately supported by commercial or bank finance.

14.2 Incentives for environmental services

Ecosystems like forests, lakes, soil and wetlands produce services that are the foundation for the functioning of our society. These natural resources and ecosystems are called 'Natural Capital'. Natural Capital is the stock of renewable and non-renewable natural resources (e.g. plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people. The Ministry of Environment and Natural Resources considers Natural Capital a cornerstone for the new sector strategy 2018- 2024.

Natural Capital in the catchment produces, amongst others, the following environmental services:

- Clean water and clean air (natural processing of waste and contamination);
- Biodiversity;
- Insects for pollination;
- Regulation of the water flow: flood protection, sponge function of forest;
- Carbon sequestration in forest and soil;
- Micro-climate regulation.

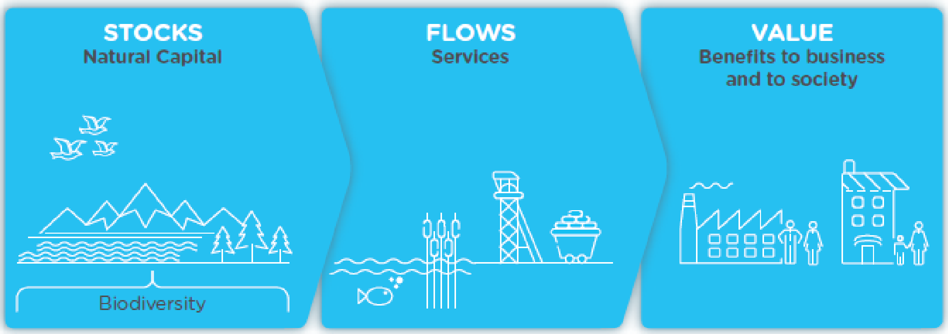


Figure 80: Natural Capital: Stocks, Flows and Value[71]

How does it work? For example: it starts with rainwater falling on the forest where it infiltrates the soil and flows into the river or groundwater. Water flows down the river system, passing by wetlands and lakes.

[71] Source: Natural Capital Protocol: A primer for Business 2016

Subsequently, people take water from rivers and lakes as sources for human consumption, animals, irrigation or industries. Hence, people and businesses use and benefit from water services from the up-stream ecosystems.

Where payments for ecosystem services, like water supply, are absent, people and businesses tend to take environmental services for granted. They are seen as part of the natural context and considered public goods available at no cost. When waterflows are contaminated or become scarce people start realising the true value of these environmental services. Downstream users, if they are large-scale water users, must invest more in water cleaning or look for alternative sources. It is only when rivers dry out or cause floods that people start worrying about the regulating function of wetlands.

Drought crisis and interruptions to crop health create an awareness of ecosystem dependency as wetlands provide water and mitigate floods. Downstream users then also realise that people living in or near to the forest, the mountains, the wetlands have influence on water quality; how they cultivate land will influence the water availability and water quality downstream. Hence, farmers and land users upstream are the stewards of the Natural Capital that produces these ecosystem services.

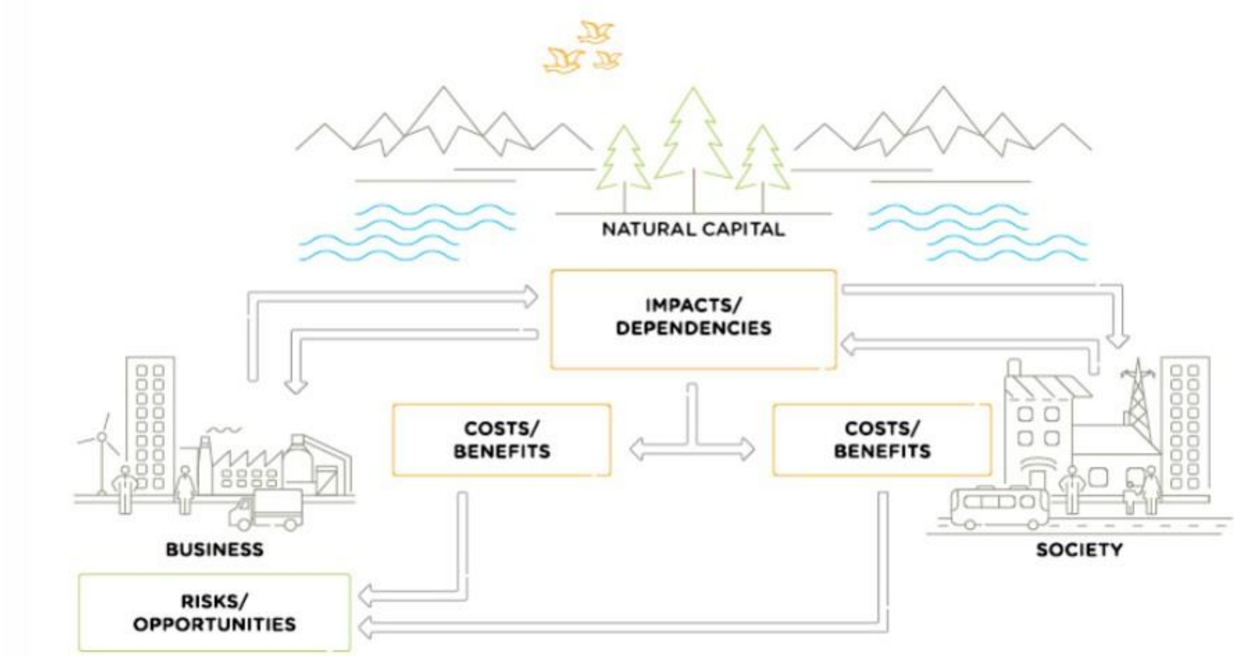


Figure 81: Natural Capital Model[72]

The first step is to acknowledge this role, of for example, protecting the water tower for a water supply intake or hydropower station, or for a coffee washing station. The second step is to agree that stewards of Natural Capital in the catchment co-create value in the coffee and tea value chains, which opens the possibility for an arrangement between up- and down-stream users. Natural Capital is part of the value chain and hence restoration and protection qualify for investments.

In Rwanda, there is a proposal to set up a mechanism that acknowledges the stewards and offers them access to goods and services to improve their livelihoods.

Possible incentives that are beneficial for the catchment management and have added value for the producers of the environmental service are:
- Rainwater harvesting;
- Trees for the agro-forestry;
- Participation in a sustainable forest management (and harvesting) plan;

[72] Source: Natural Capital Protocol: A primer for Business 2016

- Improved cookstoves;
- Training (smart agriculture, water management, agro-forestry);
- Support for the establishment of nature-based enterprises, like beekeeping.

In practice, it is possible to pool all assistance from NGOs and government programmes in Incentives for Environmental Services (IES). This requires an agreement between all agencies working in the area. It should be noted that these IES arrangements can be a challenge when producers of the environmental services start considering the exchange as a right. There is a risk of taking the environment hostage: “we cut trees if there is no incentive”. If the guardians of the Natural Capital do not derive a benefit from their job as maintainers of the resource, motivation for the responsibility of looking after the resource will be lost. A stakeholder forum uniting the producers and consumers of the services will be instrumental to create awareness about the interdependencies in the catchment.

14.3 Rainwater harvesting

Rain Water Harvesting (RWH) is a simple effective technology to increase resilience to droughts and reduce runoff and water logging in urban and settlement areas. The rainwater is not recommended as a source for drinking water, but can be used for cleaning purposes, watering of gardens and feeding small animals.

In Rwanda, many settlements are often located on the top of the hills. When runoff concentrates, it creates gullies that grow and descend to the valley where the stones and sediments are deposited. Even small runoff flows can create deep gullies and damage large tracts of agricultural land. Rwanda possesses two rainfall seasons and as a result benefits from ample water resources. However, Rwanda also suffers from low water availability and storage capacity per capita.

The Government of Rwanda promotes the adoption of rainwater harvesting as one of the key outputs of its Water Resources Management Policy. A Rain Water Harvesting Strategy RWFA2017 has been developed. RWH from rooftops is already widely practised in schools, institutions and homes in Rwanda.

RWH keeps the rainfall close to where it falls and stores it for use afterwards, reducing runoff and the risk of local flooding. Though the stored volume is low (especially from domestic household rooftops), harvesting is important as a collective approach to gathering rainwater in settlements or in cases where institutions and commercial buildings possess large roof surfaces.

The great advantage of RWH is that the technologies are simple, easily installed, scalable and relatively low cost. The operation and use is at the level of households, or clustered settlements so investments in RWH can be delivered quickly. A farmer can use the water in the holding receptacle as it can be easily accessed whenever needed and for whatever purpose. This is not the case for larger systems that require a high level of organisation, alignment with cropping patterns and perhaps joint commercial cooperation arrangements that can take a lot of time to establish.

Rainwater can be stored in the soil, in water holding tanks, farm ponds, valley dams and aquifers. Rainwater can be harvested from:

- Soil in the fields, by increasing infiltration and increasing water holding capacity of the soil (via terracing, soil improvement, filtration trenches, cut off drains and vegetation strips);
- Roofs of houses, schools and any building structure;
- Roads and other hard surfaces like school yards, business parks, industrial zones and urban areas;
- Hillside runoff;
- Small streams.

A special form of rainwater harvesting is seen in the tradition of spate irrigation. In Rwanda, it is practised on a small scale in an informal manner. Storm flows from a gully, stream or road are diverted and spread over agricultural fields with or without crops. Thus, large volumes of water are applied in a semi-controlled way in a short period. Infiltration of the water on the fields is increased by bunds and terracing. The water is stored in the soil used by crops. Spate irrigation requires special skills to avoid damaging the crops and fields.

Rooftop rainwater harvesting

Rainwater harvested from rooftops is usually stored in tanks (1-6 m^3) of plastic or ferrocement above the ground. Rainwater is basically clean but collects dirt from the rooftop surface and guttering and needs treatment before human consumption. The rainwater can be used for other domestic purposes like cleaning, washing, gardening, small animals and industrial use.

People with storage tanks use less water from contaminated sources like swamps. Most people prefer the 5 m^3 storage tanks. People that opt for the smaller 2.5 m^3 typically use the smaller tank for reasons of space limitations around the house or due to financial reasons.

Installation of RWH systems is not complicated but should be undertaken on a supervised basis by technicians from system supplier NGOs/companies. A minimum of supervision increases the quality of the work and helps to avoid tanks being installed incorrectly. Construction of the foundation for the tank and the gutter is most challenging. Standardised training of installers and of supervisors would improve the quality of construction.

Some families use the tank to store water from other water sources. They fill it during the weekend to ensure they can complete other activities during the week.

Runoff ponds

Runoff from roads or hillsides and small streams can be stored in runoff- and valley dams. Ponds and valley dams contain larger volumes of water than the rooftop harvesting tanks. The stored water is typically used for irrigation and cattle rearing. Private ponds in Rwanda have volumes of 120 m_3 and collective ponds are built to 480 m^3 (1 m^3 is 1,000 litres). In other countries farm ponds have storage capacities up to few thousand cubic meters. There are cases of systems of connected ponds that are fed by (ephemeral) streams. Water from the farm ponds is used for a small-holder farm or garden irrigation varying from a few square meters to 2,000 m^2 or more. Most farmers use pond water for supplementary irrigation of their fruit and vegetable crops. The crops benefit from seasonal rainfall, but pond water is used in those intervals where rain is scarce, or to promote final crop growth to its harvesting after the rainy season. With appropriate seeds, fertilisation and crop management, high production levels can be achieved. 30,000 kg/ha for tomatoes is no exception. High value horticultural crops provide a welcome addition to family incomes and contribute to their diet. Irrigated areas and the pond itself are often protected by a fence. Some farmers pump (via solar) water into elevated tanks and use it in drip irrigation systems in green houses. The longer-term storage of water in tanks is said to have negative influence on the quality of the water.

A pond on a small farm can also be used for raising ducks, geese and fish. Plant and animal wastes feed the fish and the sludge from the pond can be used to fertilise the croplands to raise more plants and animal-feed. Ponds are often a viable land-use for marginal land or poor land. Even a small pond of 10 m^3 in a backyard can be used for Tilapia and improve the diet. Tilapia grows fast and can be fed by garden waste and cow dung. Two fish feed factories have been recently established in Rwanda offering fish feed at competitive prices for the fish farm production in ponds and lakes.

Ponds dug on the sandy hillsides need impermeable linings to prevent water loss through seepage. Special plastic dam sheets or pond liners made for dam sized ponds can be imported from Kenya. These sheets need to be handled with care to avoid damage and water loss through the farming tools used to install the liners. Ponds can be installed with run-off pipes at the bottom to release the water for irrigation. Where that is not possible a treadle pump is used to pump the water out.

MINIRENA through the Rwanda Agricultural Board (RAB) dug hundreds of water ponds (RWH tanks brochure RAB). Clayish soils can be compacted and have low infiltration. However, soils in Rwanda are generally permeable and need a plastic liner (geotextile). The cost of pond liners to avoid infiltration is RWF 400,000 each. This was paid by a RAB program. The farmer has the obligation to dig the pond and install a fence around the pond. Fences keep livestock and animals out and are important to prevent children falling into the pond and drowning.

Organisations like Trocaire have experience with design and implementation of low-cost RWH tanks and farm ponds. They work through Community Based Organisations rooted in the local communities.

Valley dams

Valley dams are low (typically less than 3 m high) compacted earth bunds that cross a valley. The valley dams temporarily store water and often dry out in the dry season. Valley dams or pans are most commonly found in the eastern part of Rwanda which suffers from reduced rainfall. Valley dams are typically used for watering livestock in eastern Rwanda. The valley dam stops the rainwater runoff and creates a shallow lake behind the dam. Water is pumped (increasingly through solar power) into drinking troughs for livestock. To prevent the pond from premature drying out, one option is to excavate the area behind the dam creating a deeper collection area above the dam.

The water behind the dam infiltrates the soil and replenishes the groundwater or aquifer. In some cases, groundwater recharge is the main reason for the construction of the dam. The groundwater can feed the water sources downhill or can be pumped from the groundwater reservoir when needed. The advantage is that the water stored underground does not evaporate. Studies are needed to assess the potential for groundwater recharge and groundwater exploitation.

More detailed information can be found in:
- Rainwater harvesting strategy W4GR/RWFA 2017;
- Manual for low-cost rainwater harvesting techniques, Trocaire 2017.

Best practice: Loan subsidy scheme for rain water harvesting
RNRA (now RWFA), the GTBank/SACCOS and two tank providers joined forces for an innovative rainwater harvesting project installing 6,825 household tanks according to the following steps.
1. The SACCO receives the subsidy to purchase tanks;
2. 10 % down payment + loan agreement by the beneficiary to start;
3. Monthly payback (12 settlements in one year);
4. The beneficiary hires local masons for installation;
5. Field technicians of RNRA confirm the installation of the tank before giving a go-ahead for the subsidy;
6. After fulfilling the payments, the user becomes the full owner of the tank.

A 5 m^3 tank costs 375,000 RWF in Kigali. The subsidy was around a third of the total costs. The cost of additional investment for materials, transport and installation per household is around 50.000 RWF. The project also donated plastic sheets and iron sheets for people who couldn’t afford a tank. Also, underground storage tanks where built for some settlements.

Up-scaling
SACCOS now offer loans for RWH. However, the combination of subsidy and loan increases people’s access to rainwater harvesting systems and guarantees inclusiveness. An evaluation is needed including user satisfaction measurement to draw lessons for further up-scaling of the experience. There is still a great demand in other districts.

14.4 Small-scale irrigation

The key issue in Upper & Lower Muvumba and Muhazi sub-catchments, but also in other water stressed regions of Rwanda, is water scarcity and the high potential for conflicts between water users in the irrigation, livestock and domestic sectors.

More productive and more resilient agriculture requires a major shift in the way catchments and water resources are managed to ensure that they are used more efficiently while maintaining social cohesion.

Land fragmentation and high population density constitute major reasons to explore new farming systems that can increase agricultural productivity and water efficiency. To achieve this objective, new crop varieties with higher economic values which use less water should be introduced. New water-saving irrigation technologies should also be promoted (such as localised irrigation), together with farmer training in efficient irrigation water delivery and scheduling; targeting to meet full crop water demand.

Most of the efforts and investments made in Rwanda for the adoption of irrigation have resulted in increased water resources usage and few on-farm water-use efficiencies. The potential application of improved irrigation methods and techniques on small farms needs to be addressed in response to the increasing requirement for higher irrigation efficiency, improved water productivity and diversification of use.

To date MINAGRI/RAB has been supporting the adoption of small-scale irrigation technology (SSIT), providing farmers with equipment (including hose, motor and treadle pumps, sheet lining for small uphill reservoirs). The adoption of farmer based small-scale technology has been promoted through consultations with farmer groups and demonstrations of the technology in various forums, including the Irrigation Forum and at District level. The SSIT approach has the advantage that it does not require complex pump stations or a buried pipe network; and it is entirely portable and has reduced costs per hectare making it attractive to individual and small farmers.

Localised irrigation is the slow application of water to the soil through mechanical devices called emitters, located at selected points along the water delivery line. The different types of localised irrigation comprise: drip, micro-jet (also known as jet spray) and micro-sprinkler irrigation. All localised irrigation systems consist of a pumping unit, a control head, main and sub-main pipes, laterals and emitters.

Many claims of the advantages for localised irrigation have been and are still being made. Currently, the following advantages are recognised:

- A good protection against erosion and landslides and a positive influence on the water cycle in the catchment;
- The evaporative component of evapotranspiration is reduced; only a limited soil area is moistened;
- The limited moistened area results in reduced weed growth;
- The slow rate of water application improves the penetration of water into problematic soils;
- The higher degree of inbuilt management, that localised irrigation offers, reduces substantially deep percolation and runoff losses, thus attaining higher irrigation efficiencies. Therefore, localised irrigation is considered as a water-saving technology;
- The moisture availability to the plant at low soil tension results in faster growth, higher yields and better quality;
- Since fertilisers can be injected into the system in a controlled manner, fertiliser losses can be substantially reduced under localised irrigation;
- The controlled water and fertiliser application attainable with localised irrigation, make these systems more environmentally and health friendly.

Localised irrigation has however some disadvantages:

- Localised irrigation systems are prone to clogging because of the very small aperture of the water emitting devices. Hence the need for proper filtration and, at times, chemigation;

- The movement of salts to the fringes of the wetted area of the soil may cause salinity problems through the leaching of salts by rain to the main root volume. This can however be avoided if the system is turned on when it rains, especially when the amount of rain is not enough to leach the salts beyond the root zone depth;
- Rodents, dogs and other animals in search of water can damage the lateral lines. Fixed pipes and other pumping equipment can be vandalised or stolen if not properly protected.

It is proposed to promote efficient small-scale localised irrigation technology (SSLIT) through pilot irrigation plots in different locations of the Upper & Lower Muvumba and Muhazi Sub-Catchment IWRM packages. Ideally pilot plots could be implemented through Farmer Field Schools (FFS).

A strong technical support and monitoring system needs to be put in place to generate biophysical and socio-economic data to assess opportunities and constraints, and to draw lessons to assess the conditions that would facilitate a scaling up of SSLIT systems and identify potential business models that would promote greater access to small scale localised irrigation by farmer households.

15.1 Stakeholder analysis

A stakeholder analysis was carried out during the scoping workshop in March 2016. Results are presented in Annex 7. Key stakeholders comprise:

- National government, in the form of line ministries and their authorities / agencies, including the significant projects and programmes carried out under their auspices;
- Parastatal utilities, such as those for water supply and electricity;
- District authorities, as the main catchment level plan owners, represented by their members of the Catchment Task Force;
- NGOs and INGOs, active in the districts;
- Communities;
- Private sector stakeholders.

Catchment stakeholders can be classified into three broad categories according to the role they are expected to play, the level of influence they are expected to exert within the framework for design and implementation of the catchment plan, and their role in the stakeholder engagement strategy:

1. **Primary stakeholders:** Include local communities and community groups (the majority of whom are economically disadvantaged men and women), farmers, herders, fishermen etc., all of who derive their livelihoods from water resources, or whose activities directly rely or impact on water resources. They also include water users within and downstream of the catchment, as well as water user associations, and business entities directly affected by catchment management. A detailed list of primary stakeholders is included in various district survey reports and this group should be kept informed, and engaged in a participatory manner, in order to guarantee ownership of project interventions;
2. **Secondary stakeholders:** Those individuals, institutions or organisations that are intermediaries in catchment plan development and implementation. Secondary stakeholders are "indirectly affected" by outcomes in the catchment and include local Government or constituent districts, NGOs, WASAC, RURA, EWSA, electricity companies (e.g. REG), and others in the basin such as DEMP, LVEMP II, LAFREC. The catchment task force and district hydrographic basin committees are the focal points for this group. Although only indirectly affected by the outcomes, secondary stakeholders are powerful and often highly involved in the catchment planning process, and should remain (or become) so during catchment plan development and implementation;
3. **Tertiary stakeholders:** These can also be referred to as external stakeholders and usually only play an advisory, approval or advocacy role. They include the National Government, the Embassy of the Kingdom of the Netherlands in Rwanda, other development partners, and technical ministries which formulate policies, plans and programs relevant to the catchment plan (e.g. MINIRENA, MINAGRI, MINALOC, MININFRA). The apex bodies for water management, such as the Water Inter Ministerial Committee and National Water Consultative Committee, are also included in this category and play a critical role in approval of the catchment plan.

The mandate of the tertiary stakeholders involved in development and implementation of the catchment plan is as follows:

- **MINAGRI:** Ministry of Agriculture and Animal Resources is focused on increasing agricultural and animal production, modernising farming, ensuring food security and promoting surplus for the market. Given the close link between agriculture and the catchment management, especially for land husbandry, irrigation feeder roads improvement and fertilisers application in farms, this ministry will be involved in the implementation of the catchment plan;
- **NAEB:** The National Agricultural Export Development Board registered under MINAGRI was set up by bringing together three government agencies responsible for agricultural export and cash crop under the same management (OCIR THE, OCIR CAFÉ and Rwanda Horticulture: RHODA). Given its

responsibilities related to local economic development (LED) potential and their exploitation, including processing factories, NAEB will be involved in implementation of the catchment plan;

- **MININFRA:** The Ministry of Infrastructure will play a key role in supporting development and rehabilitation of infrastructure which will facilitate implementation of the catchment plan at national level, through policy and standards formulation and participation in the programme steering committee, and at local level in the catchment;
- **WASAC:** The Water and Sanitation Corporation is responsible for ensuring access to clean water and adequate sanitation infrastructure. As assessed during the district surveys, access to water supply for people, animal and industries is among the top priorities for 87.5% of the districts within the W4GR demonstration catchments. WASAC is therefore a key player in catchment plan implementation especially with regard to the growing demand for clean water in most economic activities in the catchment;
- **REMA:** The Rwanda Environmental Management Authority is mandated to facilitate coordination and oversight of environmental legislation, policy and standards. Key areas of intervention relate to prevention of soil erosion, deforestation, pollution and water contamination. REMA should support LODA in ensuring that the focus on LED does not negatively impact on the environment, including through destruction or depletion of natural resources, and should work towards promoting innovation and green enterprises;
- **RFWA:** The Rwanda Water and Forestry Authority leads management and promotion of water and forests. It is the parent authority of the water resources management department (WRMD). It is entrusted with supervision and monitoring and with ensuring implementation of policies relating to the promotion and protection of natural resources in programs and activities of all national institutions. RWFA coordinates closely with two other key authorities (Rwanda Mines, Petroleum and Gas Board, and the Rwanda Land Management and Use Authority);
- **LODA:** The Local Government Development Agency plays a unique and essential role in supporting and promoting local economic development across Rwanda. As a central agency but with staff at district level and providing funding to improve development at the local level, LODA has a key role in supporting LED. In close collaboration with MININFRA, LODA will ensure that infrastructure projects needed in the catchment are designed and executed with a sustainable economic impact;
- **RDB:** The Rwanda Development Board is responsible for supporting private investment and business development in Rwanda, including through addressing the needs of companies and investors. In catchment plan implementation, RDB will be consulted regarding Tourism Projects and approving Environmental Impact Assessments and mitigation plans for all projects having a potentially negative impact on water resources.

15.2 Stakeholder engagement plan

For each category of stakeholders, it is important to feel that they are part and parcel of plan development as well as implementation of proposed projects. Regular communication on outcomes and decisions being made is essential to achieving this. A catchment stakeholder engagement plan for the implementation phase is outlined in Table 65. In addition, it is recommended that a dedicated communication strategy for all stakeholders be designed at the beginning of the CP implementation phase.

Table 65: Stakeholder engagement matrix

Type of stakeholders	Timing of involvement	Type of participation required	Tools for participation and communication	Outcome of involvement	Comments
Communities, **Water user associations,** **Farmers, Herders, Rwanda Miners Association**	Implementation and M&E	Interactive participation, participation for material incentives. active role in management of watershed.	Community meetings, focus group discussions.	Resource mobilisation and development of community structures for catchment plan implementation and M&E phases, enhanced ownership of sub-projects.	Integration of gender, vulnerable segments of the community, conflict, HIV/AIDs and other cross cutting themes will need to be factored into project design and implementation.
Private Sector Associations including water utility companies and parastatals (REG, WASAC, RURA, EWSA)	Consultative biannual or annual meetings	Participation by information giving, by consultation.	Formal meetings and representation in Focal Group, national and multi-stakeholder meetings, email, social networking.	Exchange of best practice across sub projects e.g. water source protection, water efficiency promotion; Fulfilment of private sector objectives in economic development in the various projects they support or implement.	The water allocation plan should be discussed in depth as it affects the operations of this group of stakeholders.
Local Governments, District Hydrographic Basin Committees,	Quarterly meetings	Interactive participation.	Advisory committees, formal meetings, project monitoring visits.	Enhanced ownership and sustainability of sub- project outcomes. Contribution towards attainment of	Interventions in the catchment plans can be streamlined into joint Imihigo.

Type of stakeholders	Timing of involvement	Type of participation required	Tools for participation and communication	Outcome of involvement	Comments
Catchment Task Force				catchment plans in Imihigos.	
Technical Ministries, REMA, RWFA	Biannual	Advisory and consensus building.	Formal meetings of Focal Group and PSC, water sector meetings, exchange visits to other countries for lesson learning and exchange of best practice.	Contribution towards the attainment of sector plans in IWRM due to sub project activities.	It is envisaged that the sub-projects will be part of the sectoral plans.
Regional projects	Annual	Information exchange of best practices and lessons learnt.	Formal meetings lesson learning workshops.	Commitment to collaboration on similar projects or activities in the Nile Basin; Contribution towards regional environment and economic development goals.	It is envisaged that the IWRM Catchment Investment Plan will be in harmony with other investment plans for the region.
Regional bodies (EAC, NBI)	Annual	Information exchange of best practices and lessons learnt.	Formal meetings and lesson learning workshops.	Commitment to harmonisation of similar activities and donor coordination in the Nile Basin. Contribution towards regional environment	It is envisaged that the IWRM Catchment Investment Plan will be contributing to the goals of regional bodies.

Type of stakeholders	Timing of involvement	Type of participation required	Tools for participation and communication	Outcome of involvement	Comments
				and economic development goals.	
Sponsors of Water for Growth Programme (EKN) and other development partners	Biannual	Information exchange and updates of sub projects.	Formal meetings.	Commitment to continuation of funding for sub projects within the four demonstration catchments and/or additional catchments.	Donor funding for the IWRM activities in the catchments is factored into national budget.

Most of development partners operating in 3 Districts of Muvumba catchment are in the category of International and Local NGOs as well as government projects operating in 13 sectors of socio-economic development. Among those sectors of intervention, seven are in close relation with water sector while others such as justice & governance, microfinance, communication, ICT and education have no direct relationship with water. Among the sectors with close relation to water sector, social sector, agriculture, environment protection and land, and water and sanitation have the majority of stakeholders respectively.

In addition to NGOs and INGOs, there are also government socio-economic development projects in the catchment. These include seven major projects implemented by three government institutions: REMA (1 project), MINAGRI (3 projects), MININFRA (3 projects).

Table 66: Projects directly or indirectly pertaining to land and water management in the catchment

S/N	Project name	Implementing institution	Number of districts
1	Warufu multipurpose dam (25 million m^3): irrigation (2 500 ha), water supply and hydro-power production, funded by WB.	MINAGRI/LWH	Gatsibo district (1) (Nyagihanga, Gatsibo and Ngarama sectors)
2	Muvumba multipurpose dam (35 million m^3) for irrigation (8 000 ha), water supply and hydro-power production, funded by KOICA.	REMA/KOICA	Nyagatare district (1) (Rukomo, Rwempasha, Musheli, Tabagwe and Nyagatare sectors)
3	Livestock watering system (LWS) for 627 farms implemented by Livestock Infrastructure Support Project (LISP), funded by AfDB.	MINAGRI/LISP	Nyagatare district (1) (Rwempasha, Musheli, Tabagwe, Rwimiyaga and Nyagatare sectors)
4	Marshland development (900 ha) with dam construction (3.75 million m^3), funded by WB.	MINAGRI/RSSP	Gatsibo and Nyagatare districts (2) (Karangazi, Gatsibo and Nyagatare sectors
5	Water supply, Hygiene and Environmental sanitation, Urban drainage development and Capacity building implemented by Lake Victoria Water and Sanitation Program Phase II (LVWATSAN II) funded by AfDB.	MININFRA/WASAC	Nyagatare district (1) (Nyagatare sector)
6	Transport Sector Support Project, Phase 1: Improvement and Asphalting of 51.54 km Base, funded by AfDB.	MININFRA/RTDA	Gicumbi and Nyagatare district (2) Gicumbi-Rukomo section
7	Transport Sector Support Project, Phase 2: Improvement and Asphalting of 73 km, funded by Arab Bank.	MININFRA/RTDA	Gicumbi and Nyagatare district (2) Rukomo-Ngarama-section

Table 67: Metadata from Water for Growth Rwanda overview of stakeholders

S/N	Sector	Number of stakeholders	% of stakeholders	Stakeholders with close relation to water sector
1	Social	33	49.6	17.4

2	Agriculture	26	7.6	30.4
3	Health and Nutrition	21	11.8	8.7
4	Environment protection and land	16	2.5	4.4
5	Water and sanitation	14	3.4	17.4
6	Education	9	11.8	0
7	Justice and Governance	8	4.2	0
8	Livestock	7	0.8	0
9	Energy (Electricity& Alternative)	5	1.7	0
10	ICT	2	0.8	0
11	Communication	2	0.8	0
12	Agro-processing	2	4.2	17.4
13	Settlement	1	0.8	4
	Total	**155**	**100**	**100**

4GR CROM DSS

In brief

This annex presents the newly developed modular W4GR Catchment Restoration Opportunities Mapping Decision Support System (CROM-DSS). A flow chart, representing the process, is provided in Figure 82. The DSS process is largely automated in ArcGIS[73]. A geodatabase was developed, containing spatial data at national and catchment level. The models constituting the DSS were developed using ArcGIS Model Builder. The first nine maps, as per the numbering in the flow chart, are presented on the following pages in Figure 83 - **Error! Reference source not found.**. Eventual decision making, leading to Map 10 – Catchment Restoration Plan Map, requires detailed local consultation and consideration of additional local information, in a process of Micro-Catchment Action Planning (MCAP).

Introduction

A decision support system for catchment restoration opportunities was developed by Water for Growth Rwanda, in collaboration with the Prime Minister's Inter-Ministerial Task Force on prevention and mitigation of soil erosion and landslides. The Catchment Restoration Opportunities Mapping Decision Support System (CROM DSS) tool was developed in ArcGIS 10.5, using the software's built-in model builder capacity. The tool consists of a geo-database (spatial data infrastructure), a series of automated main processes identifying risks, locating existing protection, assessing priority areas, classifying land according to slope and soil depth to identify suitable restoration options, and ultimately a non-automated, detailed local consultation and decision-making process leads to the development of a catchment restoration map. A flow chart presenting the process flow, with inputs, processes, and outputs, is provided in Figure 82. Detailed descriptions of individual maps, produced in different steps and combined with each other to produce subsequent maps, are provided below.

The Water for Growth Rwanda CROM DSS is an integrated, participative methodology, much more than only a GIS tool. GIS is used to provide the scientific basis for the final process of detailed local consultation and decision making. Using the maps produced by CROM DSS ensures that the decision-making process is evidence based.

For most of the decision support criteria, CROM DSS is a tool at national scale. A more detailed approach is followed for the four demonstration catchments of Water for Growth Rwanda. In particular, this relates to the identification of the areas with existing terraces (which have been digitised on-screen, based on Google Earth images) and the prioritisation according to the number of water intakes downstream of any point on the map.

A generic map (Map 8) was made for the entire country (without taking into account the existing terraces and prioritisation for the number of downstream intakes), and catchment specific maps (acknowledging the existing terraces and including prioritisation for areas with 3 or more water intakes downstream) were developed for the four W4GR demonstration catchments. For details, see below in the flow chart in Figure 82 and the descriptions of individual maps, below. Despite the fact that information on existing terraces and locations of water intakes is not available yet in the nationwide geodatabase, local knowledge about these factors can and should as much as possible be integrated in the local level detailed consultation and decision-making process.

[73] ArcGIS version 10.5 was used for development. The tool was also exported in version 10.2, to be used in the ArcGIS versions available and suitable at RWFA and RLMUA.

As for soil erosion risks, it needs to be stressed that for flatter, low lying areas, the applied method (RUSLE) is not the most suitable. In a near-future update, additional soil erosion risk criteria may be added, such as drought and livestock grazing induced soil erosion risk. For the moment, the flatter Eastern part of the country seems to be less prone to soil erosion. Local knowledge about soil erosion risks related to factors of drought, grazing pressure, and other factors, should be integrated in the local level (district, sector, cell) detailed consultation and decision making on catchment restoration.

The catchment restoration classification matrix (Table 68), used to support decision making on which measures to implement, provides multiple options per class. It does not prescribe which option should be implemented at any location. Rather, this decision is made in the local detailed consultation and decision-making process of Micro-Catchment Action Planning

Table 68: Matrix of soil erosion control measures according to land slope

Land slope↓	Soil erosion control measures	Erosion risk
1: (0-6%)	**Class I** ▪ Agroforestry + contour ploughing + alley cropping with grass strips. ▪ Forestation where soil depth is too limited and unsuitable for crops; ▪ Perennial crops, coffee, tea, banana, fruit trees.	**Very low and low risk**
2: (6 - 16%)	**Class II** ▪ Progressive terraces (reinforced by agroforestry hedges and grass strips); ▪ Perennial crops, coffee, tea, banana, fruit trees. ▪ Forestation where soil depth is too limited and unsuitable for crops.	**Medium risk**
3: (16 - 40%)	**Class III** ▪ Bench terraces (option only in case of suitable, stable parent material / geology; avoid introducing landslide risks); ▪ Progressive terraces (reinforced by agroforestry hedges and grass strips); ▪ Perennial crops, coffee, tea, banana, fruit trees. ▪ Forestation where soil depth is too limited and unsuitable for crops;	**High risk**
4: (40- 60%)	**Class IV** ▪ Narrow cut terraces (option only in case of suitable, stable parent material / geology; avoid introducing landslide risks);	**Very high risk**

Land slope↓	Soil erosion control measures	Erosion risk
	▪ Progressive terraces (reinforced by agroforestry hedges and grass strips); ▪ Forestation (Biological measures); ▪ Perennial crops, coffee, tea, banana, fruit trees.	
5: (> 60)	**Class V** ▪ Forestation (Biological measures) + trenches / ditches; ▪ Perennial crops, coffee, tea, banana, fruit trees.	**Extremely high risk**

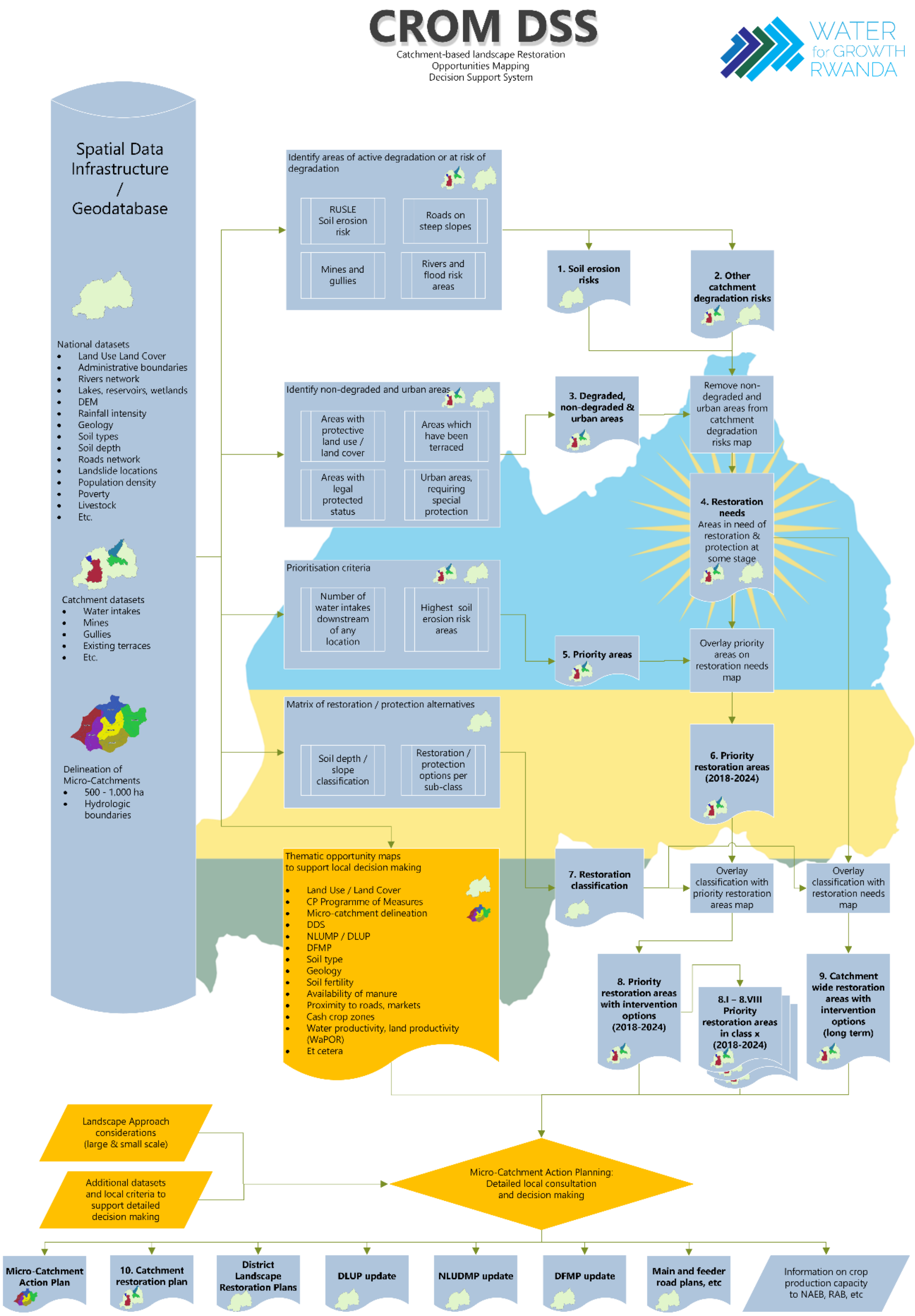


Figure 82: CROM DSS flow chart (W4GR, 2018)

A short introduction to each map is provided below. The actual maps for the catchment are included on subsequent pages.

- **Soil erosion risks (map 1)**

(Methodology: Revised Universal Soil Loss Equation (RUSLE)) A classification of hillside soil erosion risks, based on quantitative assessment according to the Revised Universal Soil Loss Equation, after Wischmeier. In the near future, lowland drought and livestock grazing induced soil erosion will be added to the DSS. Existing flexibility of the DSS means additional elements (e.g. from ROAM methodology) may be incorporated.

- **Restoration needs (map 2)**

Removing the areas that do not need to be restored (the areas identified in map 3) from the areas suffering from, or at risk of suffering from soil erosion (map 2) renders the areas in need of restoration, at some moment in time.

- **Restoration classification (map 3)**

A new decision support matrix (Table 68) was developed by the joint teams of W4GR and the Prime Minister's Inter-Ministerial Task Force on prevention and mitigation of soil erosion and landslides. Using the same parameters as in the previously used LWH land restoration matrix, but now distinguishing multiple options for most of the combinations of slope and soil depth.

- **Catchment restoration plan**

The ultimate result of the CROM DSS process is the catchment restoration plan. This plan captures the decisions made in the detailed local consultation and decision-making process, e.g. which options to choose at each location, whether or not to extend intervention areas to included adjacent areas of lower soil erosion risk, etc. The local decision-making process also may consider a set of opportunity maps, as per their availability (LULC, CP, DDS, DLUP, DFMP, soil fertility, availability of manure, proximity to roads, cash crop zones, water productivity, etc). Additional decision support tools may also be brought in: The Land Use Trade of Tool from the NCA / WAVES project, and local criteria. Other results from the exercise include inputs to updates of DLUP, DFMP, District Landscape Restoration Plans, etc.

In the final decision making and development of map 10, Catchment restoration plan, an integrated plan should be considered for selected priority areas. In such integrated plans, the entire area would be addressed, not just the identified very high and extremely high erosion risk areas. The goal should always be to restore the landscape sub-catchment by sub-catchment, or watershed by watershed, in an integrated approach, eventually leading to a completely restored and protected catchment.

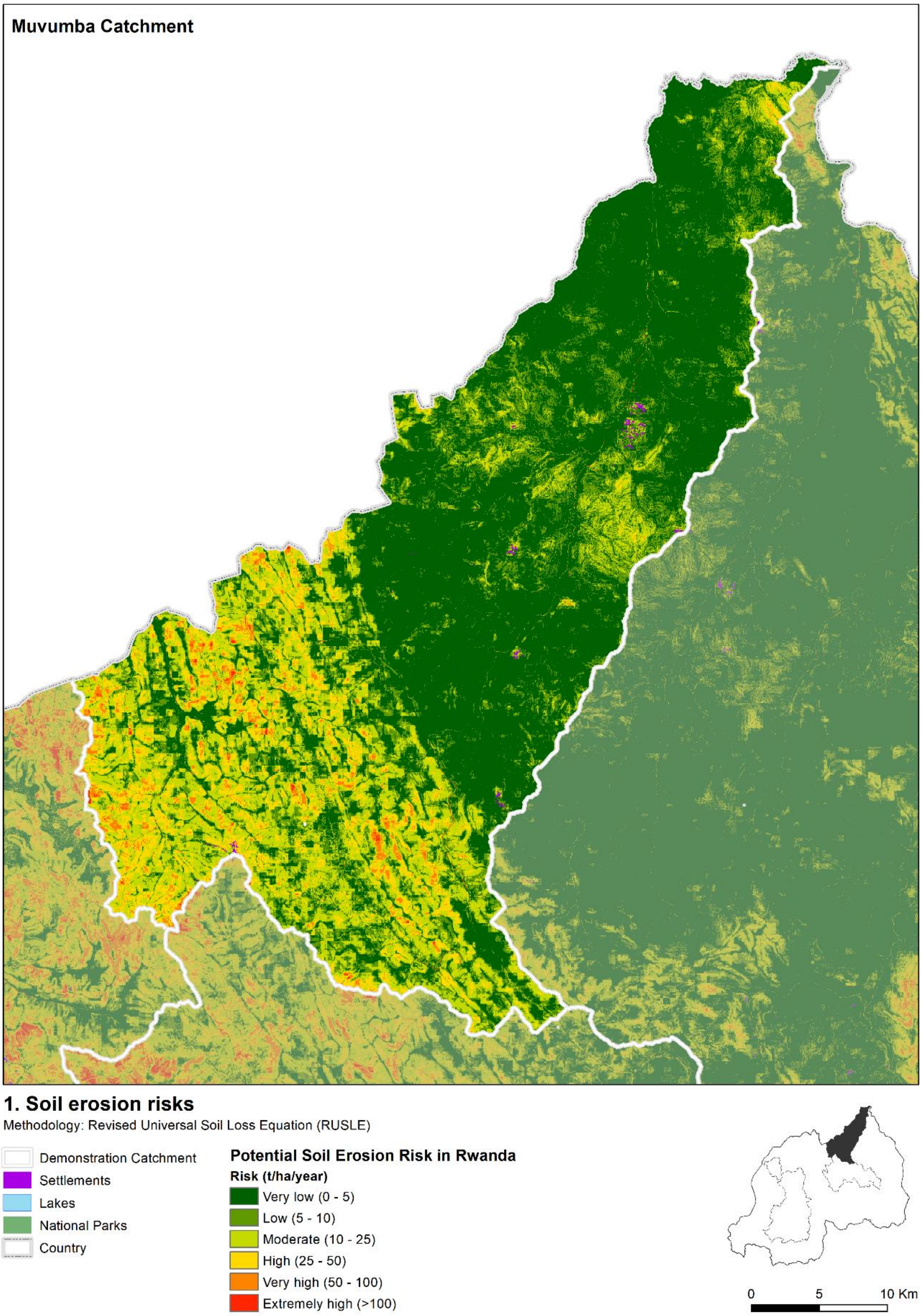


Figure 83: Map 1 – Soil Erosion Risks according to the Revised Universal Soil Loss Estimation model (RUSLE)

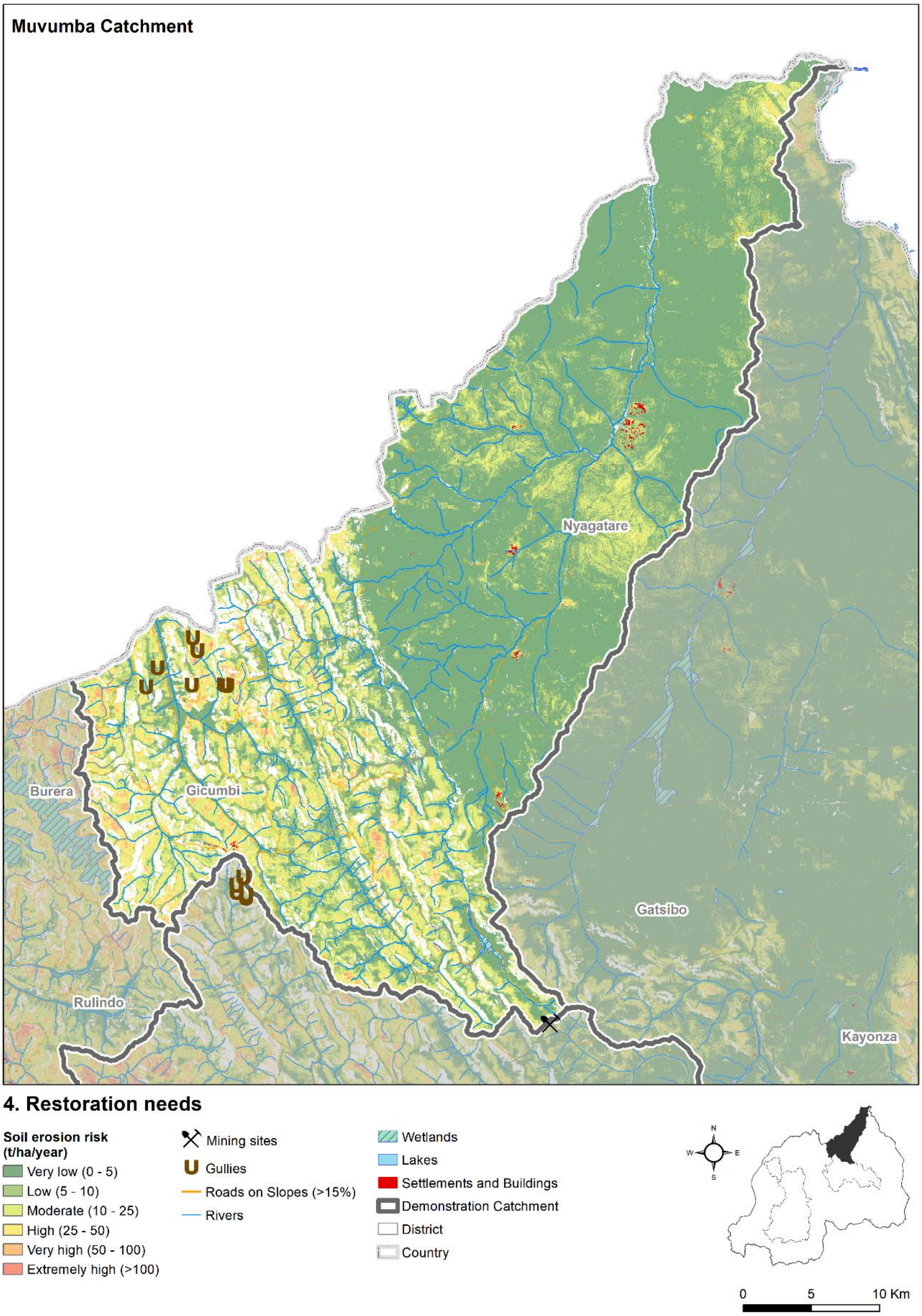


Figure 84: Map 2 – Target areas, in need of restoration & protection at some stage

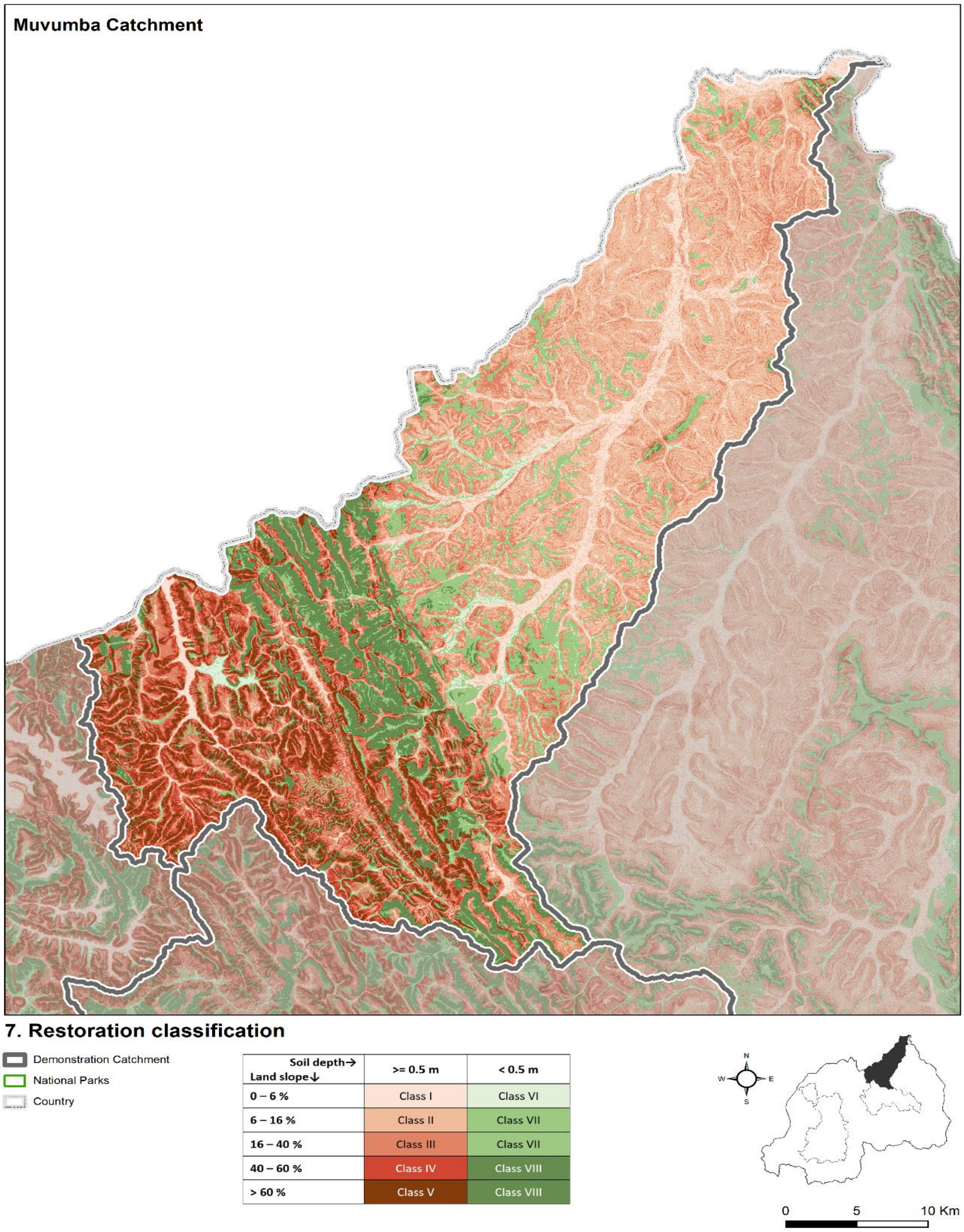


Figure 85 : map 3 Generic catchment restoration opportunities classification