REPUBLIC OF RWANDA

MINISTRY OF ENVIRONMENT

UPPER NYABARONGO CATCHMENT MANAGEMENT PLAN (2018-2024)

KIGALI , 2018

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Content

Chapter	Title	Page
List of Abbreviations		ix
Executive Summary		xii
1.	Introduction	1
1.1	The integrated catchment planning process	1
1.2	Institutional embedding	2
1.3	Joint catchment plan implementation	3
1.4	Plan structure	3
2. Integrated situation analysis		5
2.1. Catchment characteristics		5
2.1.1. Physiography		5
Table 1: Green water balance, entire Upper Nyabarongo catchment		12
Table 2: Blue water balance, entire Upper Nyabarongo catchment		13
1.4.1	Socio-economic profile	15
2.2. Catchment issues and opportunities		21
2.2.1. Issues		22
2.2.2. **Opportunities**		26
3. Vision and objectives		27
3.1. Catchment vision and objectives		27
3.1.1. Vision and objectives development process		27
3.1.3. **Overall objective and specific objectives**		27
3.2. Comparing different plan alternatives		29
4. Programme of Measures (PoM)		33
4.1. Enabling environment		33
4.1.1. Catchment restoration		33
4.1.2.	**Water allocation**	46
4.1.3. Water governance		48
4.2. PoM 2018-2024 development process		52
4.3. Project relevance screening (filter 1)		53
4.4. DPSIR analysis (filter 2)		54
4.5. IWRM packages (filter 3)		56
5.	Overview of IWRM packages	58
5.1.	Multi-Criteria Analysis (filter 4)	62
5.2.	Highlights of Programme of Measures	64
6. Implementation arrangements		67

6.1. Sector and agency planning ____ 67
6.2. Coordinated implementation ____ 68
6.3. Looking ahead – Catchment Plan 2024-2030 ____ 69
7. Intervention logic and Monitoring & Evaluation 70
Reference list 78
• **Specific objectives** ____ 231
• Beneficiaries and impacts ____ 232
• Budget for the proposed measures ____ 232
Objective 239
Specific objectives ____ 239
Beneficiaries and impacts ____ 240
Budget for the proposed measures ____ 240
Objective 242
Specific objectives ____ 242
Activities specific for projects linkage to a package ____ 243
Beneficiaries and impacts ____ 243
Budget for the proposed measures ____ 244
2. Objective of this implementation strategy ____ 274
a. Levels of catchment management/planning ____ 275
b. What is a micro-catchment action plan? ____ 275
c. Who is involved in micro-catchment action planning? ____ 275
d. What are the benefits of the micro-catchment action plan process? ____ 276
e. Steps in the micro-catchment action planning process ____ 276
i. Initiate the process ____ 277
ii. Confirm who to work with ____ 277
iii. Undertake planning ____ 277
f. Remuneration to communities ____ 280
Annexes
Annex 1. The Water for Growth Rwanda Programme 82
Annex 2. Glossary of terms 84
Annex 3. Catchment Atlas 90
Annex 4. Consistency alignment 111
4.1 Introduction consistency alignment ____ 111
4.2 Consistency analysis of policies, legislation and regulation ____ 111
4.2.1 Key strengths of existing policy instruments ____ 112
4.2.2 Key weaknesses of existing policy instruments ____ 113
4.2.3 Effective Catchment Plan implementation ____ 114
4.3 Vision 2020, Vision 2050, 7YGP and NST1 ____ 114
4.3.1 Aspirations of Vision 2050 ____ 115
4.3.2 The 7-year Government plan (NST1) ____ 115
4.4 Sector Strategic Plans (SSPs) ____ 118

4.5 Cross-cutting area alignment 131
4.5.1 Gender 131
4.5.2 Environment and climate change 134
4.5.3 Other cross-cutting areas 135
4.6 District Development Strategies (DDSs) 139
4.6.1 DDS highlights 139
Annex 5. NWRMP UNY observations and conclusions 143
Annex 6. Infrastructure, institutional and knowledge measures 145
Annex 7. SEA process report 160
7.1 SEA methodology 160
7.2 SEA step results 164
7.3 Outputs summary of IWRM/SEA process 179
7.4 Conclusions and lessons learned from IWRM/SEA process 187
Annex 8. SDGs and catchment planning 189
8.1 Catchment planning and alignment to SDGs 189
8.2 Priority SDGs key messages 192
Annex 9. Water balance and allocation modelling 194
9.1 Baseline and alternative development modelling 194
9.2 CP 2018-2024 WEAP models 194
9.3 Water allocation plan 198
Annex 10. Gender mainstreaming guidelines 206
Annex 11. Rwanda's INDC on climate change 215
Annex 12. MCA methodology 224
Annex 13. Concept notes of IWRM packages 229
Annex 14. Concept notes of typical CPIPs 246
14.1 Forestry and agroforestry 246
14.2 Mining 249
14.3 Incentives for environmental services 250
14.4 Rainwater harvesting 252
14.5 Small-scale irrigation 255
Annex 15. Stakeholder analysis and engagement plan 257
15.1 Stakeholder analysis 257
15.2 Stakeholder engagement plan 258
Annex 16. W4GR CROM DSS 263
Annex 17: Summary of Micro Catchment Action Planning Manual 271

Tables

Table 1: Green water balance, entire Upper Nyabarongo catchment 12
Table 2: Blue water balance, entire Upper Nyabarongo catchment 13
Table 3: Green water balance, Mwogo sub catchment 13
Table 4: Blue water balance, Mwogo sub-catchment 13
Table 5: Green water balance, Mbirurume sub-catchment 13
Table 6: Blue water balance, Mbirurume sub-catchment, baseline 13
Table 7: Green water balance, Hydropower sub catchment 13
Table 8: Blue water balance, Hydropower sub catchment 13
Table 9: Green water balance, Satinsyi sub catchment 14
Table 10: Blue water balance, Satinsyi sub catchment 14
Table 11: Green water balance, Nyabarongo Upper sub catchment 14
Table 12: Blue water balance, Nyabarongo Upper sub catchment 14
Table 13: Economic drivers in Upper Nyabarongo catchment 17
Table 14: Population % identified as poor and extreme poor for the Upper Nyabarongo catchment 19
Table 15: Land use / land cover classification Upper Nyabarongo (W4GR, 2018) 20
Table 16: Upper Nyabarongo catchment Drivers, Pressures, States and Impacts 25
Table 17: Final catchment plan alternatives 32
Table 18:Budget estimation for restoration of Mbirurume subcatchment 38
Table 19:Budget estimation for restoration of Kiryango subcatchment 39
Table 20:Budget estimation for restoration of mwgo subcatchment 40
Table 21:Budget estimation for restoration of mining and hydropower generation in the most degraded areas of Upper Nyabarongo 43
Table 22:Estimted cost of IWRM Package 1: LWAPES 59
Table 23:Estimated cost of IWRM 2: Kiryango 60
Table 24:Estmated cost of IWRM Package 3: LAPROM 61
Table 25:Estimated cost IWRM Package 4: Secoko 62
Table 26:Logic framework for Upper Nyabarongo Catchmant plan proposed interventions 72
Table 27:Overview of W4GR Technical Reports 79
Table 28:Results of women and men focus groups for gender mainstreaming 132
Table 29:Infrastructure measures 145
Table 30:Institutional measures 152
Table 31:Knowledge measures 153
Table 32:Combining process steps of IWRM and SEA 162
Table 33:Composition of Programme Steering Committee (PSC) 167
Table 34:: Composition of the Focal Point Group (FPG) 167
Table 35:Composition of Catchment Task Force (CTF) core team 167
Table 36:Composition of Catchment Task Force 168
Table 37:Refined alternatives for Catchment Plan 2018-2024 173
Table 38:Overview of catchment plan development workshops held with CTF and individual districts .. 179
Table 39:Overview of W4GR Focal Point Group meetings 180
Table 40:Overview of W4GR Programme Steering Committee meetings 180
Table 41:Detailed catchment planning process, activities, and results, integrating IWRM and SEA principles 181
Table 42:Key model assumptions for typical water use per unit in each category 194
Table 43:Codes and content of new alternatives for Upper Nyabarongo in WEAP model version 07...... 195
Table 44:Details of new alternatives 195
Table 45:Water demand (met/unmet) by 2050, new alternatives 196
Table 46: Mwogo sub-catchment water balance (2024 preferred alternative) 199
Table 47:Mwogo sub-catchment water balance (2030 preferred alternative) 199
Table 48:Mwogo sub-catchment water balance (2050 preferred alternative) 200

Table 49: Mbirurume sub-catchment water balance (existing conditions) 200
Table 50:Mbirurume sub-catchment water balance (2024 preferred alternative) 200
Table 51:Mbirurume sub-catchment water balance (2030 preferred alternative) 201
Table 52:Mbirurume sub-catchment water balance (2050 preferred alternative) 201
Table 53:Hydropower sub-catchment water balance (existing conditions) 201
Table 54:Hydropower sub-catchment water balance (2024 preferred alternative) 202
Table 55:Hydropower sub-catchment water balance (2030 preferred alternative) 202
Table 56:Hydropower sub-catchment water balance (2050 preferred alternative) 202
Table 57:Satinsyi sub-catchment water balance (existing conditions) 203
Table 58:Satinsyi sub-catchment water balance (2024 preferred alternative) 203
Table 59:Satinsyi sub-catchment water balance (2030 preferred alternative) 203
Table 60:Satinsyi sub-catchment water balance (2050 preferred alternative) 204
Table 61:Nyabarongo Upper sub-catchment water balance (existing conditions)................................. 204
Table 62:Nyabarongo Upper sub-catchment water balance (2024 preferred alternative)...................... 204
Table 63:Nyabarongo Upper sub-catchment water balance (2030 preferred alternative)...................... 205
Table 64:Nyabarongo Upper sub-catchment water balance (2050 preferred alternative)...................... 205
Table 65:Gender mainstreaming guidelines rationale 206
Table 66:Gender mainstreaming checklist for catchment plan implementation projects 208
Table 67:Rwanda's Intended Nationally Determined Contribution (INDC) 215
Table 68:MCA criteria explained 224
Table 69:MCA scoring rules per criterion 226
Table 70:Budget for the proposed works.. 232
Table 71:Estimated budget by component: 236
Table 72:Budget for the proposed works.. 240
Table 73:Budget for the proposed works.. 244
Table 74:Table76: Stakeholder engagement matrix 260
Table 75:Projects directly or indirectly pertaining to land and water management in the catchment..... 262
Table 76:Metadata from Water for Growth Rwanda overview of stakeholders 262
Table 77:W4GR CROM classification of catchment restoration opportunities per class according to soil depth and land slope 264
Table 79:Example micro-catchment action plan... 282

Figures

Figure 1:The IWRM and catchment planning cycle... 1
Figure 2:Embedding of CPs... 3
Figure 3:Upper Nyabarongo catchment elevation, waterways, and sub-catchments................................ 6
Figure 4:Upper Nyabarongo catchment and the ecoregions (WWF) of Rwanda.. 7
Figure 5:Upper Nyabarongo catchment and the agro-ecological zones (WWF) of Rwanda 7
Figure 6:Monthly water regime curves for station 70007 (Mwaka-Upper Nyabarongo) 9
Figure 7: Annual water allocation per water use sector, baseline scenario (source: WEAP model, WRMD, 2018).. 11
Figure 8: Turbidity and Total Suspended Solids (TSS) measurements in the catchment (RNRA-IWRMD, 2017) 15
Figure 9: Upper Nyabarongo catchment, sub-catchments and district boundaries 16
Figure 10: Land Use / Land Cover map (LULC) (W4GR 2018).. 21
Figure 11: DPSIR framework explained 23
Figure 12: Baseline / projections of met and unmet water demand (water shortage) up to 2050, BaU (W4GR, 2017)... 31
Figure 13: Met and unmet demand under BaU and different promising alternatives by the year 2050 32
Figure 14: CROM map - indicating soil erosion risk in upper Nyabarongo catchment 36

Figure 15: Map indicating the priority subcatchments that will be rehabilitated 37
Figure 16: Water allocation plan for sub-catchments for 2024 47
Figure 17: Map of existing and planned dams in the catchment 48
Figure 18: Catchment Committee Infographic 49
Figure 19: Filtering candidate projects into the programme of measures 2018-2024 and subsequent annual implementation plans 54
Figure 20: DPSIR for Upper Nyabarongo catchment 55
Figure 21: Focused DPSIR analysis for IWRM package 'Catchment restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed (LWAPES)' 59
Figure 22: Focused DPSIR analysis for IWRM package 'Rehabilitation and protection of Kiryango watersheds for sustainable agriculture exploitation' 60
Figure 23: Focused DPSIR analysis for IWRM package 'Catchment restoration and protection of water bodies in Mwogo watershed (LAPROM)' 61
Figure 24: Focused DPSIR analysis for IWRM package 'Catchment restoration supporting sustainable and efficient investments in agribusiness, mining and hydropower generation in the most degraded areas of Upper Nyabarongo' 62
Figure 25: Theme and criteria weights (example with equal weights for themes and for criteria within themes) 63
Figure 26: Water for Growth Rwanda programme components 82
Figure 27: Demonstration catchments of Water for Growth Rwanda 83
Figure 28: The DPSIR framework visualised 85
Figure 29: The water-energy-food security nexus 88
Figure 30: Upper Nyabarongo catchment elevation, waterways, and sub-catchments 90
Figure 31: Soil types in Upper Nyabarongo catchment 91
Figure 32: Geology of Upper Nyabarongo catchment 92
Figure 33: Sub-catchments map 93
Figure 34: Upper Nyabarongo catchment population density and key-infrastructure 94
Figure 35: Land Use / Land Cover map (LULC) (W4GR 2018) 95
Figure 36: Key geographic features of the Nyabarongo Upper sub-catchment 96
Figure 37: Key geographic features of the Mbirurume sub-catchment 97
Figure 38: Key geographic features of the Satinsyi sub-catchment 98
Figure 39: Key geographic features of the Nyabarongo Hydropower sub-catchment 99
Figure 40: Key geographic features of the Mwogo sub-catchment 100
Figure 41: Infrastructure projects classified (IP/CPIP) 101
Figure 42: Key interventions in Mbirurume sub-catchment (interventions included only where spatial scope is known) 102
Figure 43: Key interventions in Nyabarongo Hydropower sub-catchment (interventions included only where spatial scope is known) 103
Figure 44: Key interventions in Nyabarongo Upper sub-catchment (interventions included only where spatial scope is known) 104
Figure 45: Key interventions in Satinsyi sub-catchment (interventions included only where spatial scope is known) 105
Figure 46: Key interventions in Mwogo sub-catchment (interventions included only where spatial scope is known) 106
Figure 47: Key Overview of IWRM packages in the catchment, developed in February 2018 107
Figure 48: Water Users Survey – Water treatment plants in Upper Nyabarongo catchment 108
Figure 49: Water Users Survey – Hydro power plant sites in Upper Nyabarongo catchment (existing and potential) 109
Figure 50: Water Users Survey – Mines in Upper Nyabarongo catchment 110
Figure 51: Water Users Survey – Industries in Upper Nyabarongo catchment 110
Figure 52: Overall CP alignment to NST1 116

Figure 53: NST1 alignment with Catchment Plan based on NST1 Outcomes per Priority Area................ 117
Figure 54: Draft SSP alignment overview 119
Figure 55: Alignment CP – PSD SSP 119
Figure 56: Alignment CP – Agriculture SSP.. 121
Figure 57: Alignment CP – ENR SSP 122
Figure 58: Alignment CP – Forestry SSP 124
Figure 59: Coherence between district, forestry, and catchment planning (DDP, DLRP, DFMP, and CP) . 124
Figure 60: Alignment CP – Governance and Decentralisation SSP.. 125
Figure 61: Alignment CP – Energy SSP... 127
Figure 62: Alignment CP – Urbanisation and Rural Settlements.. 128
Figure 63: Alignment CP – WATSAN SSP 129
Figure 64: Alignment CP – Health SSP 130
Figure 65: Added value of SEA to the catchment planning process, through information, process, and procedure 166
Figure 66: Approach to comparison of alternative future scenarios, based on modelling past, present, and future.. 172
Figure 67: Development framework for catchment plan Programme of Measures................................ 175
Figure 68: Interlinkages between SDG 6 and other SDGs 189
Figure 69: Target areas of SDG 6 and SDG 11.5 (for water related disasters) 190
Figure 70: Monitoring of SDG 6.5 – Target and indicators... 191
Figure 71: Creating value through catchment planning.. 192
Figure 72: Total annual water demand (met/unmet) baseline and projections...................................... 196
Figure 73: Total annual water demand in Upper Nyabarongo by 2050 (met and unmet) under different alternatives... 196
Figure 74: Water demand Upper Nyabarongo (monthly) – Baseline.. 197
Figure 75: Water demand Upper Nyabarongo (monthly) – Future 2024 197
Figure 76: Water demand Upper Nyabarongo (monthly) – 2024+IncrSt+SLM+eFF 198
Figure 77: Natural Capital: Stocks, Flows and Value 250
Figure 78: Natural Capital Model 251
Figure 79:CROM DSS flow chart (W4GR, 2018).. 266
Figure 80: Soil Erosion Risks according to the Revised Universal Soil Loss Estimation model (RUSLE) 269
Figure 81: Map 5 – Priority areas for catchment restoration 270
Figure 82 Role player and stakeholder definition.. 276
Figure 83 Problem tree – an approach used to identify Issues, Causes and Effects 278

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 (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 Research Centra
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
WWF	World Wildlife Fund for nature

Executive Summary

Introduction

Catchment plan is the international best practice approach for integrated water resources management (IWRM) and for management of related land and natural resources. Catchment management is based on hydrological boundaries, i.e. water flows, and a catchment is an area of land where precipitation falls, collects and drains off into a single common point, such as a river, lake, or other body of water. A catchment 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, etc., and these are all also affected by and have an impact on water resources within the catchment area. The strong relationships between land, water, people (stakeholders) and the economy within a catchment, call for an integrated management thereof.

Upper Nyabarongo Catchment plan was developed by taking into consideration national orientation as articulated in its Vision 2020, Vision 2050, the National Strategy for Transformation (NST1) and the nation's Green Growth and Climate Resilience Strategy (GGCRS).
It was developed in a highly participatory manner, centrally, the Water Resources Management Department (WRMD) of Rwanda Water and Forestry Authority (RWFA) designated as lead agency, and partner ministries were represented through Programme Steering Committee (PSC) and in a 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 Environmental 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.

The CTF core team was supported by a Catchment Officer from RWFA/WRMD and a Programme Officer from Water for Growth Rwanda (W4GR), the Netherlands' funded IWRM Programme Rwanda. At district level, members of the CTF assumed a coordination role, collaborating with local implementing partners and stakeholders. 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.

Upper nyabarongo 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.

Integrated situation analysis

Upper Nyabarongo catchment is within the Nile basin and runs south to north in the western part of Rwanda. It has a total surface area is 3,348 km², representing 12.7 % of the total surface area of Rwanda (26,338 km²). The Nyabarongo rivers starts from the confluence of the Mwogo and Mbirurume Rivers and runs to the confluence with the Mukungwa River from where it continues as the Lower Nyabarongo on its way to the Akagera River and Lake Victoria. The catchment is renowned as Rwanda's 'water tower' and has a significant number of large tributaries, such as the Mwogo, Rukarara, Mbirurume River, Munzanga and Satinsyi Rivers. A significant portion of the catchment in the west is at high altitude, above 2,000 m and has steep slopes; the highest point is 2,950 m.

Catchment soils can be classified into four main categories with a mixture of Nitisols, Acrisols, Alisols and Lixisols dominating in all sub-catchments. Cambisols are dominant in western areas and Ferralsols occur throughout but mostly in the western part. Mineral soils, conditioned by flat topography, are mostly present in Mwogo sub-catchment.

The rainfall pattern shows high annual rainfall (=>1,200 mm/year). There is a relatively short dry season, 'long rains' during the months of March, April and May, and 'short rains' during the months of September, October, November and December. Evaporation data are quite constant throughout the year but peak somewhat during the dry season months (June - September); during these months the climatic water balance is negative.

The catchment is sub-divided into a granite basement aquifer in the west, with a low water storage capacity, and quartzite and shale/schist aquifer in the central areas, with intermediate water storage and recharge conditions. Along the Nyabarongo River itself, there is an alluvial aquifer composed of river sediments in the alluvial plain; this has excellent storage capacity and is of local importance, both for groundwater storage and abstraction schemes. There is a sustained flow during the dry season months (July and August) and a moderate hydrological response, i.e. receding flows prior to the rainy season. The long rains result in a robust increase of monthly flow levels, indicating that groundwater reserves are replenished at this time as this kind of hydrological response is typically caused by significant infiltration to, and storage in, groundwater along the Nyabarongo River and its tributaries.

Water quality is monitored in Rukarara, Mbirurume and Mwogo sub-catchments and at the outlet of the catchment at Mwaka. Monitoring has also been conducted upstream of the intakes of the Gihira water treatment plant. Results show very high sediment loads and turbidity, due to mining and to traditional farming methods, high levels of *E. coli* and coliform bacteria, from untreated sewage, and high organic loads with high biological and chemical oxygen demands (BOD/COD) and resulting low concentrations of oxygen (mg/L).

A basic analysis of the catchment-wide green and blue water balances reveals that 51% of water that enters the catchment is used by vegetation, 13% enters the groundwater and 36% leaves the catchment to the downstream areas, providing a total of 1,488 MCM/Y of which less than 0.5 % is abstracted. The areas downstream of the catchment, such as Kigali, benefit from the Upper Nyabarongo catchment as a whole and with Kigali's water supply depending to a large extent on abstraction from the Lower Nyabarongo sub-catchment.

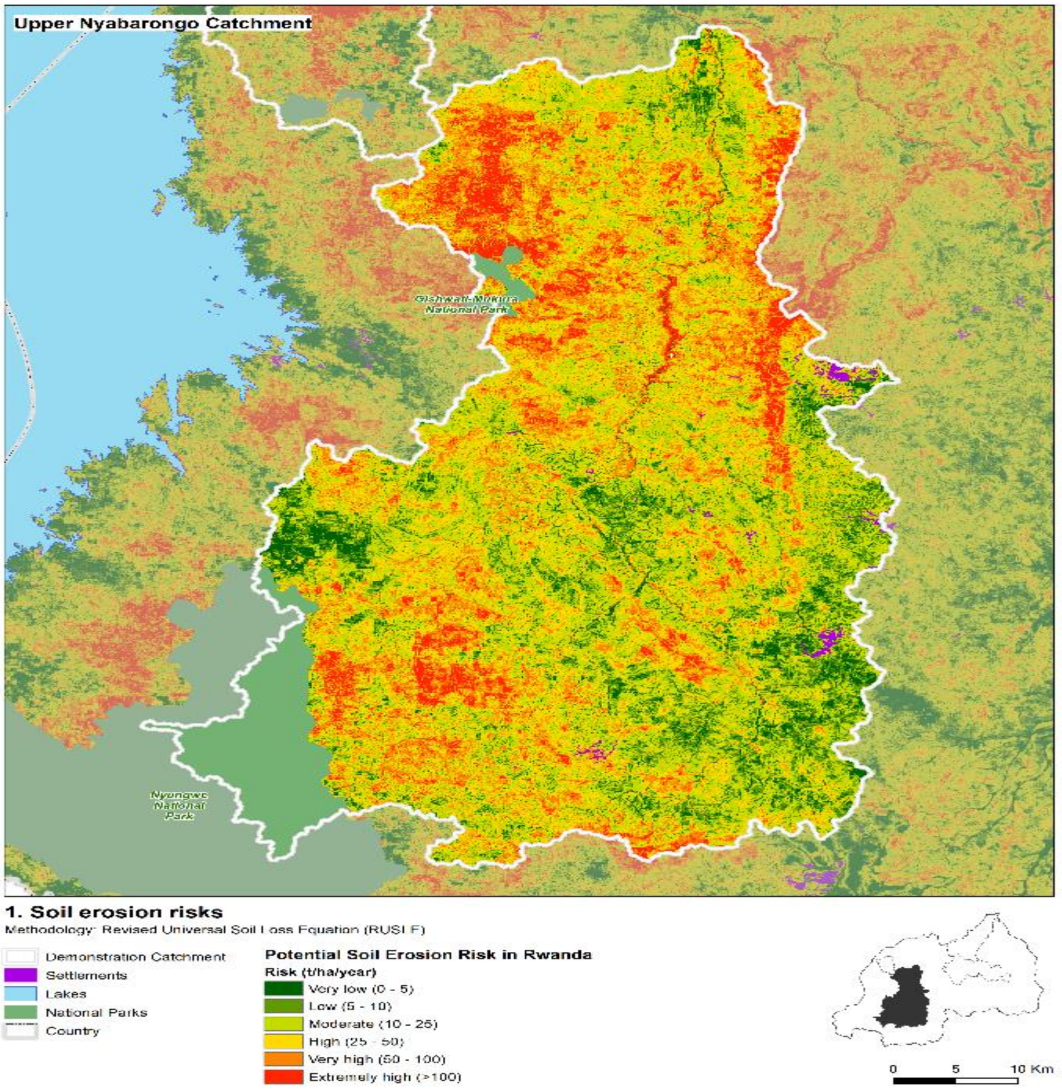


Figure 1: Upper Nyabarongo catchment soil erosion status with its drainage network

The Upper Nyabarongo catchment is strongly reliant on rainfed agriculture and produces traditional cash crops like coffee and tea, along with new ones, like honey and horticulture. Main food crops growing in the area are maize, beans, 'Irish' potato, wheat, cassava, banana, fruits and rice. Approximately 70% of households are also engaged in livestock rearing with the most commonly owned species being cattle, goats, pigs, rabbits and chickens. Fish farming is already practiced in Huye and Nyanza Districts and there is a move to increase productivity in this sector through construction of dams and fish ponds. Agroforestry and forest plantations have been promoted as appropriate land use management systems in the catchment. Mining and quarrying for and of granite, tin, wolfram, colombo-tentalite (*coltan*) and cassiterite are important sources of revenue and employment. In Rutsiro, Ngororero, Nyamagabe, Muhanga, Karongi and in the Nyungwe forest. Non-regulated artisanal mining is commonly practiced. Other industrial activities include agro-processing of maize, rice, cassava, bananas, fruits, soybean, milk and honey. There are also four tea factories, one coffee factory, a soap industry, a tannery, and ceramics and handicrafts.

Tourism opportunities around the natural forests in Nyungwe, Mukura, Gishwati and Busaga exist, but are still largely under exploited.

The total number of people who live within the catchment is around 1.2 million inhabitants (7% urban, 93% rural). The population density in the catchment is high, with the highest density areas in Muhanga and Nyamagabe and Huye (900 – 1,500 inhabitants/km^2). Another densely populated area is Ngororero (600 – 900 inhabitants/km^2). The population is generally very young with over 40% <15 years-old, and almost 52% of the population <20 (EICV4). The total female population exceeds the male population by about 10%.

Poverty rates within the catchment area are still very high, with approximately 41 % classified as poor and 16% as extremely poor. Nyamagabe, Karongi, Rutsiro, Ngororero and Ruhango have the highest poverty rates with Nyamagabe's the highest in Rwanda (EICV4). The cause of poverty has often been 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, and 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.

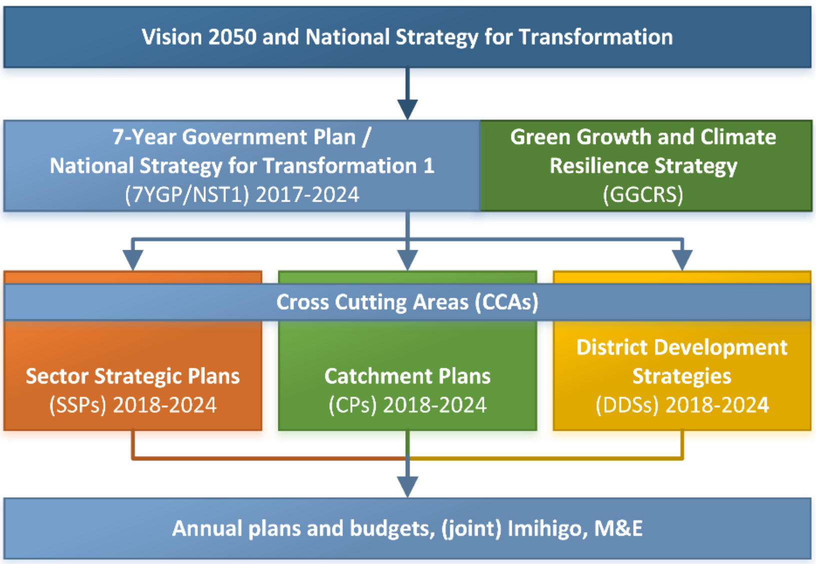


Figure 2: Consistency alignment of upper nyabarongo catchment plan with other national plans

Main issues of Upper Nyabarongo catchment

The main sources of pollution of surface water are from soil erosion of hillside agriculture, resulting in high to extremely high river sediment loads and inappropriate mining. The former has an adverse impact on, 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. The floods are recurrent in Upper Nyabarongo catchment specifically in Mwogo, Kiryango sub catchments. Deforestation is also a threat in Upper Nyabarongo catchment as it reduces soil cover and increases siltation of rivers. Inappropriate settlement leads to generation of liquid and solid waste water without any prior treatment.

Main opportunities in Upper Nyabarongo catchment

Upper Nyabarongo catchment has abundant water resources due to intense rainfall. It has various opportunities that include:

- **Water availability**
- **Reforestation**
- **Implementation of soil conservation projects**
- **Mineral resources**

Catchment vision and objectives

A catchment vision, as well as an overall, 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 Upper Nyabarongo was agreed as:

'A well-managed catchment that is home to prosperous communities living in harmony with their environment and drawing social and economic benefits from sustainable ecosystem services.'

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 Upper Nyabarongo catchment areas are the following:

1. Improve water quality and quantity in water bodies taking into account resilience 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 rural and urban users of current and future generations; **c Objective 3: Ensure equitable and efficient allocation of water resources to all users within the catchment**

4: Strengthen the water governance framework to ensure effective implementation of integrated programmes;

Programme of measures

A coherent Programme of Measures (PoM) was developed for the Upper Nyabarongo catchment plan, primarily for the implementation period 2018-2024.The main focus of the Upper Nyabarongo 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, and 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 **55000 ha** in Upper Nyabarongo catchment will be rehabilitated in the short run.

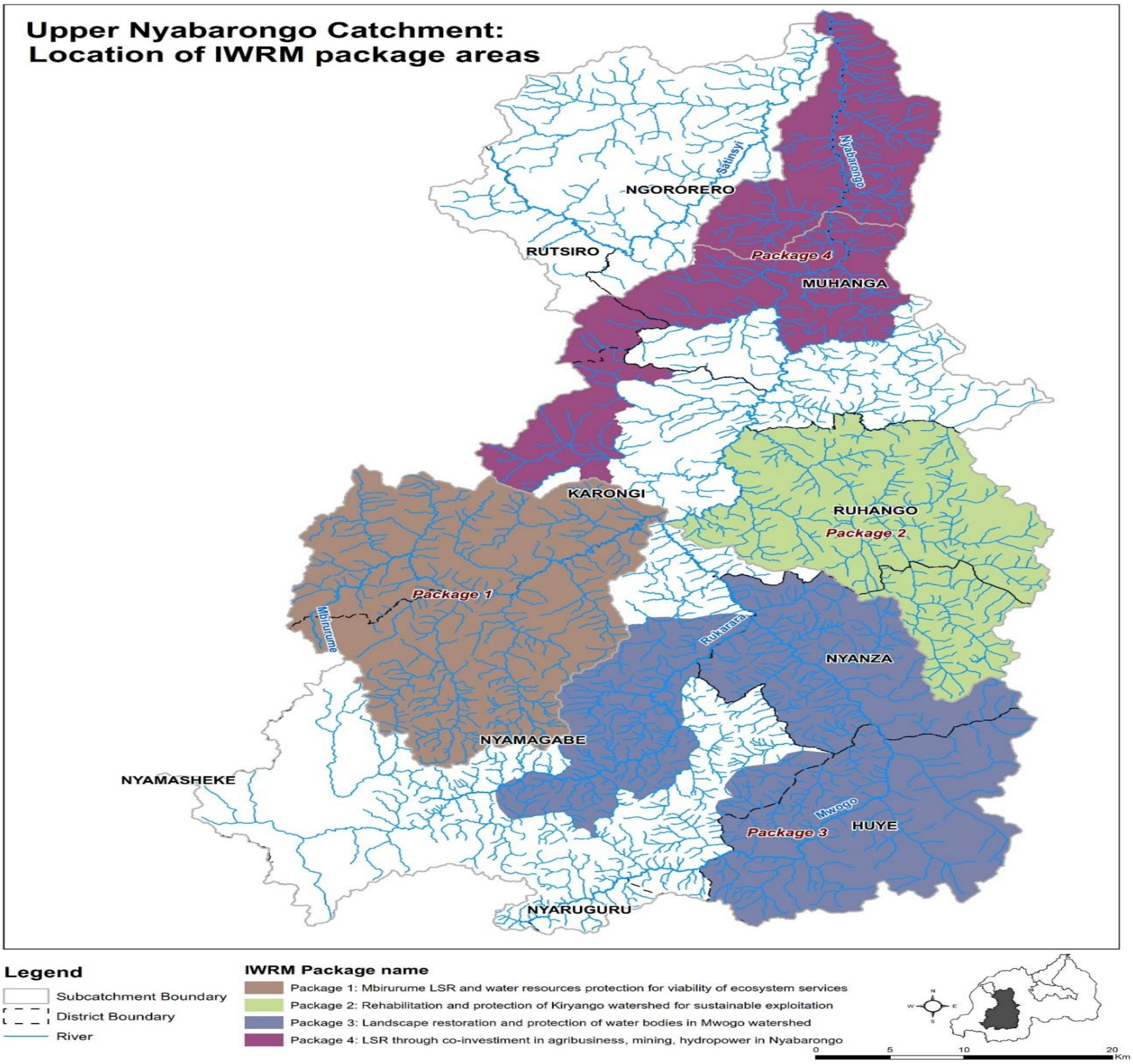


Figure 3: Landscape restoration priority sub-catchments

Table 5: The matrix of soil erosion control measures

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.	**Moderate 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**

This matrix was developed to guide the implementation of landscape restoration. The selection of measure (radical or progressive terraces etc) to use depends on the slope and the soil depth of the site to be rehabilitated.

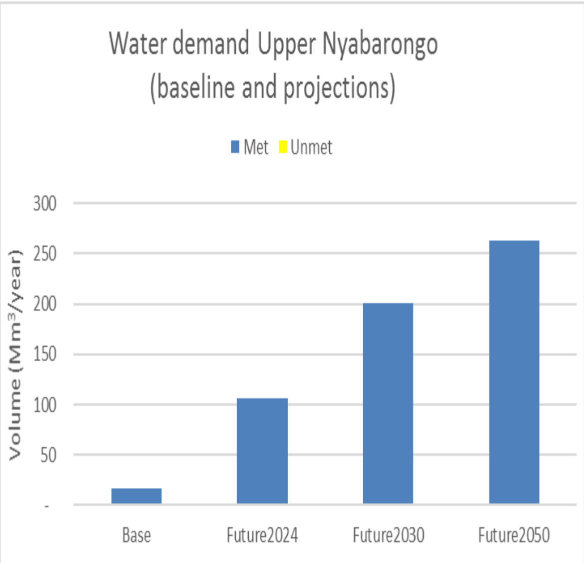
- **Water allocation**

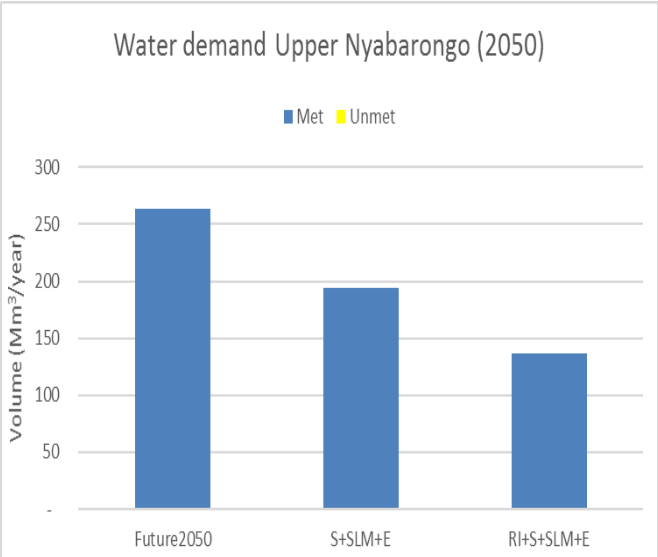
This refers to water demand and management measures that may need to be implemented to ensure that the amount of water available in the catchment, both now and in the future, meets and will continue to meet demands for it from a range of sectors, e.g. agriculture, industry, public water supply etc. The 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].

Under this aspect, the following activities will be implemented:

- To record all water users in upper nyabarongo catchment and issue water use permits
- To enforce the alternative of reducing irrigation schemes, promote water storage and soil management practices





[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.

Figure 4: Total annual water demand (met/unmet) projections and total annual water demand by 2050 under different alternatives in upper nyabarongo catchment

-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 defined area, usually sub-catchment, that were in-tune with the catchment plan's preferred water allocation alternative. In Upper Nyabarongo, IWRM packages were developed for four areas within the catchment, and around the themes of catchment restoration, agribusiness and sustainable agriculture, mining and hydropower.

The four IWRM packages for Upper Nyabarongo are as follows:

1. Catchment restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed (LWAPES);
2. Rehabilitation and protection of Kiryango catchments for sustainable agriculture exploitation;
3. Catchment restoration and protection of waterbodies in Mwogo watershed (LAPROM);
4. Catchment restoration supporting sustainable and efficient investments in agribusiness, mining and hydropower generation in the most degraded areas of Upper Nyabarongo.

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

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 Upper Nyabarongo 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

Iri buriro

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 Sebeya rwakozwe rishingiye kuri gahunda ya 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. Za minisiteri zitandukanye zifite aho zihuriye n'imicungire n'imikoreshereze y'umutungo 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, abacukuzi, 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 Nyabarongo ya ruguru.

Bitewe nuko ari ubwa mbere hagiyeho igenamigambi ry'imicungire y'icyogogo cya Nyabarongo ya ruguru, iri genamigambi rishyira imbaraga mu gukemura ku ikubitiro ibibazo byo kubungabunga umutungo kamere w'amazi aribyo gusubiranya icyogogo harwanywa isuri, kungera 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 Sebeya ryaritaye ku gukora isuzuma ry'ingamba zo kurengera ibidukikije, inama cyatanze zagendewo mu kunoza iri genamigambi. Iri genamigambi ry'icyogogo cya Nyabarongo 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 Nyabarongo ya ruguru

Icyogogo cya nyabarongo ya ruguru kibarizwa ku rwego rwa mbere rw'ibyogogo, kikaba giherereye mu cyogogo kinini cya Nili. Nyabarongo itemba iva mumagepfo ijya muma jyaruguru y'Urwanda. Ifite ubuso bungana $Km^2$3348 buhwanye na 12.7 bw'ubuso bw'igihugu cyose (Km^2 26368). Umugezi wa nyabarongo utangirira kwisangano ry' umugezi wa mwogo na mbirurume ugatemba ugana kwisangano ryumugezi wa mukungwa aho nyabarongo aho icyogogo cya nyabarongo y'epfo itangirira igakomeza mumagepfo y'uburasira xuba bw'Urwanda bigahura n umugezi w akanyaru bikabyara akagera kakiroha mu kiyaga ca Vigitoria. Iki cyogogo ni ikigega cy amazi y'igihugu. Imigezi icyisukamo yingenzi ni Mwogo, Rukarara, Mbirurume, kiryango and satinsyi. Igice kinini cy'icyogogo cya nyabarongo gituruka ku butumburuke bwa m 2000 muburengerazuba bw'igihugu mu misozi ihanamye umusozi muremure uri kubumburuke bwa m 2950 hejuru y'inyanja.

Ubutaka buboneka mu cyogogo cya nyabarongo bwiganje mubice bine byingenzi birimo: Nitisols, Acrisols, Alisols na Lixisols byiganje mu byogogo bito. Cambisols na Ferralsols nibwo bwiganjye mu gice cy'iburasirazuba. Icyogogo gito cya Mwogo gifite Ubutaka bushashe bukungahaye ku myunyu ngugu.

Impuzandengo y'imvura igwa nyinshi iboneka ku mwaka ni mm 1,200. Imvura nke igaragara mu Igihe cy' urugaryi, imvura nyinshi mu mezi ya werurwe, mata na gicurasi, umuhindoo uboneka mu mezi ya Nzeri, Ukwakira, Ugushyungo n'ukuboza. Igabanuka ry'imvura riri ku gipimo kimwe rikiyongera iyo tugeze mu gihe k'izuba (June-September); muri ayo mezi amazi aragabnuka cyane.

Yogogo cyaNyabarongo kirangwa n'ibidendezi by'ikuzimu biherereye mu bitare bya quartzite na schist / shale, granite na pegmatite. Ibitare bya quartzite na schist bifite ubushobozi buciriritse bwo kubika no guhererekanya amazi, ari nayo mpamvu amazi y'ikuzimu ataba menshi cyane. aho mugezi wa nyabarongo uca hari ibidendezi birimo isayo mu bibaya bikikije umugezi ari nabyo bibika amazi y'ikuzimu akunze gukoreshwa Mu gihe ki izuba. Igihe kirekire cy imvura kizamura ibipimo by' iboneka ry'ayamazi ari nabwo ibidendezi njya kuzimu biherereye mu cyogogo cya nyabarongo ya ruguru byongera kubona amazi binyuze mw'icengera ry' amazi mubutaka.

Isuzuma ry'Ubwiza bw'amazi rigaragarira mu byogogo bito aribyo Rukarara, Mbirurume na Mwogo, naho amazi asohokera mucyogogo I mwaka. Ryanakorewe aho uruganda ruyungurura amazi rwa Gihira rufatira amazi.

Isesengura ku buziranenge bw'amazi rigaragaza ko hari ibitaka byirunda mu migezi bikayangiza bitewe n'ibikorwa by'ubucukuzi bw'amabuye y'agaciro ndetse n'iby'ubuhinzi bidakorwa kinyamwuga. Amazi kandi yangizwa na za mikorobi nka *E. coli* and coliform ndetse n'ibinyabutabire binyuranye bituruka mu myanda bikamara oxygene mu mazi.

Isesengura ry'ibanze ku ngano y'amazi ryerekana ko amazi y'imvura angana na 51% akoreshwa n'ibimera (ibihingwa, amashyamba n'ibyatsi), cyangwa agakama. Amazi y'imvura angana na 13% yinjira mucyogogo, 36% asohokera mumanjyepfo y' icyogogo, icyogogo cya nyabarongo ya ruguru gifitiye akamaro ibice bigikikije byiganjemo umugi wa Kigali.

Umusaruro ukomoka kubuhinzi mu cyogogo cya nyabarongo ya ruguru ahanini ugengwa nimvura yaguye, ibihingwa mbatura bukungu bihaboneka n' ikawa, icyayi, ubuki n' imboga. Ibihingwa bisanzwe Bihera ni ibishyimbo, ibigori, ibirayi, ingano, imyumbati, urutoki, umuceli, imboga n'imbuto. 70% by' abaturage batuye icyogogo ni aborozi b' inka' ihene, ingurube, inkwavu n' inkoko. Ubworozi bw'amafi buboneka mu turere twa nyanza na huye, mu rwogo rwo kongera umusaruro w'ibikomoka ku mafi hari kubakwa ibizenga byo kororerwamo amafi. Amashyamba n'ibiti bivangwa n' imyaka byashyizwe imbere nk'uburyo bwo gufata neza ubutaka mucyogogo. Ubukungu n'umurimo bw'icyogogo bishingiye Amabuye y'agaciro na kariyeri za granite, tin, wolfram, Colombo-tentelite (coltan) na gasegereti mu turere twa Rutsiro, Ngororero, Nyamagabe, Muhanga, Karongi no mw'ishyamba rya Nyungwe. Ubucukuzi by'amabuye y'agaciro butari ubunyamwuga nibyo buhiganje. Ibindi Ibikorwa Bihari ni by'inganda zishingiye ku buhinzi (ibigoli, umuceli, imyumbati, urutoki) ni ubworozi (amata n' ubuki). Haboneka inganda enye, urw' ikawa, amasabune, gutunganya impu n' ubukorikori. Ubukerarugendo bugaragara mu mashyamba ya kimeza ya nyunwe na mukura ariko buracyari ku gipimo cyo hasi.

Umubare wabaturage batuye mu cyogogo cya nyabarongo ya ruguru usaga 1, 200,000(7% umugi, 93% icyaro), ubwiyongere bwabaturageburi hejuru muri muhanga, nyamagabe na huye (900 – 1,500 inhabitants/km^2) no muri ngororero (600 – 900 inhabitants/km^2). Abasaga 40% bari hejuru y'imyaka 15 naho 52% Bari munsi y'imyaka 20 (EICV4). Ubwinshi bw' Abagore buruta ubwabagabo 10%.

Mucyogogo cya nyabarongo ya ruguru haracyagaragara ubukene bukiri hejuru aho abasaga 41% bakiri munsi y'umurongo w'ubukene, 16% bari mubu mubukene bukabije. Uturere twa nyamagabe, rutsiro, karongi. Ngororero na ruhango nitwo turangwamo ubukene hejuru mu Rwanda (EICV4) aho akarere ka nyamabe kaza kwisonga. ubukene ahanini buterwa n' ubwiyongere bw' abaturage n' igunduka ry' ubutaka kandi ubukungu bushingiye ahanini kubuhinzi.

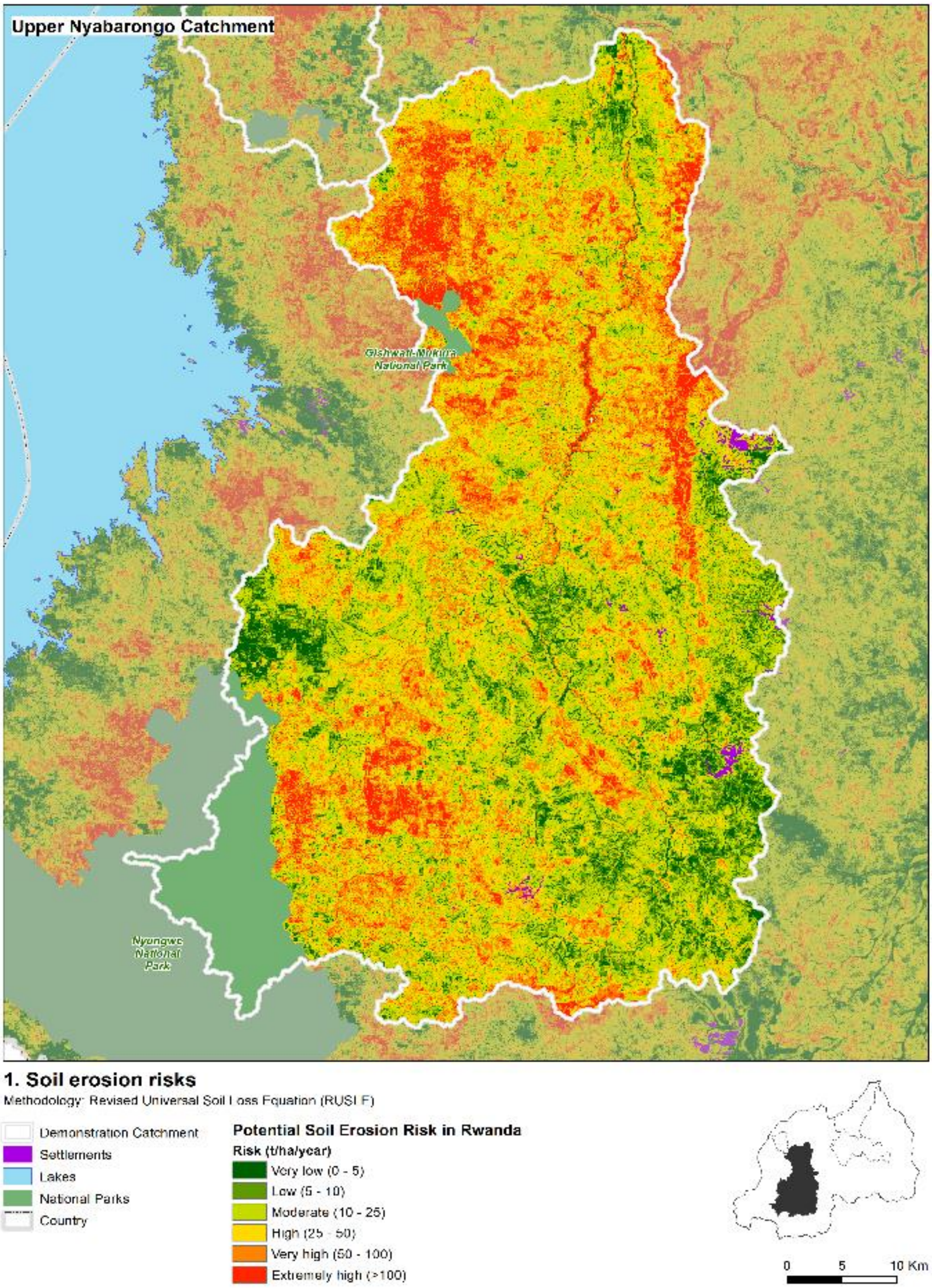


Figure 1: Ikarita igaragaza ahashobora kwibasirwa n'isuri

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

Iri genamigambi ku micungire y'icyogogo cya Nyabarongo ya ruguru 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, imiturire, ubukerarugendo ndetse n'uburinganire. Igenamigambi ry'imicungire y'icyogogo cya Sebeya rihuza igenamigambi ryo ku rwego rw'igihugu n'uturere. Isesengura ryatumye haboneka ibitekerezo byifashishijwe hakorwa iri genamigambi ku micungire y'icyogogo cya Nyabarongo ya ruguru. Kugeza ubu igenamigambi ku micungire y'icyogogo cya Nyabarongo ya ruguru ryagendeweho mu gutegura gahunda z'iterambere (DDSs) z'uturere duhuriye mu cyogogo cya Nyabarongo ya ruguru aritwo Muhanga, Ruhango, Nyanza, Huye, Nyamagabe, Karongi, Rutsiro, na Ngororero.

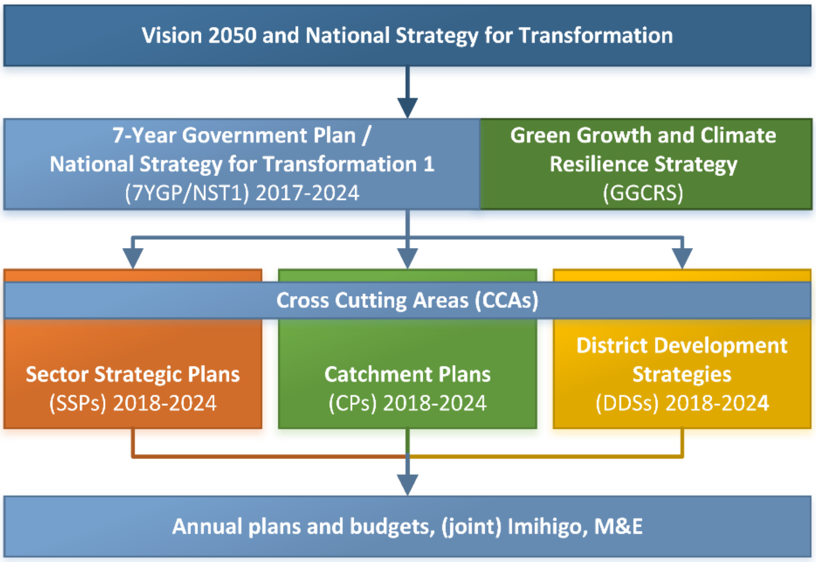


Figure 2: Guhuza itegurwa ry'igenamigambi ry'imicungire y'icyogogo cya Nyabarongo n'izindi gahunda, ingamba na politiki bya Leta bisanzwe

Ibibazo by'ingenzi biri mu cyogogo cya Nyabarongo ya ruguru

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 yiyongera bikazamura igiciro cyo kuyatunganya, ku nganda z'amashyanyarazi n'izitunganya amazi iyo urwondo rwabaye rwinshi biba ngombwa ko zihagarara gukora kugirango bamanze barukuremo.

Ibyondo n'imicanga biva mubirombe by'amabuye y'agaciro cg ibinyabutabire bikoreshwa mu koza amabuye bishobora kwanduza amazi bishyiramo ibinyabitabire bihumanya byangiza ubuzima bw'ubinyweye.

Inyuzure ihora igaruka mu dusantere twa Mahoko na Nyundo; yi myuzure ihungabanya ubukungu isenya ibikorwaremezo, yangiza imyaka, inatwara ubuzima bw'abantu.

Ugusarura amashyamba bitemewe n'ikibazo cyingorabahizi kuko bisiga ubutaka bwambaye ubusa bigatuma isuri igera mu mugezi byoroshye.

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

Amahirwe yingenzi aboneka mu cyogogo cya Nyabarongo ya ruguru

- Kuba hari amazi ahagije agaburira n'ibindi byogogo,
- Kuba hari amashyamba menshi: aya kimeza n'amaterano,
- Kuba hari imishinga myinshi yo kubungabunga ubutaka,
- Hari amabuye y'agaciro

Icyerecyezo nintego zo kubungabunga icyogogo cya Nyabarongo ya ruguru

Icyerecyezo n'intego zihariye zo kubungabunga icyogogo cya Nyabarongo ya ruguru zateguriwe hamwe n'abagize komite yo kubungabunga icyogogo cya Nyabarongo ya ruguru, 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 ziterambere rirambye ,imirongo mpuzamahanga n'amabwiriza yo kubungabunga ibidukikije ku rwego rw'isi.

Icyerecyezo cyo kubungabunga icyogogo cya Nyabarongo ya ruguru

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'uwi bidukikije Bihari.

Intego rusange:

"Umutungo kamere w'Ubutaka, amazi n'undi bifitanye isano bubungabunzwe mu buryo bunoze bigira uruhare rufatika mu kuzamura imibereho myiza, no kongera ubukungu hazirikanwa kandi isaranganywa ry'amazi ry'abatuye ku masoko n'abatuye aho amazi atemba agana, amazi agomba gusigara atemba mu ugezi no kwita kumihindagurikire y'igihe n'ibiza bifitanye isano nabyo.

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

- **Intego yihariye ya 1:** Kongera ingano n'ubwiza bw'amazi mu cyogogo hitawe ku guhangana n'ihindagurika ry'ibihe.
- **Intego yihariye ya 2:** Kugabanya ikoreshwa ry'ibikomoka ku mutungo kamere hahangwa indi mirimo isimbura ikoresha umutungo kamere.
- **Intego yihariye ya 3:** Gusaranganya amazi ahari kubayakoresha mu buryo bungana haba mu byaro no mu migi hazirikanwa n'abazayakoresha mu bihe bizaza.
- **Intego 4**: Guha ingufu inzego n'imiyoborere kugira ngo hashyirwe mu bikorwa programu zikomatanyije mu micungire y'umutungo kamere w'amazi.

Gahunda y'ibyakorwa

Igenamigambi ku ’ibikorwa mu cyogogo cya Nyabarongo ya ruguru yarakozwe kuva 2018 kugeza 2024 Kwikubitiro ibikorwa by’ingenzi byerekeye kubungabunga ubutaka, gusaranganya amazi no kongera ubumenyi.

- Kubungabunga ubutaka

Mu kubungabunga ubutaka turwanya n’isuri mu buryo burabye, hakorwa amaterrasi, amashyamba, n’ibiti bivangwa n’imyaka, gutunganya imikoki no gusubiranya aharimbutse. Hazibandwa mu kurwanya isuri twogera n’umusaruro ku butaka no mwikoreshwa ry’amazi. Mu gufata ingamba ku bikorwa bikenewe bidusaba kureba aho ibikorwa bibera n’amasezerano y’a bafatanya bikorwa.

Mu gufata ibyemezo, twifashishije amakarita yerekana aho ibikorwa bikwiye gushyirwa ndetse n’ubutaka buharanga (CROM-DSS) .Byagaragaye ko muri Nyabarongo ya ruguru ubutaka bwabungabungwa bungana na hegitari 50000.

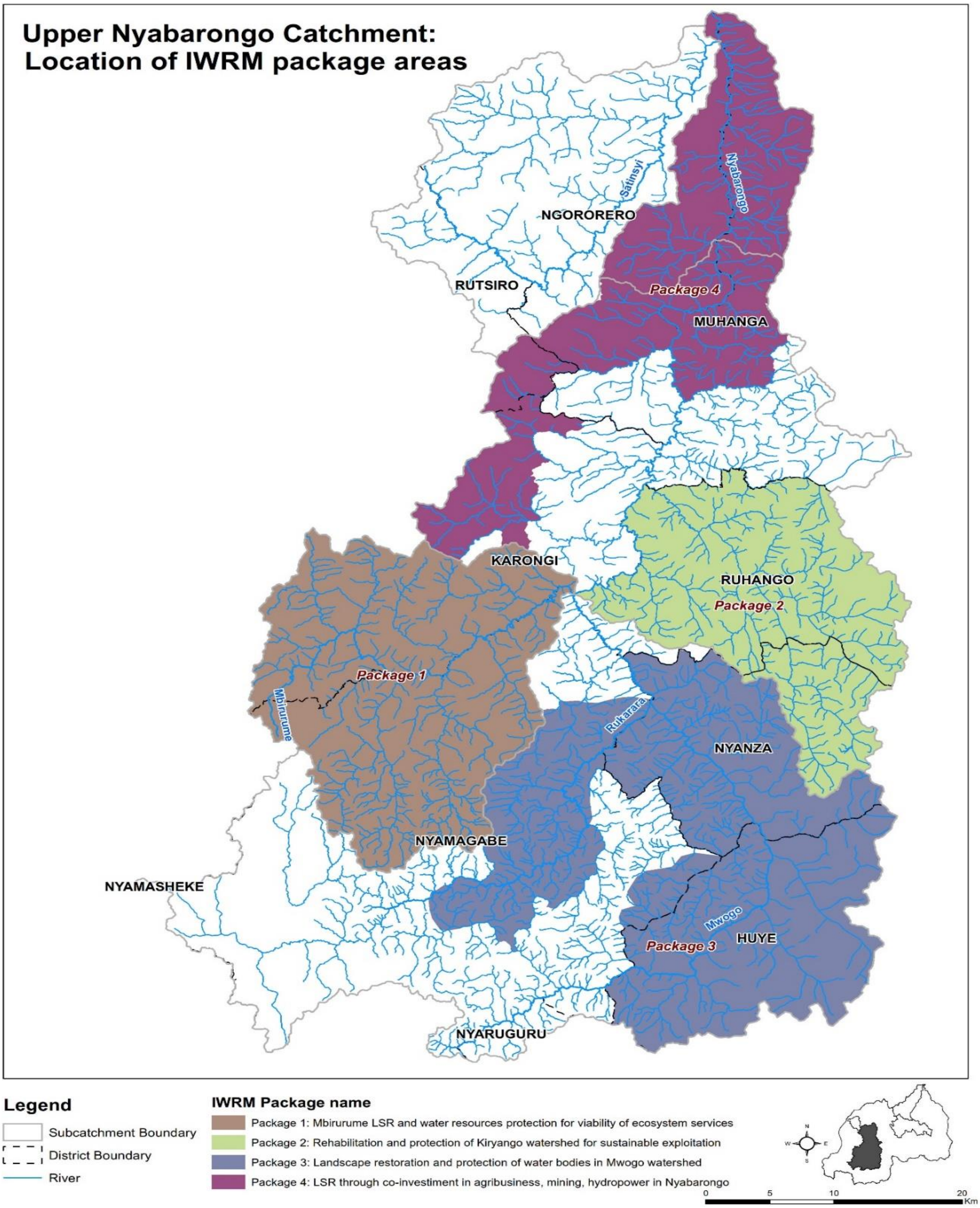


Figure 3: Ibyogogo bizaherwaho mu kubungabunga ubutaka

Table 3: Imbonerahamwe y'ingamba zo kurwanya isuri

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.	**Moderate 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**

- Gusaranganya Amazi

Ibi bireba ingamba zafatwa mu gusaranganya amazi mu buryo burambye muri iki gihe no bihe biri imbere haba mwikoresha ry'amazi mu buhinzi, mu mikoreshereze y'amazi y'ukunywa, mu nganda n'ibindi.
Amwe mu mahitamo y'imikoreshereze myiza yo kuhira, gukoresha ubutaka neza n'amazi mu buryo bunoze (RI+SLM+E) byashyizwe mw'igenamigambi mw'isaranganya ry'amazi mu cyogogo ku kwezi, ku bakoresha amazi kugeza icyerekezo cya 2024, 2030,2050. Icyo cyerekezo cy'igenamigambi mu gusaranganya amazi cyabaye imbarutso yo gushyiraho impushya zo gutanga amazi n'imikoreshereze y'umutungo kamere w'amazi hitabwa kubikenewe kurusha ibindi: Gukoresha amazi mu ngo, ubworozi, amazi ku binyabuzima, mu nganda no mu kuhira.

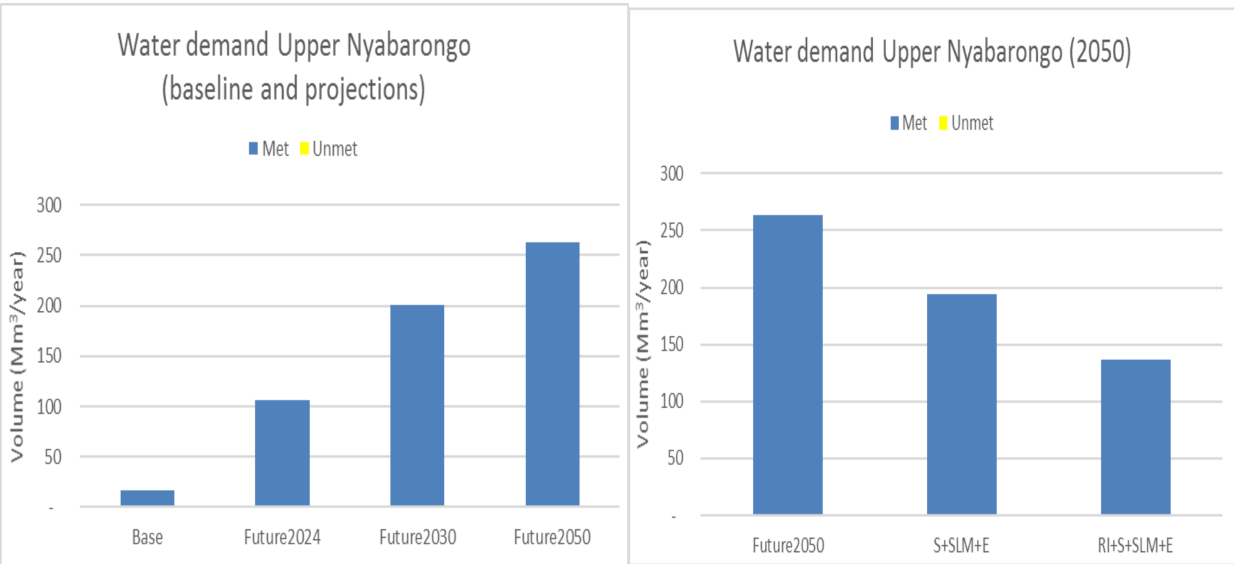


Figure 4: Ingano y'amazi azakenerwa ku mwaka uhereye mu mwaka wa 2024 kugeza mu mwaka wa 2050 mu cyogogo cya Nyabarongo

- Imiyoborere y'ikoreshwa ry'amazi

Iyo miyoborere ireba inzego, politiki, n'amategeko akurikizwa mw'ishyirwa 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'umutungo kamere w'amazi riteganya ishyirwaho rya komite y'icyogogo rishimangirwa iteka rya Minisitiri risobanura uko rkayishyirwa mu bikorwa.

- Ubushakashatsi n'amahugurwa

Ubwo bushakashatsi bureba ingamba zo kubika no gukoresha amakuru ku mibare n'ubumenyi bw'amazi hiyongereye ho ubumenyi n'ubuhanga bwo kubungabunga umutungo kamere w'Amazi. Kubera igenamigambi ryo kubungabunga icyogogo, ubumenyi byo gukoresha amakarita ngaragaza shusho n'ikoreshwa ryayo n'inzego zifata ibyemezo. Ibyo bizatuma kubungabunga icyogogo bikorwa mu buryo bukomatanije. Nicyo gituma imbumbe y' imishinga yashyizwe hamwe haherewe ku ngamba zihamwe z'icyogogo mu duce twibanze. Mu cyogogo cya Nyabarongo ya ruguru, imishinga ine yatoranijwe haherewe mu kurwanya isuri, ubuhinzi burambye kandi bubyara umusaruro, gucukura amabuye y'agaciro bya kinyamwuga n'ingomero z'amashanyarazi.
Iyo mbumbe y'mishinga ine ni:

- Kubungabunga icyogogo gito cya Mbirurume mu kurwanya isuri no kubungabunga urusobe rw'ibinyabuzima
- Kubungabunga icyogogo gito cya Kiryango hibanzwe ku buhinzi burabye butanga umusaruro.
- Kubungabunga icyogogo gito cya Mwogo n'ibizenga byacyo.
- Kubungabunga icyogogo hibanzwe ku ishoramari rigamije ubuhinzi bubyara inyungu, amabuye y'agaciro n'ingomero z' amashanyarazi mu duce twangiritse tw'icyogogo cya Nyabarongo ya ruguru.

Igenamigambi ry'iyo mishanga ryibanze no ku buringanire n'impinduka z'ibihe kugirango bimwe mu bibazo byi ingutu birebana nimicungire y'umutungo kamere yamazi bibonerwe ibisubizo birambye.

Ishyirwa mu bikorwa ry'igenamigambi

Irigena migambi ry'icyogogo n' igikorwa gihuriweho n'abafatanya bikorwa benshi, kuburyo buri buriwese agiramo inyungu n' igihe ntarengwa cyo gushyira mubikorwa iyo migambi.

Igenamigambi rikaba ariryo tangiriro ihuza abafatanya bikorwa batandukanye muburyo bwo kugena uburyo iyo migambi izashyirwa mubukorwa. Gushyira mubikorwa igena migambi bizajya bikorwa burimwaka, kuburyo bujyanye n'agahunda y'aburimwaka. Imbanziriza nyigo y'imishinga igendanye n'imikoreshereze n'imicungire y'umutungo kamere w'amazi yarangije gukorwa.

Inkunga ikenewe mugushyira mubikorwa iri gena migambi ryo kubungabunga icyogogo yose izishingirwa na Guverinoma y'URwanda ifatanyije n'abandi bafatanya bikorwa bayo batandukanye.Abo bafatanya bikorwa batandukanye bahuriye mw'ishyirwa mubikorwa ry'igena migambi ry'icyogogo, baba abikorera kugiti cyabo cyangwa amashyirahamwe bafite uruhare rugarara mugushyira mubikorwa iri gena migambi, hakenewe Guhuriza hamwe ibikorwa kurwego rw'akarere no mu cyogogo murwego rwo gukurikirana imigendekere myiza y'umushinga n'ishyirwa mubikorwa ry'igenamigambi ryo kubunga bunga icyogogo cyane cyane ku mishanga ifite aho ihuriye n'imikoreshereze y'umutungo kamere w'amazi, ubutaka n'undi mutungo kamere.

Ingigo yo kubunga bunga icyogogo cya Nyabarongo ya ruguru yerekana ingaruka nziza zo kubunga bunga umutungo kamere w'amazi mucyogogo cyose, kubidukikije, ndetse n'abantubose bafite aho bahuriye nacyo.

Ni muri urwo rwego ikiciro cyambere cyo gushyira mubikorwa igenamigambi ryo kubunga bunga icyogogo mu Rwanda, riza zana ingaruka nziza rika natwigisha uburyo twakemura ibibazo bigaragara mucyogogo. Ubumenyi butandukanye tuzavana mw'ishyirwa mubikorwa ry'irigenamigambi buzadufasha gutegura neza no gushyira mubikorwa irindi gena migambi ryo kubunga bunga icyogogo rya 2024-2031-2038.

Uburyo bwo gushyira mubikorwa, gukurikirana no gusuzuma igenamigambi

Gahunda yo gushyira mubikorwa, gusuzuma no gukurikirana igena migambi ryo kubunga bunga icyogogo zahujwe na gahunda ya Guverinoma y'imyaka 7 y'imbatura bukungu, muri za minisiteri zitandukanye n'imihigo y'uturere.

Uruhererekane rw'ibikorwa ku rwego rw'akarere ruzajya rushyirwa mubikorwa mugice cy'icyogogo gaherereyemo, nyuma bikazajya bihurizwa hamwe ku rwego rw'igihugu, kugirango hagaragazwe uruhare rw'igenamigambi mukubunga bunga icyogogo mw'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.

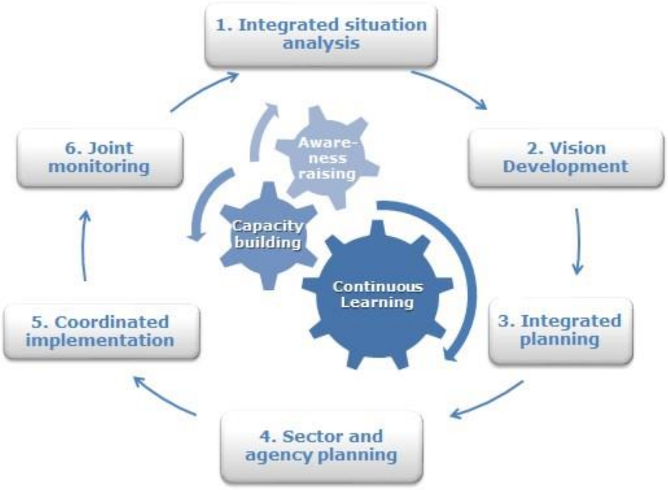


Figure 1:The IWRM and catchment planning cycle

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 **Error! Reference source not found.** above. The I WRM 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 **Error! Reference source not found.**. 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 the law, 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 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:

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

[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.

- 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.

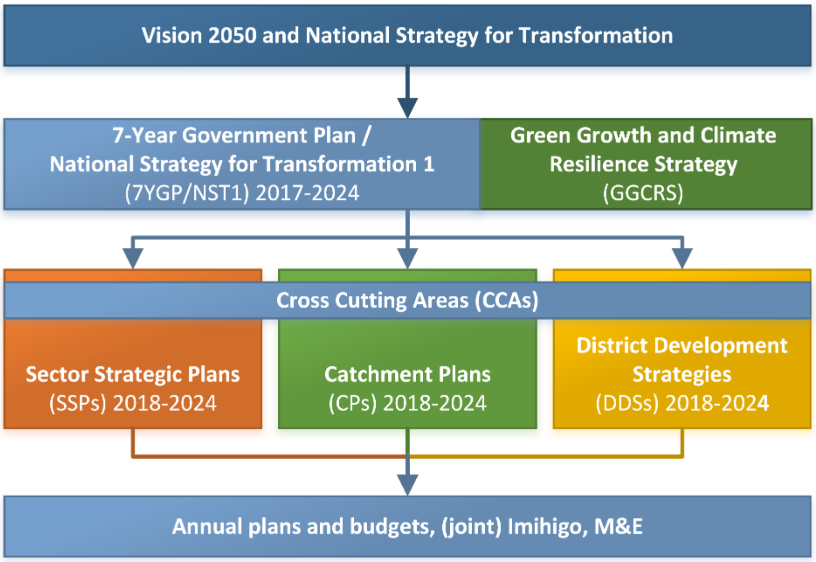

Figure 2:Embedding of CPs in NST framework

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 (**Error! Reference source not found.**). Step 4 (sector and agency planning) refers to mandated entities, p reparing 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 0). 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.

1.4 Plan structure

The structure of this catchment plan generally follows the steps of the IWRM cycle in **Error! Reference s ource not found.**. Chapter 0Is 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 0(Vision and objectives). The integrated plan follows in the form of Chapter 0(Programme of Measures). Sector and agency planning, as well as coordinated implementation, are the topic of Chapter 0(Implementation arrangements). Stipulations for joint monitoring are laid down in Chapter 0(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).

2. Integrated situation analysis

2.1. Catchment characteristics

2.1.1. Physiography

Upper Nyabarongo is part of the Nile basin and runs from south to north in the western part of Rwanda. The total surface area is 3,348 km, which represents 12.7 % of the total surface area of Rwanda (26,338 km^2 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.

2.1.2. Rivers and elevation

The Upper Nyabarongo springs from the confluence of the Mwogo and Mbirurume rivers and runs to the confluence with the Mukungwa River from where the Nyabarongo continues as the Lower Nyabarongo on its way to the Akagera River and Lake Victoria. The catchment is also reputed to be the water tower of Rwanda and boosts a significant number of tributaries, of which the most important are from south to north:

- Mwogo River with a length of 81.1 km;
- Rukarara River (length of 47.4 km) springing from the Rubyiro and the Nyarubugoyi rivers;
- Mbirurume River (51.6 km);
- Mashyiga River (12.2 km);
- Kiryango River (10.4 km);
- Munzanga River (24.4 km);
- Miguramo River (15.0 km);
- Satinsyi River (59.7 km).

The land morphology of a catchment is a crucial characteristic that determines a significant part of its hydrological response to rainfall. A significant portion of the area (particularly in the west of the catchment) is of high altitude (above 2000 m) with steep slopes, peaking at 2950 m. **Error! Reference source not found.** (also included in Annex 3) shows Upper Nyabarongo's hydrology and elevation. The outflow of the catchment is at 1410 masl altitude, at the confluence of the Upper Nyabarongo and the Mukungwa Rivers.

2.1.3. Geology, soils and ecology

The catchment watershed is sub-divided into the granite basement aquifer (Nile-Congo watershed in the West), with a low water storage capacity, and the quartzite and shale/schist aquifer in the central part with intermediate water storage and recharge conditions. Along the River Nyabarongo itself an alluvial aquifer is distinguished that is composed of the river sediments in the alluvial plain. The alluvial aquifer has excellent storage capacity (> 25 %) and can be of local importance for groundwater storage and abstraction schemes.

The dominant soils can be classified into four categories. A mixture of Nitisols, Acrisols, Alisols and Lixisols is predominant in the major parts of all sub-catchments. Cambisols are dominant in the western part of the catchment. Ferralsols occur throughout the entire catchment, but mostly in the western part of the hydropower sub-catchment. Mineral soils conditioned by flat topography are mostly present in Mwogo sub-catchment. Annex 3, Figure 31 shows the soil and Figure 32 the geological characteristics of the catchment.

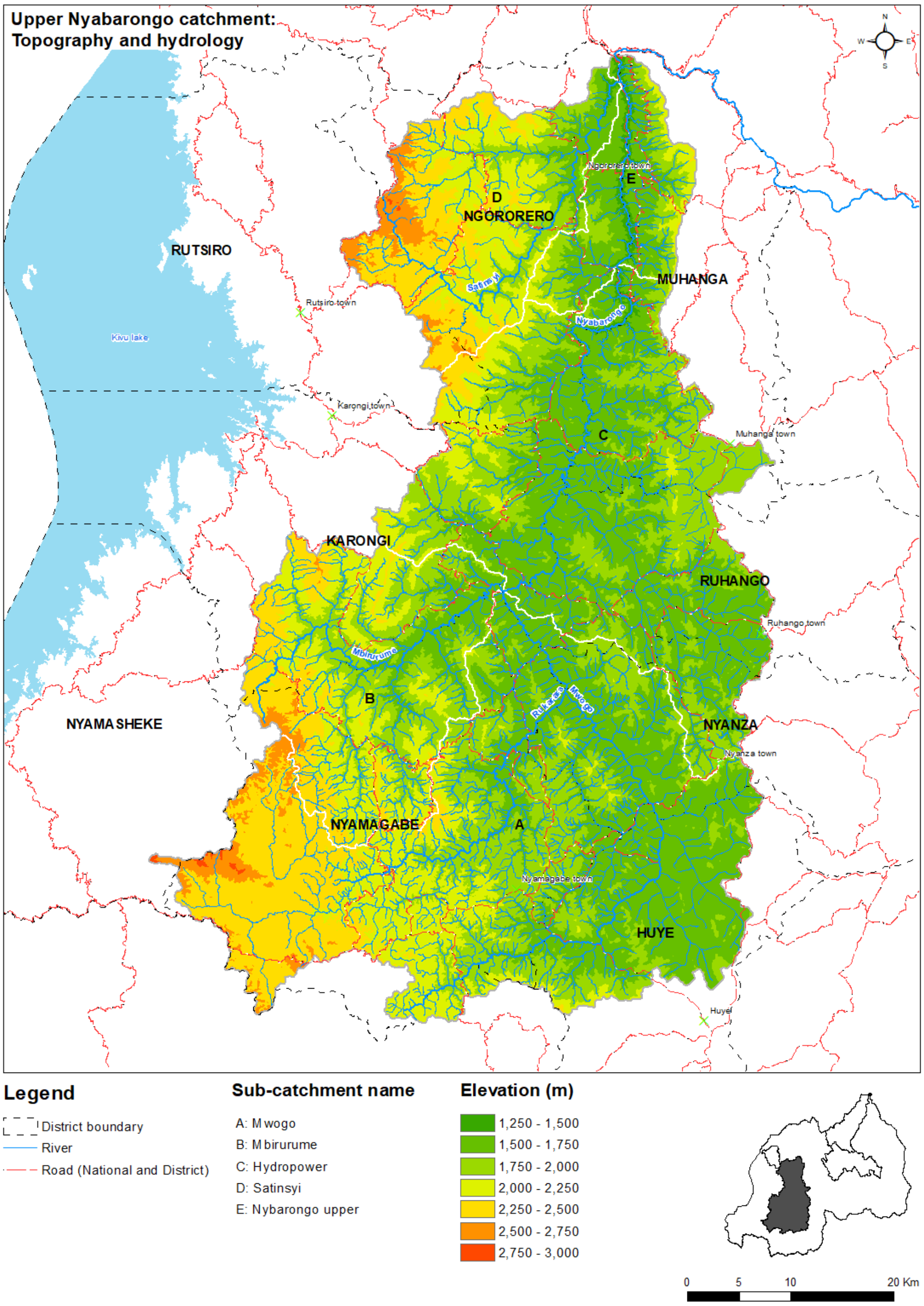

Figure 3:Upper Nyabarongo catchment elevation, waterways, and sub-catchments

The Upper Nyabarongo catchment lies within the Albertine Rift Montane Forests ecoregion and the Victoria Basin forest-savanna mosaic (see **Error! Reference source not found.**). Figure 10 also shows that the c atchment straddles three agro-ecological regions namely: The eastern Ridges and Plateaux; the Buberuka Highlands, and; the eastern Savanna. Water management arrangements and management defined for Upper Nyabarongo must, therefore, comply with the management practices eventually defined (by REMA) for the ecoregion. Ecoregions and agro-ecological zones of Rwanda are presented in **Error! Reference s ource not found.**.

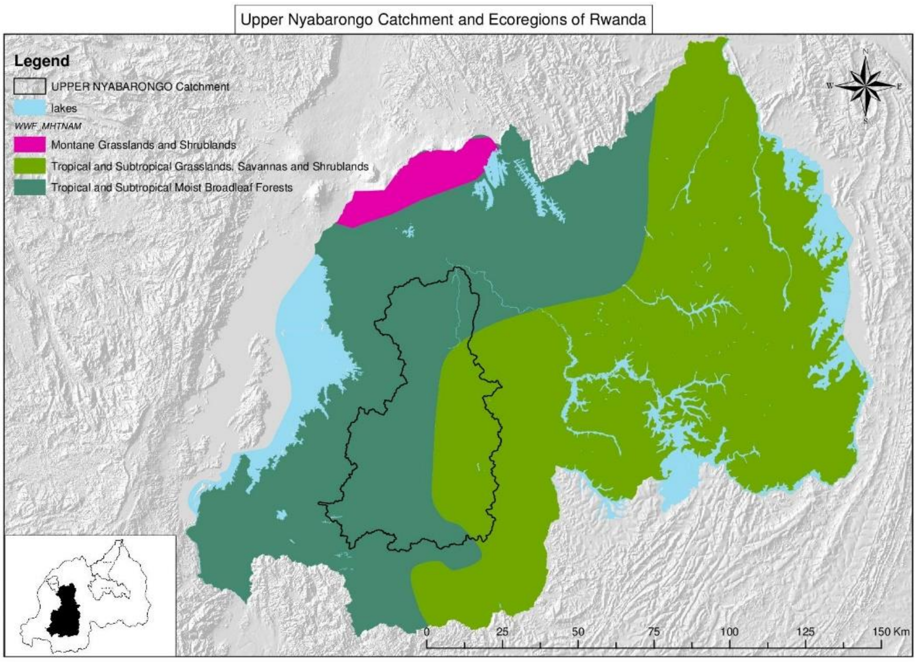

Figure 4:Upper Nyabarongo catchment and the ecoregions (WWF) of Rwanda

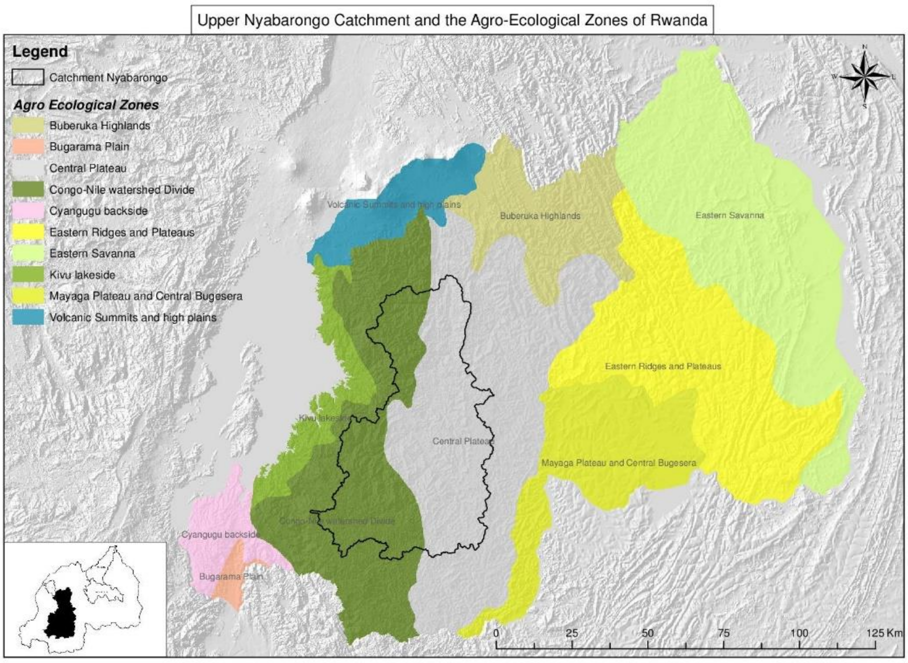

Figure 5:Upper Nyabarongo catchment and the agro-ecological zones (WWF) of Rwanda

Rainfall

The rainfall pattern of the catchment shows high annual rainfall (1200 mm/year and above). There is a relatively short dry season, 'long rains' during the months of March, April and May, and 'short rains' during the months of September, October, November and December. Evaporation data is quite constant throughout the year but peak somewhat during the dry season months (June - September); during these months the climatic water balance is negative.

Climate change

Rwanda has a climate with an average temperature around 20°C and low monthly variation. Despite its location in the tropical belt, Rwanda experiences a temperate climate as a result of the high elevation. Temperature observation data within Upper Nyabarongo catchment shows a maximum daily temperature of almost 25.3°C and minimum of 14.6°C in the western part of the catchment. The southern part of the catchment has a maximum daily temperature of 23.6 °C and a minimum daily temperature of 14.0°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 vulnerability maps to hazards for Rwanda. Upper Nyabarongo catchment covers 8 districts, each vulnerable to hazards to differing degrees (drought vulnerability, landslides, and windstorms):

1. Rutsiro: Drought vulnerability (none), landslides (moderate), windstorms (low);
2. Ngororero: Drought vulnerability (very low), landslides (high), windstorms (low);
3. Muhanga: Drought vulnerability (low), landslides (moderate), windstorms (low);
4. Ruhango: Drought vulnerability (moderate), landslides (moderate), windstorms (low);
5. Nyanza: Drought vulnerability (moderate), landslides (low), windstorms (low);
6. Huye: Drought vulnerability (moderate), landslides (low), windstorms (low);
7. Nyamagabe: Drought vulnerability (very low), landslides (moderate), windstorms (low);
8. Karongi: Drought vulnerability (very low), landslides (high), windstorms (low).

Recently, a 30-year historical dataset for Rwanda was completed, using a combination of station and satellite data (Rwanda Meteo Maproom[5]), and 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) indicates a general increase in temperature across the country for the next 30 years but it is not 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).

Hydrology and groundwater

The Upper Nyabarongo has a sustained flow during the dry season months (July and August) and a moderate hydrological response i.e. with receding flow prior to the rainy season from the months of September up to December. The large rainy season from February up to May shows a more robust increase of monthly flow levels, which indicates that groundwater reserves are replenished in these months. This kind of hydrological response is typically caused by significant infiltration and groundwater storage of rainfall along the Nyabarongo River and its tributaries. **Error! Reference source not found.** presents the m onthly water regime curves for a representative monitoring station in the main rivers (70007, Mwaka - Upper Nyabarongo).

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

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

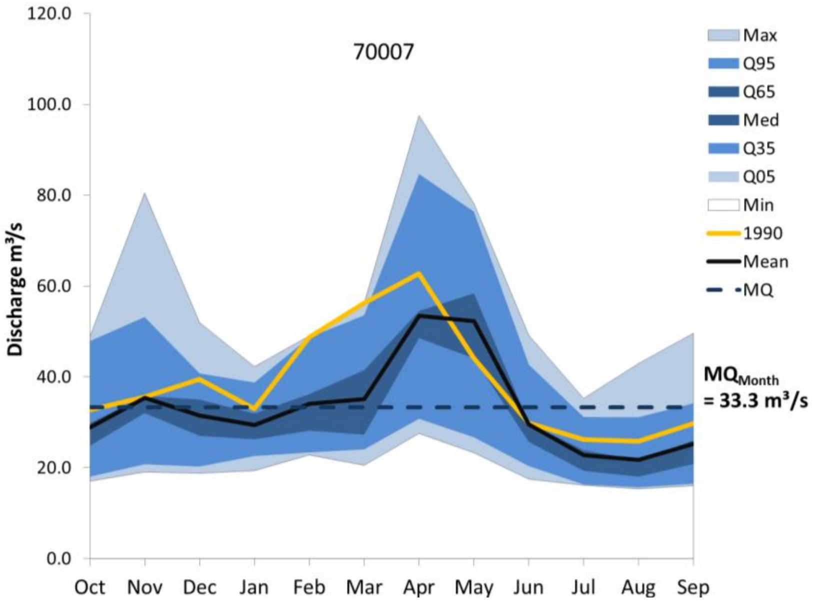

Figure 6:Monthly water regime curves for station 70007 (Mwaka-Upper Nyabarongo)

In the above **Error! Reference source not found.**, Q95 refers to average monthly flow exceeding 95% of m onthly flow events in m³/s; (similar for Q65 exceeding 65% of events, etc.).

High infiltration rates along with the deeply weathered groundwater holding layers, constitute significant groundwater reserves that are difficult to access for large abstractions, but effectively regulate surface flows in a range from 20 to 40 m^3/s for most of the year.

Meteorological data, more especially observed flows and rainfall data is essential for purposes of deriving runoff estimates. Some historical data is available for Rwanda; however, the time series data is extremely fragmented and not continuous. Recent data is also difficult to obtain, and with limited spatial coverage. Extensive data quality checks and quality control have to be performed. On the other hand, global initiatives of various research groups around the world have resulted in compilation of consistent data sets of precipitation, based on using remote sensing, observations, and advanced data assimilation techniques. These can readily be utilised as they are accepted as high quality. One such example is the so-called CHIRPS precipitation data set[6].

Additional climate data is required to estimate the potential evapotranspiration. Average monthly values of temperature and humidity at Kigali (elevation 1567 MASL) have been utilised within a Water Evaluation and Planning (WEAP) system model[7] to derive water balance estimates for each of the demonstration catchments for a baseline period of 10 years from 2006 to 2015. Calibration and assessment of the model performance based on flow records at Mwaka, is illustrated in Figure .

[6] CHIRPS is the Climate Hazards Group InfraRed Precipitation with Station data and is a 30+ year quasi-global rainfall dataset. Spanning 50°S-50°N (and all longitudes), starting in 1981 to near-present, CHIRPS incorporates 0.05° resolution satellite imagery with in-situ station data to create gridded rainfall time series for trend analysis and seasonal drought monitoring. The creation of CHIRPS has supported drought monitoring efforts by the USAID Famine Early Warning Systems Network (FEWS NET). The CHIRPS data can be downloaded free of charge from http://chg.geog.ucsb.edu/data/chirps/. Data is delivered for the entire continent daily. Using QGIS and python scripting this data was aggregated to monthly values for each sub-catchment.

[7] Future Water and eLeaf (2017). Water Balance and Allocation Modelling in Rwanda.

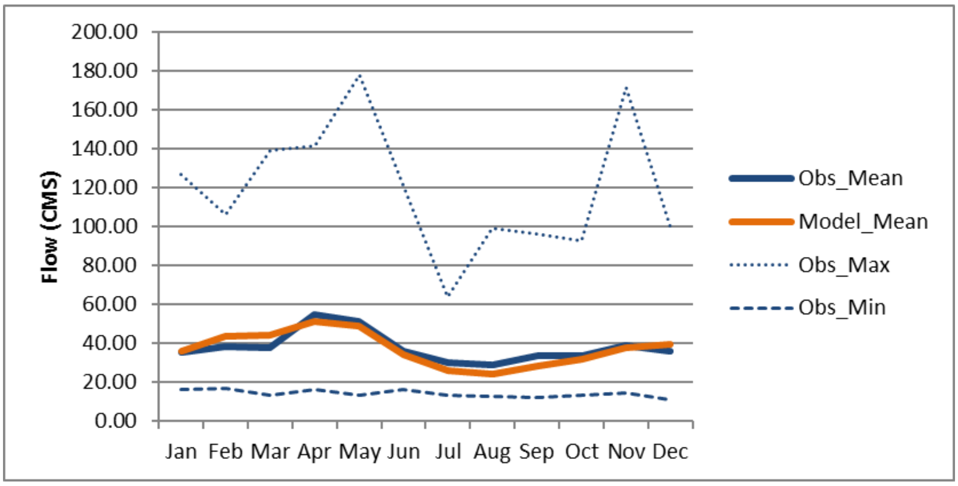

Figure 7: Observed and simulated mean, min, and max flow for station Mwaka

Water balance

Adequate and quantified knowledge of current water resources utilisation by sector is limited due to unregulated water use and lack of water use survey information. In November 2016, a Water Users' Survey was carried out to get an overview of the water usage in each of the four studied catchments (W4GR TR28, 2017). The observed water users in this survey are: Coffee washing stations, hydropower plants, water treatment plants, mineral extraction sites, dams, irrigation schemes, fishing farms, and industries, as far as they exist 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). They will also be included in the first Catchment Atlas, a knowledge product that will be developed as one of the knowledge measures of this catchment plan.

The self-estimates of actual water use by these users appear unreliable as of yet. 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 have been combined in the latest version of the water balance and allocation model for Upper Nyabarongo (see Section 0 below, and (W4GR TR59, 2017).

The water balances for the current situation are provided below, both for the catchment as a whole and for the sub-catchments (Figure 33, Annex 3). The green water balance (presented for the catchment as a whole) comprises all the precipitation that falls in the catchment, water used by vegetation (transpiration) or lost by direct evaporation, water that infiltrates to groundwater or is conveyed to surface water, and water abstracted from or returned to surface water or groundwater. The manageable water balance (presented for the catchment as a whole and for the sub-catchments), also referred to as blue water balance, comprises inputs to and outputs from the surface water or groundwater bodies in the catchment, including abstractions and return flows related to use by people in the catchment. The water balances are based on model simulations in the Water Allocation and Planning software (WEAP; Stockholm Environment Institute), version 07, as developed by the water resources management department and reported in W4GR TR59 (2017). Current 'blue' water[8] use is very limited compared to actual resources (Figure 7 and Table 2). In all sub-catchments, the largest amount of 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

[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.

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.

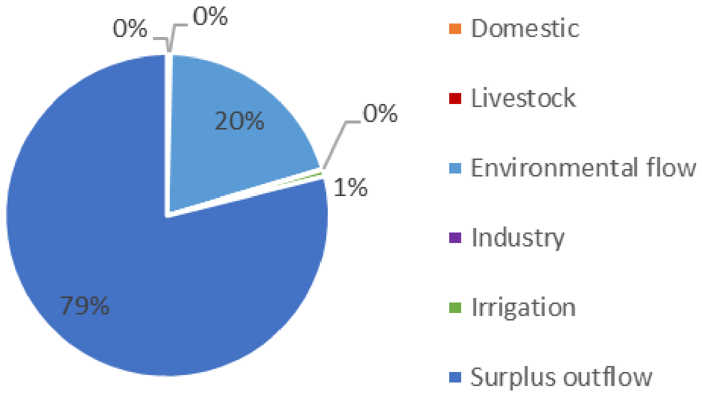

Figure 7: Annual water allocation per water use sector, baseline scenario (source: WEAP model, WRMD, 2018)

Table 1: Green water balance, entire Upper Nyabarongo catchment

IN	(MCM/y)	OUT	(MCM/y)
Precipitation	4116.92	Evapotranspiration	2077.13
Return flows	6.14	Withdrawals	16.43
Storage change	-23.35	Outflow	1487.49
Inflow	0	Groundwater recharge	519.11
Total	**4100**	**Total**	**4100**

Table 2: Blue water balance, entire Upper Nyabarongo catchment

IN	(MCM/y)	OUT	(MCM/y)
Runoff	401.57	Domestic	3.57
Base flow	1096.22	Industry	0.90
Groundwater	0	Irrigation	10.20
Return flows	6.14	Livestock	1.75
Inflow	0	Outflow	1487.49
Total	**1503.9**	**Total**	**1503.9**

Table 3: Green water balance, Mwogo sub catchment

IN	(MCM/y)	OUT	(MCM/y)
Precipitation	1640.04	Evapotranspiration	810.30
Return flows	3.17	Withdrawals+Dom Ruhango	8.94
Storage change	-7.67	Outflow	582.83
Inflow	246.39	Groundwater recharge	233.68
Total	**1635.54**	**Total**	**1635.75**

Table 4: Blue water balance, Mwogo sub-catchment

IN	(MCM/y)	OUT	(MCM/y)
Runoff	179.55	Domestic+Dom Ruhango	1.3
Base flow	409.04	Industry	0.52
Groundwater	0.0	Irrigation	6.48
Return flows	3.17	Livestock	0.62
Inflow	246.39	Outflow	829.22
Total	**839.15**	**Total**	**838.14**

Table 5: Green water balance, Mbirurume sub-catchment

IN	(MCM/y)	OUT	(MCM/y)
Precipitation	662.20	Evapotranspiration	317.66
Return flows	0.44	Withdrawals	1.16
Storage change	-5.95	Outflow	246.39
Inflow	0	Groundwater recharge	91.55
Total	**656.7**	**Total**	**656.7**

Table 6: Blue water balance, Mbirurume sub-catchment, baseline

IN	(MCM/y)	OUT	(MCM/y)
Runoff	66.60	Domestic	0.38
Base flow	180.51	Industry	0.01
Groundwater	0	Irrigation	0.57
Return flows	0.44	Livestock	0.21
Inflow	0	Outflow	246.39
Total	**248**	**Total**	**248**

Table 7: Green water balance, Hydropower sub catchment

IN	(MCM/y)	OUT	(MCM/y)
Precipitation	1073.54	Evapotranspiration	581.04
Return flows	1.90	Withdrawals	5.07
Storage change	-2.04	Outflow	1208.40
Inflow	829.22	Groundwater recharge	108.22
Total	**1902.7**	**Total**	**1902.7**

Table 8: Blue water balance, Hydropower sub catchment

IN	(MCM/y)	OUT	(MCM/y)
Runoff	94.05	Domestic	1.16

Base flow	288.29	Industry	0.21
Groundwater	0	Irrigation	3.15
Return flows	1.90	Livestock	0.54
Inflow	829.22	Outflow	1208.40
Total	**1213.46**	**Total**	**1213.46**

Table 9: Green water balance, Satinsyi sub catchment

IN	(MCM/y)	OUT	(MCM/y)
Precipitation	505.94	Evapotranspiration	239.54
Return flows	0.41	Withdrawals	0.83
Storage change	-4.83	Outflow	207.96
Inflow	0	Groundwater recharge	53.24
Total	**501.5**	**Total**	**501.5**

Table 10: Blue water balance, Satinsyi sub catchment

IN	(MCM/y)	OUT	(MCM/y)
Runoff	47.35	Domestic	0.49
Base flow	161.02	Industry	0.11
Groundwater	0	Irrigation	0.00
Return flows	0.41	Livestock	0.24
Inflow	0	Outflow	207.96
Total	**208.8**	**Total**	**208.8**

Table 11: Green water balance, Nyabarongo Upper sub catchment

IN	(MCM/y)	OUT	(MCM/y)
Precipitation	235.20	Evapotranspiration	128.60
Return flows	0.21	Withdrawals	0.44
Storage change	-2.54	Outflow	1487.49
Inflow	1416.36	Groundwater recharge	32.42
Total	**1649.23**	**Total**	**1648.95**

Table 12: Blue water balance, Nyabarongo Upper sub catchment

IN	(MCM/y)	OUT	(MCM/y)
Runoff	14.00	Domestic	0.24
Base flow	57.36	Industry	0.06
Groundwater	0.00	Irrigation	0.00
Return flows	0.21	Livestock	0.14
Inflow	1416.36	Outflow	1487.49
Total	**1487.93**	**Total**	**1487.93**

For Upper Nyabarongo, 51% of water that enters the catchment is used by vegetation, 13% enters the groundwater and 36% leaves the catchment to the downstream areas providing a total of 1487.49 MCM/y to downstream water users. Upper Nyabarongo is the largest ‘water tower’ in Rwanda and only less than 0.5% is abstracted within the catchment at present. The areas downstream of the catchment, such as Kigali, benefit from the water tower, with Kigali’s water supply depending to a large extent on extractions from the Lower Nyabarongo sub-catchment.

Water quality

Systematic monitoring of water quality data in Rwanda has only been taken up recently by the RNRA-IWRM[9] department at a limited number of locations throughout the country. Currently, water quality is monitored in Rukarara, Mbirurume and Mwogo sub-catchments and at the outlet of the catchment at

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

Mwaka. Monitoring has also been conducted at Kadahokwa tributary in the adjacent Akanyaru catchment and the Miguramo tributary in Muhanga Distict.

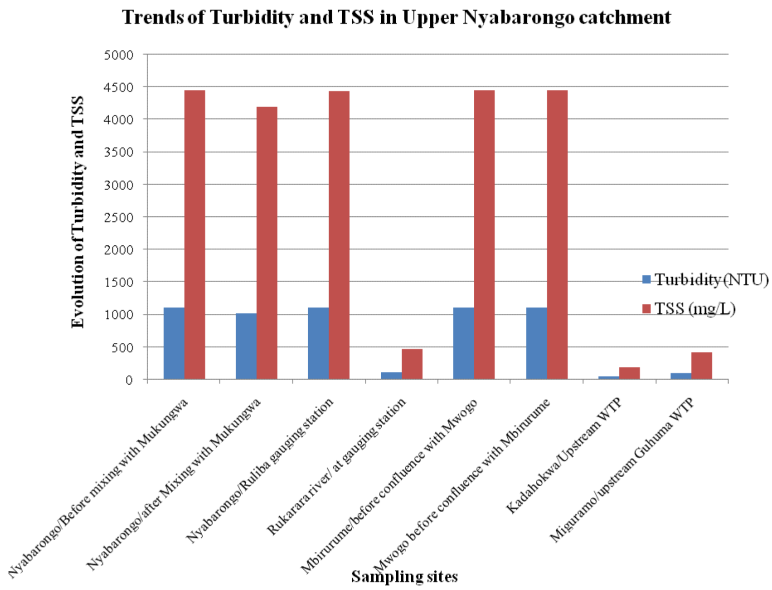

Figure 8: Turbidity and Total Suspended Solids (TSS) measurements in the catchment (RNRA-IWRMD, 2017)

Data analysed from these measurements and findings corroborated from the NWRMP indicate that there are:

- Very high sediment loads and turbidity, due to mining and to traditional farming methods;
- High loads of e. coli and coliform bacteria (and others not measured) from untreated sewage;
- High organic loads and high biological oxygen demands (BOD) and chemical oxygen demands and resulting low concentrations of oxygen (mg/L).

Figure 8 shows that Kadahokwa river (in Akanyaru catchment) recorded lowest turbidity and TSS values (46.505 NTU and 195 mg/L respectively) while Mbirurume and Mwogo rivers recorded the highest values (1112.5 NTU and 4452/4449.5 mg/L, respectively). All turbidity values recorded in Upper Nyabarongo catchment were above WHO and RSB drinking water standards (5-25 NTU). Sediment finger printing studies[10] have also been undertaken to indicate the most likely levels of sediment contribution from the different geological types. Potential sources were identified based on the geological types and mapped as potential prioritised hotspots for rehabilitation. The finger printing study highlighted mining activities in the upstream part of the catchment, as a major source of sediment with additional significant contribution from areas with open agriculture.

The Nyabarongo is a source for the water supply of Kigali, and a source for irrigation development. It is therefore most important to monitor, protect and reduce loads of organic matter and nutrients.

1.4.1 Socio-economic profile

Upper Nyabarongo is the largest catchment in western Rwanda and is home to the farthest source of the Nile. Originating in the mountain ridge of the Congo-Nile divide, the catchment combines valuable natural ecosystems, such as the Nyungwe National Park (the source of the Nile). The catchment covers significant areas of eight districts and is home to very small pieces of Nyamasheke and Nyaruguru districts. The overlay of the catchment and the districts is presented in Figure 9.

[10] GLOWS-FIU. 2016. Sediment Fingerprinting in Nile Nyabarongo Upper Catchment, Rwanda. Global Water for Sustainability Program, Florida International University.

Figure 9: Upper Nyabarongo catchment, sub-catchments and district boundaries

Economic activities and basic services infrastructure

The Upper Nyabarongo catchment is strongly reliant on rain-fed agriculture. Traditional cash crops are coffee and tea, while new ones are honey and horticulture. Main food crops entail: maize, beans, Irish potato, wheat, cassava, banana, fruits and rice. Rainfed agriculture is generally utilized due to the favourable climate with two rainy seasons per year. The main challenges of this type of agriculture are the fragility of the land due to high slopes and persistent poor farming methods. Approximately 70% of the households are also engaged in livestock rearing. The most commonly owned types of livestock are: cattle, goats, pigs, rabbits and chicken. The one cow per poor family program known as 'GIRINKA" has increased the number of cows producing milk countrywide (including Upper Nyabarongo). Fish farming is practiced in Huye and Nyanza districts where productivity is sought to be increased through construction of dams and fish ponds. Agroforestry and forest plantations have been promoted as appropriate land use management systems in the catchment, e.g. in the catchment rehabilitation plan for the catchment. Exotic species such as eucalyptus, pines, cypress, acacia and alnus have also been promoted. However, despite these initiatives, forests cover has been declining due to the high pressure exerted by demands for agricultural expansion, human settlement and use of firewood for cooking.

Mining and quarrying are considered as important sources of revenue and employment. The main precious mineral resources exploited are: granite, tin, tungsten, colombo-tantalite (*coltan*) and cassiterite. The sites where extraction takes place are in Rutsiro, Ngororero, Nyamagabe, Muhanga, Karongi and in the Nyungwe forest. Non-regulated artisanal mining is commonly practiced. Other industrial activities include agro-processing of maize, rice, cassava, bananas, fruits, soybean, milk and honey. There are also four tea factories, one coffee factory, a soap industry, a tannery, and ceramics and handicrafts for Agaseke[11].

In addition, there are many tourism opportunities, but these still remain largely under-exploited. The opportunities are around the natural forests in Nyungwe, Mukura, Gishwati and Busaga. Nyanza is home to the traditional royal palaces of the ancient kingdoms, hence there is opportunity to further develop cultural tourism.

Socio-economic drivers of catchment development

[11] Agaseke project is a Rwandan Handcrafts Making Project established in 2007 in Kigali City, with support and partnership of Imbuto Foundation, and Rwanda Investment and Export Promotion Agency ("RIEPA").

Economic drivers of development are understood as existing and emerging economic sectors and value chains with high potential for creating sustainable jobs and generating government revenues (tax, VAT, levies, etc.). For the catchment plan we consider the economic drivers that have strong links with water resource management in the catchment.

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 (SEZs), Business and Industrial Parks); transport; tourism (meetings, incentives, conferences and exhibitions); manufacturing “Made in Rwanda” and ICT “Smart Rwanda” (MINECOFIN, 2017).

In each catchment one can identify one or more dominant existing or potential economic drivers with a strong relation to the water resources. For Upper Nyabarongo catchment, these include the water tower function for the nation, mining, coffee, and National Park tourism. Catchment planning aims to maximise socio-economic development around the value chains in relation to the available water resources in sustainable ways. The value chain concept (ref Value Chains Michael Porter) includes all steps from producer to consumer including processing and transport and related support services. For example, the coffee value chain includes: the farms, coffee washing stations, roasting, transport, packaging, customs, advisory services and finance).

Drivers at catchment level are identified by observing, analysing and discussing the current land use patterns, investments, production and other economic data in the catchment. Key guiding questions are: where do people work and earn their money; what value chains, sectors, industries are growing and what is the importance of the activity for the local and national economy? Important information for identifying the socio-economic champions is also found in the National Sector Strategic Plan (SSPs), District Development Strategies (DDSs) and master plans.

Examples of drivers of socio-economic development with strong links to water resources in the sub-catchments of Upper Nyabarongo are listed in Table 13.

Table 13: Economic drivers in Upper Nyabarongo catchment

Sub-catchment	Economic drivers	Districts
Mbirurume	Agri-business (incl. beekeeping/honey) forestry, horticulture, hydropower, tea (i.e. factory processing, plantations and outgrowers), water tower.	Karongi, Nyamagabe
Mwogo	Coffee, tea (i.e. factory processing, plantations and out growers), tourism (incl. Nyungwe National Park), wetland irrigated agriculture.	Huye, Nyamagabe, Nyanza, Ruhango
Hydropower	Forestry, hydropower, small-holder marshland irrigated agriculture, mining.	Karongi, Muhanga, Ngororero, Nyanza
Satinyi	Forestry, mining, small-holder agriculture.	Muhanga, Ngororero
Nyabarongo Upper	Forestry, mining, small-holder agriculture.	Ngororero, Rutsiro

Value chains are often organised around so-called anchor companies: e.g. a tea factory in the tea value chain, or an irrigation system or a mine (cluster). Anchor companies are often instrumental for improvement of the products. They create jobs and income in the area and prominent companies, such as a tea factory, can develop the entire value chain through their forward and backward linkages. Value chains promote rural-urban linkages since parts of the chain from producer to consumer can be found in the urban and other parts in the rural areas. The value chain and operations of the anchor company are assessed in relation to the overall catchment plan and IWRM criteria[12].

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

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

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 ecosystems 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 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 firewood needed for curing the tea leaves. In this case, both the forest and the business benefit from the cooperation. Other joint venture opportunities exist to achieve more inclusive development, for example, through integrating smallholder farmers in out-growers' schemes. The joint investments generate multiple returns an improved environment with its services, and an enhanced and diversified economy, in addition to sustainable livelihoods and stronger resilient communities.

Population distribution and poverty rates

The population and housing census conducted in Rwanda in 2012 indicated that the total number of people who lived within the catchment was around 1.2 million with 6.7% living in urban areas and 93.3% living in rural areas. The population density in the catchment is high (see Figure 34, Annex 3). Sectors with the highest population densities are located in urban areas in Muhanga, Nyamagabe and Huye. In these areas, the population density ranges from 900 - 1500 habitants/km^2. Other areas that are densely populated lie in the northern part of the catchment in Ngororero where the population density is 600 – 900 habitants/km^2. Previously, human settlement was encroaching on Nyungwe forest area, but recently these communities have been resettled. The high population densities exert a lot of pressure on water and land resources which manifests itself in the high rate of land and wetland degradation and pollution of water sources.

The catchment has a very young population; over 40% of the population is younger than 15 and almost 52% of the population is below 20. The total female population exceeds the male population by about 10%.

Poverty rates within the catchment area are still very high with approximately 40.8% of the population classified as poor while 15.6% are regarded as extremely poor. The statistics relating to poverty are derived from the Household Living Surveys (EICV4)[13] and are defined on the basis of consumption figures. The 'poor' poverty classification is related to a consumption level of a basket of food and non-food items defined as 159,375 RWF per capita per year for the EICV4 survey (January 2014 prices). The 'extreme poor' poverty level classification is defined on the basis of consumption related to the cost of the basket of food items costed at 105,064 RWF per capita per year.

Nyamagabe, Karongi, Rutsiro, Ngororero and Ruhango have the highest poverty rates (Table 14), with Nyamagabe district having the highest poverty and extreme poverty rates of all Rwandan districts. The cause of poverty has often been linked to high population growth and declining soil fertility in a largely agrarian economy.

Table 14: Population % identified as poor and extreme poor for the Upper Nyabarongo catchment[14]

District	% poor[15] (district population)	% extreme poor (district population)
Karongi	45.3%	21.3%
Ngororero	49.6%	23.5%
Rutsiro	51.4%	23.6%
Huye	32.5%	5.7%
Nyanza	38%	17.6%
Ruhango	37.8%	23.6%
Muhanga	30.5%	7.8%
Nyamagabe	41.5%	13%
Average	**40.8%**	**15.6%**

Access to basic services

The primary road network is well developed with good tarmac road access from Kigali to Muhanga, and subsequently from Muhanga to Nyabihu, Muhanga to Karongi, Muhanga to Nyanza and Huye, and Huye to Nyamasheke and further to Rusizi. However, road travel outside the primary road network is challenging. Access to electricity is limited, only a low percentage of households uses electricity for lighting. Energy consumed is in the form of traditional biomass burning, particularly firewood and charcoal. Cooking with firewood is practised by more than 92% of the population. Alternative sources of energy like biogas and improved cooking stoves are still limited.

[13] Rwanda Poverty Profile Report - Results of EICV 4 2014.

[14] Source: EICV4: 2013/2014.

[15] The percentage of poor population comprises the percentage of extreme poor population.

Access to safe drinking water and improved sanitation and hygiene practises is also low. 60% of the population in the catchment has access to a public tap or a protected spring for water supply and 15% of the households make use of unprotected springs for water supply. In comparison with the national data (76% of the Rwandan population has access to a public tap or protected spring), the Upper Nyabarongo catchment shows a lower percentage of access to improved sources of drinking water. Sanitation figures show more than 80% of the households use a private pit latrine albeit only about two- thirds comply with the international standard definitions of an improved sanitation facility. Very few Rwandan households have installed flush toilets (which require a house connection to a public water supply network). The prevailing practice remains that water is used for cooking and washing only (its 'grey' wastewater is discharged mostly on surface) while the excreta are disposed of in waterless latrines[16]. According to the latest WHO/UNICEF (JMP) report 2015 [17], the percentage of Rwanda's population with a hand washing facility at home, consisting of soap and running water, is estimated at only 6% in urban and 1% in rural areas.

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 Upper Nyabarongo catchment is presented in Table 15.

Despite the presence of parts of two national parks (Nyungwe and Mukura Forests), the total forested area covers only about 10% of the catchment area and from this, about 10% is considered sparse, i.e. shows signs of tree felling or other forms of degradation. The influence of pressure resulting from a high population is very clear with agriculture the prominent land use, comprised of the classes 'agriculture (seasonal)', 'agriculture (perennial)' and 'open areas or grass', jointly adding up to 85%. 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. Settlements and building, water, and wetlands occupy very limited areas of the catchment. Several district capitals can be clearly distinguished on the map.

Table 15: Land use / land cover classification Upper Nyabarongo (W4GR, 2018)

Class	Area (ha)	Percentage (%)
Forest	14,347	9%
Sparse Forest	1,212	1%
Open areas or grass	37,914	23%
Agriculture (seasonal)	83,462	50%
Agriculture (perennial)	20,710	12%
Settlements and buildings	4,338	3%
Water	3,816	2%
Wetlands	337	0%
Total	166,135	100%

Key geographic features of Upper Nyabarongo's sub-catchments

[16] National Sanitation Policy and strategy (NSPS) February 2016.

[17] WHO/ UNICEF JMP Joint Monitoring Programme on water supply and sanitation Rwanda 2015.

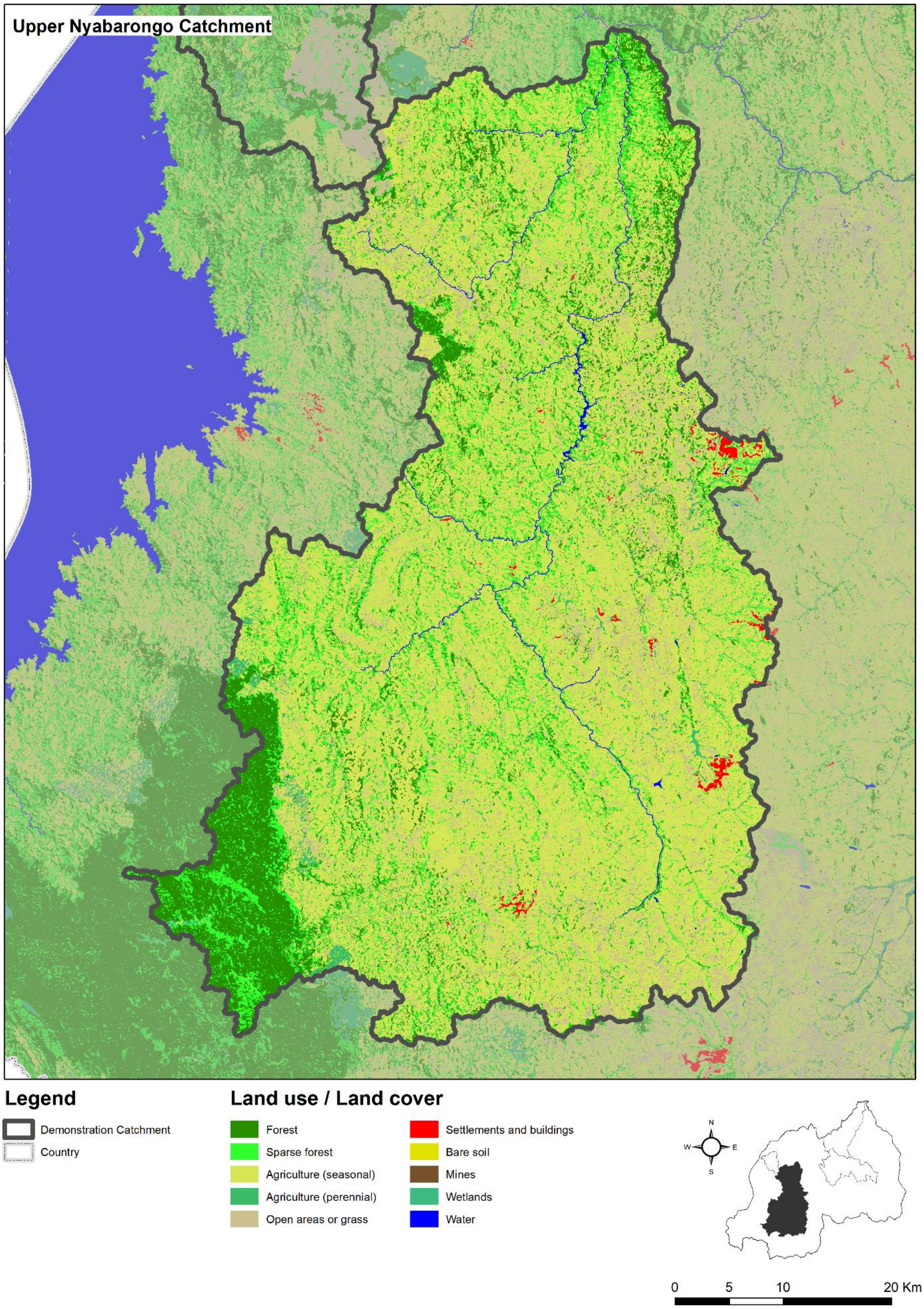

Figure 10: Land Use / Land Cover map (LULC) (W4GR 2018)

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 catchment plan partners. Then, CTF members scored and ranked these issues in their perceived order of importance for them (W4GR TR53, 2016). Finally, the exact locations of key issues were mapped, 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 0) for a number of areas targeted for priority implementation.

2.2.1. Issues

Catchment issues were ranked as follows in the scoping workshop:

1. Soil erosion (including riverbank erosion by agriculture & cattle);
2. Mining exploitation increasing siltation to rivers;
3. Deforestation reducing the soil cover;
4. Waste water management;
5. Poor agricultural practices.

Further analysis of the water resources eventually led to 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 their underlying causes and opportunities, are discussed in detail below.

1. **Sediments in rivers caused by soil erosion and mining:** The high population density in the catchment, combined with a high use of fuel wood for cooking and poor agricultural practices, leads to deforestation and over- exploitation of agricultural land. Due to a lack of adequate management, soils become depleted of nutrient and, especially in the western part of the catchment which has steep slopes, rates of soil loss are very high. Once the eroded soils enter waterways, they contribute to high sediment loads thereby, amongst other adverse impacts, they increase flood risk as they deposit in the riverbed and floodplains reducing flow capacity.

   Farmers will need to be encouraged to adopt and utilise agro-forestry and other tree species e.g. fruit trees, on their farms. Combined with other tailor-made and already popular soil and water conservation technologies, based on lessons from ongoing and past projects, this can curb the rates of deforestation, soil erosion, stream sedimentation and flood risk.

   Sediment loads in rivers are further aggravated by mining activities throughout the catchment. Both formal licensed and informal, unlicensed, usually artisanal, mines use poor, environmentally damaging practices that lead to ingress of large quantities of sediment into watercourses. The contribution of mining activities to sediment loading in rivers is considered at least to be equal to the contribution made by agricultural soil erosion, and in some individual sub-catchments mines are the predominant source of sediments;

2. **Poor water quality:** Surface water pollution as a key problem. The most obvious and visible pollution is caused by watershed degradation and unsustainable mining activities described above, causing high sediment loading and siltation. Other pollution sources are the lack of proper sanitation, poor farming practices and the organic load discharged by coffee washing stations. In addition, water pollution of the surrounding urban areas, industrial waste, and use of agrochemicals, all adversely affect water quality. More efforts are required to prevent pollution, including the introduction of waste water treatment;
3. **Population pressure:** The Upper Nyabarongo catchment is a highly populated area, with highest densities in the urban centres of Muhanga and Nyamagabe (900 - 1500 habitants/km^2). Population pressure has contributed to land fragmentation, agricultural intensification, and a shift from intensive cultivation on the hillside fields to conversion of the lower wetlands to agricultural fields. As population continues to grow and the upland per capita farmlands decrease in size, this

conversion of the wetlands will most likely continue. Land shortage is often believed to be a major factor in forcing families and individuals to encroach on marginal lands;

4. **Insufficient drinking water supply and sanitation:** In comparison with the national data (76% of the Rwandan population has access to a public tap or protected spring), the Upper Nyabarongo catchment shows a lower percentage of access (60%) to improved sources of drinking water. 40% of the population are still using unprotected springs and rivers for drinking and household water. Poor water quality (high turbidity, high loads of e. coli, coliform bacteria, and organic matter) has a profound negative impact on health of the local population.

   The provision of adequate water supply, sanitation, and hygiene (WASH) services plays a crucial role in preventive health care and is more generally a pre-requisite and indicator for socio-economic development. Access to drinking water is also a basic amenity, ranked among the highest priority public services by Rwanda's population. Reduction of time spent on fetching water has a positive impact on school attendance, in particular for girls. Women's lives are strongly affected by unsafe, distant water supply, as women are generally responsible for water collection and handling, for household hygiene, and caring for the sick. It is recommended to develop a catchment or (sub-)catchment-based water supply masterplan to enhance water supply systems and encourage rainwater harvesting initiatives. An outline of a catchment-based drinking water supply master plan is presented in the NWRMP. Full-fledged WASH plans should be complemented with adequate sanitation and hygiene solutions.

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 0) to achieve sustainable solutions.

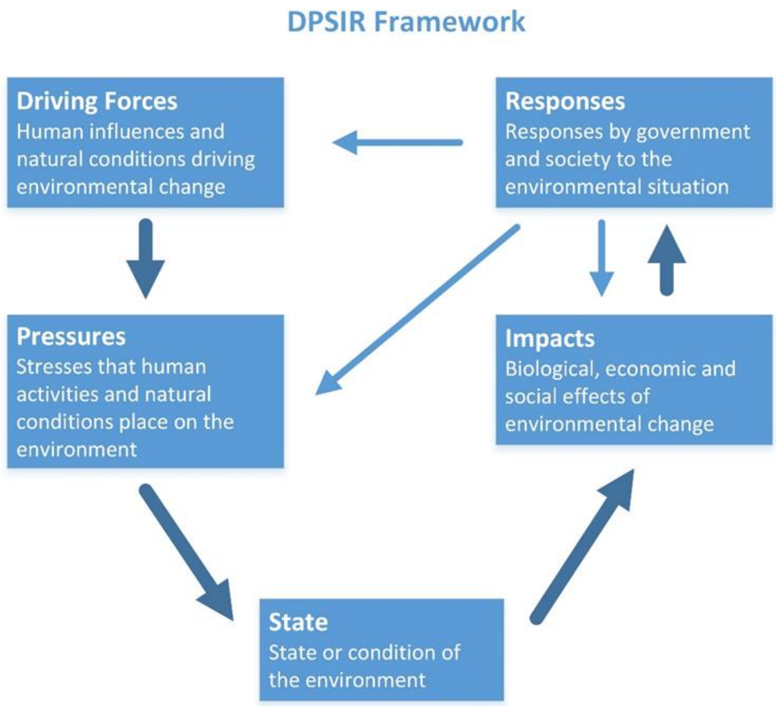

Figure 11: DPSIR framework explained

The DPSIR analysis for Upper Nyabarongo catchment, based on inputs from the participatory process, integrated assessment of catchment physiography (paragraph 0) and catchment socio-economic profile (paragraph 1.4.1), is presented in Table 16. Here, the focus is on Drivers, Pressures, States, and Impacts; Responses are presented in the Programme of Measures in Chapter 0

- **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 constitute 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 16: Upper Nyabarongo catchment Drivers, Pressures, States and Impacts

DPSIR Upper Nyabarongo Catchment
Driving Forces
High population density and population growth
Economic development
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
Challenging geographical conditions (high slopes, underground water channels, etc)
Underdeveloped institutions to implement policies and enforce laws
New settlements (deforestation around settlement, less deforestation in area of origin)
Little knowledge, understanding, skills in sustainable agriculture
↓
Pressures
Siltation from mining
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 and steep hillsides
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
Increasing water consumption per capita, following changes in consumption patterns at increasing household income levels
↓
States
Reduced soil fertility
High turbidity in rivers
Low water quality, including high E. coli counts in surface water
High variations in river discharge
Low land productivity
Low water productivity
Low aquatic biodiversity
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
↓
Impacts
River water often unsuitable for drinking water intake
High costs of drinking water treatment and maintenance of distribution networks
Many people / users with low water security (low quality, low quantity)
River water often unsuitable for hydropower generation intake
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 water security/food security
Floods damaging public infrastructure, private properties, and taking lives
Water borne diseases
Health issues related to low water, energy, and food security

2.2.2. **Opportunities**

The CTF identified and ranked the following main opportunities:

1. Water availability;
2. Reforestation;
3. Implementation of soil conservation projects;
4. Mineral resources;
5. Rules and regulations.

The main opportunity for Upper Nyabarongo is its large water availability. The catchment is the main water tower of Rwanda and is home to the most upstream sources of the Nile Basin. Despite high population density, ample water is available to meet water demands in the catchment, thus offering a solid input to a water-based economy.

Reforestation and other soil conservation projects are key activities to restore the natural resilience of the catchment, and to assure long-term water availability. This can be considered an opportunity as well as a necessity.

Mineral resources are listed among the opportunities for economic activity in the catchment. Importantly, mining activities are also mentioned among the main issues in the catchment. A sustainable approach to mining is required in order for there to be economic benefit from this sector without associated environmental damage. Experience needs to be developed in sustainable mining, e.g. through the concept of model mines. Best practices can be developed in pilot projects e.g. in one sub-catchment and replicated in other sub-catchments within and beyond catchment boundaries.

Last but not least, existing rules and regulations are regarded as opportunities to improve sustainable catchment management. A key factor hampering positive results from rules and regulations is the limited enforcement capacity. For this opportunity to become effective, plan partners need to join hands in improving enforcement of legislation, e.g. through water permitting and strengthening of field-level enforcement of environmental legislation, combined with enhanced awareness raising and capacity building of stakeholders, to improve levels of environmental friendliness in all sectors.

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 0). The more tangible opportunities from Table 16 are reflected in the programme of measures, forming the R for Responses in the catchment DPSIR analysis (Chapter 0).

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[18] took into account local issues and opportunities, the United Nations Sustainable Development Goals (SDGs), 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[19] 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[20] for Upper Nyabarongo catchment:

‘A well-managed catchment that is home to prosperous communities living in harmony with their environment and drawing social and economic benefits from sustainable ecosystem services.’

3.1.3. Overall objective and specific objectives

The overall objective for development of the catchment was initially developed by the CTF[21], 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.’

Specific objectives (SOs) were also developed by the CTF and national plan partners, with a subsequent update made in 2018[22]. The original catchment specific objectives, representing the initial CTF priorities, are highlighted in bold text.

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[18] 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.

[19] 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 Upper Nyabarongo catchment, and put forward what they felt should be addressed in the catchment plan and achieved in future.

[20] 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).

[21] 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.’

[22] 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,

Specific objective 1: Improve 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 rural and urban users of current and future generations;
Specific objective 4: Strengthen the water governance framework to ensure effective implementation of integrated programmes;

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 aspects of good water management is the mandate of national Government. Decentralisation policy, legislation on local government, 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 0) were developed to result in specific outcomes. The ultimate aim of the vision is that water and land management should contribute to "*A well-managed catchment that is home to prosperous communities living in harmony with their environment and drawing social and economic benefits from sustainable ecosystem services*". The vision's theme of *living in harmony with their environment* was 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 downstream catchments. After all, Upper Nyabarongo is one of the main water towers of the nation. The vision's aspect of a *well-managed catchment* 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. The water allocation alternatives considered in the water balance model simulations, ranged from a baseline, through autonomous development scenarios, to a number of management alternatives and sub-alternatives; each was assessed with regard to its implications on water balance and water allocation. 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. Upper Nyabarongo is considered a level 1 catchment for Rwanda. Sub-catchment level 2.5 has been introduced for the water balance models. Level 2 sub-catchments as defined within the NWRMP were considered too big, and level 3 and 4 sub-catchments too small to be used for meaningful water balance modelling, considering the limitations in data availability[23]. The same five level 2.5 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 33.

Water balance and allocation model governance
The water allocation alternatives that have been produced using the WEAP model for Upper Nyabarongo 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 2024-2031. 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[24].

Upper Nyabarongo is one of the water towers of Rwanda, providing more than enough water compared to current demand. However, according to projection modelling, water demand 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;
- 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

[23] 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.

[24] Details of the modelling approach and results are provided in dedicated reports (W4GR TR29 (2017), W4GR TR56 (2017), and W4GR TR 60 (2017). The approach and key results are summarised in this section and in Annex 7 of this catchment plan.

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).

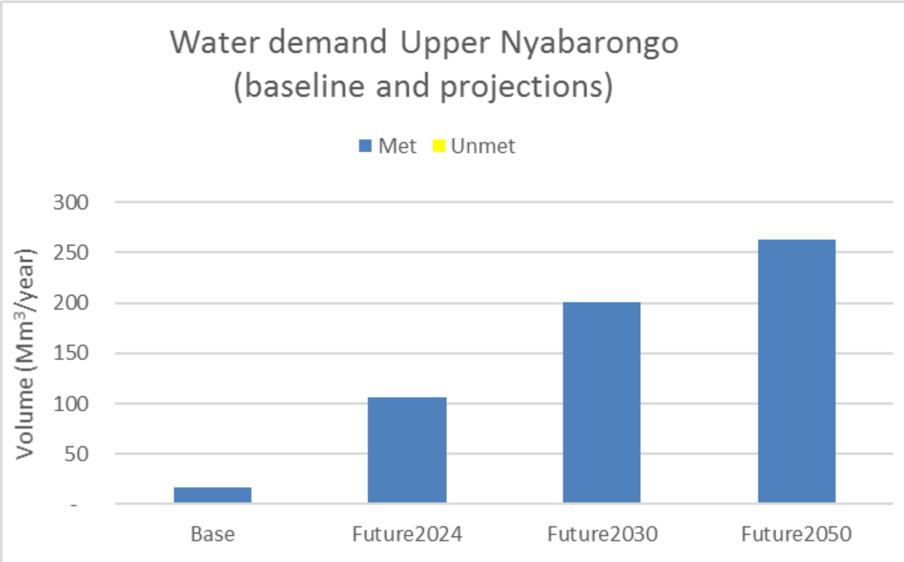

Figure 12: Baseline / projections of met and unmet water demand (water shortage) up to 2050, BaU (W4GR, 2017)

Figure 12 clearly shows that more than enough water resources will remain available in future, to keep up with growth of blue[25] water demand in the catchment. This can be explained by the high amounts of precipitation and runoff, compared to limited abstraction of surface water. The predominant water use in the catchment is rain-fed agriculture, which does not depend on blue water. The strong increase in met water demand (or actual water use), however, implies a reduction of outflow from the catchment. This hampers the water tower function of the catchment, or in the wording of the catchment vision and overall objective, the provision of water to the environment and to downstream users. In order to safeguard the water tower function, several development alternatives were analysed on their merits, in terms of optimising outflow throughout the year whilst optimising water-based economic development and food security.

Table 17 presents the main characteristics of the final catchment plan alternatives. The results of the most ambitious alternatives, in terms of met and unmet water demand in 2050, 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.

[25] ‘Blue’ water is the manageable component of the total water balance, comprising surface water in rivers and lakes, as well as deep groundwater aquifers from which water can be pumped up for different uses. The total water balance in the catchment also considers precipitation on land areas (the largest share of the catchment) and the evapotranspiration from vegetation, as well as water in the rooted soil layer.

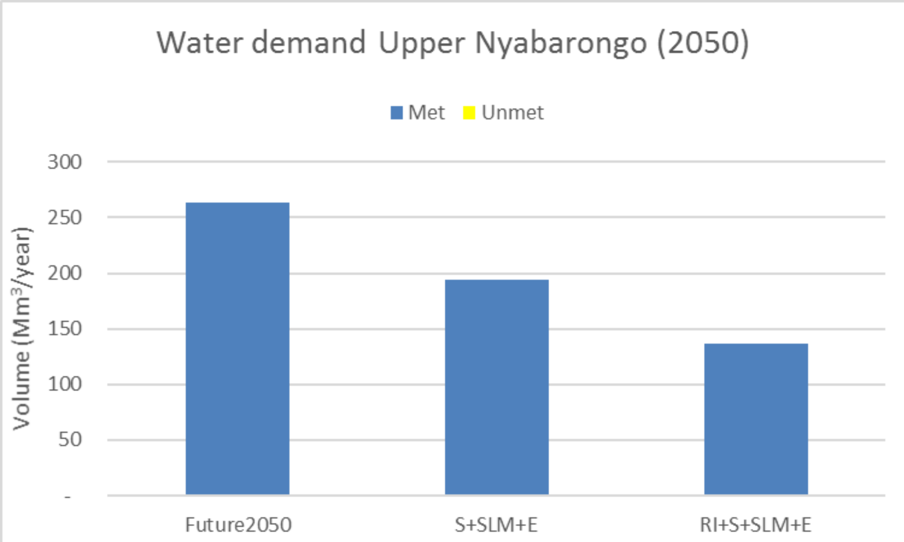

Figure 13: Met and unmet demand under BaU and different promising alternatives by the year 2050

Table 17: 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

In selecting a preferred alternative, the merits of the two most ambitious alternatives were compared to each other. Considering the importance of irrigated agriculture for food security in Rwanda, and the fact that water availability is not a limiting factor in Upper Nyabarongo, the alternative 'S+SLM+E' was adopted as preferred alternative for the catchment, and translated into a water allocation plan for all sub-catchments therein (Annex 9). This alternative has the desired effect of balancing the water tower function of the catchment with food security, whilst avoiding local water shortage. This can be achieved by combining development of water storage, sustainable land management, and enhanced water use efficiency in all sectors.

4. Programme of Measures (PoM)

4.1. Enabling environment

The programme of measures (PoM) for Upper Nyabarongo 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. Together with (sub)catchment restoration plans and water allocation plans, they form the basis for development and implementation of a programme of measures.

4.1.1. Catchment restoration

A key element to sustainable management of Upper Nyabarongo is restoration of its 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, lead 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 in **Error! Reference source not found.**, Annex 6), to enhance a nd/or promote adherence to 'best practice' mining (see knowledge measures in **Error! Reference source not found.**, Annex 6).

The largest investments by far for this catchment plan will be for catchment restoration and the core intervention there in 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 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 is being promoted. Suitable local species include conifers (*Podocarpus*), Parasol trees (*Polyscias fulva),* Kenya croton (*Croton megalocarpus*), Nile tulip (*Markhamia lutea*), Bitter leaf (*Vernonia amydalina*), 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. Vegetative buffers help to reduce 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, consisting of the following components:

- A geodatabase of all available relevant spatial datasets:
  - The new national land use / land cover map[26];
  - 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 (DEM), 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 Annex 16). 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;

[26] 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.

    - 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 is 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[27] 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), 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[28] 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)..At 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.

[27] 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.

[28] 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.

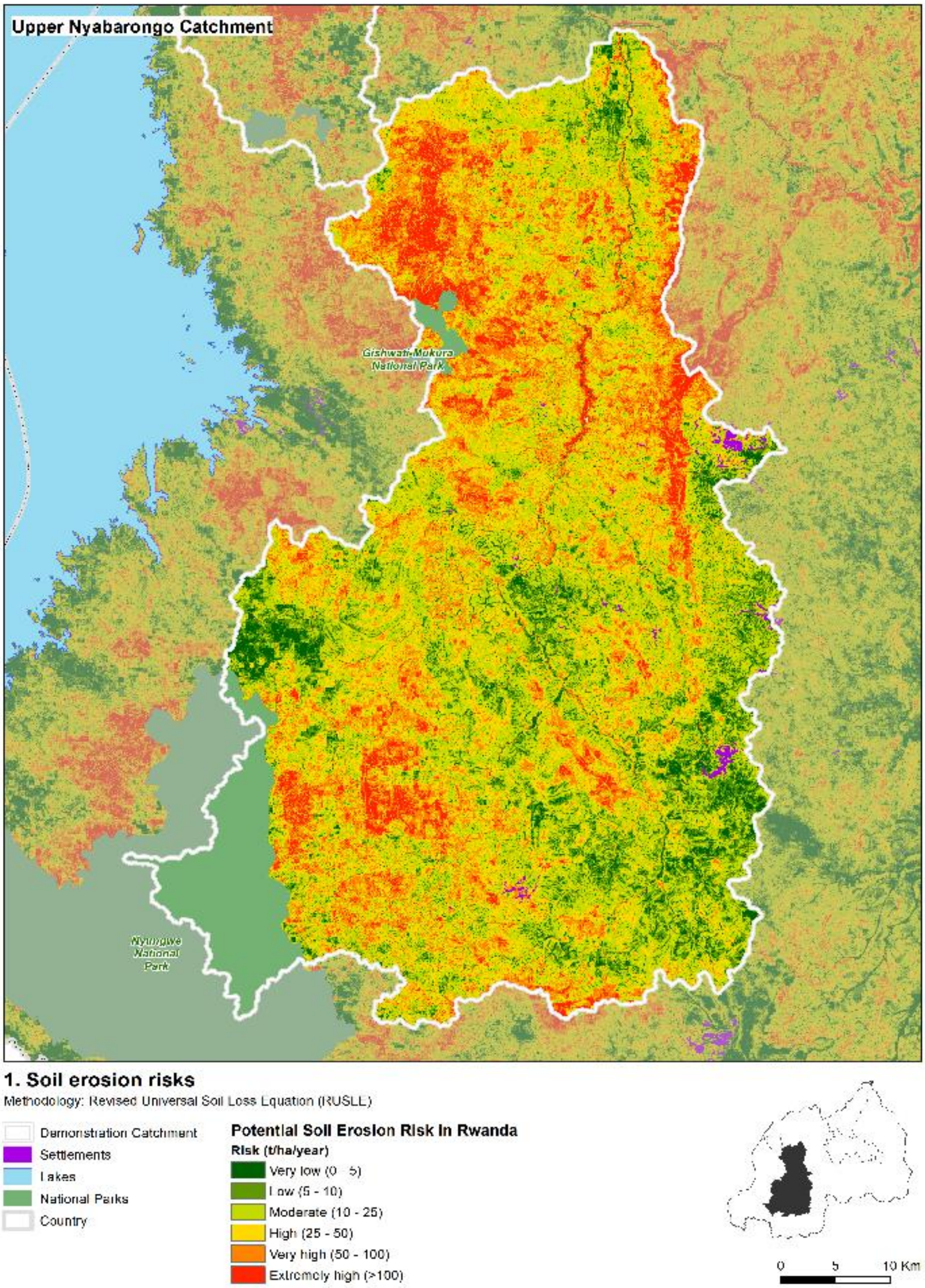

Figure 14: CROM map - indicating soil erosion risk in upper Nyabarongo catchment

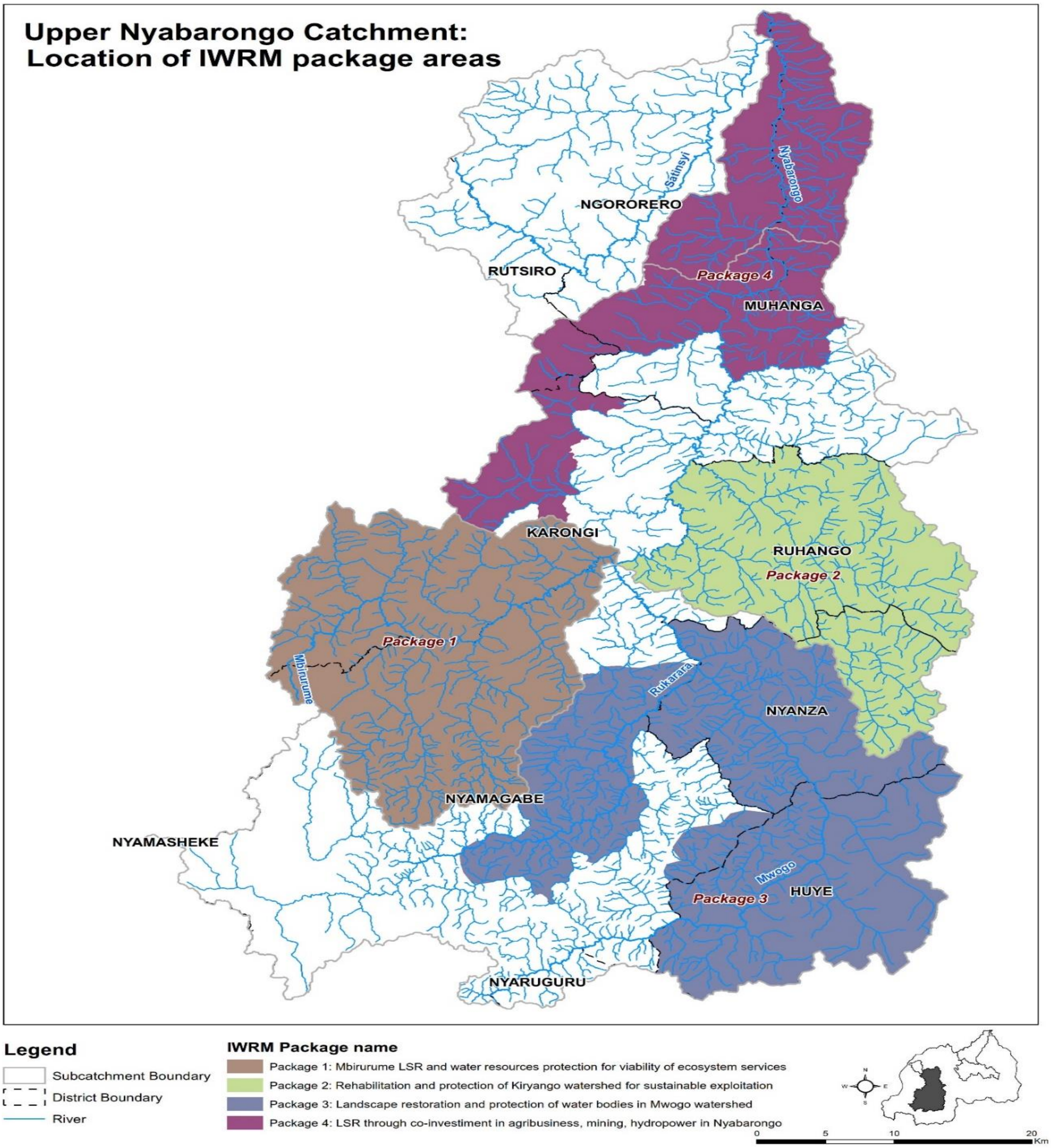

Figure 15: Map indicating the priority subcatchments that will be rehabilitated

Table 18:Budget estimation for restoration of Mbirurume subcatchment

Components /Activities	Unit	Quantities	Unit cost	Total cost (RWF)
CPIP 1 - Land husbandly and landscape restoration				
1.1. Terracing with trenches with agroforestry	ha	1,700	633,000	1,076,100,000
1.2. Terracing on steep slopes	Ha	450	2,427,420	1,092,339,000
1.3. Afforestation	ha	850	750000	637,500,000
1.4. River buffer zone protection (Mbirurume, Kirago, Kabavu, Rurongora, Nzavu, Musasa and Gatare)	ha	140	209,000	29,260,000
1.5. Incentive for ecosystem services with livestock to farmers around protected areas	Cows	100	500,000	50,000,000
	Bee-hives	50	70,000	3,500,000
1.6. Gullies Rehabilitation	Number	7	3,000,000	21,000,000
1.7. Cross cutting issues				
1.7.1. Training of farmers, District staff and Water users on climate smart agriculture and Environmental laws	Persons	200	100,000	20,000,000
1.7.2. Capacity building in sustainable mining approach and law enforcement	Persons	100	100,000	10,000,000
S/Total CPIP 1				**2,939,699,000**
CPIP 2: Rain water harvesting in residential areas and large institutions				
2.1. Rain water harvesting in residential areas	Households in villages (2.5 m^3)	200	200,000	40,000,000
	Boarding schools	5	1,600,000	8,000,000
S/Total CPIP 2				**48,000,000**
IP⁺ 1 - Improved cooking stoves to selected HHs, and boarding schools.				
3.1. Improved cooking stoves to selected HHs and boarding schools.	Households	200	200,000	40,000,000
	Boarding schools	5	1,500,000	7,500,000
Total IP⁺ 1				**47,500,000**
IP⁺ 2 - Optimisation of Hydropower potential through hydrologic and topographic studies for Gatare and Kabebe sites (Knowledge)				
4.1. Support to hydrological and topographical study for economic value of water (Knowledge)	Study	2	25,000,000	50,000,000
S/Total IP⁺ 2				**50,000,000**
Total cost Package 1				**3,085,199,000**
Less National project (Knowledge IP⁺ 2)				**3,035,199,000**

Table 19:Budget estimation for restoration of Kiryango subcatchment

Components /Activities	Unit	Quantities	Unit cost	Total cost
CPIP 1 - Land husbandry and landscape restoration in Base, Nkubi, Nyamigogo and Kiryango watersheds				
1.1. Terracing on medium slopes with agroforestry and fodder grass belt	Ha	3200	603,600	1,931,520,000
1.2. Protect riverbanks of Kiryango, Nkubi and Nyamigogo with fodder grass and bamboos	ha	120	209,600	25,152,000
1.3. Re-afforestation in line with District Forest Master plan: Bweramana, Mwendo and Mukingo Sectors	Ha	500	750,000	375,000,000
1.5. Incentive for ecosystem services around protected marshlands and rivers	Cows	100	500,000	50,000,000
1.6. Cross cutting issues				
1.6.1. Training of farmers, water users' associations and district staff in climate smart agriculture and environmental laws	Persons	200	100,000	20,000,000
1.6.2. Training of mining operators on sustainable mining concept	Number	50	100,000	5,000,000
Total CPIP 1				2,406,672,000
CPIP 2 - Rain water harvesting, water drainage and storage for floods mitigation				
1.Rain water harvesting on the roof tops of settlement area	Households (2.5 m^3)	100	200,000	20,000,000
2.Rain water harvesting on the roof tops of boarding schools	Classrooms (5 m^3)	20	400,000	8,000,000
3.Rain water harvesting on the roof tops of public institutions	Buildings (5m^3)	4	400,000	1,600,000
4.Rain water harvesting on the roof tops of HHs in trading centres	Buildings (5m^3)	60	400,000	24,000,000
5.Feeder roads cross drainage structures downstream protection	Km	13	30,000,000	390,000,000
6.Construction of ponds for water storage	Pond	5	800,000	4,000,000
7.Construction of canals linking the road drainage ditches to infiltration ponds	m	1,000	30,000	30,000,000
Sub Total CPIP 2	-	-	-	477,600,000
Total Package 2	-	-	-	2,884,272,000

Table 20:Budget estimation for restoration of mwgo subcatchment

Components /Activities	Unit	Quantities	Unit cost	Total cost (Rwf)
CPIP 1 Landscape restoration and protection of water bodies in Mwogo watershed				
1.1. Terracing with agroforestry (incl. avocado) and fodder grass belt	Ha	2700	633,000	1,709,100,000
1.2. Afforestation in line with District Forest Master Plan	Ha	1700	750,000	1,275,000,000
1.3. Protect riverbanks of Mwogo, 6 tributaries (Rusuri, Nyakagezi, Butambu, Rundazi, Rwagahogo and Gasayo) and 2 dams: Kabakobwa, Cyarubare)	Ha	250	209,600	52,400,000
1.4. Gullies rehabilitation in 8 Sectors of Huye Districts (Study available)	Nbr	50	7,000,000	350,000,000
1.5. Cross cutting issues				
1.5.1. Training of farmers, District Staff, water users associations and district staff in climate smart agriculture environmental laws	Persons	200	100,000	20,000,000
1.5.2. Capacity building in sustainable mining approach and law enforcement	Number	50	100,000	5,000,000
Sub Total CPIP 1				**3,411,500,000**
IP+1: Optimisation of Hydropower potential through hydrologic and topographic study for Musange Pico Hydropower site				
5.1. Support to hydrological and topographical study for economic value of water (Knowledge)	**study**	**1**	**25,000,000**	**25,000,000**
CPIP 2: Rain water harvesting, water drainage and water storage for floods mitigation in Kigoma, Simbi and Kinazi				
2.1. Rain water harvesting on the roof tops of settlement area	Households (2.5 m3)	100	200,000	20,000,000
2.2. Construction of ponds for water storage	Pond	3	800,000	2,400,000
2.3. Construction of water drainage from road drainage and settlement areas to	m	1000	30,000	30,000,000

Components /Activities	Unit	Quantities	Unit cost	Total cost (Rwf)
infiltration ponds				
Sub Total CPIP 2:				**52,400,000**
CPIP 3: Land husbandry and landscape restoration around Rukarara river				
3.1. Terracing on moderate slopes with agroforestry and grasses	Ha	1650	633,000	1,044,450,000
3.2. Terracing on steep slopes (including lime and compost) with agroforestry	Ha	80	2,427,420	194,193,600
3.3. Afforestation in line with District Forest Master plan: Kibumbwe, Kibirizi, Kaduha and Musange	Ha	1100	750,000	825,000,000
3.4. Protect riverbanks of Rukarara, Gisuma, Gitega, Mazimeru and Nyirabikeri with fodder grass and bamboos	Ha	100	209,600	20,960,000
3.5. Incentive for ecosystem services around protected marshlands and river banks	Cows	100	500,000	50,000,000
3.6. Gullies rehabilitation in Nyamagabe District	nb	7	3,000,000	21,000,000
3.7. Rehabilitation and protection of catchment area (50 m) of springs supplying domestic water	nb	100	200,000	20,000,000
3.8. Cross cutting issues				
3.8.1. Training of farmers, District Staff, water users associations and district staff in climate smart agriculture environmental laws	Persons	200	100,000	20,000,000
Total Cost of CPIP 3				**2,195,603,600**
CPIP 4: Landscape Restoration and promotion of forestry for Sustainable Livelihood in Mwogo Catchment Area				
4.1. Afforestation in Nyanza, Huye and Ruhango	Ha	900	213,748	192,373,200
4.2. Terracing on moderate slopes and agroforestry in Nyanza, Huye and Ruhango	Ha	600	633,000	379,800,000

Components /Activities	Unit	Quantities	Unit cost	Total cost (Rwf)
4.3. Riverbank protection on Mwogo, Rwagahogo, Makera and Rurangazi	Ha	80	209,600	16,768,000
4.4. Rain water harvesting and urban water drainage management to reduce floods around Rwabicuma and Nyamagana dams	HH	200	200,000	40,000,000
4.5. Promote innovative income generating activities through timber and fruits value chains	HH	200	200,00	40,000,000
4.6. Awareness raising and capacity building among farmer communities in climate smart agriculture and business diversification	Nbr	200	100,000	20,000,000
Sub Total CPIP 4				**688,941,200**
Less co funding (NFOR)				*381,861,200*
Total Cost of Package				**6,066,364,800**
Less National project (Knowledge)				**6,041,364,800**

Table 21:Budget estimation for restoration of mining and hydropower generation in the most degraded areas of Upper Nyabarongo

CPIPs/Activities	Unit	Quantity	Unit cost (Rwf)	Total cost (Rwf)
IP I: Pilot project for demonstrating cleaner production and resources efficiency in mining sites				
1.1. Construction of Processing plant for water and waste management	LS			600,000,000
1.2. Equipment (static and mobile ore extraction water & waste management process)	LS			859,000,000
1.3. A study into mining sedimentation and pollution in the Upper Nyaborongo catchment (added value to RWFA & USAID studies as it will concentrate on mining pollutants to fluvial system). Knowledge*	LS			66,000,000
1.4. Train mining operators and District staff &Cooperatives in sustainable mining and environment regulation	Nbr	200	100,000	20,000,000
Total Cost IP 1				**1,545,000,000**
Less National project (Knowledge)				**1,479,000,000**
IP+: Landscape restoration to facilitate investment in Agribusiness in Rugabano sector				
1. Development of terraces with agroforestry and grasses	Ha	1,100	1,410,866	1,551,952,600
2. Planting of green manure plants (Vetiver, Grevilia, Tephrosia and Tea)	Ha	4000	422,075	1,688,300,000.00
4. Set an incentive mechanism between the tea co-ops growers and the land-owners in the watershed surrounding the tea plantations to ensure the maintenance of anti-erosive infrastructure.	LS		50,000,000	50,000,000
5. Capacity building of farmers and District staff on climate smart agriculture	Nbr	200	100,000	20,000,000
Total Cost IP+ 1				**3,290,252,600**

CPIPs/Activities	Unit	Quantity	Unit cost (Rwf)	Total cost (Rwf)
Less co funding (TWFA&ROS)				**1,601,952,600**
PIP II: Rehabilitation of the watershed around of Gisuma, Muhembe and Nyakabanda streams for hydropower generation				
2.1.Terracing , agroforestry and grasses	HA	1800	1,001,993	1,803,587,400
2.2. Agroforestry on non-terraced lands	Ha	2800	300,000	840,000,000
2.3. Afforestation	HA	170	750,000	127,500,000
2.4. Gullies treatment	LS	1	7,000,000	7,000,000
2.5. Riverbank protection	Ha	30	209,600	6,288,000
2.6. Support to hydrological and topographical study for economic value of water at Nyakabanda site (Knowledge)*	LS	LS	25,000,000	25,000,000
2.7. Capacity building of farmers and District staff on Climate smart agriculture	Nbr	200	100,000	20,000,000
Total CPIP 2				**2,829,375,400**
Less national project (Knowledge)				**2,804,375,400**
Total Cost Package 4				**4,426,328,000**

Costs for mining pilot are subject to economies of scale being achieved in the pilot co-operative/partnership group, with co-financing arrangements to be agreed between the service beneficiaries and the project's sponsors. Prices and process requirements were benchmarked and determined on 2014 study into innovation and modernisation of the mining sector.

Table 22: 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.	**Moderate 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**

Different restoration options come at different costs. An overview of lowest and highest unit costs per CROM class is provided in Table .

Table 23: CROM unit costs per class per hectare (minimum/maximum) (Source: RWFA SPIU)

Class	Lowest unit cost per hectare (RWF, excl. tax)	Highest unit cost per hectare (RWF, excl. tax)
I	209,600	209,600
II	564,600	633,600
III	2,358,420	2,382,600
IV	2,427,420	2,451,600
V	766,000	983,750
VI	209,600	983,750
VII	564,600	1,129,200
VIII	766,000	983,750

Overlaying the unit costs per hectare (Table) with the areas in need of restoration (**Error! Reference source n ot found.**), combined with high priority areas (Map 8) and the total area in need of restoration, over time (Map 9) results in the cost estimates shown in Table , based on prices for 2018 (RWFA SPIU). Actual costs may, however, be higher if a comprehensive approach is taken and implementation projects also target areas in between those at highest risk.

Table 24: Cost estimates for catchment restoration (2018-2024 and long term)

Timeline	Area (ha)	Minimum total costs (M RWF excl. tax)	Minimum total costs (M RWF incl. tax)	Maximum total costs (M RWF excl. tax)	Maximum total costs (M RWF incl. tax)
Restoration needs (map 9, total, long-term)	144,358	163,241	192,625	168,505	199,351
Priority restoration areas (map 8, 2018-2024)	11,090	11,497	13,566	14,197	16,753

4.1.2. Water allocation

A WEAP model was used to compare alternative water use scenarios for the Upper Nyabarongo 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. The modelling approach, and results of first model runs, are presented in W4GR TR29 (2017) with the most recent versions, used for development of a water allocation plan, described in TR59 (2018). Model results are summarised in Annex 9 of this catchment plan. A preliminary, preferred alternative was developed through a few iterations of model simulations and participatory decision-making. This preliminary alternative was selected by the CTF and PSC, then fine-tuned per sub-catchment and time horizon (2020, 2030 etc.), and subsequently translated into a month-by-month water allocation per water use sector by the WEAP modellers of the WRMD. This resulted in a balance between optimal development of a water-based economy and the immediate needs of domestic and ecosystem water needs.

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;
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 avoid developing 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, provided 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.

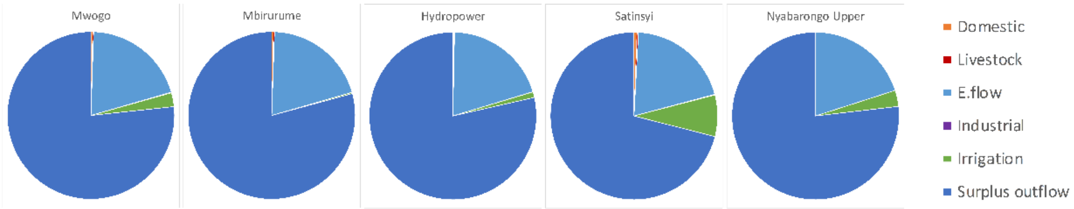

Figure 16: Water allocation plan for sub-catchments for 2024

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, =/< 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 new permits can be issued, as long as combined individual permits issued at that moment, do not add up to the total allocation. This approach is initially adhered to within each water use category and refers to allocation to that category up to the applicable time horizon (e.g. 2024, the time horizon for this catchment plan) and per sub-catchment. Once a limit is (nearly) reached, the WRM department will have to consider their options. Options might include re-allocation of water between/across categories, thereby allowing for quicker growth of water use to allow quicker development of water-based economic activities (but staying within growth allocations for 2030 and 2050), and/or denying permits within a sub-catchment and referring 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 all 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). 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 25: Requirements for water use efficiency gains for key sectors per user or ha

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.

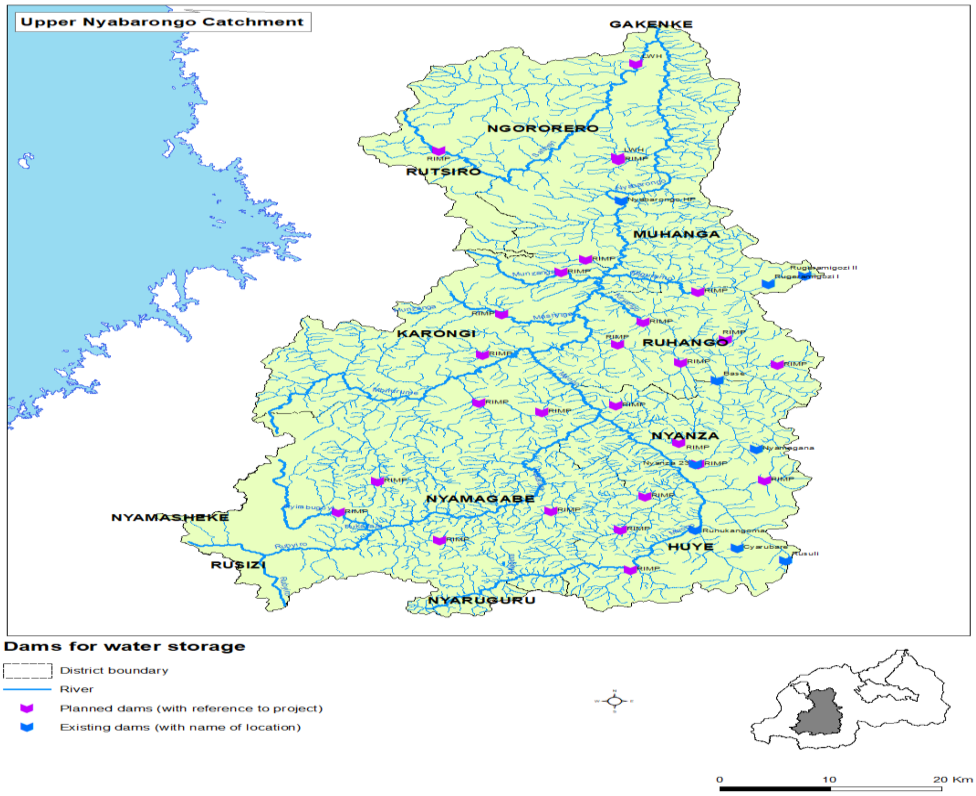

Figure 17: Map of existing and planned dams in the catchment

4.1.3. Water governance

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[29].

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

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

in IWRM measures in catchments. In this instance, several new institutional measures were required (see **Error! Reference source not found.** in Annex 6), and these will embed the principles of IWRM and c atchment planning firmly into the Rwandan water governance context. By their nature, most of the initial institutional developments will have to be at 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 may need to be added to the list. An overview of potential institutional measures is provided in **Error! Reference source not found.**, 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 would be the sustainable transformation of the current catchment task force and would require a clear mandate. Composition and mandate of catchment committees will be laid down in a Ministerial Order, accompanying the Water Law. Such a catchment committee would need to be supported technically and organisationally, by some form of a permanent secretariat.

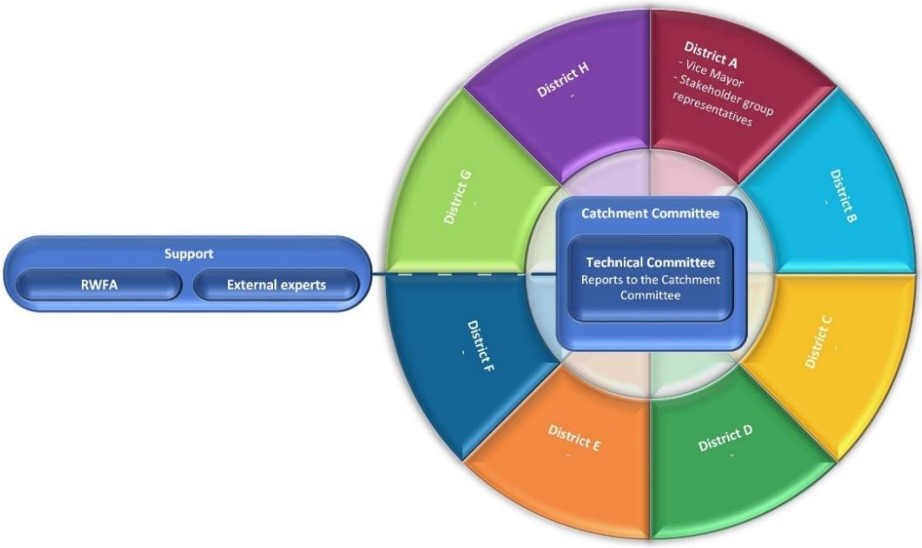

Figure 18: Catchment Committee Infographic

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 Upper Nyabarongo will gradually increase and thus, that 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. Table2 provides an overview of areas of innovation with examples that impact water resources management within catchments.

Table26: 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 create jobs, while state-of-the-art technologies increase 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 public-private-civil society partnerships (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[30], 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, commercialisation, 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 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

[30] For curing locally harvested tea leaves.

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. **Error! Reference source not found.** (Annex 6) presents a series of useful k nowledge 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 Upper Nyabarongo 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[31] 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 0 to 5.1). 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

[31] Of preferred alternatives, as described in in paragraph 0, simulated in the water balance and allocation model and selected by the catchment task force and national plan partners.

be passed through to the first filter (relevance screening) and new IWRM packages will have to be developed for AIP 2019-2010 and beyond.

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[32] 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.

Infrastructure measures

The geographical intervention areas of projects that contain significant infrastructure elements were mapped, provided that spatial data was available for the project[33].

All projects of a primary or significant secondary infrastructure nature in the catchment, and for which GIS data existed, are presented in Figure 41 to Figure 46 in Annex 3 (Catchment Atlas) and in **Error! Reference source not found.**, 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 **Error! Reference source not found.**, information i s 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 41 presents all infrastructure projects in the catchment, by their project classification ($IP_{ongoing}$, $IP_{planned}$, IP+, or CPIP). Figure 42 to Figure 46 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 **Error! Reference source not found.**.

[32] 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.

[33] 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.

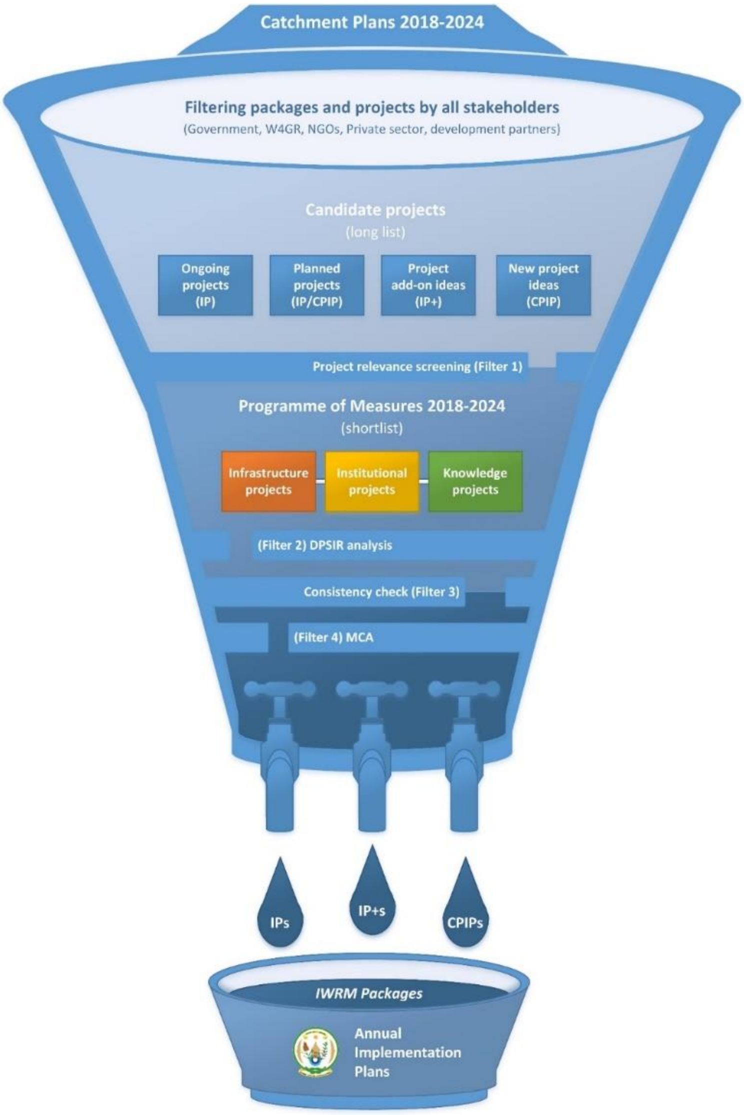

Figure 19: Filtering candidate projects into the programme of measures 2018-2024 and subsequent annual implementation plans

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 0) 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 DPSI analysis in Section 0, and narrow-focus DPSIRs were developed for individual IWRM packages (further introduced in Section 0).

Generic DPSIR for the catchment

Generic responses (R) were developed for all relevant D-P-S-I levels. In **Error! Reference source not found.**, REF _Ref515004126 \h **Error! Reference source not found.** and **Error! Reference source not found.** 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.

DPSIR Upper Nyabarongo Catchment

Driving Forces	Response
1 High population density and population growth	a Climate change mitigation through planting trees / increasing forest cover and agro-forestry
2 Economic development	b TVET programmes in agriculture / agribusiness / agricultural value chains / off-farm jobs
3 Climate change	c Resettlement of population from high erosion/landslide/flood risk prone areas to model villages
4 Poverty	d Enhance institutional capacities and skills for spatial planning and zonation of activities that respect floodplains and vulnerable landscapes, including GIS and remote sensing interpretation skills at district level
5 Low education, skills, and awareness levels	e Enhance environmental enforcement capacity through capacity strengthening and collaboration between districts and government agencies
6 Little environmental enforcement in mining sector	f Develop a strong yet environmentally friendly mining sector
7 Little or no spatial planning / enforcement aimed at providing room to the rivers to flood	g Enhance levels of urbanisation, optimising 'climate smart' and 'sustainability' concepts in secondary cities and introducing similar measures in smaller cities and villages
8 Low public sector investment capability	h Strengthen the forestry, fish and agricultural value chains
9 Low private sector investment capability	i Enhance access to finance for SMEs
10 Challenging geographical conditions (high slopes, underground water channels, etc)	j Organise fund raising conference for development partners, to enhance availability of funds to implement the catchment plan
11 Underdeveloped institutions to implement policies and enforce laws	k Enhance environmental awareness among population and promote water saving in all economic sectors and at households
12 New settlements (deforestation around settlement, less deforestation in area of origin)	l Define national water quality standards/ environmental sanitation regulation and standards
13 Little knowledge, understanding, skills in sustainable agriculture	m Promotion of nature based enterprises (forestry, bufferzone, wetlands, honey)
	n Align landuse planning/ catchment planning to other sectoral plans
	o Install a system of rules and procedures for water allocation and water
	p Set up institutional learning/ research for IWRM

Pressures	Response
1 Siltation from mining	a Rainwater harvesting at public- and households, ponds and valley dams
2 Soil over-exploitation, soil erosion, land degradation	b Mainstream climate smart agriculture
3 Dependence on wood fuel, deforestation	c Rollout IWRM tools across all sectors
4 Concentration of rain water in built up areas, leading to soil erosion and gully forming	d Enhance network of feeder roads and management and funding of maintenance
5 Cattle watering in rivers, trampling river banks and polluting water with E coli and soils	e Develop missing elements in key agricultural value chains to enhance food security, land and water productivity, and to create off-farm jobs
6 Limited management of solid and liquid waste	f Landscape restoration / soil erosion protection / land husbandry
7 Flooding in areas with anthropogenic assets	g Support mining companies in environmental compliance
8 Small farmland plot size, encroachment on forests and steep hillsides	h Formalise artisanal mining sector activities and enhance environmental
9 Sub-optimal farming and mining practice, aggravating soil erosion, pollution, and low water use efficiency	i Develop water treatment facilities and water supply networks to increase coverage
10 Limited private sector investment in efficient water use and protection of the environment	j Develop sewerage systems, waste water treatment plans, sludge collection and treatment facilities for urban areas
11 Limited public sector investment in efficient water use and protection of the environment	k Develop a ground and surface water monitoring and information system
12 More intense rainfall and longer dry spells due to climate change	l Promotion of nature based enterprises (e.g forestry, beekeeping, bamboo)
13 Low levels of access to markets, i.e. to storage, transportation, distribution facilities for agricultural produce	m Pursue cost recovery and reduction of non revenue water across water supply and irrigation systems
14 Limited coverage of water supply and sanitation infrastructure	n Market inspired solutions for catchment restoration
15 Increasing water consumption per capita, following changes in consumption patterns at increasing household income levels	

States	Monitoring
1 Reduced soil fertility	a Monitor key state parameters, to inform responses at all levels
2 High turbidity in rivers	b Water monitoring and information system
3 Low water quality, including high E. coli counts in surface water	c Meteorological monitoring for climate change and disasters information
4 High variations in river discharge	
5 Low land productivity	
6 Low water productivity	
7 Low aquatic biodiversity	
8 Low connectivity and reliability of electricity grid	
8 Low coverage of water supply and sanitation networks	
10 Low protection of public assets, habitation, and crop lands in floodplains	

Impacts	Response
1 River water often unsuitable for drinking water intake	a Improve water supply sector treatment abilities to cope with high turbidity in intake water
2 High costs of drinking water treatment and maintenance of distribution	b Enhance maintenance of infrastructure, e.g. of water supply networks
3 Many people / users with low water security (low quality, low quantity)	c Enhance capacity of hydropower equipment to operate under high turbidity conditions
4 River water often unsuitable for hydropower generation intake	d Increase hydropower generation facilities in sub catchments with low river turbidity
5 High costs of operation and maintenance of hydropower infrastructure	e Restore gullies to protect against further deterioration and landslides
6 Low levels of energy security among businesses and households	f Early flood warning systems, advanced seasonal drought warning systems,
7 Gully development, reducing suitability of land	g Disaster management and policies to compensate affected sectors in case of emergency in relation to food production / food insecurity
8 Landslides, damaging property and taking lives	h Use water permits to enhance adherance to water allocation plan
9 Impeded levels of water security/food security	
10 Floods damaging public infrastructure, private properties, and taking lives	
11 Water borne diseases	
12 Health issues related to low water, energy, and food security	

Figure 20: DPSIR for Upper Nyabarongo catchment

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.

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 in the PoM; Table 2 provides a list of responses that have not been addressed sufficiently in the current PoM. The table 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 current plan partners, and additional governmental stakeholder may need to step in, or the private sector may be 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 27: 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. the district capitals of Muhanga, Ruhango, Nyanza, and Nyamagabe.
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. A maintenance plan may need to be developed for the reservoir of Nyabarongo I hydropower plant, to prevent silting up beyond acceptable levels.

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[34] with or reinforcing[35] 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.

[34] E.g. requiring the same resources at the same time/place.

[35] E.g. effectively making use of the same resources in sequence without deterioration.

5. Overview of IWRM packages

IWRM packages have been developed for four areas within the catchment, and around the key themes of catchment restoration, agriculture, ecosystem services, mining and hydropower (either issue-focused or opportunity-focused) (Figure 47, Annex 3). The integrated approach of responding to the key issues and opportunities is explained via a focused DPSIR analyses for each package. 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 solutions may be replicated there and adapted to lessons learnt in these first IWRM packages.

The four IWRM packages to date are as follows:

1. Catchment restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed (LWAPES);
2. Rehabilitation and protection of Kiryango catchments for sustainable agriculture exploitation;
3. Catchment restoration and protection of water bodies in Mwogo watershed (LAPROM);
4. Catchment restoration supporting sustainable and efficient investments in agribusiness, mining and hydropower generation in the most degraded areas of Upper Nyabarongo.

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 for Upper Nyabarongo 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. The total cost of the four IWRM packages was estimated to 23.7 billion Rwf as presented in the tables 24, 25, 26 and 27.

Catchment restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed (LWAPES)

Mbirurume River, before its confluence with the Mwogo River, is one of the major sources of the sediments and floods which disrupt the hydrology of the Nyabarongo River.

Economic water users are often under stress due to the high levels of pollution of the water they use resulting from sediments from soil erosion, landslides and floods. Continual erosion in the catchment also reduces the ability of the soil to store water required for groundwater recharge thereby depleting reserves needed for future socio-economic development.

More particularly, marshlands suitable for irrigated agriculture are often flooded with sand-laden sediments, rendering these marshes unusable until such time as the upstream catchment areas are protected and restored. This analysis of issues, their causal relationships, and potential responses to them is summarised in the focused DPSIR framework in Figure 21.

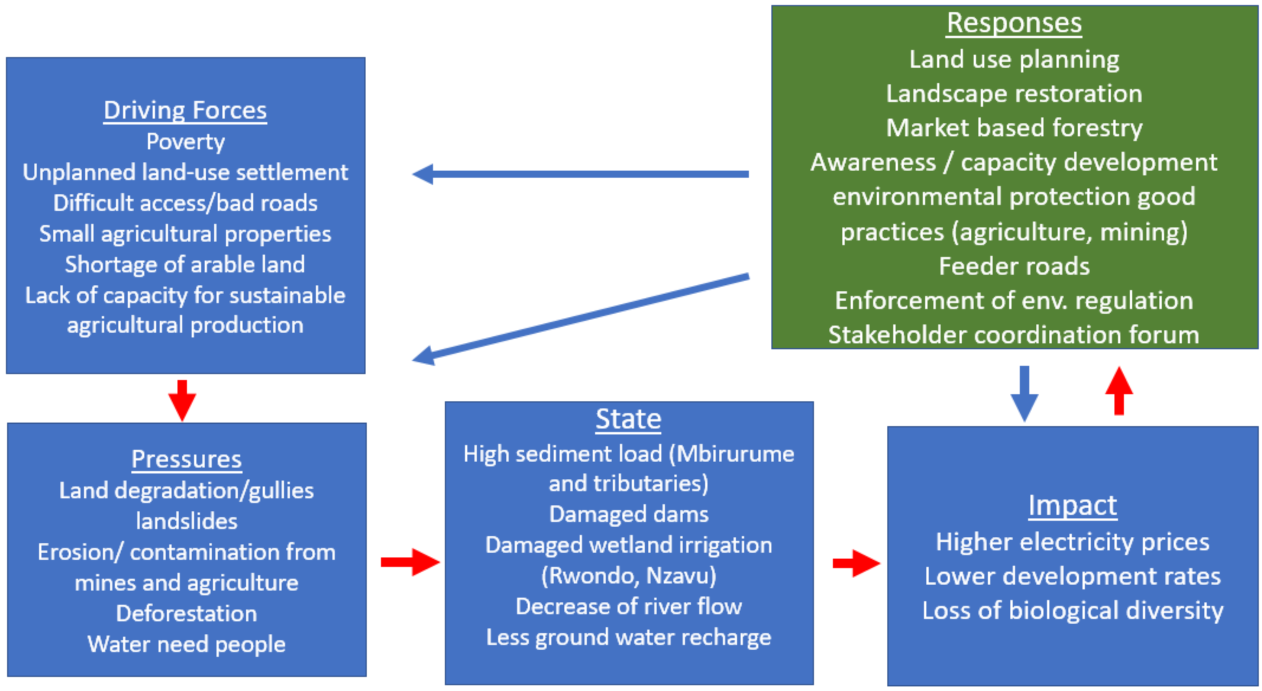

Figure 21: Focused DPSIR analysis for IWRM package 'Catchment restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed (LWAPES)'

Table 22:Estimted cost of IWRM Package 1: LWAPES

CPIP &IP	Total cost
Gatare sub-catchment	**2,657,962,093**
Nzavu sub-catchment	**815,071,347**
Rurongora sub-catchment	**3,098,536,087**
Total Upper Nyabarongo Mbirurume Package (RWF)	**6,571,569,527**

Rehabilitation and protection of Kiryango watersheds for sustainable agriculture exploitation

The main objective of Rwanda's current Irrigation Master Plan (IMP) is to develop and manage water resources to promote intensive and sustainable irrigated agriculture and to improve food security. Specifically, the plan's objective is to provide a planning tool for rational exploitation of soil and water resources.

The water evaluation and allocation modelling conducted revealed that in the Upper Nyabarongo 'Hydropower' sub-catchment, the overall water balance offers ample opportunities for enhanced allocation of water to productive sectors, both within the sub-catchment and downstream. This includes opportunities for the development of new irrigation schemes.

This opportunity cannot, however, be fully exploited without altering existing unfavourable conditions, including siltation of marshes from soil erosion and floods, unsustainable mining activities and poor management of marshlands and entire micro-catchments in the sub-catchment. This affects particularly Kiryango, Base, Nkubi and Nyamigogo marshes and their related dams: Kiryango, Base and Bishya in Ruhango and Nyanza Districts. Bishya dam has the particular function of supplying water to Nyanza and Ruhango Districts, via Mpanga Water treatment plant under the management of WASAC.

District efforts to rehabilitate the catchment and manage marshlands have been limited due to the severity of constraints, especially combined with the effects of climate change and catchment degradation.

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

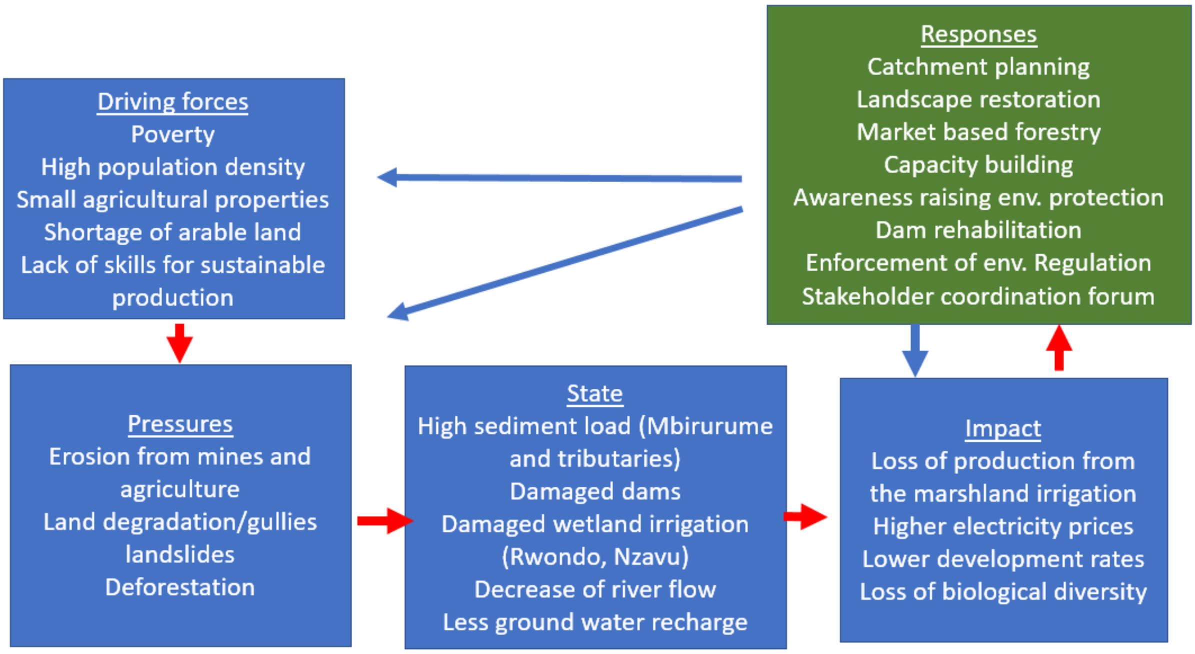

Figure 22: Focused DPSIR analysis for IWRM package 'Rehabilitation and protection of Kiryango watersheds for sustainable agriculture exploitation'

Table 23:Estimated cost of IWRM 2: Kiryango

CPIP &IP	Total cost
CPIP 1 - Land husbandry and landscape restoration in Base, Nkubi, Nyamigogo and Kiryango watersheds	2,406,672,000
CPIP 2 - Rain water harvesting, water drainage and storage for floods mitigation	477,600,000
Total cost Package 1	2,884,272,000

Catchment restoration and protection of water bodies in Mwogo watershed (LAPROM)

The main objective of Rwanda's current Irrigation Master Plan (IMP) is to develop and manage water resources to promote intensive and sustainable irrigated agriculture and to improve food security. Specifically, the plan's objective is to provide a planning tool for rational exploitation of soil and water resources.

The water evaluation and allocation modelling recently conducted revealed that for the Mwogo sub-catchment, the overall water balance offers ample opportunities for enhanced allocation of water to productive sectors, both within the sub-catchment and downstream. This includes opportunities for the development of new irrigation schemes or extension of existing schemes.

This opportunity cannot, however, be fully exploited yet, due to unfavourable conditions including siltation of marshes from soil erosion and floods, poor management of marshlands and their entire catchments in the sub-catchment. This particularly affects the Mwogo River, its tributaries and two Dams (Kabakobwa and Cyarubare).

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

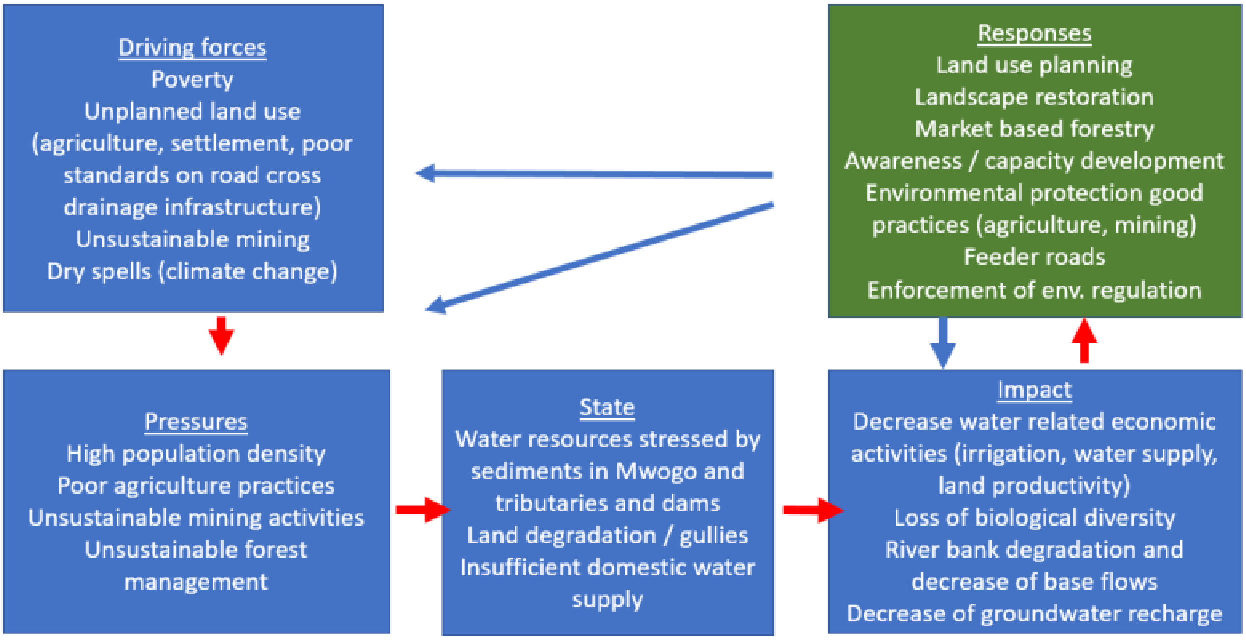

Figure 23: Focused DPSIR analysis for IWRM package 'Catchment restoration and protection of water bodies in Mwogo watershed (LAPROM)'

Table 24:Estmated cost of IWRM Package 3: LAPROM

CPIP	**Total cost**
Muhura sub-catchment	***1,746,400,887***
Nyakigezi - Nyamiseke sub-catchment	***2,492,643,761***
Butamu - Rundazi sub-catchment	***5,184,507,957***
Total cost Package 3	**9,423,552,606**

Catchment restoration supporting sustainable and efficient investments in agribusiness, mining and hydropower generation in the most degraded areas of Upper Nyabarongo

The upper section of the Nyabarongo River, formed by confluence of the Mwogo and Mbirurume Rivers, is adversely affected by intense silting resulting from the very significant sediment load carried by these two tributaries.

Even if catchment rehabilitation measures in the Upper Nyabarongo catchment continue to be implemented, sedimentation of the Nyabarongo River will not be reduced unless the same actions are also undertaken all along its course where the adverse impacts of human activities, especially mining, poor agricultural practices on steep slopes and poor road drainage occur.

In the rehabilitation of the Nyabarongo catchment it is essential to consider the multiple actual and potential benefits, such as hydropower, it does and can provide to the local and national population. This IWRM package is aimed at creating appropriate conditions for investment in, and sustainable operation of the agribusiness sector as well as for sustainable mining and effective hydropower.

This analysis of issues, their causal relationships, and potential responses to them is summarised in the focused DPSIR framework in Figure 24.

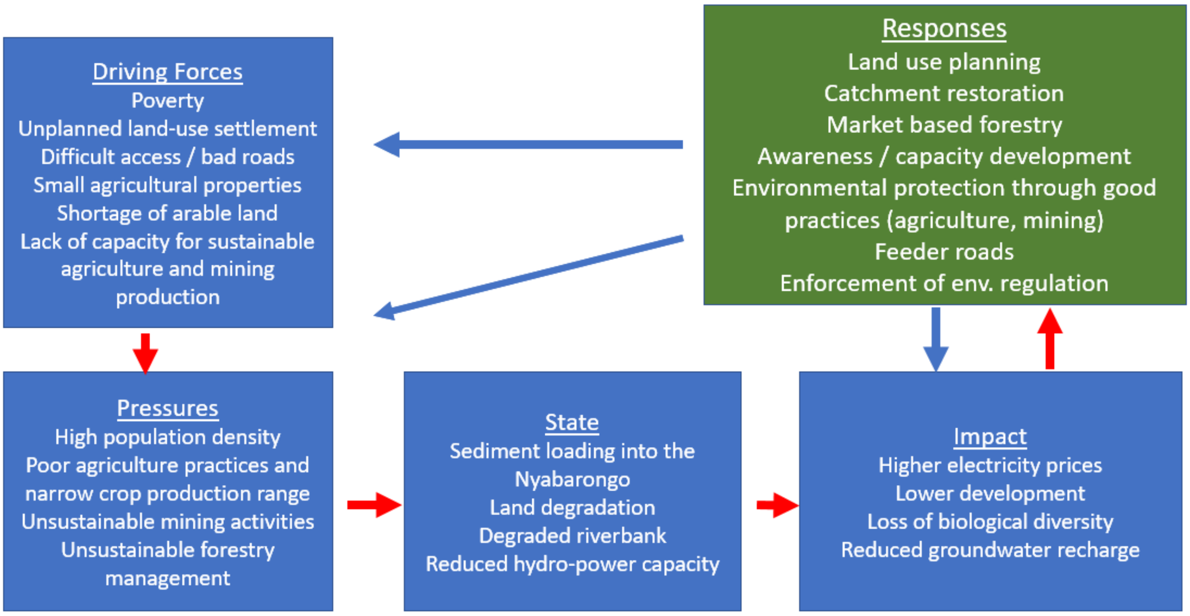

Figure 24: Focused DPSIR analysis for IWRM package 'Catchment restoration supporting sustainable and efficient investments in agribusiness, mining and hydropower generation in the most degraded areas of Upper Nyabarongo'

Table 25:Estimated cost IWRM Package 4: Secoko

CPIP &IP	Total cost
Catchment Restoration	2,859,485,846
Pilot Incentive for ecosystem services	1,904,447,970
Mine remediation	176,700,000
Total cost Package 4	**4,940,633,816**

5.1. 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 25[36] (weights in this overview are theoretic, for illustration).

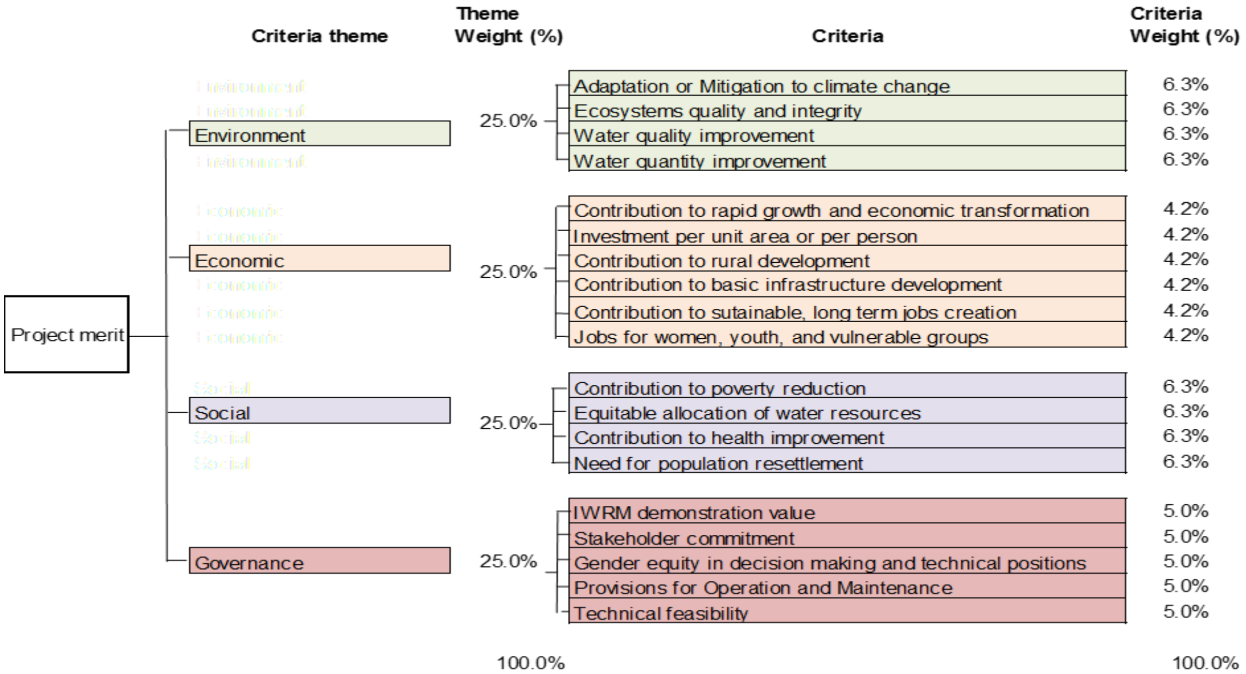

Figure 25: Theme and criteria weights (example with equal weights for themes and for criteria within themes)

36 The weights per theme and criterion in this overview are solely illustrative.

5.2. 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 6 and several of these have been combined in IWRM packages introduced in Section 0. 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%.

IWRM Packages

- Catchment restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed (LWAPES);
- Rehabilitation and protection of Kiryango catchments for sustainable agriculture exploitation;
- Catchment restoration and protection of water bodies in Mwogo watershed (LAPROM);
- Catchment restoration supporting sustainable and efficient investments in agribusiness, mining and hydropower generation in the most degraded areas of Upper Nyabarongo.

Landscape restoration

- Catchment restoration throughout the catchment, following the priorities set in map 8 of the CROM DSS (**Error! Reference source not found.**);
- Resettlement of population from high risk areas;
- Buffer zones and river bank protection along all rivers in the catchment.

Water supply, wastewater and solid waste

- Waste water discharge, pollution control and cleaner production in settlement areas;
- Implement Upper Nyabarongo water supply master plan.

Environmentally friendly economic development

- Develop infrastructure for sustainable marshlands and hillside irrigation;
- Construct infrastructure for hydropower generation;
- Developing sustainable mining practices.

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.

Enhance enforcement of environmental legislation

- Enforce legislation on sustainable mining and close-out restoration of mines;
- Roll out water permitting.

Payment for ecosystem services

- Introduce payments or other incentives for ecosystem services.

Enhance Public-Private Partnerships

- Engagement private sector through Public Private Sector Partnership to exploit catchment opportunities, enhance catchment plan financing, create business environment, and to introduce the business model into all development plans;
- Support large scale investment in catchment opportunities: beekeeping, coffee value chain, tea value chain, big and small livestock, milk value chain, horticulture value chain, and tourism.

Knowledge measures

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;
- Raise awareness of IWRM best practices using DPSIR approach for decision makers, sectoral institutions and community;
- Capacity building of farmers on climate smart agriculture and sensitisation on project ownership and sustainability;

- Support the use of GIS tools for decision making during the design and monitoring of all interventions for catchment plans implementation.

Information management

- Construct and maintain gauging stations 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;
- Continuously update water use data in WEAP models and use the information in the water permitting process.

6. 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 (**Error! Reference source not found.**, 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.

6.1. Sector and agency planning

Planning for implementation will take place yearly, resulting in annual implementation plans (AIPs). Figure30 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. 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 (**Error! Reference source not found.** in Annex 16) and the approach will be first tested in planning for the Muhazi IWRM 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 2018-2020 will include funding for the Muhazi IWRM Package, as selected by the W4GR PSC. An investment opportunities meeting will be held to obtain additional funding for remaining 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.

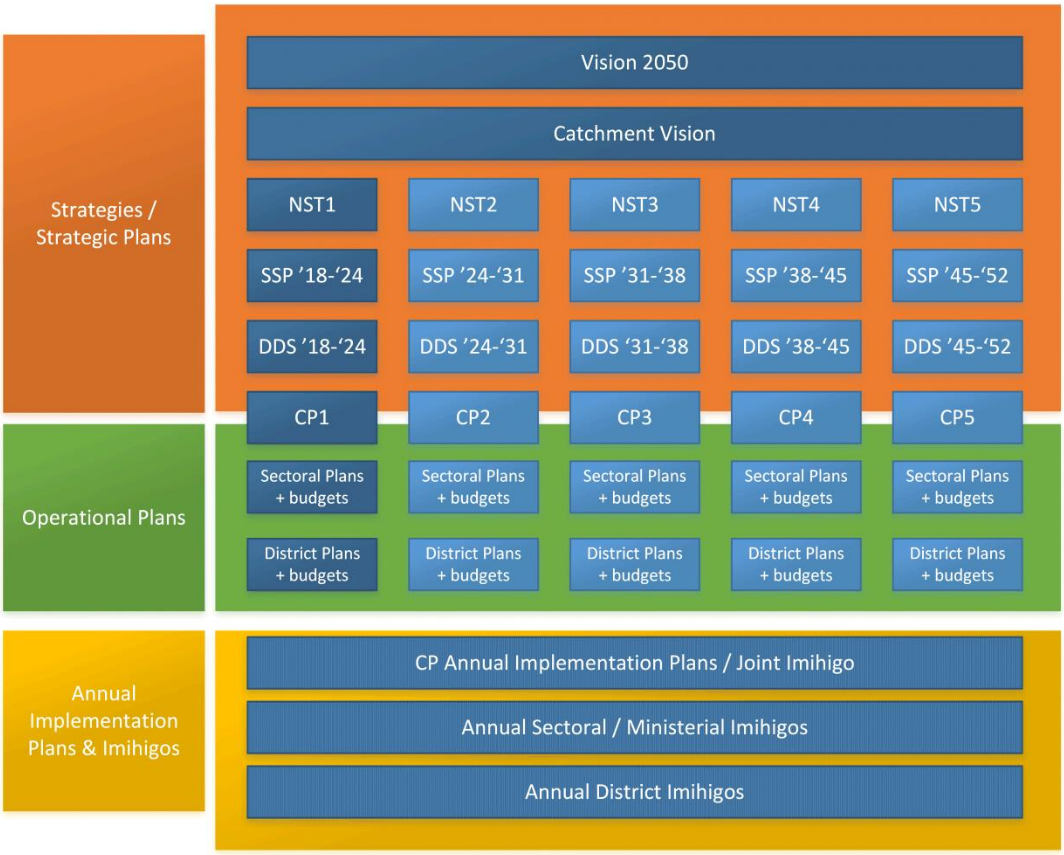

Figure30: Overview of strategies, plans, and Imihigos

6.2. 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 support 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 AIP 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.

6.3. 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 **Error! Reference source not found.**, 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.

7. Intervention logic and Monitoring & Evaluation

7.1. 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 **Error! Reference source not found.**. As per i ts 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[37]. The overview of relevant outcomes and outputs is presented in Table 28.

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

[37] 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.

catchment goals and visions demonstrates the added value of an integrated (IWRM) approach to spatial planning and management.

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 Annual Implementation Plans, activities will be defined and target values (laid down in Joint Imihigos) set for each.[38]

7.2. 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 (**Error! Reference source not found.** in Chapter 1.), joint monitoring and e valuation 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 0, 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.

[38] 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).

Table 26:Logic framework for Upper Nyabarongo Catchmant plan proposed interventions

Hierarchy of results	Key Performance Indicator	Target 2024	Means of Verification	Costing (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)	0.00298	WRMD Annual survey reports/WEAP		
Impact 2: Land productivity increased	Average Yield of main crops in the catchment (Tons/ha / Year)	610,000	Districts Imihigo Reports		
Specific objective 1: Improve 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 functions restored	Area (ha) of land protected against soil erosion in the catchment	55,000	Reports		Ministries, central agencies and, districts have mainstreamed erosion control in their DDPs, sectoral and annual action plans
Output 1.1.1 Areas prone to erosion are protected with terraces and agroforestry	Areas of developed terraces in combination with agroforestry (ha)	41,000	MINAGRI Quarterly Reports	See table 18 , 19& 21	All stakeholders in the Districts committed to mainstream erosion measures
Output 1.1.2 Forest plantations increased in public and private lands in line with District Forest Management Plans (DFMP)	Area ha of forestry cover increased	14000	Forest Department Quarterly reports	See table 18 , 19& 21	District to have updated their DFMP with the support of RWFA
Output 1.1.3 Gullies and degraded old mines rehabilitated	Area (ha) of gullies and old mines rehabilitated	160	WRMD Quarterly reports	See table 18 , 19& 21	Enforcement of laws regulating mining and quarries
Output 1.1.4 Mining companies adopt the application of sustainable mining practices	% of mining companies complying with sustainable mining practices	100%	RMB/WRMD Quarterly reports	See table 18 , 19& 21	Mining companies are willing to comply with mining low and their mining licenses

Output 1.1.5 **Agricultural practices driving soil erosion in the catchment are decreased and replaced with climate smart agriculture**	% of farmlands with improved (climate resilient agriculture) farming methods	60%	MINAGRI/DistrictsQuarterly reports	See table 18 , 19& 21	The Ministry of Agriculture cooperates to adopt improved farming methods protecting land in FFS
Outcome 1.2: Floods related hazards reduced	Area of high risk zones protected against flooding (ha)	2000	WRMD Quarterly reports		Early warning capability for floods or shortage of rains is established and regularly updated
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	100 km.	MININFRA / RTDA Quarterly reports	See table 18 , 19& 21	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	4000	Districts Imihigo reports	To be determined	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	Households:30,000 Public buildings: 200	WRMD reports	To be determined	
Outcome 1.3. Water pollution by solid and liquid waste in urban and villages areas reduced	% reduction in solid and wastewater discharges into rivers	80%	MININFRA Annual reports		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 treatment facilities in urban cities	100% 10%	MININFRA Quarterly reports	To be determined	
	% HHs with access to solid waste collection facilities in rural areas	100%	MINAGRI/Districts /Quarterly reports	To be determined	

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	100%	MINICOM quarterly report		
Outcome 2.1. Protected areas to maintain biological diversity increased	Proportion of protected area to maintain biological diversity (%)	1000 ha	IWRMD Quarterly reports		Business opportunities in the catchment are known by the communities
Output 2.1.1. Buffer zone around reservoirs demarcated and protected	Area of buffer zones around reservoirs protected(ha)	104	IWRMD Quarterly reports	See table 18 , 19& 21	
Output 2.1.2. Buffer zones along rivers and wetlands demarcated and protected	Area of buffer zones along rivers and wetlands protected (ha)	580	IWRMD Quarterly reports	See table 18 , 19& 21	
Output 2.1.3. Natural forest boundaries demarcated and protected	% of Natural forest buffer protected (Mukura, Nyungwe)	80%	MoEQuarterly reports	See table 18 , 19& 21	
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	10000	MoE Quarterly reports	To be determined	
Outcome 2.2. Reduced fire wood demand in households and industries	Balance between the supply and demand of wood biomass (Oven dry Tons of wood per year)	60%	Forest Department/MININFRA Quarterly report		Alternative wood biomass source of energy are available and certified by the Rwanda Bureau of Standards
Output 2.2.1. Efficient and alternative wood biomass energy identified and disseminated to relevant households	% of HHs with alternative and efficient wood energy (ICS, biogas and Liquefied Petrol Gaz)	75%	MININFRA Quarterly report	To be determined	
Output2.2.2 Increased management of existing forest resources	Number of Districts with Forest Management plans	8	Forest Department Quarterly report	To be determined	

Specific Objective 3: Ensure equitable allocation of available water resources for all users of current and future generations					
Outcome 3.1: Equitable allocation of water resources ensured to sector users	Water balance for Domestic use (MCM/y)	7.372	Water permits, WASAC and other water supply companies	To be determined	Water allocation framework in place, and aligned to the Irrigation Master Plan, National Water Resources Master Plan and Upper Nyabarongo Catchmant plan S+SLM+E scenarion
	Water balance for industry (TCM/y	1.738	Water permits and monitoring data	To be determined	
	Volume of water needed for irrigation (MCM/Y)	88.261	Water permits and monitoring data	To be determined	
	Water Demand for livestock (MCM/Y	3.912	Water permits and monitoring data	To be determined	
Output 3.1.1 **Water users with water abstraction permits increased**	% of water users with water abstraction permits (gender-disaggregated data)	100%	WRMD Quarterly report	To be determined	Decision makers committed to conduct a Water user survey
Output 3.1.2 Increased area **for** marshland and hillside irrigation for adaptation to climate change	Command area for marshlands and hillside irrigation from various sources of water (groundwater and rivers) increased (ha)	10000	MINAGRI Quarterly reports	To be determined	
Output 3.1.3 Sustainable access of the population to safe water for domestic use	% of households with access to safe drinking water Number (%) of protected water sources	100% 1342	MININFRA and WASAC Quarterly reports Study Reports	To be determined	Implementation of Upper Nyabarongo Water supply Master plan (WASAC).
Output 3.1.4 **Efficient water use technologies/practices are adopted by all users**	% of users adopting new technologies	20%	WASAC and Districts quarterly reports	TBD	
Specific Objective 4: Strengthen the water governance framework to ensure effective implementation of integrated programmers					
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	To be determined	IWRM Mainstreaming guidelines (by WRMD) available and endorsed by the Ministry of finance and economic planning
	% of central institutions mainstreaming approved catchment	100%	WRMD Quarterly reports	To be determined	IWRM Mainstreaming guidelines (by WRMD) available

	plans in their strategic and annual work plans		Catchment Plan annual M&E report		and endorsed by the Ministry of finance and economic planning
Output 4.1.1 Catchment management committees is established and operationalized	One catchment committee is established and operationalized	One catchment committee in place 100%	WRMD Quarterly reports Catchment Plan annual M&E report	To be determined	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		
	% of representation in Catchment Committees meetings (actual/intended numbers) (disaggregated by gender and district)	100%	Catchment Plan annual M&E report		
Outputs 4.1.2 Conflicts among water users identified, discussed & solved	% of water conflicts raised and solved annually	90%	RWFA/WRMD Quarterly reports Catchment Plan annual M&E report	To be determined	
Output 4.1.3 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	To be determined	
Output 4.1.4 The capacity building plan relevant to IWRM in local organizations (GoR, NGOs, CBOs, Private Sector) elaborated	Availability of the capacity building plan relevant to IWRM in the catchment	1 per district	The capacity building plan	To be determined	
Output 4.1.5 Staff of partner organizations (GoR, NGOs, CBOs, Private Sector) empowered to effectively participate in integrated water management processes	% of people (disaggregated by gender) at national and local level trained according to skills gaps	100% TBA	WRMD Quarterly report Catchment Plan annual M&E report	To be determined	
Outcome 4.2: Knowledge Management for evidence-based decision making in IWRM improved	Type of Studies conducted to inform decision making in the application of IWRM.	1. PES pilot study 2. A study on the sustainable	WRMD Quarterly reports Catchment Plan annual M&E report	To be determined	

		mining in Secoko Sub-catchment available			
Outputs 4.2.1: Study on the sustainability of Ecosystem Services in the catchment is conducted and disseminated	Availability of the study report	Report available	IWRMD Quarterly reports	To be determined	
Output 4.2.2..A plan with sustainable mining measures produced to adress on-going adverse impact to the environment in Secoko Sub-catchment	Availability of the study report	Study Report available	IWRMD Quarterly reports	To be determined	
Output 4.2.3. Water monitoring stations installed and operational	Number of water monitoring stations installed and operational	5	WRMD Quarterly reports Catchment Plan annual M&E report	To be determined	
Output 4.2.4 Knowledge on IWRM transferred and disseminated	Number of best practices and lessons documented and shared Water MIS is online accessible and actively used (number of hits, downloads and unique users)	TBA	WRMD Quarterly reports Catchment Plan annual M&E report	To be determined	
Output 4.2.5. 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	To be determined	

Reference list

General references

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- 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 uses 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;
- Water for Growth Rwanda, 2017. Catchment Plans v1.0, Demonstration catchment Muvumba, Sebeya, Upper Nyabarongo, Nyabugogo);
- 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 27: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.

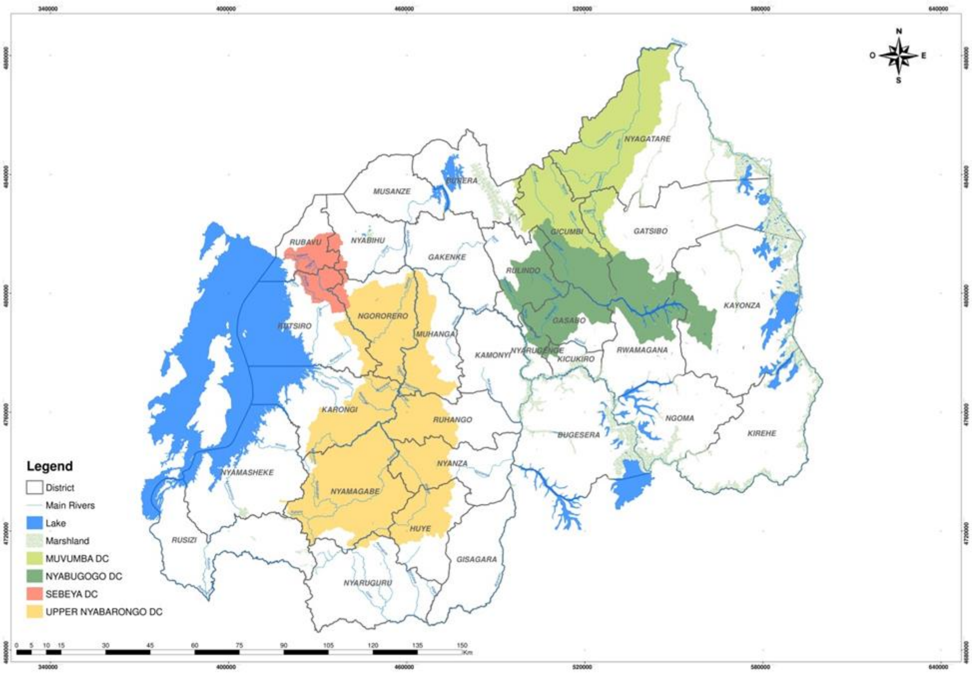

Figure 27: Demonstration catchments of Water for Growth Rwanda

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.

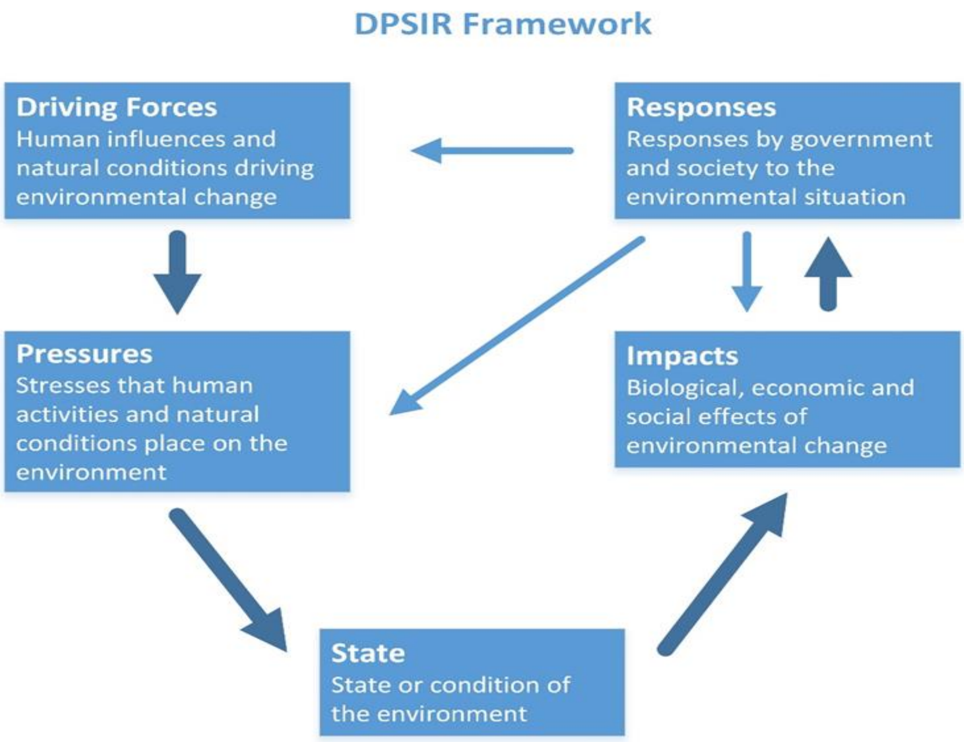

Figure 28: The DPSIR framework visualised

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 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.

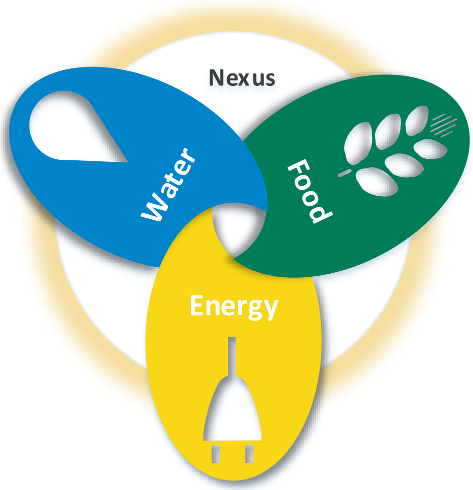

Figure 29: The water-energy-food security nexus

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.

Annex 3. Catchment Atlas

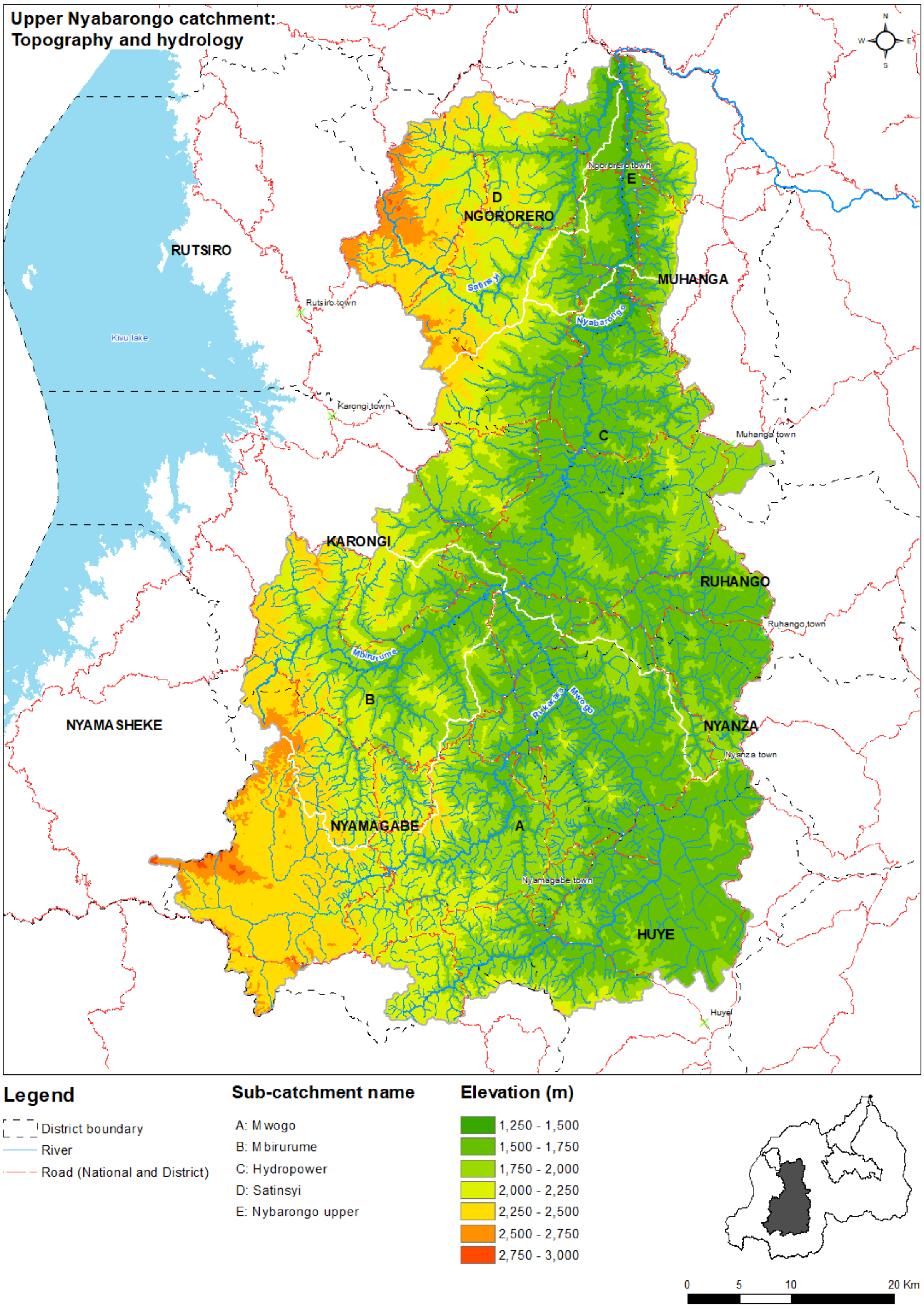

Figure 30: Upper Nyabarongo catchment elevation, waterways, and sub-catchments

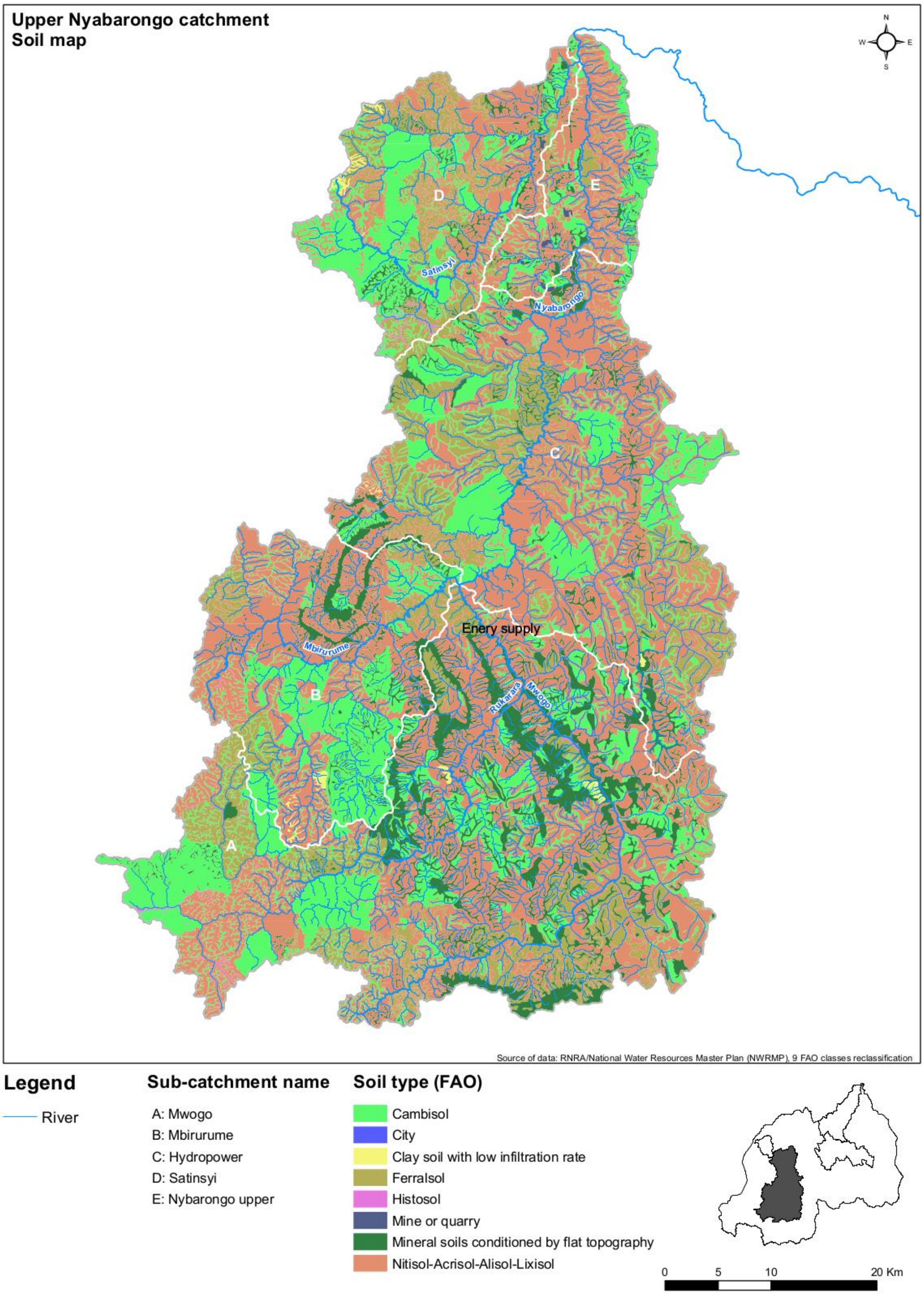

Figure 31: Soil types in Upper Nyabarongo catchment

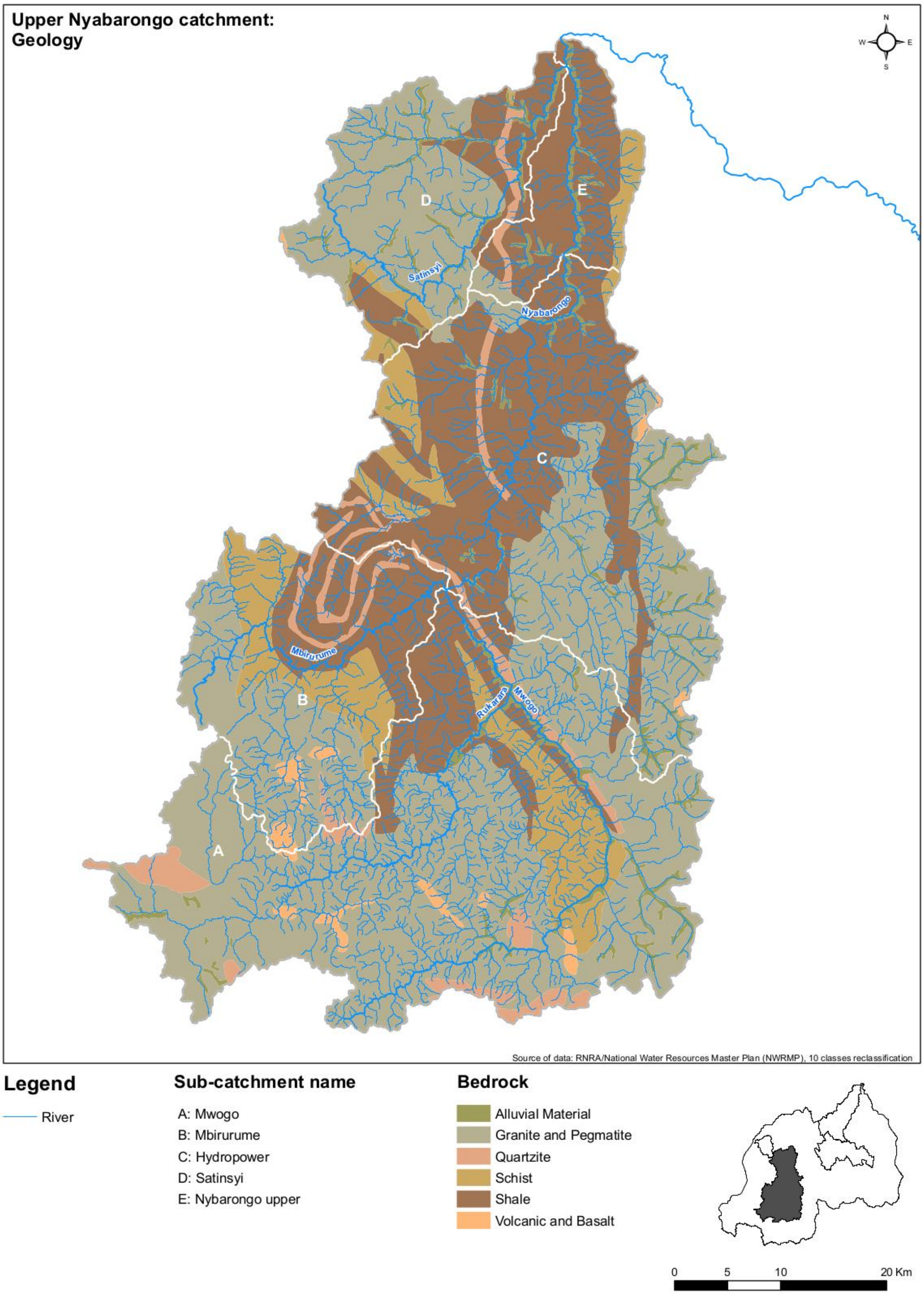

Figure 32: Geology of Upper Nyabarongo catchment

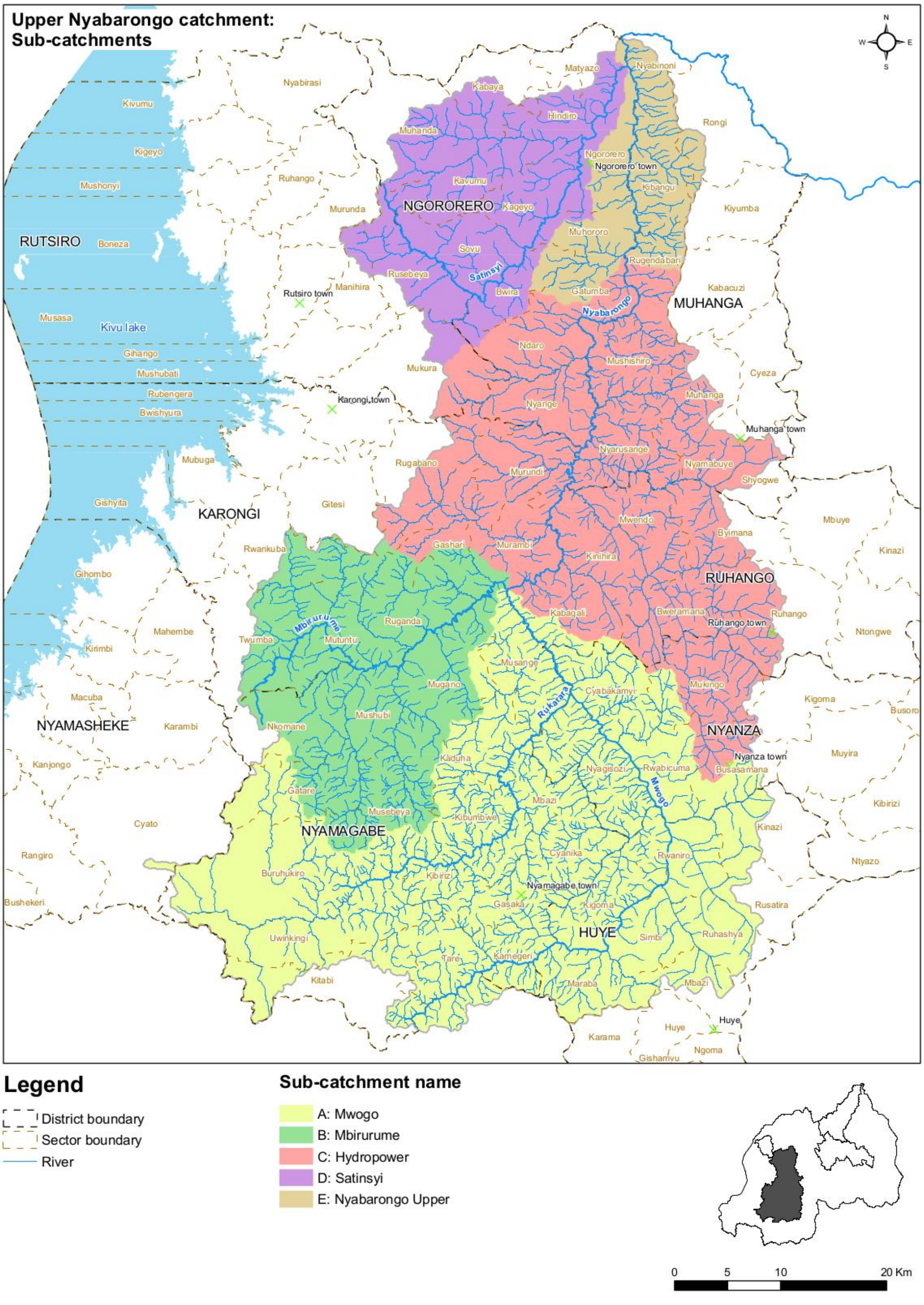

Figure 33: Sub-catchments map

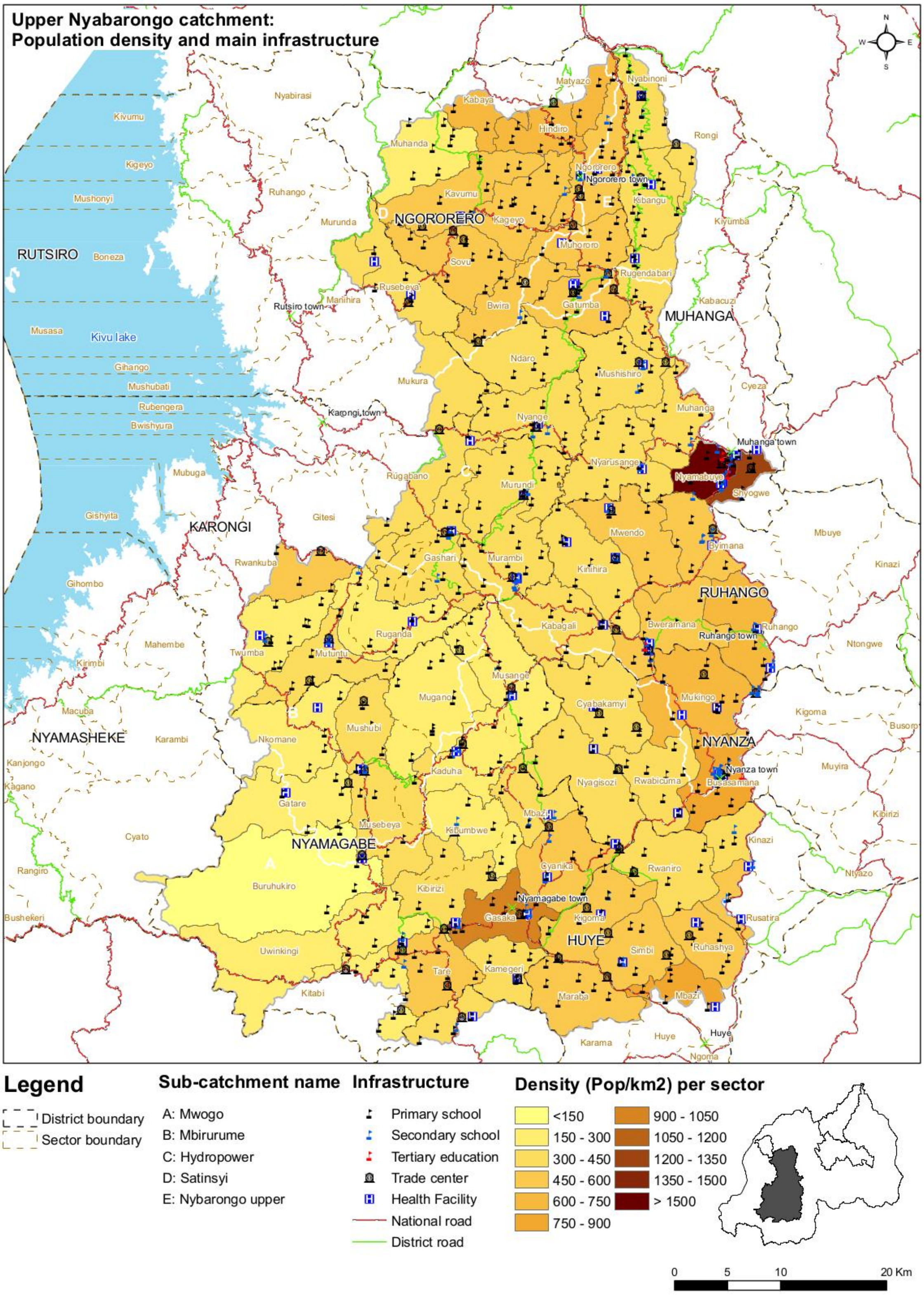

Figure 34: Upper Nyabarongo catchment population density and key-infrastructure

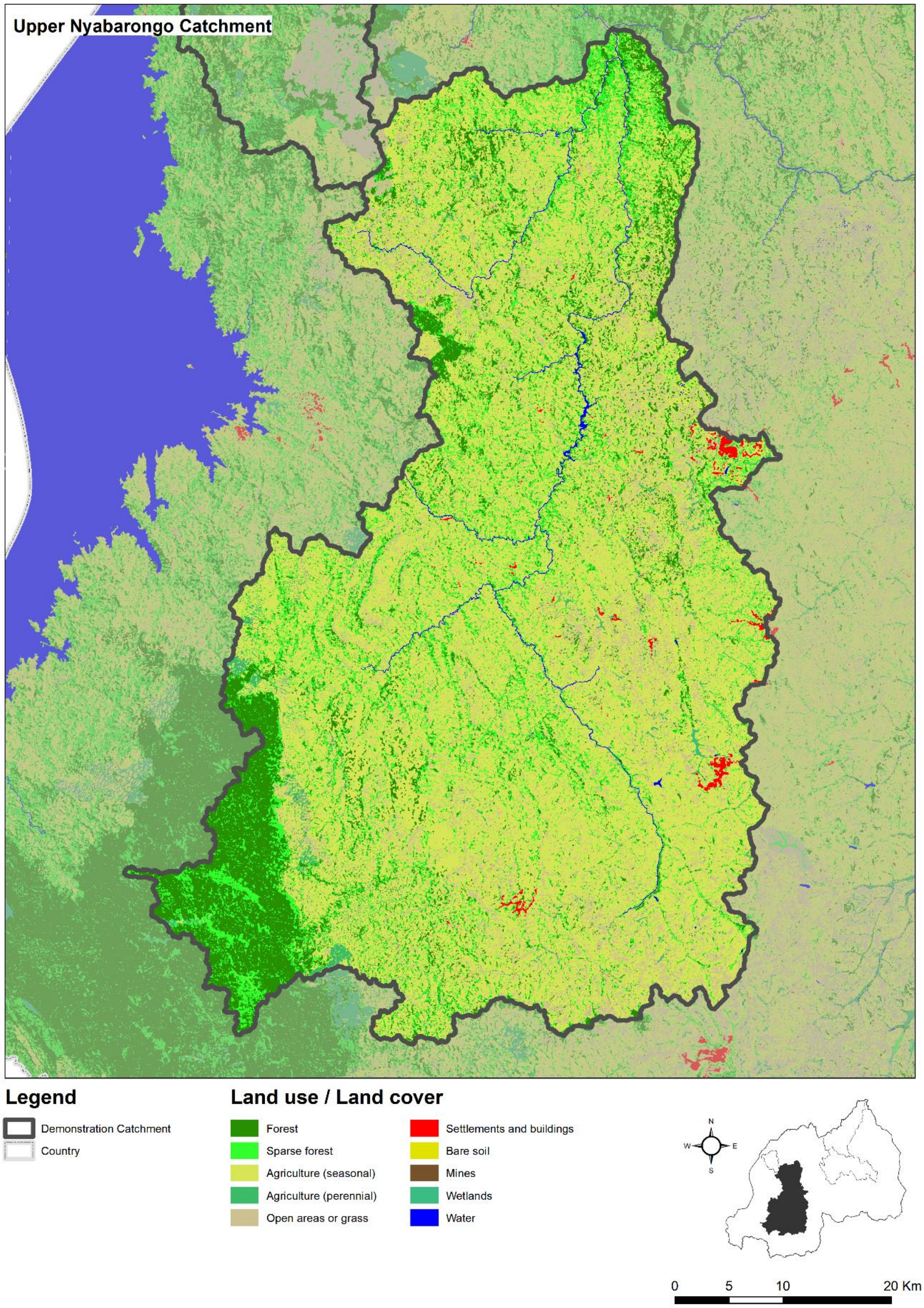

Figure 35: Land Use / Land Cover map (LULC) (W4GR 2018)

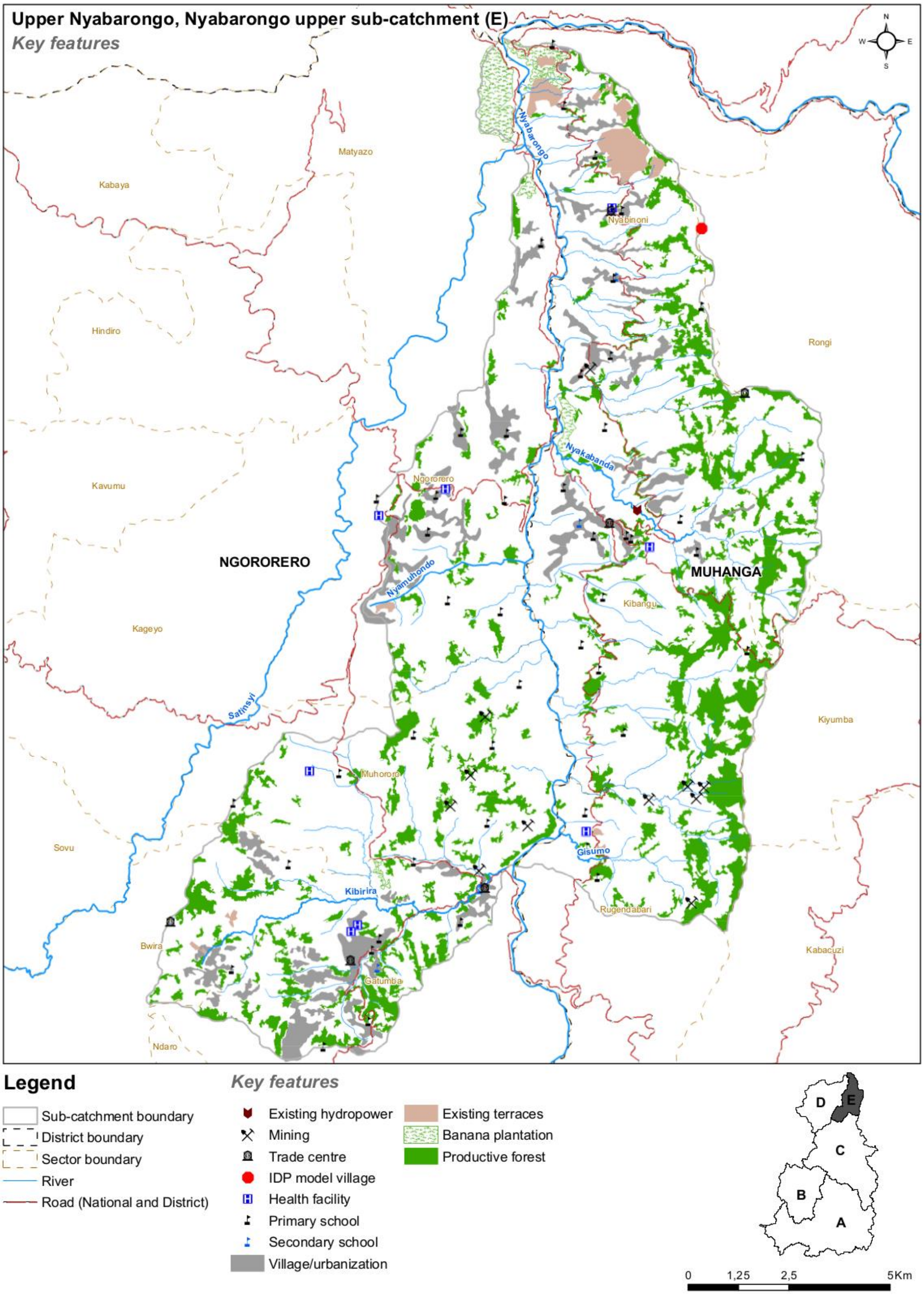

Figure 36: Key geographic features of the Nyabarongo Upper sub-catchment

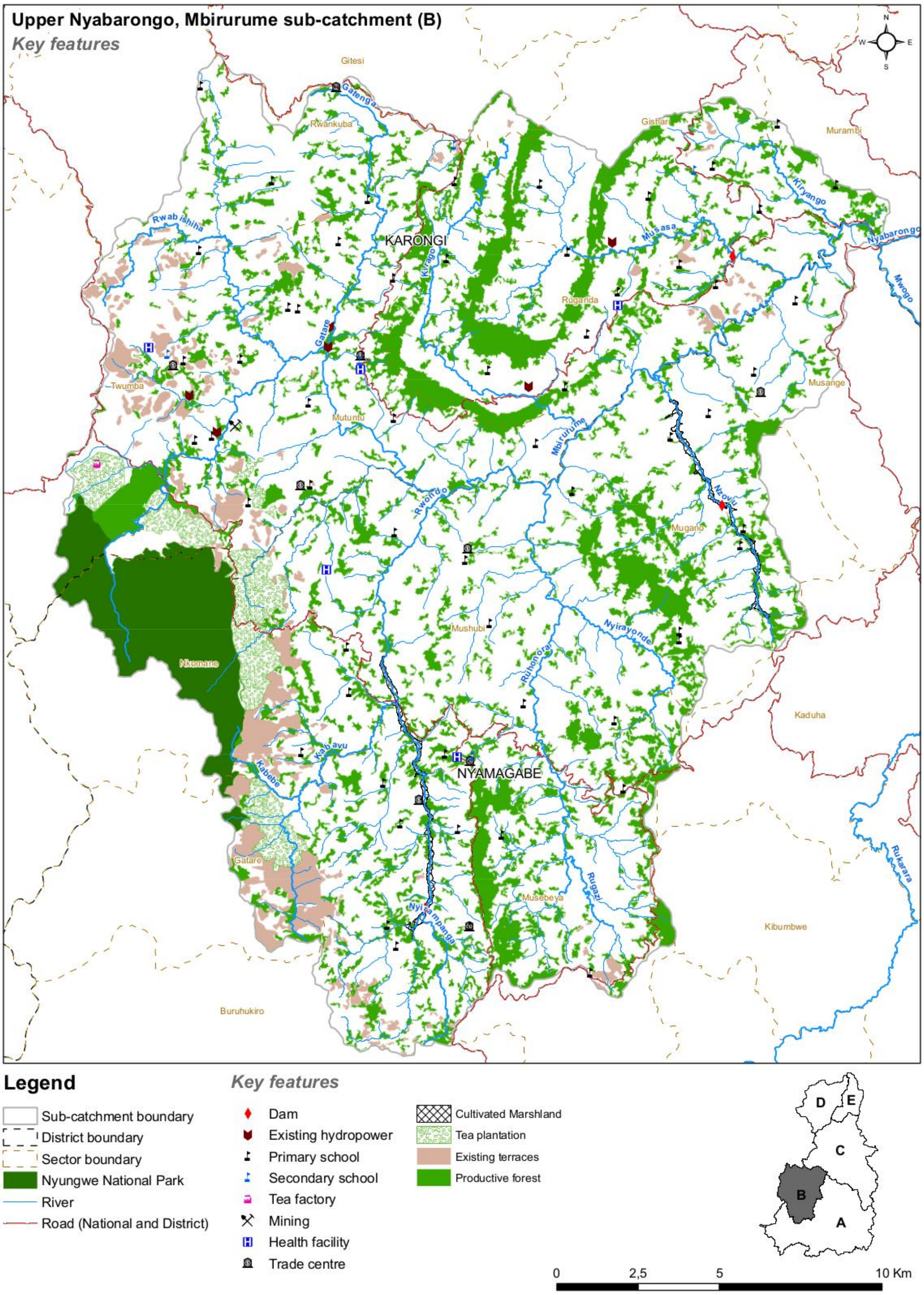

Figure 37: Key geographic features of the Mbirurume sub-catchment

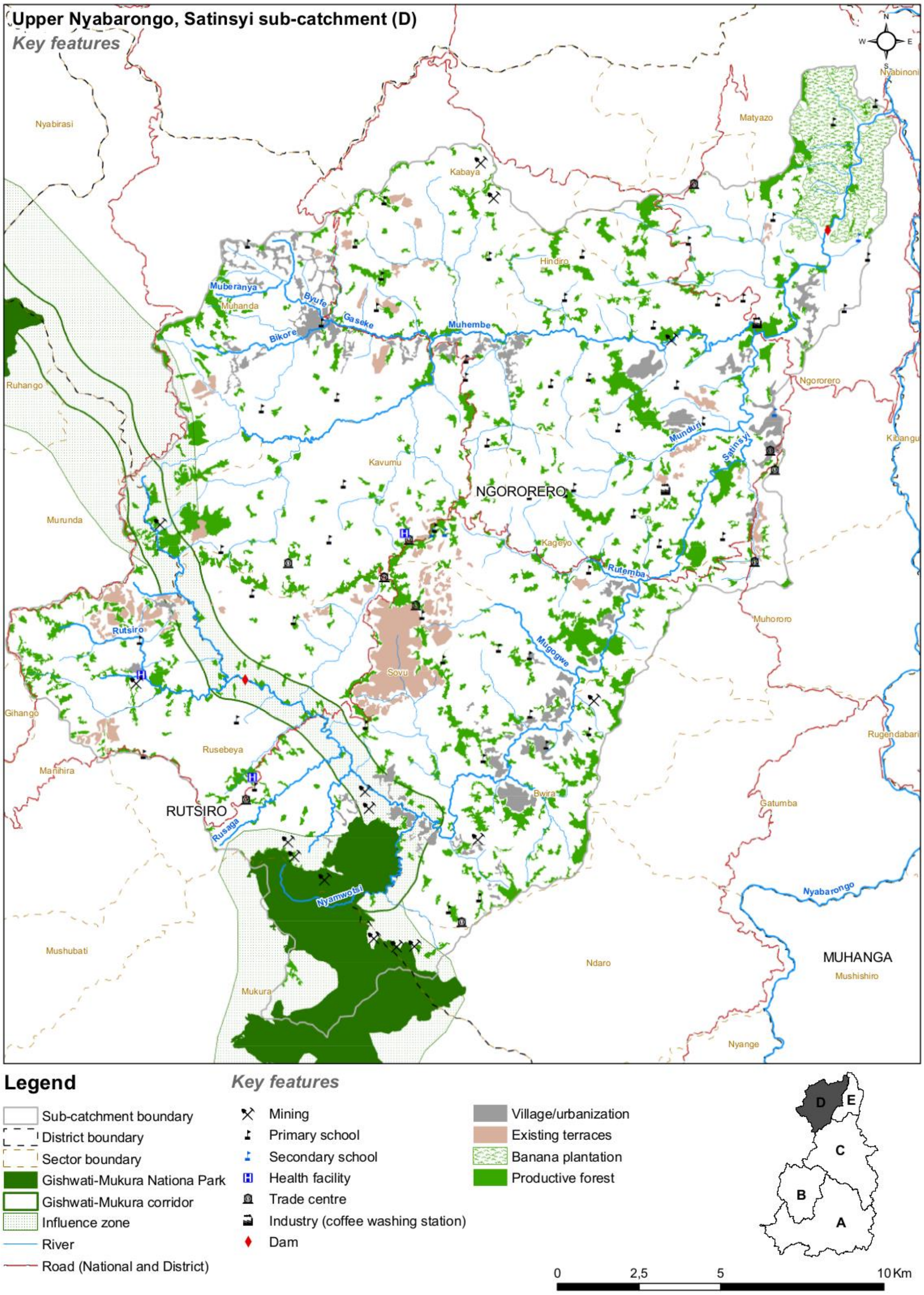

Figure 38: Key geographic features of the Satinsyi sub-catchment

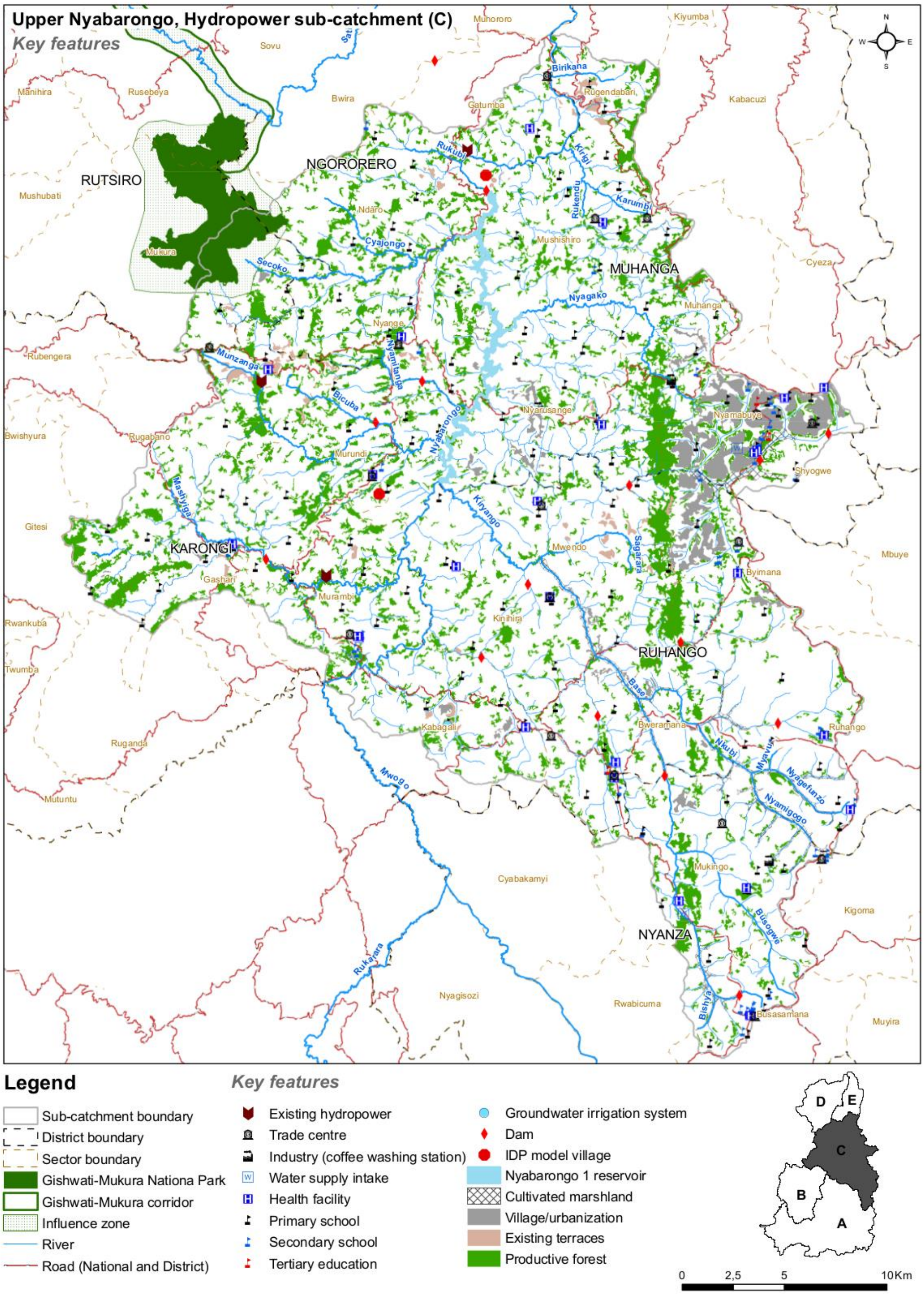

Figure 39: Key geographic features of the Nyabarongo Hydropower sub-catchment

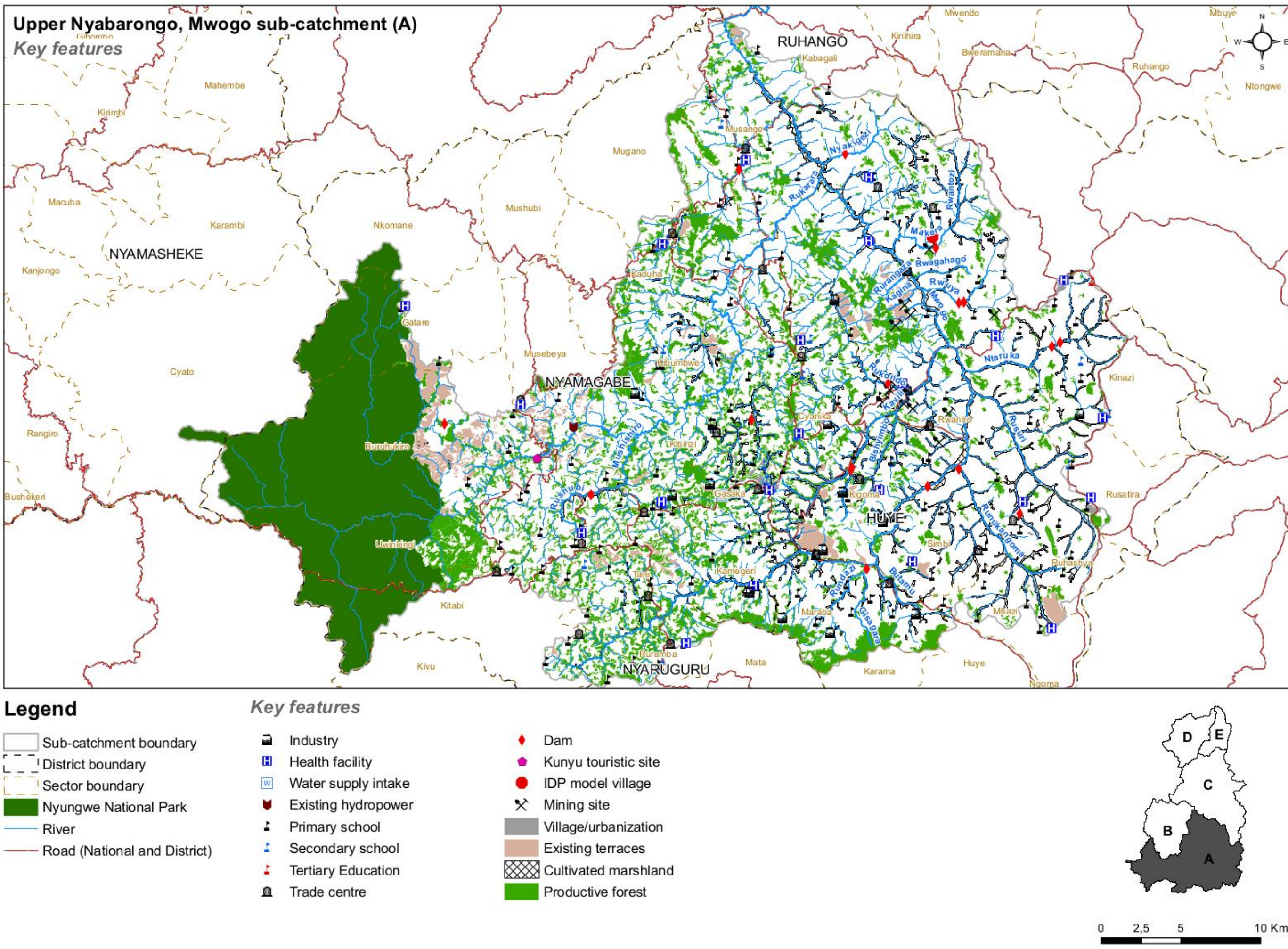

Figure 40: Key geographic features of the Mwogo sub-catchment

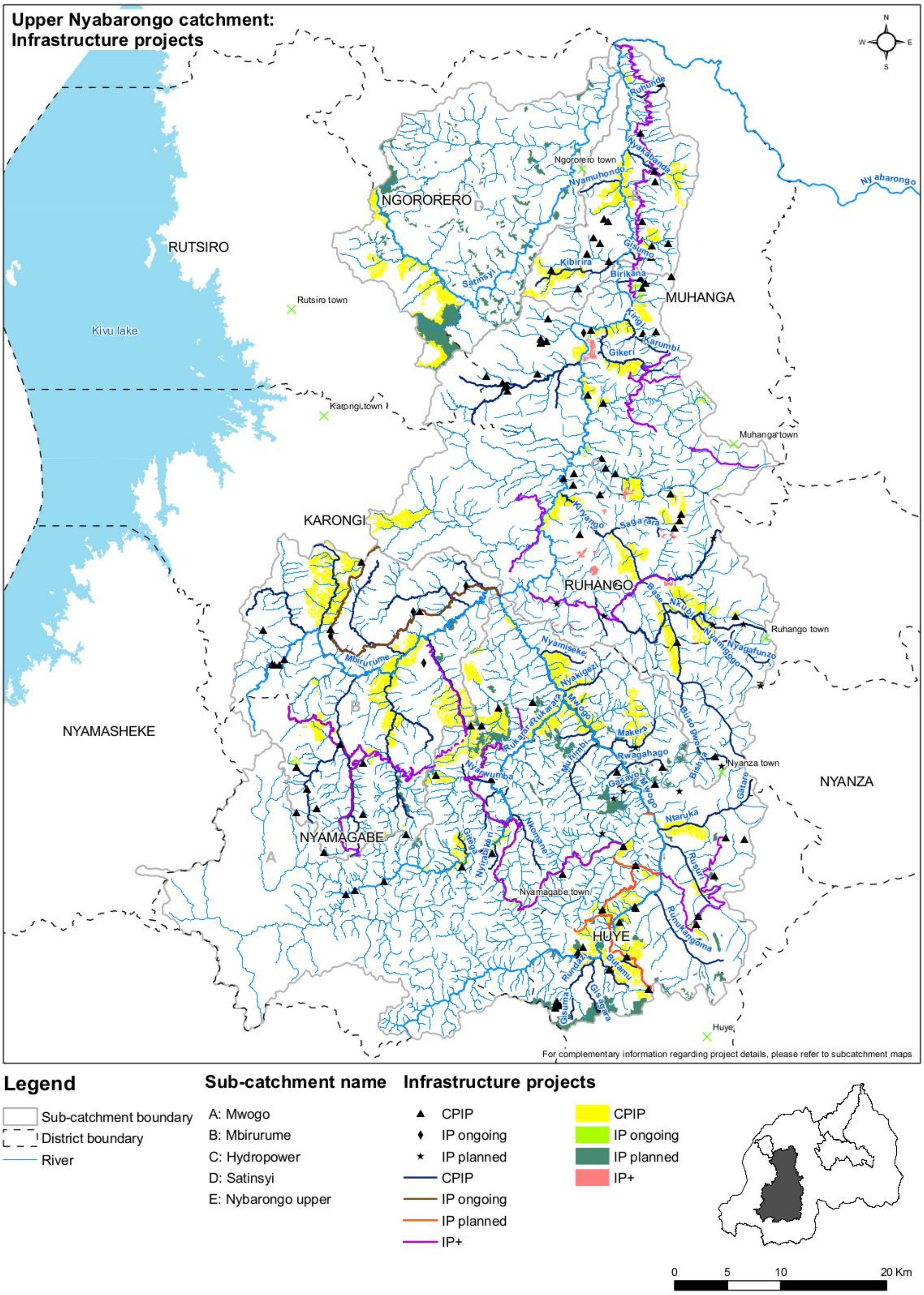

Figure 41: Infrastructure projects classified (IP/CPIP)

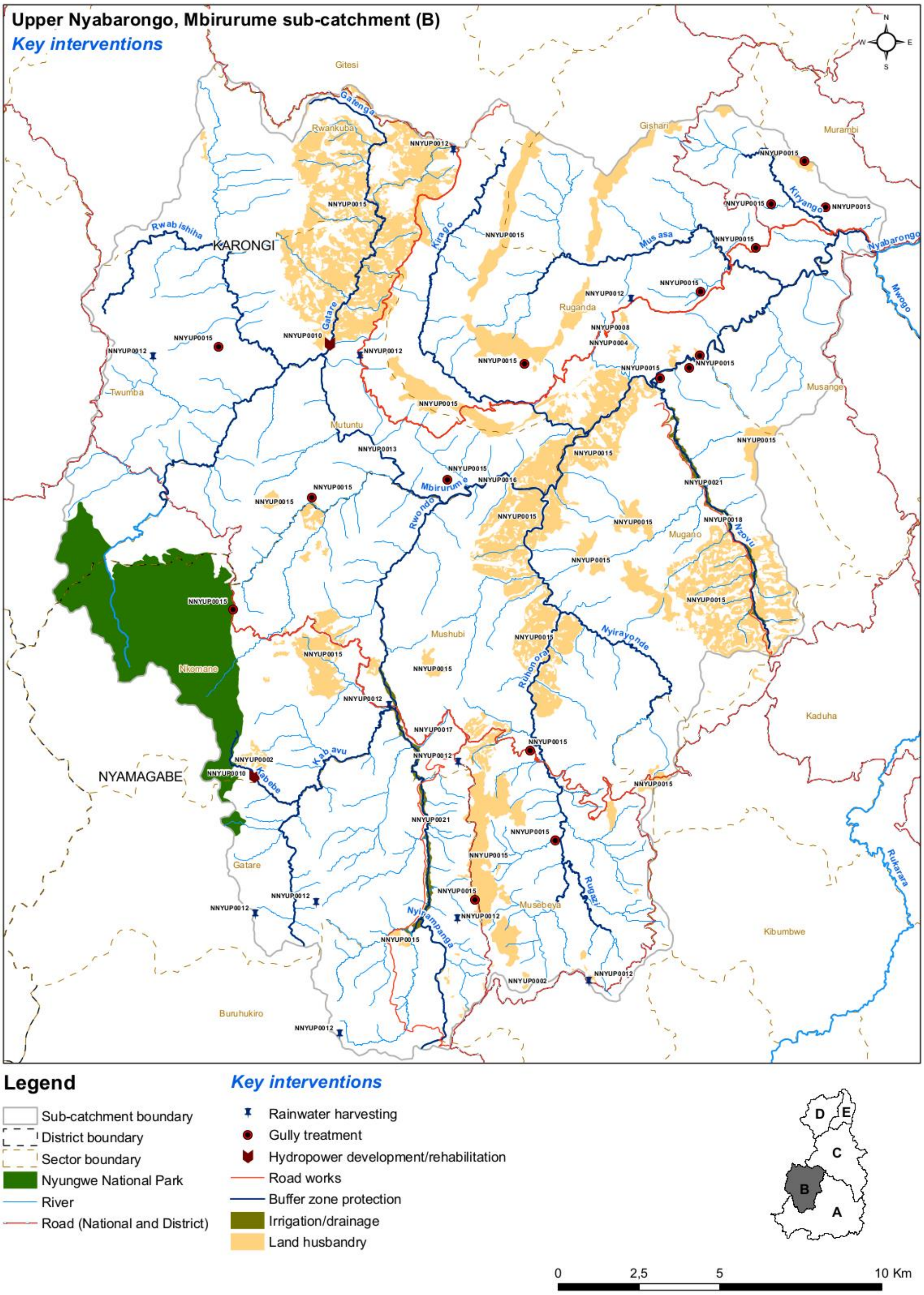

Figure 42: Key interventions in Mbirurume sub-catchment (interventions included only where spatial scope is known)

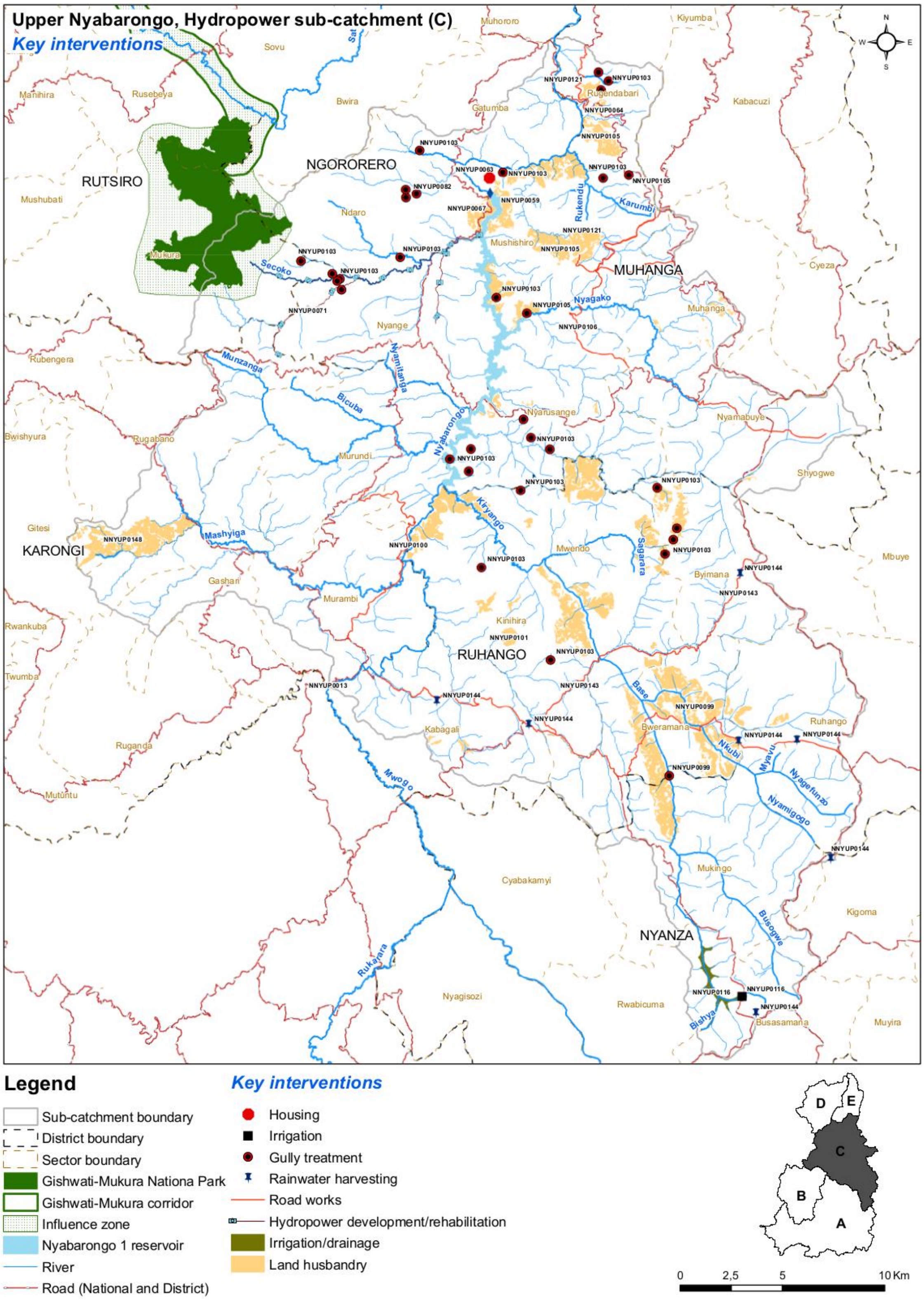

Figure 43: Key interventions in Nyabarongo Hydropower sub-catchment (interventions included only where spatial scope is known)

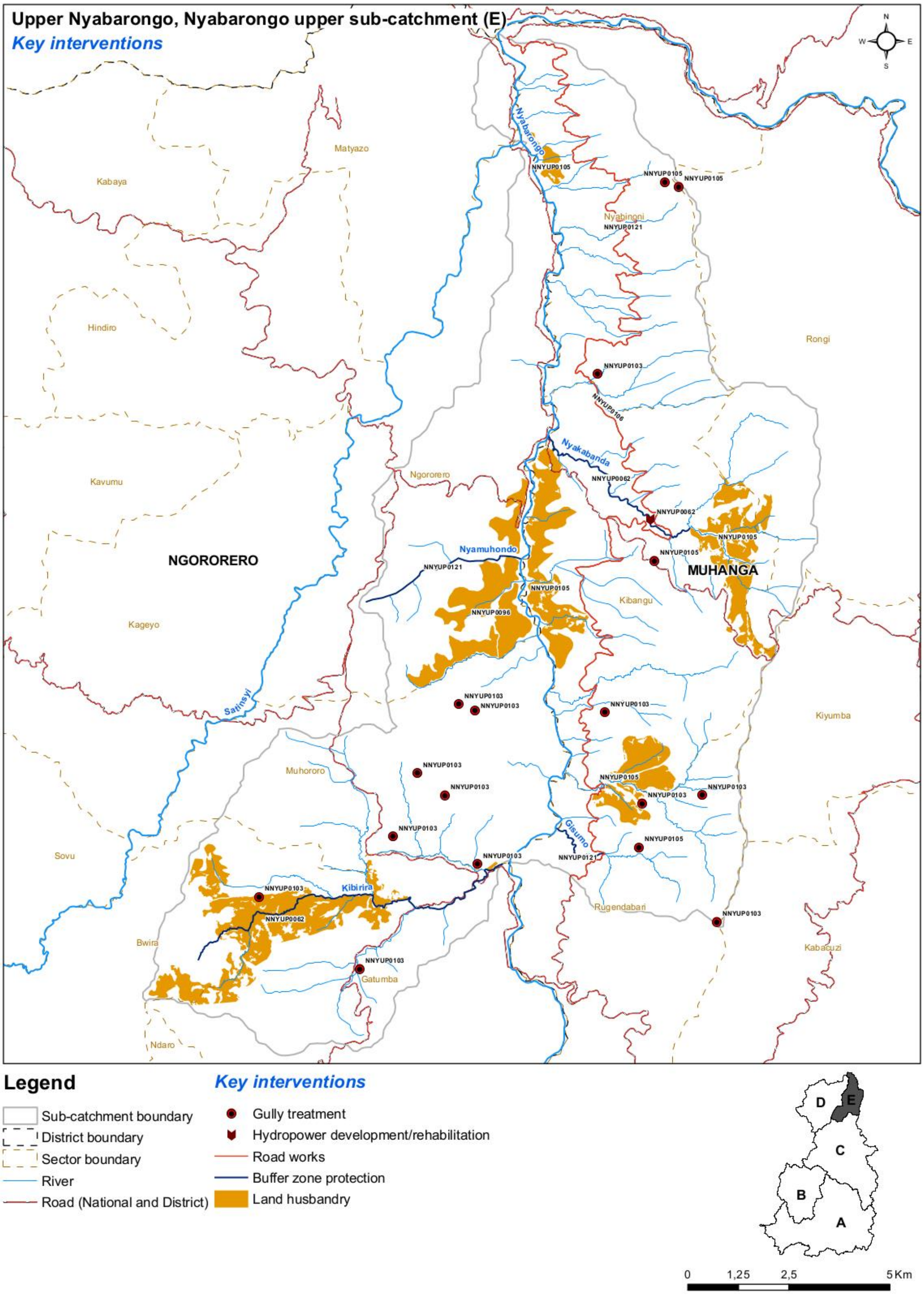

Figure 44: Key interventions in Nyabarongo Upper sub-catchment (interventions included only where spatial scope is known)

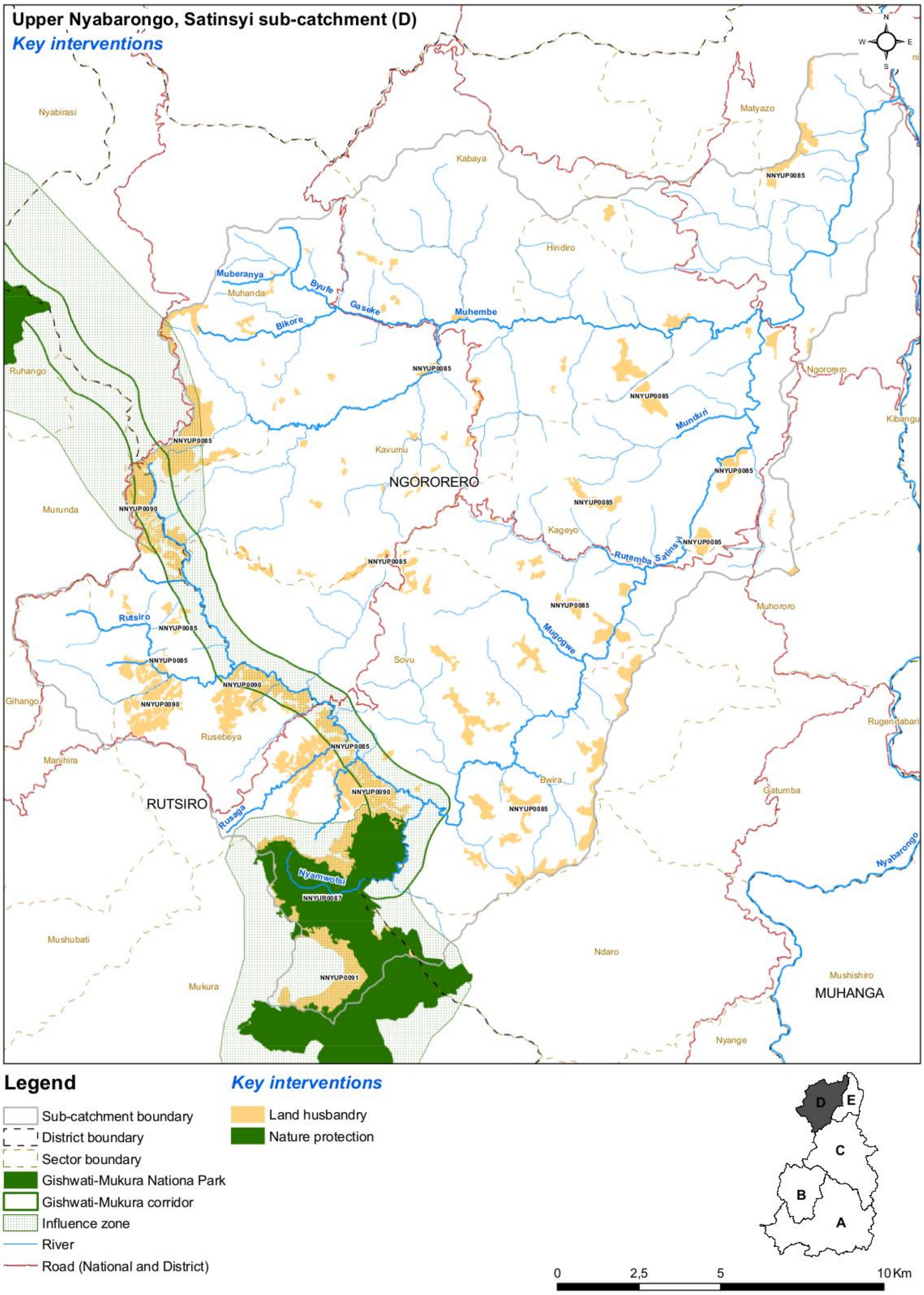

Figure 45: Key interventions in Satinsyi sub-catchment (interventions included only where spatial scope is known)

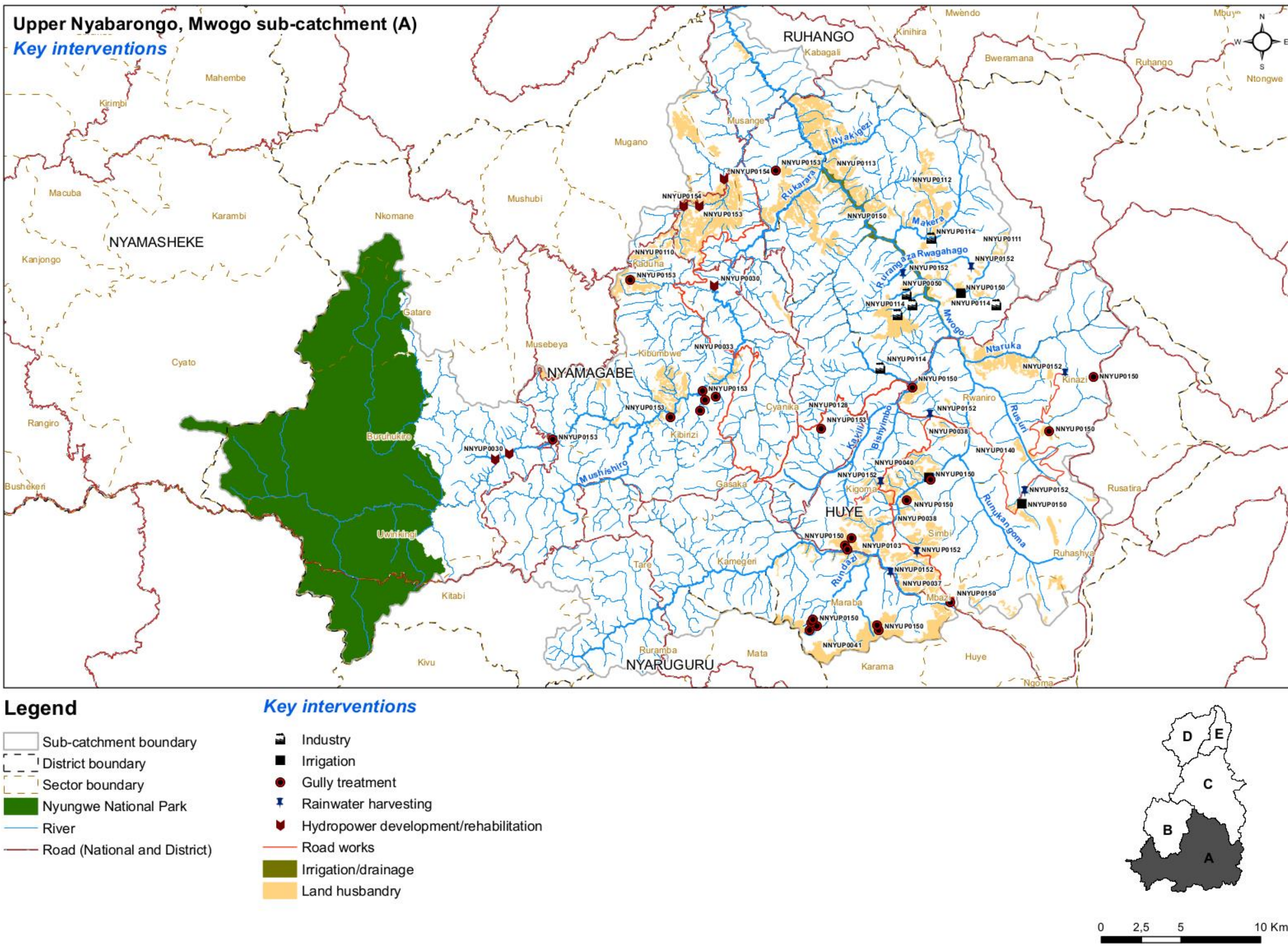

Figure 46: Key interventions in Mwogo sub-catchment (interventions included only where spatial scope is known)

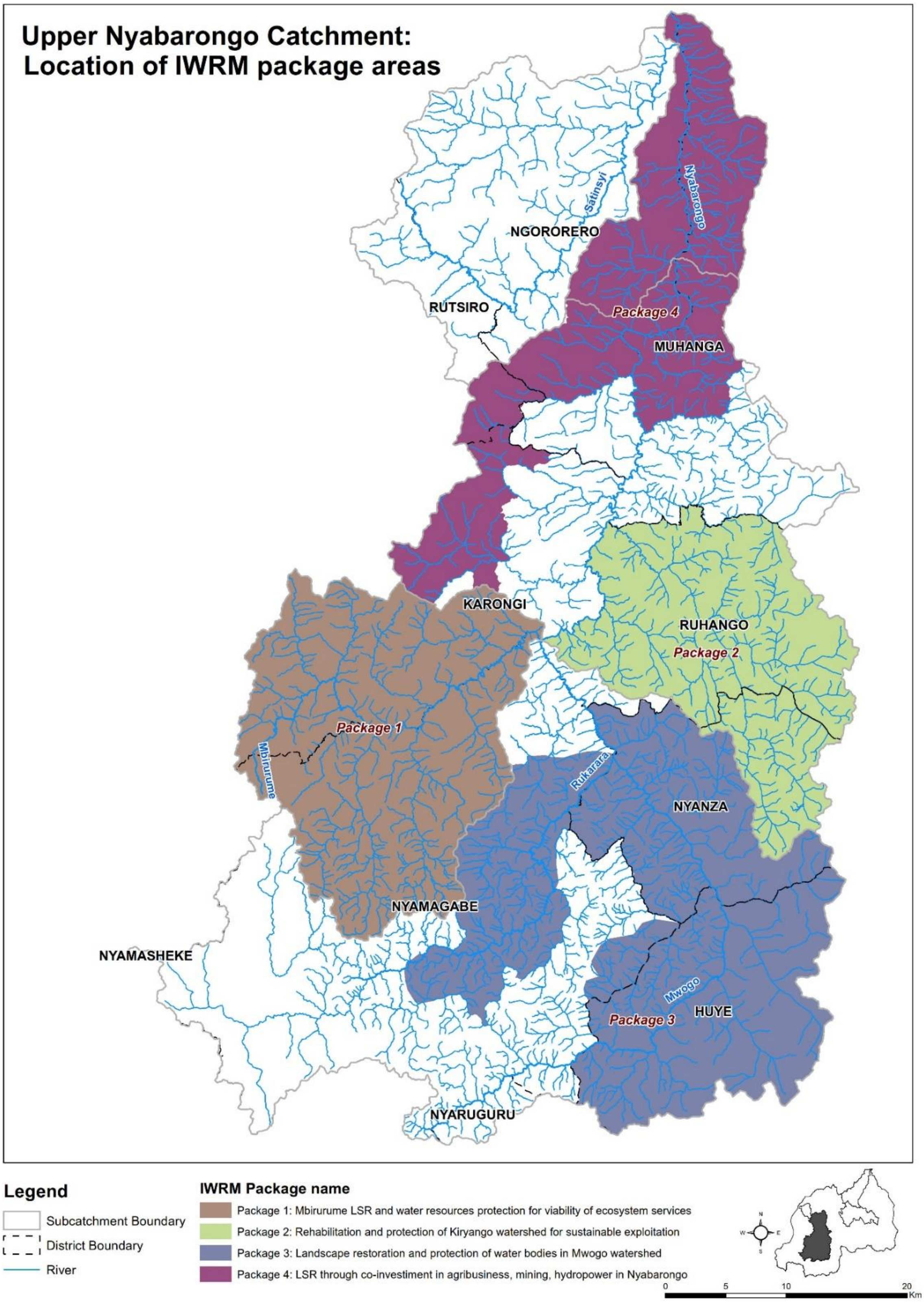

Figure 47: Key Overview of IWRM packages in the catchment, developed in February 2018

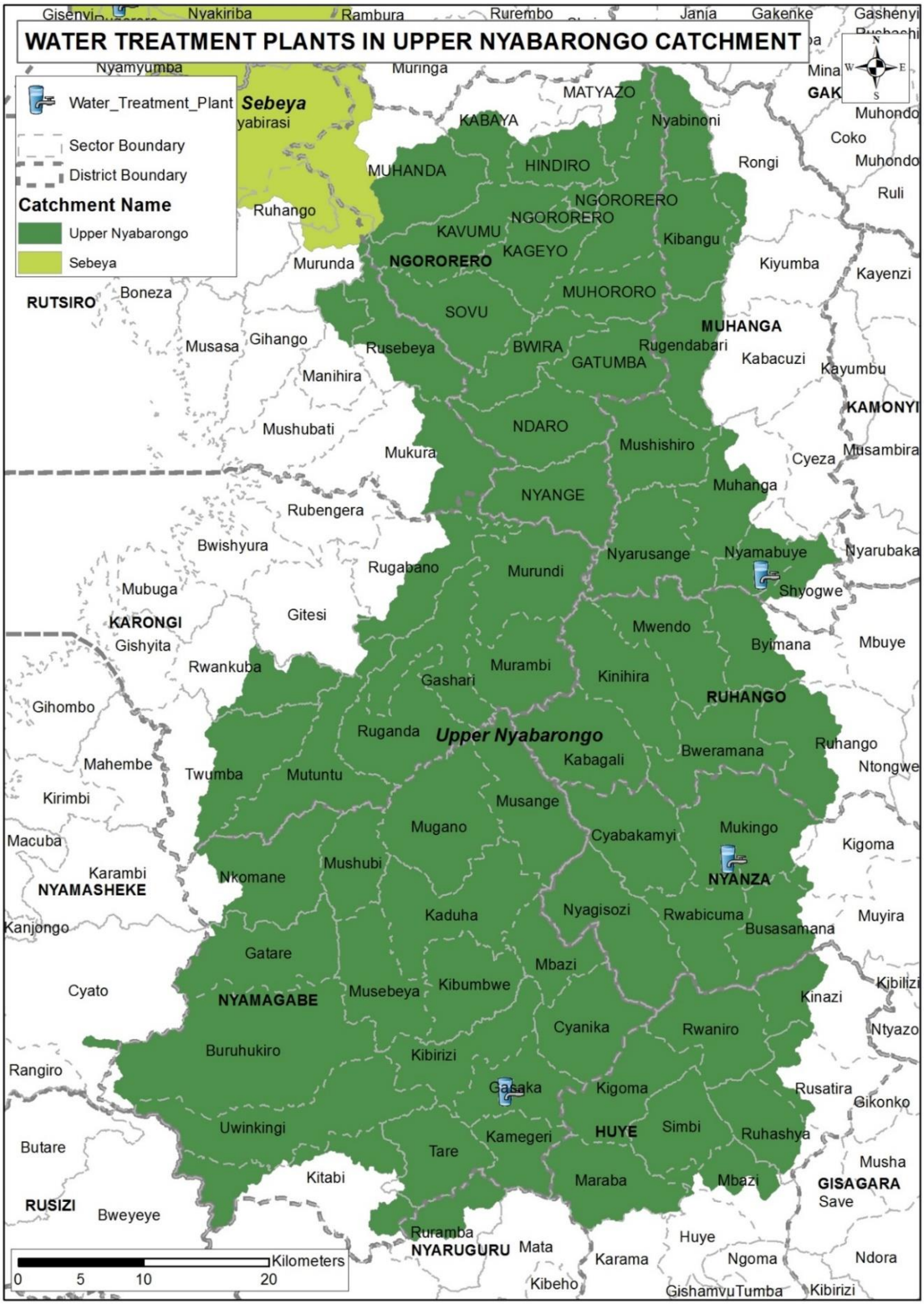

Figure 48: Water Users Survey – Water treatment plants in Upper Nyabarongo catchment

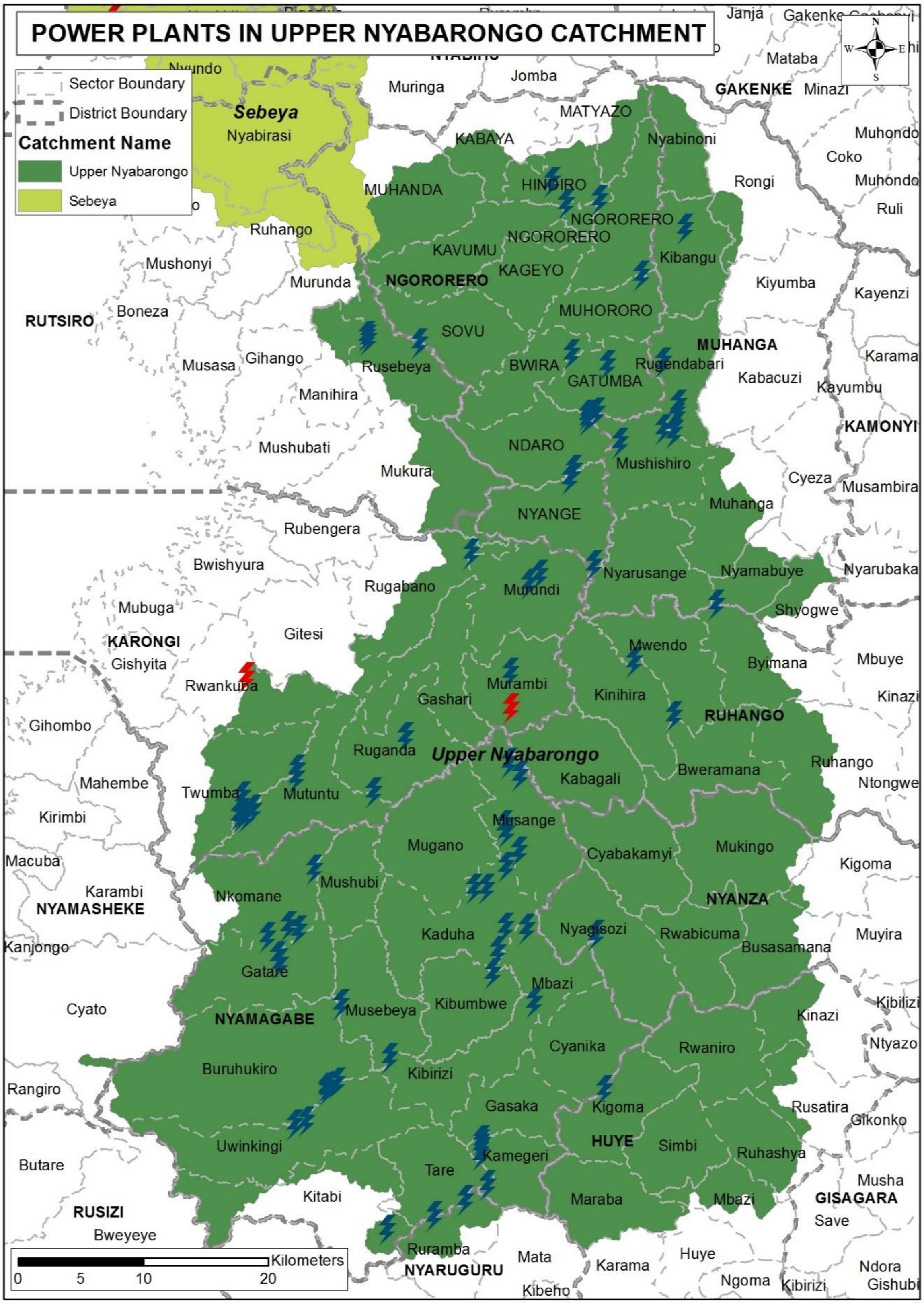

Figure 49: Water Users Survey – Hydro power plant sites in Upper Nyabarongo catchment (existing and potential)

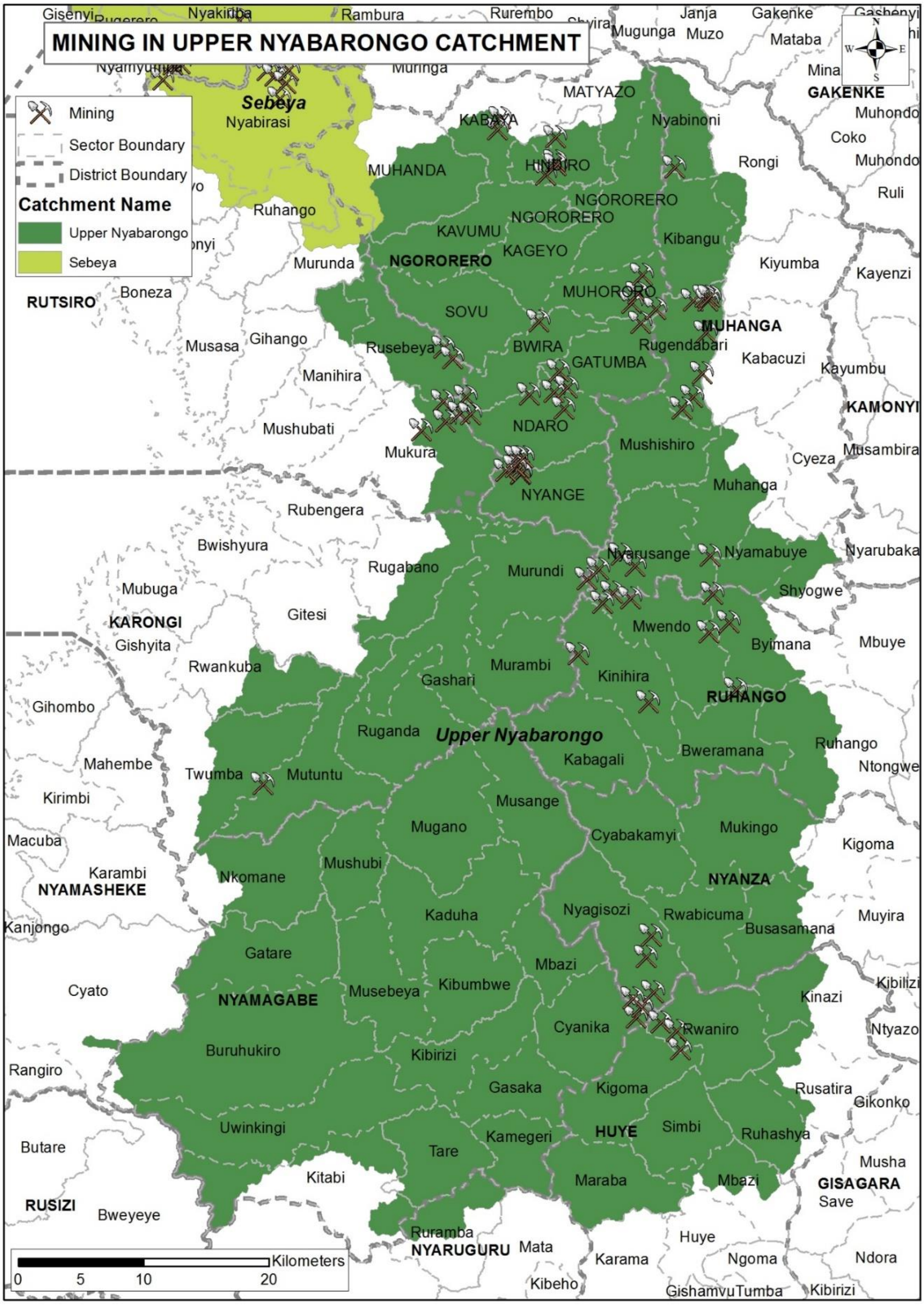

Figure 50: Water Users Survey – Mines in Upper Nyabarongo catchment

Figure 51: Water Users Survey – Industries in Upper Nyabarongo 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[39]. 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 4.2.3).

[39] 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 emphasize 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/RWFA, 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[40];
- 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 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

[40] The SDGs also formed key input for the development of the vision and objectives for this catchment plan. The selection and formulation process is 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).

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 **Error! Reference source not found.**, 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 Figure30, chapter 0Catchment 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 52), demonstrating the added value of catchment planning – as key IWRM instrument – to achieving national objectives and priorities.

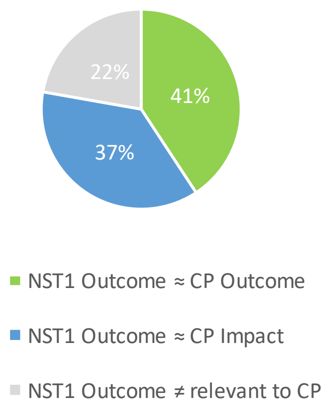

Figure 52: Overall CP alignment to NST1

Figure 53 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.

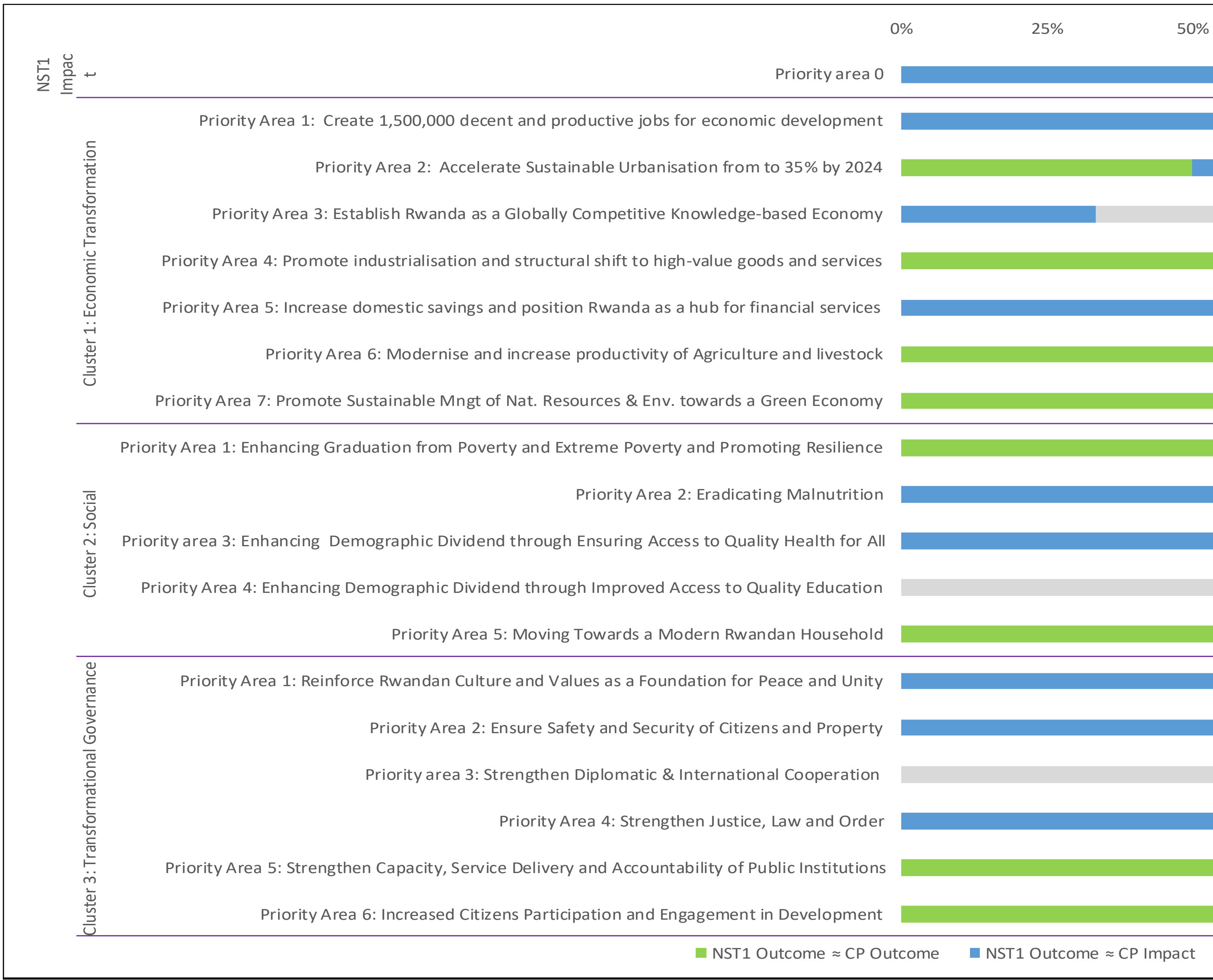

Figure 53: NST1 alignment with Catchment Plan based on NST1 Outcomes per Priority Area

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 54. 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 for 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.

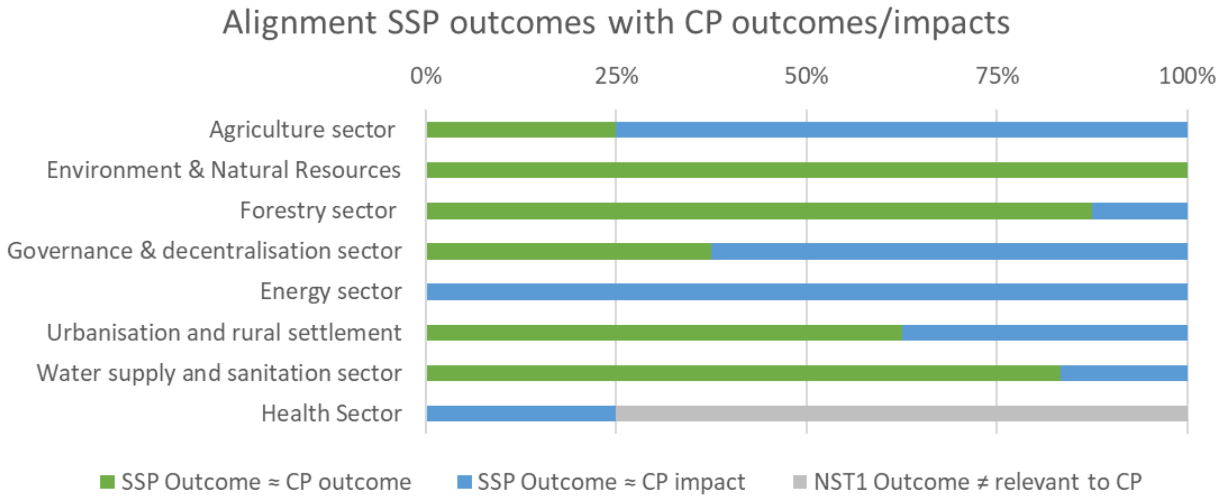

Figure 54: Draft SSP alignment overview

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 55). 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.

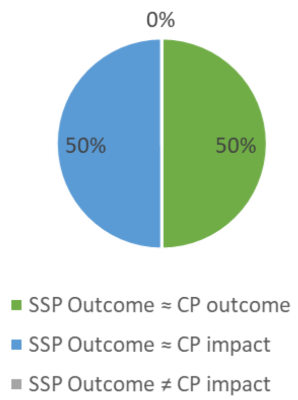

Figure 55: Alignment CP – PSD SSP

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 56).

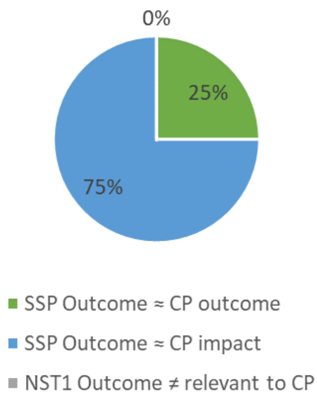

Figure 56: Alignment CP – Agriculture SSP

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[41];
- 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.

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:

[41] 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.

- 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 57).

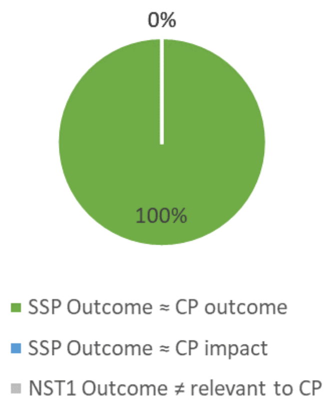

Figure 57: Alignment CP – ENR SSP

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 strategizing 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 58).

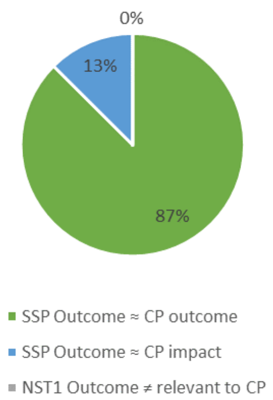

Figure 58: Alignment CP – Forestry SSP

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 59.

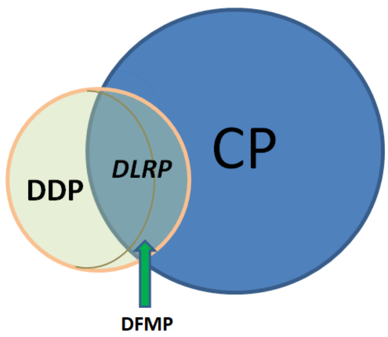

Figure 59: Coherence between district, forestry, and catchment planning (DDP, DLRP, DFMP, and CP)

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 60). 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.

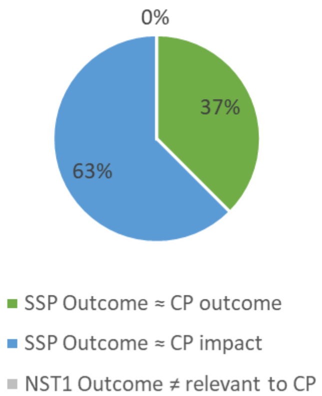

Figure 60: Alignment CP – Governance and Decentralisation SSP

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 impact shows how catchment planning indirectly fully supports energy sector objectives (Figure 61). 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.

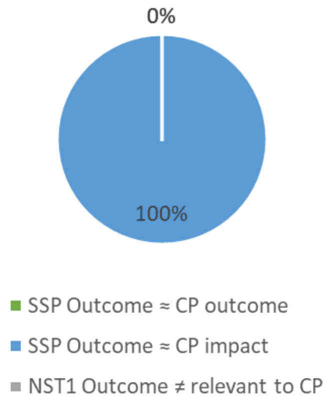

Figure 61: Alignment CP – Energy SSP

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- hydropower, 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 62). 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.

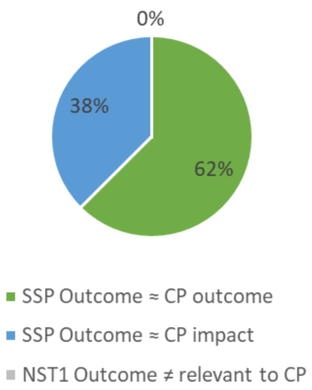

Figure 62: Alignment CP – Urbanisation and Rural Settlements

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 63).

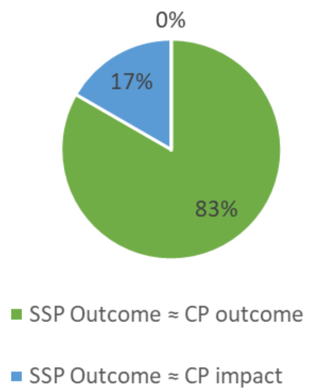

Figure 63: Alignment CP – WATSAN SSP

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.

CP → SSP WATSAN: 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 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 and 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 64) for the alignment between the CP and the health SSP).

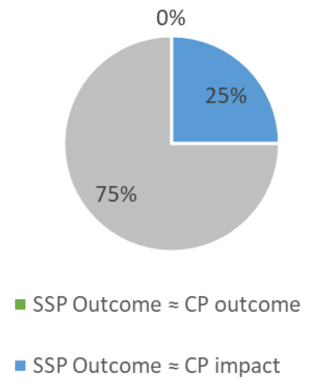

Figure 64: Alignment CP – Health SSP

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 (The 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 list of References of this catchment plan.

An overview of the results of focus group discussions with women and with men in the catchment (October 2017) is provided in **Error! Reference source not found.**

Table 28:Results of women and men focus groups for gender mainstreaming

Women's group	
Issues/constraints	**Solutions**
- Soil erosion and drought-induced vulnerability is more pronounced for women due to their gender roles; - Drought due to low rainfall in the catchment with impact on daily livelihoods (farms) is more pronounced for women and children; - Limited capacity to afford modern RWH tanks presents a challenge domestic water needs; - Inappropriate sanitation in households; - Scarce firewood and degraded forests; - Spouses' unequal control over family resources (land, cash crop, livestock) and decision making over them. Control and decisions are limited for women; - Limited involvement of women in agroforestry to improve land degradation.	- Job creation for women and men for catchment rehabilitation, terracing, river bank protection; - Promote small livestock to incentivise catchment restoration efforts among women; - Improve farm practices and introduce drought resistant seeds; - Support farmers to afford the cost of RWH tanks; - Guideline development for IWRM portfolio for model villages (include RWH); - Farmer field learning schools with life skills; - Initiate family tree nurseries (agroforestry and fruit trees).
Men's group	
Issues/constraints	**Solutions**
- Limited forest cover and wood resources for different uses (construction, wood-based business); - Drought affects farm yields and increases vulnerability, skill gaps in technology for enhancing adaptation capacity; - Costly irrigation equipment for adapting to droughts; - Soil erosion from old mining sites impacts on crop yield and water quality (rivers), high number of unemployed	- Afforestation and reforestation of degraded forests. increase tree nurseries per cell; - Training of men in improved farm practices, hillside irrigation, alternative livestock and drought resistant breeds; - Increase the limited knowledge of irrigation investment for new crops (cash generating) by mixed cooperatives (men and women);

youth (young men) that dropped out of school for mining activities; ▪ Organic manure is insufficient.	▪ Sustainable mining with add-ons to support local TVETs in hands-on skills for unemployed youth (young men).

The drought in Upper Nyabarongo reduces access to water for domestic use, livestock in zero-grazing areas, and crop irrigation. Solution includes enhancing access to domestic water and water for livestock. Any response in that sense is expected to leverage the unequal division of labour among spouses. A gender approach to drought resilience is to include women in the schemes to afford small-scale irrigation SSI for efficient and increased water productivity and to train farmers (women and men) in climate smart agriculture.

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 not limited to:

- Gender based IWRM projects for increasing water productivity and drought resilience in Upper Nyabarongo, through businesses (beekeeping, climate smart agriculture, hydropower) that require minimal water in Mbirurume and other sub-catchments;
- Showcase key IWRM packages through farmers' field school with promotion of women's participation in water governance and LSR measures, progressive terracing, horticulture etc.;
- Training of women and men for improved cooking stove manufacturing and use;
- Scale-up of some IWRM measures at household (HH) level: family agro-forestry and fruit tree nurseries, (mainstream in the Rwandan modern HH package);
- Gully rehabilitation through Initiating women-led productive gullies (fruits, beekeeping, high value trees) etc.;
- Initiate affordable RWH tanks made from bamboo;
- Initiating organic manure production or small-scale composting plants by women's groups or cooperatives. This has the potential to attract buyers and service providers in LSR, as national planning includes large-scale bench terracing which requires soil fertility restoration.

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".[42]

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.

[42] 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 [43] 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 0(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;

[43] CPIP: Catchment Plan Implementation Project. See Annex 2, Glossary of terms, and Chapter 0, 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[44] and national and catchment scale water and food security (key elements of the water-energy-food security nexus).

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,

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

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 district development strategies (DDSs) with the strategic framework of NST1, and the SSPs and CCAs contained therein. DDSs provide a concretisation of sector strategies into tangible projects at the local level. Districts within Upper Nyabarongo catchment should furthermore align their DDSs with the Upper Nyabarongo catchment plan and water related projects should be included in the programme of measures, and vice versa.

All districts that jointly compose Upper Nyabarongo 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 Upper Nyabarongo districts (Nyamagabe, Huye, Nyanza, Ruhango, Muhanga, Ngororero, Karongi).

4.6.1 DDS highlights

Highlights DDS Nyamagabe

In order to respond to the National priority for Sustainable Management of Natural Resources and Environment to Transition Rwanda towards a Carbon Neutral Economy, Nyamagabe District Development Strategy has planned for key interventions closely aligned to Upper Nyabarongo CP and vice versa. The District will play a major role in rehabilitating watersheds and enhancing water storage facilities by controlling soil erosion in catchments; through land husbandry, afforestation; protecting Nyabarongo river catchment, providing information on people abstracting water. The district will promote rainwater harvesting at household and institution levels and promote clean technologies such as biogas and improved cooking stoves. The district plans for catchment restoration projects such as irrigation and hillside irrigation on 1000 Ha, marshland development on 300 Ha, radical terracing 1,200 Ha, a forestation 3,000 Ha, Agroforestry 6,000 Ha, sustainable land use, promotion of coffee plantation as land cover to enhance water infiltration. All these interventions are aligned in the CP and the DDS. The District intends to establish a partnership window with the private sector, to foster the implementation of planned measures in this area.

The DDS plans to train small scale miners in resources evaluation; in terms of building technical and management capacities of mining cooperatives and small-scale mining companies, organising sensitisation and training sessions on entrepreneurship in mining for women and youth, but also the rehabilitation of the degraded land in abandoned mining and quarry sites. These mining related actions need to be integrated in the PoM of the catchment plan and the sub-catchment.

Highlights DDS Huye

Huye DDS plans for water related interventions that are in alignment with those in the catchment plan:

- Increase and rehabilitate irrigation infrastructure, hillside irrigation;
- Increase land covered by radical and progressive terraces;
- Train and empower water users' associations;
- Tourism development;
- Construction of a mini-hydro-power plant;
- Promote use of sustainable and renewable energy, biogas, gas and solar power;
- Sensitisation on sustainable production and use of water (Rain water harvesting, waste water recycling and reuse);
- Rehabilitate and sustainably manage forests, increase district's forest coverage to 30%;
- Restoration of mining and quarry extraction sites;
- Industrial Park development and extension;
- establish water resource management framework in residential and commercial areas;
- construct and operate new milk collection centres.

The DDS plans to ensure 100% access to clean water by 2024: increase the production of safe water, rehabilitation of wells and water networks (including connection of water to all public institutions), establish a water treatment and fire-fighting systems. Some projects planned in the DDS still need to be integrated in the catchment plan, such as mainstreaming IWRM measures to the Industrial Park in Huye district for harmony between DDS and CP.

Highlights DDS Nyanza

Nyanza DDS targets to increase the surface of the catchment managed and protected. Including both the Akanyaru and Upper Nyabarango catchments. Specific actions include:

- Increasing land area covered by new terraces; progressive terraces will be created, and the existing terraces will be valorised;
- Increasing surface area of land irrigated and agricultural mechanisation. This will be done through SSIT on 300 ha (50 ha each year), laying out and developing Mwogo and Akanyaru swamp as well as promotion of hillside irrigation;
- Increasing households using cooking gas and biogas; and
- Increasing the surface covered by forest and agro-forestry, hillside irrigation will be developed by 500 ha each year. The new surface covered by forestry and agro-forestry should accrue to 600 ha.

The district aspires to the national target whereby 100% of the population in Nyanza will have access to electricity and clean water by 2024. This necessitates to expand electrical lines as well as to increase water supply systems.

Other projects are related to feeder road construction, promotion of productivity of key crops, promotion of farmers field schools. To date, the catchment plan considered key interventions planned in Nyanza DDS, but not entirely, therefore the specific targets will require further harmonisation with the final DDS.

Highlights DDS Ruhango

Ruhango DDS identifies key specific IWRM measures aligned to the CP intervention projects, which include:

- Total land under agroforestry of 16,794 ha; 30% of this land is to be maintained and meeting the national forest standards by 2024;
- Marshland irrigation will be increased from 949 ha to 1,156 ha. Ruhango DDS plans to increase land under hillside irrigation from 77.5 ha to 905 ha.

The DDS plans for large scale water supply projects: rehabilitating and extending water supply system in Mahama-Nzuki, construction of Mukingo-Kaganza-Gitisi-Bweramana water pipeline, extension of water supply system in Ntongwe Sector, rehabilitation of water supply system of Shyogwe-Mayaga, extension of water supply system in Ruhango- Ntenyo- Munini-Tambwe, and rehabilitation of the water treatment plant of AIDER.

Some projects of the Ruhango DDS are aligned to those in the catchment plan, although requiring IWRM proofing (IP+). For example, feeder roads for routine maintenance activities, would mainstream IWRM sensitive measures for water drainage, retention, and possibly collection on road sides. Projects on rain water harvesting in ponds, afforestation, erosion control measures, IES, and river buffer zone protection, are not yet integrated in the DDS, whereas they are already present in the CP programme of measures.

Highlights DDS Muhanga

Muhanga DDS is well aligned with the Upper Nyabarongo Catchment plan, whereby harmony is noted with:

- Hillside irrigation with green technologies (759 ha);
- New area covered by terraces (1,876 ha);
- Promoting modern techniques of hillside irrigation & water harvesting ponds;
- Protection of Nyabarongo River bank through terraces (3949 ha) and afforestation (319 ha);
- Model mining sites are to be constructed and operationalised through PPPs (Nyarusange, Muhanga & Kabacuzi sites).

Planned actions in Muhanga are well aligned with the CP, although updates are needed to harmonise the targets for different IWRM related measures. The CP plans for riverbank protection on tributaries of Nyabarongo (Ruhunde, Gassayo, Gisumo, Birikana and Gikeri) and this is also reflected in the DDS. However, additional inputs are required in the CP, for the sub-catchments of Nyabarongo Upper and Hydropower, relating to enhancing the knowledge for mining and for aquaculture projects. These include:

- Training of mining cooperatives in mineral exploitation techniques;
- Environment protection and climate change resilience;
- Detailed studies carried out for rehabilitation and degraded mines and quarry areas;
- Promotion of less water consumptive industries such as modern technologies in bee keeping; Aquaculture development through farming cooperatives trained in sustainable techniques.

Highlights DDS Ngororero

Ngororero's DDS identifies among its key development drivers: The mining sector; coffee and tea; strong private sector engagement, and; development of priority value chains (wheat, maize, cassava, beans, banana and fruits).

Alignment between the draft DDS and the Catchment Plan for Upper Nyabarongo is strong and key IWRM proof measures include: Catchment rehabilitation through terracing and riverbank protection; private sector partnership; involvement for increased climate resilience in agriculture, and; public forest management. The DDS plans for a new 251 ha irrigation scheme and commits to achieving the national target of 100% access to clean water by 2024 (SSP infrastructure target). Regarding value chain development, four milk collection centres and three coffee washing station are planned.

Highlights DDS Rutsiro

Alignment with the catchment plan was one of the leading principles in development of the DDS of Rutsiro. Among its strategic priorities, the DDS highlights catchment rehabilitation and integrated land conservation. The DDS describes the district's hydrology and outlines its location in the Kivu catchment (Congo river basin) and the Nile river basin. The DDS highlights that water resources management will be improved, and identifies key specific IWRM measures such as afforestation, sustainable land conservation, sustainable mining, and ecosystems rehabilitation along the DDS cycle. Furthermore, the DDS focuses on sustainable and rational land use, improvement of the quality of mining activities, and increased sustainability and profitability of forestry.

The DDS identifies its key development drivers as:

- Basic infrastructure development (roads, electricity, water & ICT);
- Promotion of human settlement in planned villages;
- Promotion of agriculture production, agro-processing; and
- tourism development.

Among its outputs are:

- IWRM to maximise reliable, efficient and productive investments for all;
- district forest management plan Implemented; and
- renewable energy and other alternative energy promoted.

Highlights DDS Karongi

Karongi DDS highlights its alignment with the Upper Nyabarongo catchment rehabilitation plan. Key developments drivers include:

- Enhancement of active involvement of private sector and youth;
- Promotion of agribusiness, urban and rural development, tourism development, and citizen participation;
- Increase sustainability and profitability of lakes, river and rain water;
- Nyabarongo river bank protection;
- Develop mining sites and to promote rain water harvesting within households.

The DDSs identified comparative advantages that are closely related to the DPSIR analysis namely,

- Tourism potential;
- The Kivu Belt Road;
- Cross border trade;
- Positioning Karongi in the centre of the Western Province; and
- Cash crop potentials (quantity and quality tea).

The Karongi DDS plans for IWRM proof measures planned in the Upper Nyabarongo CP and vice versa. Improving activities toward soil protection and climate change resilience, through terracing, to increase the area for small scale irrigation, and to develop and increase the productivity for export crops, namely coffee; tea; silk worms, and macadamia.

Annex 5. NWRMP UNY 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 have been used as input for this catchment plan in the scoping phase and are reflected in the overview of issues and opportunities for the catchment, and in the DPSIR analyses. Priority recommendations have been incorporated in the programme of measures and priority CPIPs for the first Annual Implementation Plan.

The main observations and conclusions on the Upper Nyabarongo catchment are:

- Predominance of good, deeply weathered soils with relatively high infiltration rates;
- There is significant erosion which is due to agriculture and mining activities;
- High rainfall with a relatively short dry season;
- Significant surface flow generated from a number of larger tributaries and the upper Nyabarongo river;
- Significant groundwater reserves that are however mostly difficult to access;
- Population to increase from 1.5 million to 3.3 million, urban population scheduled to grow about sevenfold from one hundred and sixty thousand to almost 1,2 million;
- Difficult accessibility outside of the main roads (3 axes: Muhanga - Nyabihu; Muhanga - Karongi and Huye - Nyamasheke);
- Current level of water use is very low (registered use less than one percent of renewable resources; current demand estimated at less than three percent);
- Adjusted water balance for the Upper Nyabarongo catchment up to 2040 indicates that all essential demand and presumably viable commercial ventures can be developed without restrictions or compromising environmental flow requirements. The Upper Nyabarongo, together with the Mukungwa catchment constitute the water tower for Rwanda.

Necessary developments and recommendations are:

- Water supply services in the rural domain is still insufficient for reasons of planning, investment, exploitation and repair, resources decline and inadequate service solutions. The development of a catchment-based water supply plan is highly recommended and so far, initiated by EWSA for this catchment as well as for Eastern Area (comprising lower Akagera and Muvumba) and the Akanyaru catchment. The approach should be 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 locations and zoning of adequate least cost services (spring - borehole - gravity pipeline - pumped pipeline - rainwater harvesting) considering exploitation and investment costs (in this order). An opportunity waiting to be developed is the combination of energy supply from pico-hydropower (surface water) with water supply from natural springs. The required planning exercise should apply GIS software with DTM layer and automation of dynamic height from source. All districts of the catchment should however be implicated in the development of the catchment water supply plan and they should derive from it for the district development plans;
- Water supply services in the urban domain seems mostly satisfactory for the principal urban centres of the catchment (Muhanga, Ruhango, Nyanza and Nyamagabe) but there is a list of twenty emerging urban areas with insufficient supply. 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. Currently there is no central treatment;
- 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 water supply). 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 RWFA-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;
- Notwithstanding the substantial investments in the irrigation sector, rain fed agriculture shall remain the mainstay of the catchment's agricultural production. The protection of the catchment's land resources is therefore 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;
- Although irrigation ponds are likely to have more impact on farmer's household in dryer areas (central and east), water supply from irrigation ponds is endorsed. Further research and additional training of farmers in the use of the ponds may raise the profitability;
- Being relatively cheap and effective, water supply in marchlands is endorsed for the full identified area of almost 23,000 ha in the catchment;
- Irrigation of hillsides from surface water has been curtailed as compared with the areas proposed in the RIMP (Rwanda Irrigation Master Plan) mainly with respect to excessive lift required. Where land and water resources are available, and the required skills have been acquired by farmers and cooperatives, an area of about 2,200 ha may be profitable exploited;
- Irrigation from dams. A number of 7 out of 26 dam sites have been found to be most interesting from a hydrological perspective. Further to the irrigation of command area, these reservoirs have a positive effect on sustaining dry season flow especially when irrigation infrastructure and operation rules are not directed at the highest possible water efficiency. After further study, each site should be optimised for the highest possible storage capacity that can be efficiently exploited for irrigation and other purposes;
- There is scope for the development of irrigation command area from groundwater. It is suggested that groundwater is first and foremost allocated to drinking water supply. Irrigation of alluvial plains from alluvial aquifers may proof effective and sustainable and can be developed for motorised and human powered pumping equipment. It is estimated that about 2,500 ha may be developed in this catchment;
- There is substantial scope for the development of small hydropower in the catchment. A number of sites have been developed recently (Rukarara river) and further (smaller) sites are available.

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 29:Infrastructure measures

ID	Type[45]	Title	Scope	Sub-catchment	DPSIR[46] level	Lead & support entities
NNYUP0002	IP	Development of radical terraces in Sectors: Mugano, Nkomane, Musebeya.	Reduce soil erosion, increase water infiltration and land productivity:85 Ha.	Mbirurume	P	District
NNYUP0004	IP	Feeder road rehabilitation (Gitesi-Ruganda-Gasharu-Murambi).	75.5 km. Land rights will be complicated for rain water harvesting. Perhaps road-side population will be interested in a sharing arrangement. Add on for RWH can be investigated/ hydrological study. Protect against gully forming as ponds are likely to be too small for intense rainfall. Also, intuitional component should be added (O&M). Industrial/business needs assessment can also be component of this study.	Mbirurume	D P	MINAGRI
NNYUP0008	IP+	Feeder road maintenance with water drainage and storage in ponds Mutuntu-Murambi.	Same as above. Feeder road (project 4.0).	Mbirurume	P	District
NNYUP0010	CPIP	Support to feasibility and detailed design study for the development of two Pico hydropower sites (Gatare, Kabebe) for electricity generation.	IWRM PACKAGE 1: Landscape restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed: LWAPES. Optimise the design (hydrological and topographical study) in order to exploit the full potential of each site.	Mbirurume	P	EAPICO HYDRO DEVELOPERS Ltd, EPICONE Ltd.
NNYUP0012	CPIP	Rain water harvesting and water storage in ponds in residential areas and commercial buildings.	IWRM PACKAGE 1: Landscape restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed: LWAPES. Reduce flooding resulting from water runoff in residential areas (100 hhs) and 5 trading centres.	Mbirurume	P	Tbd
NNYUP0013	IP	Mbirurume bank protection with bamboo and grasses.	To keep the course of the river, maintain riverbed, reduce the sediments to the river:82 km.	Mbirurume	D	REMA
NNYUP0014	IP	Feeder road rehabilitation (Buruhukiro-Gatare-Nkomane-Mushubi-Musebeya).	Decongest rural areas and facilitate the flow of agricultural products, see project 4.	Mbirurume	P	MINAGRI

[45] Types: IP/IP+/CPIP

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

ID	Type[45]	Title	Scope	Sub-catchment	DPSIR[46] level	Lead & support entities
NNYUP0015	CPIP	Land husbandry and landscape rehabilitation and gullies rehabilitation.	IWRM PACKAGE 1: Landscape restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed: LWAPES. Reduce soil erosion, increase water infiltration and land productivity: 3375 ha.	Mbirurume	D P I	Tbd
NNYUP0016	IP	Mbirurume and tributaries bank protection.	To keep the course of the river, maintain riverbed, reduce the sediments to the rivers: Mbirurume, Gatare,Kiraga, Musasa, Rwondo,Nzavu and Rurongora.	Mbirurume	D P	VUP
NNYUP0017	IP+	Roadside protection, water drainage and storage in ponds on existing rehabilitation of Buruhukiro-Gatare-Nkomane-Mushubi-Musebeya roads.	Reduce landslides on feeder roads, drain water to avoid erosion and flooding and store water in ponds for small scale irrigation. See above feeder road.	Mbirurume	D P	District, Road maintenance
NNYUP0018	IP+	Rehabilitation of feeder roads with roadside protection and water drainage: a) Kaduha-Mushubi; b) Musebeya-Kaduha; c) Kaduha-Mugano.	Reduce landslides on feeder road and drain water to avoid erosion and flooding. See above, feed roads.	Mbirurume	D P	District, road maintenance
NNYUP0021	IP	Marshlands development on Nzavu, Rwondo.	Exploit marshlands to increase water productivity (maize, rice) and adaptation to CC.	Mbirurume	D P	MINAGRI, District
NNYUP0025	IP	Coffee value chain development in Mugano and Kaduha sectors.	Increase land cover and support rural farmers to grow coffee for rural income and revenue for exports.	Mbirurume	D P	Private sector
NNYUP0030	CPIP	Picohydro / microhydro development on Rukarara and Mbirurume.	Use SHER ongoing study.	Multiple (Mwogo, Mbirurume)	P	Tbd
NNYUP0033	IP	Roadside protection (RTDA); Nyamagabe.	Water drainage.	Mwogo	D P	RTDA
NNYUP0037	CPIP	Rehabilitation and development of Progressive, radical terraces, grasses and agroforestry plus afforestation and trenches Huye.	Propose to change from BaU approach to IWRM value for money landscape rehabilitation + proper construction.	Mwogo	D P	District
NNYUP0037	IP	IDP Model village in Mutuntu, Ruganda Gashari and Mugano.	To relocate 120 households. See other model village project idea. See Project 28.	Mbirurume	D	RHA
NNYUP0037	IP+	Landscape Rehabilitation EIP by W4GR; Muhanga.	Add-on capacity building of farmers through Farmer Field Schools, enhance gender responsiveness, see other EIPs.	Hydropower	D	RWFA

ID	Type[45]	Title	Scope	Sub-catchment	DPSIR[46] level	Lead & support entities
NNYUP0037	IP	Development of touristic and ecolodges sites: Mukura NP; Rutsiro.	Eco-tourism builds on, and supports, protections and maintenance of restored natural and agricultural landscapes, and provides off-farm jobs. SME opportunities for economic development. Study Tourism Master Plan for further details.	Satinsyi	D P	RDB
NNYUP0038	IP	Rain water harvesting in in sector, Ruhashya, Simbi, Kigoma, Rwaniro and Maraba Sectors; Huye.	Extension of previous national RWH incentives programme	Mwogo	P	District
NNYUP0040	IP	Roadsides and bridges protection with drainage; Huye.	Check indicated locations on map.	Mwogo	P	RTDA
NNYUP0041	IP	Re-afforestation on the hillsides in line with District Forest Management plan (Ecological species); Huye.	Species suitability for specific areas.	Mwogo	D	District, RWFA
NNYUP0047	IP	River bank protection of Butambu, Rundazi tributaries of Mwogo; Huye.	Preference is reeds and grasses.	Mwogo	D P	District, REMA
NNYUP0050	CPIP	Community led eco-friendly marshland development: Mwogo III: Nyagisozi, Rwabicuma (Nyanza).	Agro-action expressed interest in financing this project.	Mwogo	D P	AAR
NNYUP0062	CPIP	Rehabilitation of the watershed and dam of Nyakabanda and kibirira stream for hydropower generation.	IWRM Package 4: Landscape restoration through investment in agribusiness, mining demonstration and hydropower generation in the most degraded sites Nyabarongo watershed. Increase land protected against soil erosion and floods and generate hydropower on Nyakabanda and Kibirira stream.	Nyabarongo Upper	P I	Tbd
NNYUP0063	IP	IDP Model; Muhanga.	See above.	Hydropower	D	REMA
NNYUP0064	IP	Radical terraces by LVEMP II; Muhanga.	Best practice already implemented (check for gender responsiveness).	Hydropower	D	REMA
NNYUP0067	CPIP	Water for Growth Rwanda EIP (Ndaro and Nyange sectors); Ngororero.	Add-on capacity building of farmers through Farmer Field Schools, enhance gender responsiveness, see other EIPs.	Hydropower	D	RWFA
NNYUP0071	CPIP	Developing check dams on Secoko river to protect Nyabarongo hydropower reservoir from sediments; Ngororero.	Address this project after rehabilitation of upstream catchment only (project 75, below).	Hydropower	P I	W4GR
NNYUP0082	CPIP	Rehabilitation of old mining sites in Ndaro (Kibanda cell, Ruhuha village) by LAFREC; Ngororero.	Exchange with LAFREC best practices on landscape rehabilitation on old mines sites.	Hydropower	D P I	RWFA

ID	Type[45]	Title	Scope	Sub-catchment	DPSIR[46] level	Lead & support entities
NNYUP0084	IP	Restoration of Sanza forest (Muhororo sector: Sanza cell); Ngororero.	-	Satinsyi	D	RWFA
NNYUP0085	IP	ADEHAMU: Association de Haute Altitude de Mukura (Reforestation): Zone Kabona: whole sub-catchment; Rutsiro.	Follow closely, exchange experiences and best practices.	Satinsyi	D	RWFA
NNYUP0090	CPIP	Land restoration: Agroforestry, terracing (whole); Rutsiro.	Include in general landscape rehabilitation programme.	Satinsyi	D P	RWFA, District
NNYUP0091	CPIP	Afforestation (Buffer zone of Mukura), sylvo-pastoralism in Mukura 1 & 2 admin villages, gender mainstreaming of proposed interventions; Rutsiro.	-	Satinsyi	D	RWFA
NNYUP0096	CPIP	Terracing in Ngororero sector, Torero and Nyange cells and protection of Nyamuhondo riverbank with bamboos; Ngororero.	Landscape rehabilitation programme.	Nyabarongo Upper	D	RWFA, District
NNYUP0099	CPIP	Land husbandry and landscape rehabilitation in Base, Nkubi, Nyamigogo and Kiryango watersheds Incentive for ecosystem services around protected riverbanks of Base, Nkubi, Nyamigogo and Kiryango rivers.	IWRM Package 2: Rehabilitation and protection of Kiryango watersheds for sustainable exploitation. a) Increase area of watershed protected against soil erosion and floods :4179 ha around 4 Rivers (Kiryango, Base, Nyamigogo, Nkubi) and 4 Marshlands (Kiryango, Base, Nkubi, Nyamigogo) and 3 dams (Kiryango, Base, Bishya) Ensure sustainable protection of river banks by providing alternative livelihoods to 100 farmers.	Hydropower	D P	RWFA
NNYUP0100	IP+	Feeder road Rehabilitation and protection with drainage in Kinihira, Kabagari and Mwendo.	Avoid the destruction of roads and roadsides and the creation of runoff that accelerate erosion on the hillside and floods in the valleys.	Hydropower	P	RTDA
NNYUP0101	IP+	Re-afforestation in line with District Forest Master plan in Kinihira, Kabagari, Mwendo.	Increase forest cover to reduce excessive flow of rain water, promote water infiltration, mitigation of CC and increase timber product for various uses.	Hydropower	D	District
NNYUP0103	CPIP	Mining sites landscape restoration and model mining demonstration in the most degraded sites of the watershed of Nyabarongo river.	Reduce sediments from mining sites and build capacity of miners and VTC to comply with environmental regulations. Improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and	Multiple (Hydropower, Nyabarongo Upper)	D P I	Rwanda Mining Board

ID	Type[45]	Title	Scope	Sub-catchment	DPSIR[46] level	Lead & support entities
			materials, halving the proportion on untreated waste water and substantially increasing recycling and safe reuse globally.			
NNYUP0103	CPIP	Mining sites landscape restoration and model mining demonstration in the most degraded sites of the watershed of Nyabarongo river.	Reduce sediments from mining sites and build capacity of miners and VTC to comply with environmental regulations. Improve water quality by reducing pollution, eliminating dumping and minimising release of hazardous chemicals and materials, halving the proportion on untreated waste water and substantially increasing recycling and safe reuse globally.	Multiple (Hydropower, Nyabarongo Upper)	D P I	Rwanda Mining Board
NNYUP0105	CPIP	Landscape rehabilitation with gullies rehabilitation, agro-forestry, radical and progressive terraces: Kibangu, Nyabinoni, Rugendabari and Mushishiro.	Reduce soil erosion, increase water infiltration and land productivity.	Multiple (Hydropower, Nyabarongo Upper)	D I	RWFA
NNYUP0106	IP+	Feeder Roads rehabilitation and protection: Kibangu, Nyabinoni, Mushishiro, Nyarusange, Rugendabari, Nyabinoni, Muhanga, Kibangu, Nyamabuye.	Avoid the destruction of roadways and roadsides and the creation of runoff that accelerate erosion on the hillside and floods in the valleys.	Multiple (Hydropower, Nyabarongo Upper)	P	RTDA
NNYUP0110	IP	Re-afforestation on the hillside of Shyunda and Gihara in Nyagisozi, Musebeya, Kaduha, Musange and Mbazi sectors.	Increase forest cover to reduce excessive flow of rain water, promote water infiltration, mitigation of CC and increase timber product for various uses.	Mwogo	D	RWFA, Districts
NNYUP0111	CPIP	Valorisation of old radical terraces with fertilisers, agroforestry in Nyagisozi, Rwabicuma, Cyabakamyi.	Increase land productivity.	Mwogo	D	MINAGRI
NNYUP0112	CPIP	Mwogo River and tributaries bank protection and rehabilitation of their watershed in Nyagisozi, Rwabicuma, Cyabakamyi, Mukingo, Busasamana sectors.	To keep the course of the river, maintain riverbed, reduce the sediments to the river.	Mwogo	D	RWFA, MINAGRI
NNYUP0113	IP	Mwogo marshland development for irrigation.	Increase land for irrigation and adaptation to climate.	Mwogo	D	MINAGRI, RAB, NAEB
NNYUP0114	CPIP	Implementation of sustainable mining project.	Extract minerals without pollution to water at downstream with sediments.	Mwogo	D P	MAWARID
NNYUP0116	IP	Protection of Bishya marshland and Dam for water supply.	Reduce pollution to the dam source of Mpanga Water treatment plant.	Hydropower	D	WASAC

ID	Type[45]	Title	Scope	Sub-catchment	DPSIR[46] level	Lead & support entities
NNYUP0121	CPIP	Riverbank protection on 6 streams tributaries of Nyabarongo: Ruhunde, Gassayo, Gisumo, Birikana and Gikeri).	To keep the course of the river and reduce the sediments polluting the water and reducing the flow of the river.	Nyabarongo Upper	D	RWFA, REMA
NNYUP0128	IP+	Roadside protection with drainage and collection in ponds: Gasaka-Musange, Kibirizi-Kibumbwe-Kaduha.	Avoid the destruction of roadways and roadsides and the creation of runoff that accelerate erosion on the hillside and floods in the valleys.	Mwogo	P	RTDA
NNYUP0140	IP+	Roadsides and bridges protection with drainage in Kigoma, Rwaniro, Ruhashya, Rusatira, Simbi and Kinazi.	Reduce landslides on feeder road, drain water to avoid erosion and floodings and store water in ponds for small scale irrigation:101 km.	Mwogo	P	RTDA
NNYUP0143	IP	Feeder -road rehabilitation, water drainage and storage in ponds.	IWRM Package 2: Rehabilitation and protection of Kiryango watersheds for sustainable exploitation. Reduce water flow from degraded roads without drainage: Mukingo and Bweramana (13 km), Buhanda Kirengeri(25km).	Hydropower	P	MINAGRI, RWFA
NNYUP0144	CPIP	Rain water harvesting and water storage in ponds for small scale irrigation.	IWRM Package 2: Rehabilitation and protection of Kiryango watersheds for sustainable exploitation.	Hydropower	P	MINAGRI, RWFA
NNYUP0148	CPIP	Landscape restoration to facilitate investment in Agribusiness in Rugabano sector.	IWRM Package 4: Landscape restoration through investment in agribusiness, mining demonstration and hydropower generation in the most degraded sites Nyabarongo watershed. Conserve the landscape and increase investment in export crop product: tea (4000ha).	Hydropower	D P I	The Wood Foundation Africa (TWFA) & Rugabano Outgrowers Services Company (ROS)
NNYUP0150	CPIP	Erosion control and floods mitigation around Mwogo, 3 Dams and 6 tributaries.	IWRM Package 3: Landscape restoration and protection of water bodies in Mwogo watershed. Reduce pollution of water bodies by sediments from erosion and floods risk areas (5404 ha) around Mwogo, Kaviri, Nyakagezi, Butambu, Rundazi, Gisuma, Rwagahogo, Rurangazi and Gasayo and 3 dams (Rwabicuma, Kabakobwa and Cyarubare), and gullies rehabilitation in Huye District.	Mwogo	D	Tbd
NNYUP0152	CPIP	Rain water harvesting in residential areas, trading centers and public institutions of Huye and Nyanza.	IWRM Package 3: Catchment restoration and protection of water bodies in Mwogo watershed. Reduce floods and increase water storage for domestic use and small-scale irrigation.	Mwogo	P	Districts

ID	Type[45]	Title	Scope	Sub-catchment	DPSIR[46] level	Lead & support entities
NNYUP0153	CPIP	Erosion control and floods mitigation around Rukarara river.	IWRM Package 3: Catchment restoration and protection of water bodies in Mwogo watershed. Increase area a of watershed protected against soil erosion and floods on Rukarara:1494 ha in Kibumbwe, Kibirizi, Kaduha and Musange, and gullies rehabilitation in Nyamagabe District.	Mwogo	D	RWFA
NNYUP0153	CPIP	Landscape Conservation and Rural Development Activities in Nyanza.	IWRM Package 3: Catchment restoration and protection of water bodies in Mwogo watershed: • To scale up afforestation leading to incentivised sustainable timber harvesting at farm level; • Promote farm level rain harvesting and water management; • Promote the diversification of rural livelihoods.	Mwogo Hydropower	D	New Forests Organisation Rwanda, Nyanza District, W4G, RWFA, Nyanza Tree Growers Savings and Loans Associations
NNYUP0154	CPIP	Support to feasibility and detailed design study for the development of Musange Pico hydropower.	IWRM Package 3: Catchment restoration and protection of water bodies in Mwogo watershed. Optimise the design (hydrological and topographical study) in order to exploit the full potential of each site.	Mwogo	P	EAPICO HYDRO DEVELOPERS Ltd,

Table 30:Institutional measures

ID	Title	Content	DPSIR[47] 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 water management at catchment level	Facilitate options for operational level collaboration on IWRM topics, including sharing of information and joint operational decision making, in transboundary catchments (e.g. Muvumba) and catchments with transboundary external water transfers (e.g. Sebeya).	D	RWFA, MINILAF, MINENV, MINAFFET, CTF

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

Table 31:Knowledge measures

ID	Title	Type [48]	Objective/Content	DPSIR[49] 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 / catchment restoration guidelines	R, BP, S	Review practises in socio-economic terms depending on geographical characteristics.	D	Recommendations for optimisation of guidelines	MINAGRI, MINLAF, MINEFOCFIN

[48] 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

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

ID	Title	Type [48]	Objective/Content	DPSIR[49] level	Output	Potential implementing partners
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 map, catchment restoration map	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 [48]	Objective/Content	DPSIR[49] level	Output	Potential implementing partners
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
14	Development of IWRM training programme for local stakeholders	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):	D	Capacity building plan Trainings	Tbd

ID	Title	Type [48]	Objective/Content	DPSIR[49] level	Output	Potential implementing partners
	and beneficiaries		▪ 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).			
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 community of practise	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
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

ID	Title	Type [48]	Objective/Content	DPSIR[49] level	Output	Potential implementing partners
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	Tbd
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	Tbd
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	I	FEWS models, monitoring network, warning system	RWFA/IWRM REMA

ID	Title	Type [48]	Objective/Content	DPSIR[49] level	Output	Potential implementing partners
			information dissemination means to communicate warnings on time, to the intended recipients.			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
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

Annex 7. SEA process report

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 (Chapter 1.).

Error! Reference source not found. links the process steps of IWRM and SEA to each other and Annex 7.2 p rovides a detailed report of activities for each of the official ten SEA steps to facilitate independent review by REMA. Annex 0provides 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 32:Combining process steps of IWRM and SEA

Steps in IWRM[50]	Elements	Phases in SEA[51]	Steps in SEA
N/a	N/a	Screening	1. Reach consensus on the need for SEA and its link to planning; 2. Find stakeholders and announce start of the plan process;
Situation analysis	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).	Scoping	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;
Vision development	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).		
Integrated planning	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). 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).	Assessment	6. Assess the impacts of alternatives and document this; 7. Review: organise (independent) quality assurance of documentation (preferably involving stakeholders);
		Formal decision making	8. Discuss with all stakeholders the alternative to prefer; 9. Motivate the (political) decision in writing;

[50] Source: Integrated Water Resources Management Programme Rwanda 2015 – 2019. Project document 15 October 2014.
[51] Source: Netherlands Commission for Environmental Assessment.

Steps in IWRM[50]	Elements	Phases in SEA[51]	Steps in SEA
	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 organisations, resulting in annual catchment plan implementation M&E reports (implementation of SEA step 10).	Monitoring	10. Monitor the implementation and discuss the results

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[52] 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.

[52] 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[53]. 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 65), 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.

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

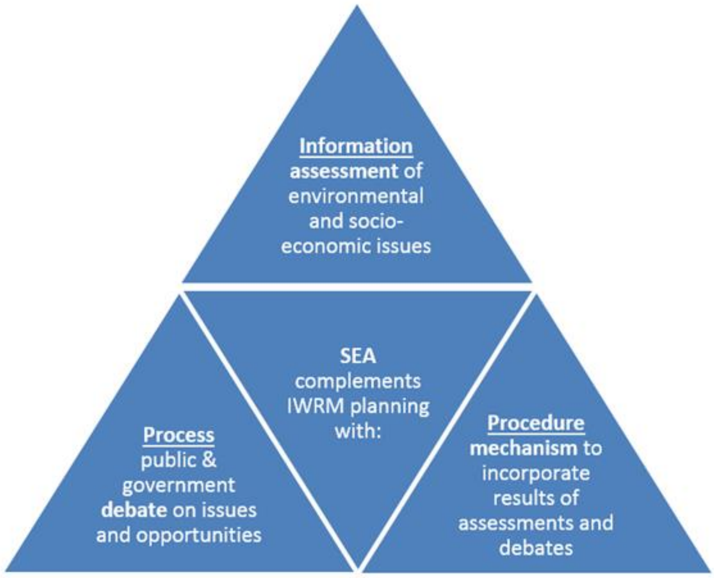

Figure 65: Added value of SEA to the catchment planning process, through information, process, and procedure[54]

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 Upper Nyabarongo. 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 1.4.1). 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 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 **Error! Reference source not found.** and **Error! Re**

[54] 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.

ference source not found. (situation as of January 2018). Composition of the catchment-based Catchment Task Force core team, and the full CTF from which it was elected by its members, is shown in **Error! Reference source not found.** and **Error! Reference source not found.**, respectively. 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 33: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 34:: 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 35:Composition of Catchment Task Force (CTF) core team

Ministry / organisation	Name	Position	Role in PSC	Gender
Nyamagabe District	KABAYIZA, Lambert	Vice Mayor	President	M
Muhanga District	MPAGARITSWENIMANA, Védaste	District Environment Officer (DEO)	Vice President	M
Ruhango District	MUTEZIMANA, Christine	Water and Sanitation Officer	Secretary	F
Nyanza District	NZUNGIZE, Gustave	Director of Agriculture and Livestock	Advisor 1	M
Ngororero District	BIZIMANA, Jean Bosco	Officer of a Mining company	Advisor 2	M
Huye District	UWANYIRIGIRA, Helene	CNF representative	Advisor 3	F
Rutsiro District	TUYISABE, Etienne	NGO Officer (RRC)	Advisor 4	M
Karongi District	AGASARO, Aurore	Officer of a mining company	Advisor 5	F

Table 36:Composition of Catchment Task Force

Ministry / organisation	Name	Position	Role in PSC	Gender
Rutsiro District	Innocent GAKURU	Vice Mayor FED	Member	M
Rutsiro District	Sérevérien TURAMYE	District Agronomist	Member	M
Rutsiro District	Aimé Adrien NIZEYIMANA	District Environmental Officer	Member	M
Rutsiro District	Agnès UWAMAHORO	Representative of National Women's Council	Member	F
Rutsiro District	-	Representative of NGOs	Member	-
Rutsiro District	-	Private sector representative	Member	-
Muhanga District	Innocent KAYIRANGA	Vice Mayor FED	Member	M
Muhanga District	Védaste MPAGARITSWENIMANA	District Environment Officer	Vice President	M
Muhanga District	Thacien NGUMYEMBAREBE	District Agronomist	Member	M
Muhanga District	Jeanne KAMPORORO	Representative of National Women's Council	Member	F
Muhanga District	-	Representative of NGOs	Member	-
Muhanga District	-	Private sector representative	Member	-
Ruhango District	Jean Marie RUSILIBANA	Vice Mayor FED	Member	M
Ruhango District	Francois MUNYAMPIRWA	District Agronomist	Member	F
Ruhango District	Philip RUKAMBA	NGOs representative	Member	M
Ruhango District	-	District Environment Officer	Member	-
Ruhango District	-	Private sector representative	Member	-
Ruhango District	-	Representative of National Women's Council	Member	-
Nyanza District	Patrick KAJYAMBERE	Vice Mayor FED	Member	M
Nyanza District	Theogene MUGABONAKE	District Agronomist	Member	M
Nyanza District	Philbert NSENGIMANA	District Environment Officer	Member	M
Nyanza District	Dahlie MUHONGERWA	Representative of National Women's Council	Member	F
Nyanza District	-	Private sector representative	Member	-
Nyanza District	-	NGOs Representative	Member	-
Huye District	Andre KAMANA	Vice Mayor FED	Member	M
Huye District	Martin BUTERA	District Environment Officer	Member	M
Huye District	Aimable Rene NSENGIYUMVA	District Agronomist	Member	M
Huye District	Callixte HAGUMA	Private sector representative	Member	M
Huye District	Cyprien UGIRUMURERA	NGOs Representative	Member	M
Huye District	-	Representative of National Women's Council	Member	-

Ministry / organisation	Name	Position	Role in PSC	Gender
Nyamagabe District	Lambert KABAYIZA	Vice Mayor FED	President	M
Nyamagabe Disrict	Ancille KARANGWAYIRE	District Environment Officer	Member	F
Nyamagabe District	Donatha MUKAMUGANGA	District Agronomist	Member	F
Nyamagabe District	Jean Bosco GAHAMANYI	NGOs representative (HEAD OF AARP)	Member	M
Nyamagabe District	Antoine KANANGA	Private sector representative (WASAC)	Member	M
Nyamagabe District	Chantal NYIRAZANA NYIRAMUTUZO	Representative of National Women's Council	Member	F
Karongi District	Esperance BAGWIRE	Vice Mayor FED	Member	F
Karongi District	Calter MUHAWENIMANA	District Environment Officer	Member	M
Karongi District	Fabien SAFARI NYIRIMANZI	District Agronomist	Member	M
Karongi District	Aurore AGASARO	Private sector representative (PSF)	Advisor 5	F
Karongi District	Larissa MAHIRWE	WASH: NGOs Representative (World Vision)	Member	F
Karongi District	-	Representative of National Women's Council	Member	-
Ngororero District	Christine KANYANGE	Vice Mayor FED	Member	F
Ngororero District	Aloys MUNYARUKIKO	District Environment Officer	Member	M
PSF/Mining Sector	Jean Bosco BIZIMANA	Representative of Private Sector	Advisor 2	M
Ngororero District	Leonidas DUSABIMANA	District Agronomist	Member	M
Ngororero District	Christine KAMPIRE	Representative of National Women's Council	Member	M
Adi-Terimbere	Mathieu BAVUKIYIKI	NGOs Representative	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 **Error! Reference source not found.**. It proved difficult to arrange for regular meetings with e ither 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 (**Error! Reference source not found.**). For national decision makers, PSC meetings are listed i n **Error! Reference source not found.**.

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 (Upper Nyabarongo scoping workshop report, W4GR TR53, 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 Upper Nyabarongo, Characterisation and Vision' (W4GR TR18, 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[55]:

- **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 for the largest possible number of beneficiaries within the available financial and water resources;

[55] 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.

- **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. 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 TR18, 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[56], 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, of alternatives and variations simulated, and of the results were provided in the report 'Water balance and allocation modelling in Rwanda' (W4GR TR29, 2017).

[56] Autonomous developments, or projections, are developments that occur beyond the influence of the catchment plan. In the 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).

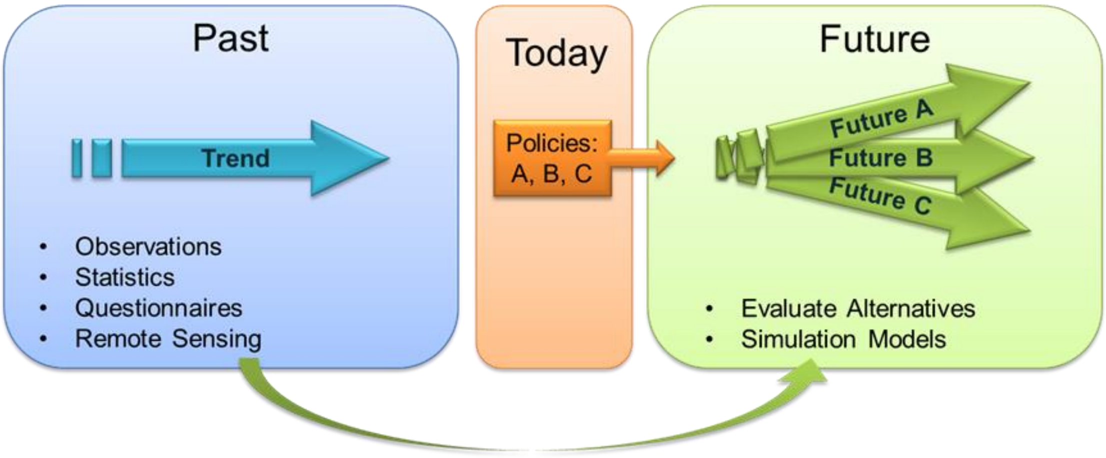

Figure 66: Approach to comparison of alternative future scenarios, based on modelling past, present, and future

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);
  - 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 six 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 **Error! Reference source not found.**.

Detailed results of this phase are presented in Section 0 of this Annex and the model results elaborated in Annex 9. A main conclusion of the model simulations was that Upper Nyabarongo has ample water availability, also in future. The CTF was informed on these and a recommendation was given to consider the S+SLM+E alternative 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. Subsequently, water allocation plans were developed per sub-catchment, per month, and per time horizon 2024; 2030; 2050, and included in Annex 9 of this catchment plan.

Table 37:Refined alternatives for Catchment Plan 2018-2024

Alternative abbreviation	Alternative content
S	Increased water storage
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 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[57], 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 67 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. Rainwater harvesting for houses and public buildings is, however, recommended as local solution, albeit of limited significance for the catchment water balance;
- **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) 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.

[57] 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.

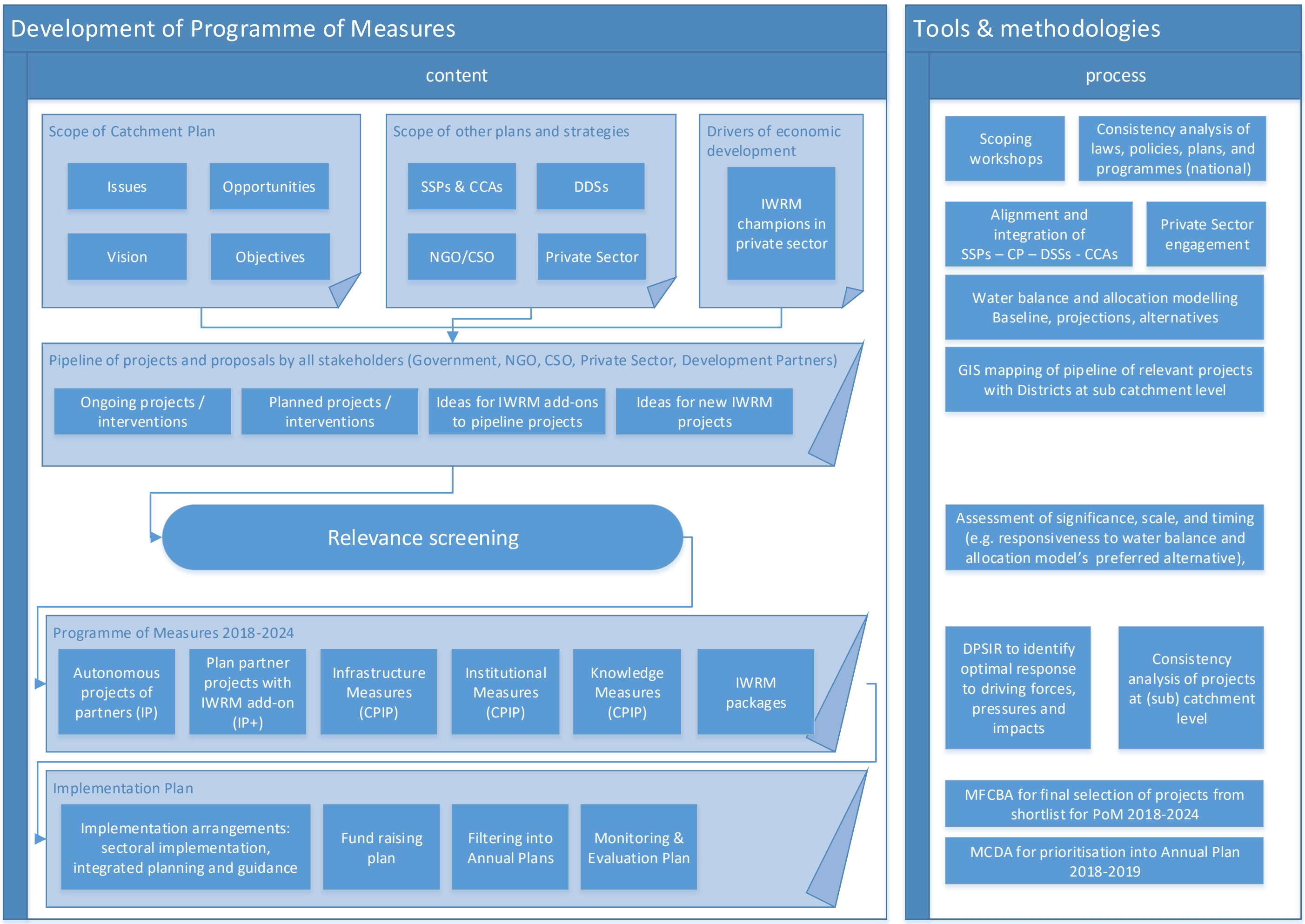

Figure 67: Development framework for catchment plan Programme of Measures

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[58]. 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.

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

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 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 **Error! Reference source not found.** 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 longlist 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 0and 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 TR60, 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 S+SLM+E[59], was identified as the one balancing optimally the development of new irrigation schemes with upkeep of high outflows from the catchment, safeguarding the water tower function of Upper Nyabarongo.

This alternative was adopted by the CTF, FPG, and PSC as the preferred alternative. This was subsequently translated into the water allocation plan presented in Annex 9. The water allocation plan details the amount of water to be allocated to each water use category, including the environment, 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 increased storage capacity, enhanced water use efficiency, and sustainable land management.

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 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 and will subsequently decide which of these should receive IIF funds in the Annual Implementation Plan 2018-2019.

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[59] Combination of enhanced storage, sustainable land management, and efficiency gains in irrigated agriculture, industry, and domestic water supply.

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 0which 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, **Error! Reference source not found.** below p rovides an overview of the entire integrated IWRM / SEA process. **Error! Reference source not found.** provides details of the locations etc. of meetings held with the CTF or with individual districts, and **Error! R eference source not found.** 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 **Error! Reference source not found.**.

Table 38:Overview of catchment plan development workshops held with CTF and individual districts

Meeting	Date	Location	Participants	% women
DHBC training Ngororero and Rubavu (Upper Nyabarongo catchments and Sebeya) (2 days)	04/02/2016	Rubavu	45	22
DHBC training Muhanga and Ruhango (Upper Nyabarongo catchment)	05/02/2016	Muhanga	53	13
DHBC training Karongi and Rutsiro (Sebeya and Upper Nyabarongo catchment)	12/02/2016	Karongi	58	10
DHBC training Nyamagabe and Nyanza (Upper Nyabarongo catchment)	12/02/2016	Huye	63	30
Upper Nyabarongo, catchment planning process workshop, 3-6 May 2016	06/05/2016	Huye	45	38
Upper Nyabarongo, catchment planning process scoping workshop	06/06/2016	Huye	40	33
Upper Nyabarongo, technical launch meeting of EIP	12/06/2016	Muhanga	42	31
SEA and catchment plan scoping follow up (2 days)	04/10/2016	Musanze	46	30
Upper Nyabarongo catchment: validation workshop on alternatives and measures	31/1/2017	Nyamagabe	28	21
Upper Nyabarongo: launch meeting of EIP (official)	25/03/2017	Muhanga	11	18
CTF meeting: implementation of the catchment plan version 1.0	05/04/2017	Muhanga	8	38
CP2.0 Mapping and alignment to DDS (Karongi district)	31/10/2017	Karongi	14	7
CP2.0 Mapping and alignment to DDS (Muhanga District)	02/11/2017	Muhanga	9	22
Alignment of Upper Nyabarongo catchment plan to Muhanga District plan	06/11/2017	Muhanga	27	19
Alignment of Upper Nyabarongo catchment plan to Ruhango District plan	06/11/2017	Ruhango	27	7
Alignment of Sebeya and Upper Nyabarongo catchment plans to Ngororero District plan	06/11/2017	Ngororero	26	31
Alignment of Upper Nyabarongo catchment plan to Nyanza District plan	06/11/2017	Nyanza	21	43
Alignment of Sebeya and Upper Nyabarongo catchment plans to Ngororero District plan	07/11/2017	Ngororero	26	31
CP2.0 Mapping and alignment to DDS (Ruhango district)	07/11/2017	Ruhango	14	7
Alignment of Sebeya and Upper Nyabarongo catchment plans to Rutsiro District plan	08/11/2017	Rutsiro	32	13
Alignment of Upper Nyabarongo catchment plan to Huye District plan	08/11/2017	Huye	17	12
CP2.0 Mapping and alignment to DDS (Rutsiro district)	09/11/2017	Rutsiro	11	0
CP2.0 Mapping and alignment to DDS (Nyanza District)	10/11/2017	Nyanza	8	38

Meeting	Date	Location	Participants	% women
Alignment of Upper Nyabarongo catchment plan to Karongi District plan	13/11/2017	Karongi	32	19
Alignment of Upper Nyabarongo catchment plan to Nyamagabe District plan	14/11/2017	Nyamagabe	35	31
CP2.0 Mapping and alignment to DDS (Nyamagabe district)	14/11/2017	Nyamagabe	22	27
CP2.0 Mapping and alignment to DDS (Ngorerero district)	15/11/2017	Ngororero	9	11
CP2.0 Mapping and alignment to DDS (Huye district)	16/11/2017	Huye	17	18

Table 39: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 40: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 41: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); ▪ Joint definition of stakeholder issues and opportunities with CTF June 2016).	Scoping report (TR53, June 2016), covering issues and opportunities, 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 Upper Nyabarongo and Sebeya combined, as 2 districts overlap) in May 2016.	▪ Scoping report (TR53, 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?	▪ Initial CTF consistency analysis of main policies during scoping workshop;	▪ Scoping report (June 2016), covering issues and opportunities, stakeholders, initial consistency analysis, and vision and objectives;

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
	▪ Which feedback needs to be provided to existing PPPs, from a catchment plan point of view?	▪ 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 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).	▪ 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); ▪ 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	▪ 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);	▪ TR28 – Water Users' Survey (March 2017) including spreadsheets and GIS maps of water users; ▪ TR29 – Water balance and allocation modelling in Rwanda (March 2017); ▪ TR56 – Water balance and allocation modelling, Upper Nyabarongo catchment (August 2017) ▪ TR60 – Water balance and allocation modelling in Rwanda, Upper Nyabarongo catchment draft final report (November

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
	developments) for each of the plan alternatives; ▪ 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).	▪ 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, 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.	2017) Several subsequent versions of working versions of CP/SEA roadmap; ▪ 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; ▪ 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.	▪ Meeting with the CTF held on 30 January 2017, in which MCA was carried out to select preferred alternative (PCB+); ▪ 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.	▪ Meeting report CTF 30 January 2017; ▪ Minutes of Meeting / Action & Decision list of PSC meeting 5 April 2017; ▪ 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	▪ Letter by DG MINIRENA/RNRA to REMA, requesting review of CP1;

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
		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 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.
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;	▪ 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;	▪ 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
	▪ Align with key water using economic sectors via participation in Sector Workings Groups, Thematic Working 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.	▪ 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; ▪ 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 and/or sessions of Parliament.	▪ 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.
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	▪ Assign representatives of implementing partners and CTF to CP implementation oversight committee; ▪ Support 'permanent secretariat'/ catchment management support team;	▪ Letters of assignment by implementing partners and from CTF chair person, supported by letters from mayors of districts; ▪ Minutes of meetings.

IWRM and SEA phase	Details	Activities (implemented / way forward)	Results / means of verification
	implementing authorities to oversee plan implementation.	▪ Support regular meetings, aligned with national and district planning calendar.	
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 learnt, 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's 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.

Annex 8. SDGs and catchment planning

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 68 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 68: 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

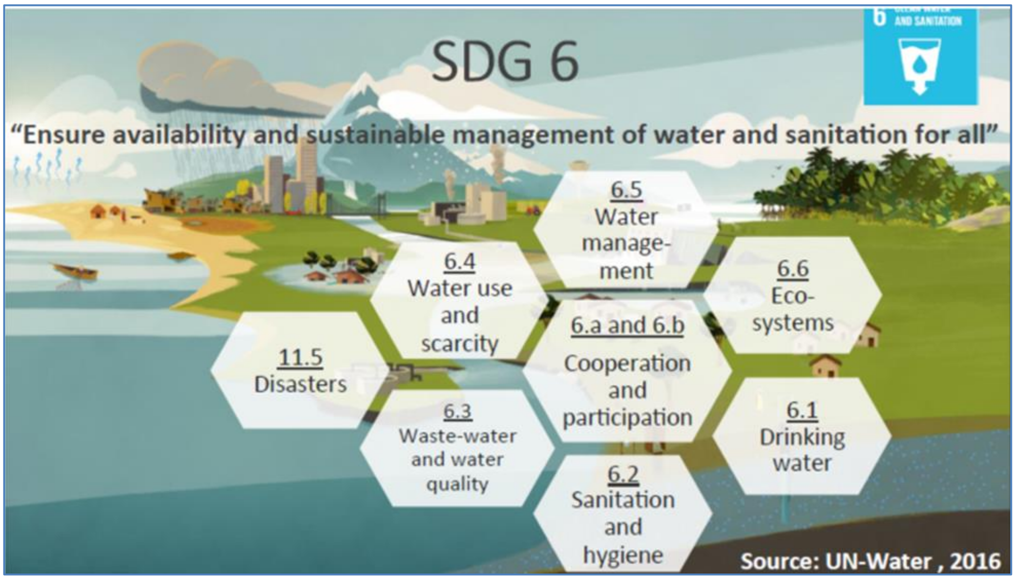


Figure 69: Target areas of SDG 6 and SDG 11.5 (for water related disasters)

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.

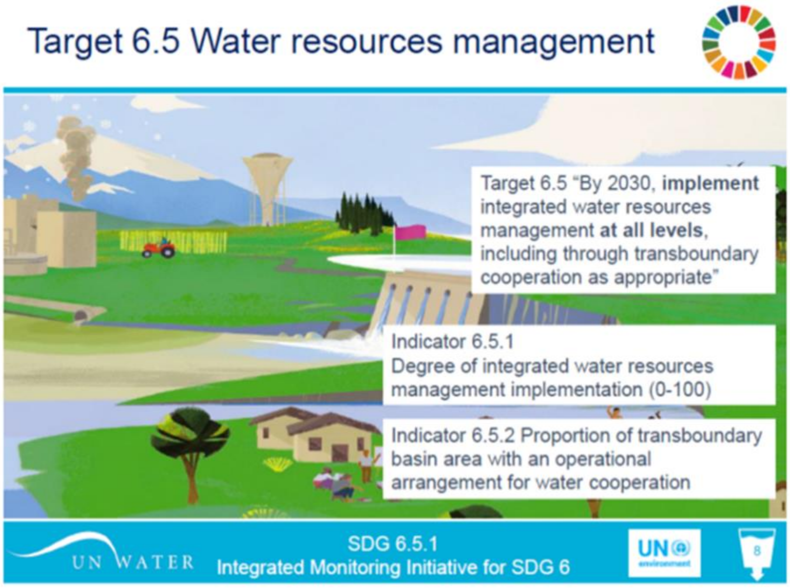


Figure 70: Monitoring of SDG 6.5 – Target and indicators

Scoping workshops held in 2016 led to the following statements used in development of Catchment Plan vision and objectives:

- Contribute to the achievement of surface water quality standards in catchment waterbodies (SDG 6.3.2);
- Ensure equitable and efficient allocation of water resources to all users within the catchment taking into account future projections (SDG 6.4.1, 6.4.2, 6.5.1);
- Restore and protect critical sub-catchments and wetlands to reduce soil erosion and enhance resilience to climate change (SDG 6.5.1, 6.6.1);
- Strengthen the water governance framework to ensure implementation of identified key public-private partnerships (PPPs) in an integrated approach (SDG 6.5.1, 6.6.6b);
- Reduce demographic pressure on natural resources by diversifying livelihoods and promoting family planning (SDG 6.4.2, SDG 1);
- Ecosystem and biodiversity management, through sustainable land management and focusing on sustainable use of land and freshwater ecosystems and reducing disasters (SDG 6.3, 6.4, 6.5, 6.6);
- Water supply and sanitation, quality and management of water, focus on IWRM (SDG 6);
- Food security, focus on sustainable agricultural production (SDG 2).

Upper Nyabarongo catchment stakeholders prioritised the following SDGs:

- SDG 15 Life on land: Sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss. This goal was clearly considered to be of basic importance to all other goals. Participants argued that if land, ecosystems and biodiversity were not well managed and integrated into planning, no other goals could be achieved;
- SDG 6: Clean water and sanitation. Ensuring access to water and sanitation for all came second in the district groups and in the IWRMD/ISU group;
- SDG 12: Responsible consumption and production: Ensuring sustainable consumption and production patterns, specifically 12.1: Sustainable management and efficient use of natural resources;
- SDG 2: Zero Hunger: End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

Further detailed group analysis of SDG targets refined the above selection:

- SDG target 15.1 Conservation, restoration and sustainable use of land and freshwater ecosystems and their services;
- SDG target 6.5 Integrated water resources management (transboundary cooperation);
- SDG target 12.2 Sustainable management and efficient use of natural resources;
- SDG target 11.5 Reduce disasters, including water-related disasters (poor and vulnerable).

It was a shared view that government, the private sector, and civil society should move hand-in-hand towards achievement of the goals: Government by creating the right policies and regulations to enable business to make the goals part of their business models; business to integrate social goals in their strategies and business models, and; civil society to bring about the behaviour change needed to care for the environment as a natural capital for future generations.

Figure 71: 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 strengthen the institutions around water resources.

Annex 9. Water balance and allocation modelling

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'[60]. 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), and 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 Upper Nyabarongo, the improvements and results are described in W4GR TR60 (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 **Error! Reference source not found.**. Typical usage f igures have been taken from MINIRENA, (2017) 'Baseline study on water users and water uses 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 42: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 Upper Nyabarongo covered in TR60. 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 **Error! Reference source not found.**.

[60] 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 43:Codes and content of new alternatives for Upper Nyabarongo 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 **Error! Reference source not found.**.

Table 44: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: 1.9 2030: 1.9 2050: 1.9	24: 50% 30: 100% 50: 100%	BAU[61]	BAU	BAU
2. Development of new storage	2024: 1.9 2030: 10.0 2050: 18.0				
3. Development of new storage, sustainable land management[62] 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[63]'.

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 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 72[64] 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

[61] BAU = Business as Usual.

[62] Several soil/water parameters are changed to simulate sustainable land management, see W4GR TR60 (2017).

[63] 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.

[64] The approach is described in detail in W4GR TR29 (2017).

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 73 and **Error! Reference source not found.** 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.

It should, however, be noted that more water use in the catchment leads automatically to a reduction of outflow, i.e. a reduction of Upper Nyabarongo's 'water tower' role for downstream catchments. The selection of development of new storage, combined with sustainable land management, and water use efficiency (S+SLM+E) as the preferred alternative, offers an optimal solution between efficient water use for food production on one hand, and a water tower function on the other.

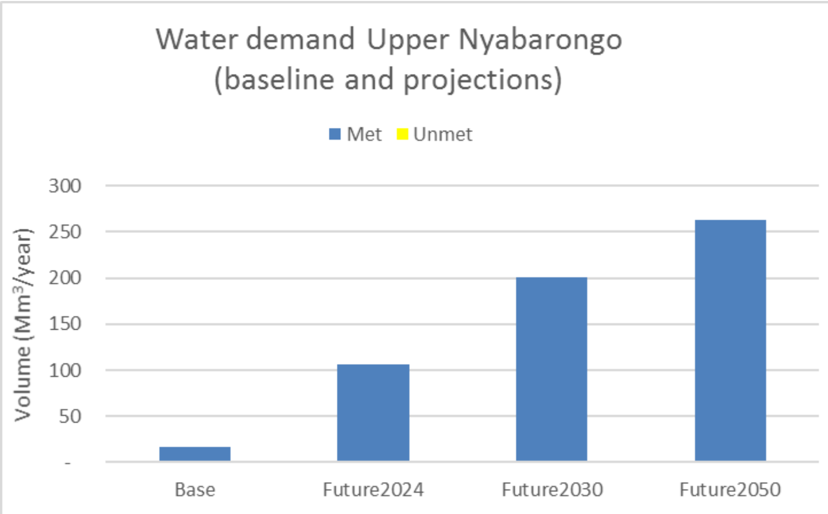


Figure 72: Total annual water demand (met/unmet) baseline and projections

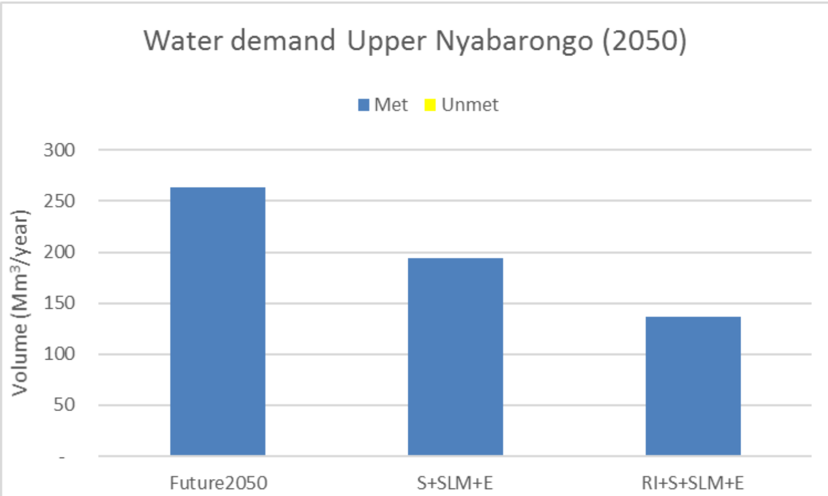


Figure 73: Total annual water demand in Upper Nyabarongo by 2050 (met and unmet) under different alternatives

Table 45:Water demand (met/unmet) by 2050, new alternatives

Alternative	Met demand (2050) (MCM/y)	Unmet demand (2050) (MCM/y)
Future 2050	263	0
S+SLM+E	194	0
RI+S+SLM+E	136	0

An analysis of monthly water demand (see Figure 74 for the baseline) for Upper Nyabarongo catchment as a whole for 2024 under the medium projection is shown in Figure 75[65]. Small reductions in water demand are achieved using the preferred alternative as shown in Figure 76. 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.

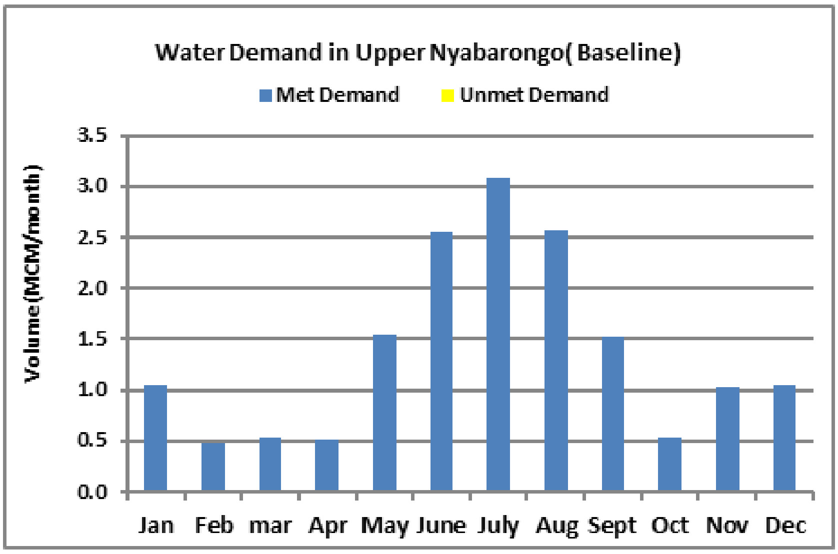


Figure 74: Water demand Upper Nyabarongo (monthly) – Baseline

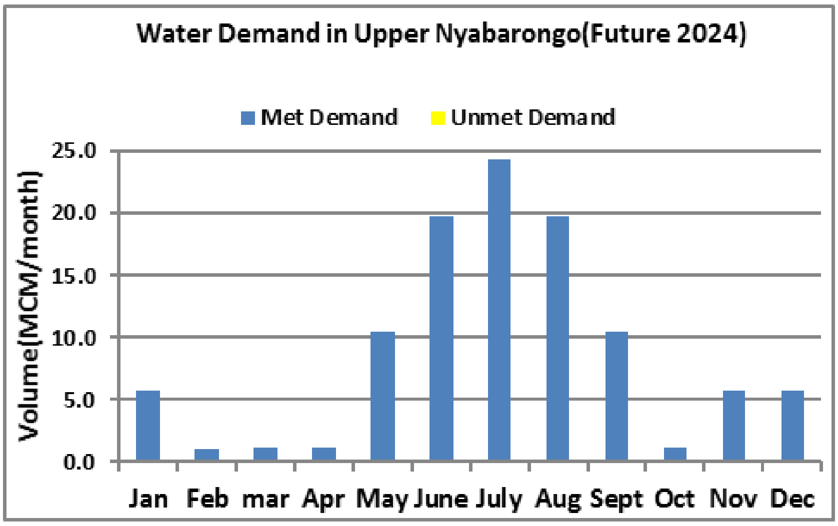


Figure 75: Water demand Upper Nyabarongo (monthly) – Future 2024

[65] Note the change in the vertical axis, with the maximum value shifting from just over 3 million m3/month in the baseline situation, to nearly 25 million m3/month by the year 2024.

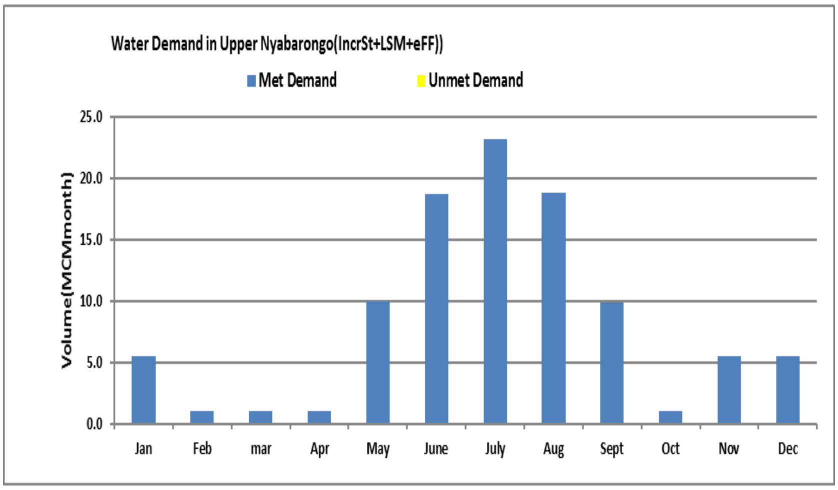


Figure 76: Water demand Upper Nyabarongo (monthly) – 2024+IncrSt+SLM+eFF

A detailed analysis of similar water demand figures per sub-catchment and for different alternatives can be found in W4GR TR60 (2017).

Conclusions

- Growing water demand can be fully met up to 2050, sustaining Upper Nyabarongo's 'water tower' function for the nation;
- The catchment plan's programme of measures, including IWRM packages and CPIPs, needs to assist in implementation of the preferred alternative and to incorporate all elements of the selected alternative, i.e. increased storage, enhanced sustainable land management and improved water use efficiency.

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[66], 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 and for Upper Nyabarongo, no restrictions have had to be incorporated in water allocation. In situations of extreme water scarcity, however, i.e. in very dry years, the volume of water allocated to all users may need to be reduced if all are also to still receive some allocation. 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.

[66] 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.*

Mwogo sub-catchment water allocation plan

Table52: Mwogo 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	70,491	111	53	14,098	44	324	14,631	55,860
Feb	76,405	101	48	15,281	40	0	15,470	60,934
Mar	83,982	111	53	16,796	44	0	17,005	66,977
Apr	94,376	107	51	18,875	43	0	19,077	75,300
May	93,501	111	53	18,700	44	648	19,557	73,945
Jun	63,107	107	51	12,621	43	1,297	14,120	48,987
Jul	49,840	111	53	9,968	44	1,621	11,797	38,043
Aug	47,230	111	53	9,446	44	1,297	10,951	36,279
Sep	52,311	107	51	10,462	43	648	11,312	40,999
Oct	60,805	111	53	12,161	44	0	12,369	48,436
Nov	69,824	107	51	13,965	43	324	14,491	55,334
Dec	76,289	111	53	15,258	44	324	15,790	60,498

Table 46: Mwogo 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	65,603	227	114	13,121	77	1,032	14,570	51,033
Feb	68,738	207	104	13,748	70	0	14,127	54,611
Mar	71,380	227	114	14,276	77	0	14,694	56,687
Apr	75,771	220	110	15,154	74	0	15,558	60,212
May	74,355	227	114	14,871	77	2,063	17,352	57,003
Jun	61,750	220	110	12,350	74	4,127	16,881	44,869
Jul	56,149	227	114	11,230	77	5,158	16,805	39,343
Aug	53,686	227	114	10,737	77	4,127	15,281	38,404
Sep	54,474	220	110	10,895	74	2,063	13,362	41,112
Oct	57,623	227	114	11,525	77	0	11,942	45,681
Nov	62,635	220	110	12,527	74	1,032	13,963	48,673
Dec	68,979	227	114	13,796	77	1,032	15,245	53,734

Table 47:Mwogo 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	68,233	364	213	13,647	127	1,571	15,922	52,312
Feb	71,738	331	194	14,348	116	0	14,988	56,750
Mar	74,107	364	213	14,821	127	0	15,526	58,581
Apr	78,513	352	206	15,703	123	0	16,384	62,129
May	76,498	364	213	15,300	127	3,141	19,145	57,353
Jun	63,423	352	206	12,685	123	6,282	19,648	43,774
Jul	57,946	364	213	11,589	127	7,853	20,146	37,800
Aug	54,939	364	213	10,988	127	6,282	17,974	36,965
Sep	55,019	352	206	11,004	123	3,141	14,827	40,192
Oct	57,702	364	213	11,540	127	0	12,245	45,457
Nov	63,206	352	206	12,641	123	1,571	14,893	48,313
Dec	71,501	364	213	14,300	127	1,571	16,575	54,926

Table 48:Mwogo 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	77,227	1,028	762	15,445	363	1,293	18,892	58,336
Feb	82,168	935	693	16,434	330	0	18,392	63,776
Mar	83,518	1,028	762	16,704	363	0	18,856	64,662
Apr	88,004	995	737	17,601	351	0	19,684	68,320
May	82,976	1,028	762	16,595	363	2,587	21,335	61,641
Jun	67,673	995	737	13,535	351	5,174	20,791	46,882
Jul	61,897	1,028	762	12,379	363	6,467	20,999	40,898
Aug	57,853	1,028	762	11,571	363	5,174	18,897	38,956
Sep	57,109	995	737	11,422	351	2,587	16,092	41,017
Oct	59,660	1,028	762	11,932	363	0	14,085	45,575
Nov	66,082	995	737	13,216	351	1,293	16,593	49,489
Dec	80,084	1,028	762	16,017	363	1,293	19,463	60,621

Mbirurume sub-catchment water allocation plan

Table 49: Mbirurume 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	20,694	32	18	4,139	1	28	4,218	16,477
Feb	22,262	29	16	4,452	1	0	4,498	17,764
Mar	24,720	32	18	4,944	1	0	4,995	19,726
Apr	26,709	31	17	5,342	1	0	5,391	21,318
May	26,658	32	18	5,332	1	57	5,439	21,219
Jun	19,003	31	17	3,801	1	113	3,963	15,041
Jul	15,216	32	18	3,043	1	141	3,235	11,981
Aug	14,461	32	18	2,892	1	113	3,056	11,405
Sep	16,436	31	17	3,287	1	57	3,393	13,043
Oct	18,342	32	18	3,668	1	0	3,719	14,623
Nov	20,689	31	17	4,138	1	28	4,215	16,474
Dec	22,362	32	18	4,472	1	28	4,551	17,810

Table 50:Mbirurume 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	19,392	67	38	3,878	2	27	4,012	15,380
Feb	20,297	61	35	4,059	1	0	4,156	16,141
Mar	21,244	67	38	4,249	2	0	4,355	16,888
Apr	22,097	65	37	4,419	2	0	4,522	17,574
May	21,776	67	38	4,355	2	54	4,515	17,261
Jun	18,543	65	37	3,709	2	107	3,919	14,624
Jul	16,794	67	38	3,359	2	134	3,600	13,194
Aug	16,056	67	38	3,211	2	107	3,425	12,631
Sep	16,542	65	37	3,308	2	54	3,465	13,077
Oct	17,344	67	38	3,469	2	0	3,575	13,769
Nov	18,573	65	37	3,715	2	27	3,845	14,729
Dec	20,259	67	38	4,052	2	27	4,185	16,074

Table 51:Mbirurume 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	20,190	108	71	4,038	4	24	4,245	15,945
Feb	21,258	98	65	4,252	4	0	4,418	16,840
Mar	22,176	108	71	4,435	4	0	4,618	17,558
Apr	23,022	104	69	4,604	4	0	4,781	18,241
May	22,479	108	71	4,496	4	48	4,727	17,752
Jun	19,008	104	69	3,802	4	96	4,075	14,933
Jul	17,221	108	71	3,444	4	120	3,747	13,473
Aug	16,361	108	71	3,272	4	96	3,551	12,810
Sep	16,715	104	69	3,343	4	48	3,568	13,147
Oct	17,486	108	71	3,497	4	0	3,680	13,806
Nov	18,800	104	69	3,760	4	24	3,961	14,839
Dec	21,001	108	71	4,200	4	24	4,407	16,594

Table 52:Mbirurume 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	22,647	307	255	4,529	21	20	5,132	17,515
Feb	24,129	279	232	4,826	19	0	5,356	18,773
Mar	24,892	307	255	4,978	21	0	5,561	19,331
Apr	25,713	297	247	5,143	20	0	5,707	20,006
May	24,465	307	255	4,893	21	40	5,516	18,949
Jun	20,372	297	247	4,074	20	79	4,718	15,654
Jul	18,475	307	255	3,695	21	99	4,377	14,098
Aug	17,284	307	255	3,457	21	79	4,119	13,165
Sep	17,307	297	247	3,461	20	40	4,065	13,242
Oct	18,014	307	255	3,603	21	0	4,186	13,828
Nov	19,581	297	247	3,916	20	20	4,500	15,081
Dec	23,272	307	255	4,654	21	20	5,257	18,015

Hydropower sub-catchment water allocation plan

Table 53:Hydropower 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	106,701	99	46	21,340	18	158	21,660	85,041
Feb	119,576	90	42	23,915	16	0	24,063	95,513
Mar	134,545	99	46	26,909	18	0	27,071	107,473
Apr	150,698	96	45	30,140	17	0	30,297	120,401
May	148,765	99	46	29,753	18	315	30,231	118,535
Jun	95,681	96	45	19,136	17	630	19,924	75,758
Jul	73,310	99	46	14,662	18	788	15,612	57,698
Aug	70,888	99	46	14,178	18	630	14,970	55,918
Sep	82,260	96	45	16,452	17	315	16,924	65,336
Oct	95,674	99	46	19,135	18	0	19,297	76,377
Nov	110,778	96	45	22,156	17	158	22,470	88,308
Dec	118,641	99	46	23,728	18	158	24,048	94,593

Table 54:Hydropower 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	92,349	205	99	18,470	38	591	19,404	72,946
Feb	97,836	186	90	19,567	35	0	19,879	77,958
Mar	101,844	205	99	20,369	38	0	20,711	81,133
Apr	107,550	198	96	21,510	37	0	21,841	85,709
May	104,249	205	99	20,850	38	1,183	22,375	81,874
Jun	86,359	198	96	17,272	37	2,365	19,969	66,391
Jul	77,750	205	99	15,550	38	2,957	18,849	58,900
Aug	75,083	205	99	15,017	38	2,365	17,724	57,358
Sep	77,886	198	96	15,577	37	1,183	17,091	60,795
Oct	83,521	205	99	16,704	38	0	17,046	66,474
Nov	89,205	198	96	17,841	37	591	18,764	70,442
Dec	97,017	205	99	19,403	38	591	20,337	76,680

Table 55:Hydropower 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	95,001	330	186	19,000	81	924	20,521	74,480
Feb	101,561	300	169	20,312	74	0	20,855	80,706
Mar	105,278	330	186	21,056	81	0	21,653	83,626
Apr	111,016	319	180	22,203	78	0	22,781	88,235
May	105,988	330	186	21,198	81	1,849	23,643	82,345
Jun	86,500	319	180	17,300	78	3,697	21,575	64,925
Jul	77,544	330	186	15,509	81	4,621	20,727	56,817
Aug	74,645	330	186	14,929	81	3,697	19,223	55,422
Sep	77,473	319	180	15,495	78	1,849	17,921	59,552
Oct	83,459	330	186	16,692	81	0	17,289	66,170
Nov	89,277	319	180	17,855	78	924	19,357	69,919
Dec	99,535	330	186	19,907	81	924	21,428	78,107

Table 56:Hydropower 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	106,070	941	665	21,214	363	761	23,945	82,125
Feb	114,603	856	605	22,921	330	0	24,713	89,891
Mar	117,158	941	665	23,432	363	0	25,401	91,756
Apr	123,052	911	644	24,610	351	0	26,517	96,535
May	114,685	941	665	22,937	363	1,522	26,429	88,255
Jun	92,775	911	644	18,555	351	3,045	23,506	69,269
Jul	83,593	941	665	16,719	363	3,806	22,494	61,099
Aug	79,038	941	665	15,808	363	3,045	20,822	58,216
Sep	80,216	911	644	16,043	351	1,522	19,472	60,744
Oct	85,459	941	665	17,092	363	0	19,062	66,397
Nov	92,694	911	644	18,539	351	761	21,206	71,488
Dec	110,096	941	665	22,019	363	761	24,750	85,346

Satinsyi sub-catchment water allocation plan

Table 57:Satinsyi 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	18,454	41	20	3,691	9	0	3,761	14,693
Feb	22,744	38	18	4,549	8	0	4,613	18,131
Mar	25,847	41	20	5,169	9	0	5,240	20,607
Apr	28,557	40	19	5,711	9	0	5,780	22,778
May	30,496	41	20	6,099	9	0	6,170	24,327
Jun	19,582	40	19	3,916	9	0	3,985	15,598
Jul	14,299	41	20	2,860	9	0	2,930	11,369
Aug	14,446	41	20	2,889	9	0	2,959	11,486
Sep	17,155	40	19	3,431	9	0	3,499	13,656
Oct	19,087	41	20	3,817	9	0	3,888	15,199
Nov	22,873	40	19	4,575	9	0	4,643	18,230
Dec	22,607	41	20	4,521	9	0	4,592	18,015

Table 58:Satinsyi 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	14,540	86	43	2,908	20	723	3,780	10,761
Feb	14,716	78	39	2,943	18	0	3,078	11,637
Mar	15,199	86	43	3,040	20	0	3,188	12,010
Apr	15,714	83	42	3,143	19	0	3,287	12,427
May	16,506	86	43	3,301	20	1,447	4,896	11,610
Jun	16,214	83	42	3,243	19	2,893	6,280	9,934
Jul	15,571	86	43	3,114	20	3,616	6,879	8,692
Aug	14,741	86	43	2,948	20	2,893	5,990	8,751
Sep	14,161	83	42	2,832	19	1,447	4,422	9,738
Oct	13,869	86	43	2,774	20	0	2,922	10,947
Nov	14,577	83	42	2,915	19	723	3,782	10,794
Dec	15,056	86	43	3,011	20	723	3,883	11,173

Table 59:Satinsyi 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	14,320	138	81	2,864	42	1,294	4,419	9,901
Feb	14,407	125	74	2,881	38	0	3,119	11,288
Mar	14,915	138	81	2,983	42	0	3,244	11,671
Apr	15,435	133	78	3,087	41	0	3,339	12,096
May	16,516	138	81	3,303	42	2,589	6,153	10,364
Jun	16,482	133	78	3,296	41	5,177	8,726	7,756
Jul	16,009	138	81	3,202	42	6,471	9,934	6,075
Aug	14,987	138	81	2,997	42	5,177	8,435	6,552
Sep	14,021	133	78	2,804	41	2,589	5,645	8,375
Oct	13,357	138	81	2,671	42	0	2,932	10,425
Nov	14,234	133	78	2,847	41	1,294	4,393	9,840
Dec	14,821	138	81	2,964	42	1,294	4,519	10,302

Table 60:Satinsyi 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	15,430	393	289	3,086	191	1,066	5,025	10,405
Feb	15,821	358	263	3,164	173	0	3,958	11,862
Mar	16,439	393	289	3,288	191	0	4,161	12,278
Apr	17,014	381	280	3,403	185	0	4,248	12,767
May	17,828	393	289	3,566	191	2,132	6,570	11,257
Jun	17,391	381	280	3,478	185	4,263	8,586	8,804
Jul	16,754	393	289	3,351	191	5,329	9,553	7,201
Aug	15,649	393	289	3,130	191	4,263	8,266	7,383
Sep	14,659	381	280	2,932	185	2,132	5,908	8,750
Oct	14,062	393	289	2,812	191	0	3,685	10,376
Nov	14,904	381	280	2,981	185	1,066	4,892	10,013
Dec	15,861	393	289	3,172	191	1,066	5,111	10,750

Nyabarongo Upper sub-catchment water allocation plan

Table 61:Nyabarongo Upper 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	121,923	20	12	24,385	5	0	24,422	97,502
Feb	135,394	18	11	27,079	5	0	27,113	108,282
Mar	150,819	20	12	30,164	5	0	30,201	120,618
Apr	167,632	19	12	33,526	5	0	33,562	134,070
May	167,928	20	12	33,586	5	0	33,623	134,305
Jun	115,815	19	12	23,163	5	0	23,199	92,616
Jul	90,557	20	12	18,111	5	0	18,148	72,408
Aug	85,891	20	12	17,178	5	0	17,215	68,676
Sep	96,038	19	12	19,208	5	0	19,243	76,795
Oct	109,867	20	12	21,973	5	0	22,010	87,857
Nov	126,009	19	12	25,202	5	0	25,238	100,772
Dec	134,057	20	12	26,811	5	0	26,848	107,209

Table 62:Nyabarongo Upper 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	110,764	42	26	22,153	11	2,040	24,271	86,493
Feb	117,555	38	23	23,511	10	0	23,582	93,972
Mar	122,376	42	26	24,475	11	0	24,554	97,822
Apr	128,847	40	25	25,769	11	0	25,845	103,001
May	124,931	42	26	24,986	11	4,080	29,145	95,787
Jun	104,658	40	25	20,932	11	8,160	29,167	75,491
Jul	94,218	42	26	18,844	11	10,200	29,122	65,096
Aug	91,198	42	26	18,240	11	8,160	26,478	64,721
Sep	94,859	40	25	18,972	11	4,080	23,128	71,732
Oct	101,740	42	26	20,348	11	0	20,426	81,314
Nov	107,780	40	25	21,556	11	2,040	23,672	84,108
Dec	116,251	42	26	23,250	11	2,040	25,369	90,883

Table 63:Nyabarongo Upper 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	**112,302**	67	48	22,460	25	3,650	**26,250**	86,052
Feb	**120,593**	61	44	24,119	22	0	**24,245**	96,347
Mar	**125,123**	67	48	25,025	25	0	**25,164**	99,959
Apr	**131,634**	65	46	26,327	24	0	**26,462**	105,172
May	**125,377**	67	48	25,075	25	7,301	**32,516**	92,861
Jun	**102,877**	65	46	20,575	24	14,602	**35,312**	67,565
Jul	**91,832**	67	48	18,366	25	18,252	**36,758**	55,074
Aug	**88,792**	67	48	17,758	25	14,602	**32,499**	56,292
Sep	**92,924**	65	46	18,585	24	7,301	**26,021**	66,903
Oct	**100,604**	67	48	20,121	25	0	**20,260**	80,344
Nov	**106,547**	65	46	21,309	24	3,650	**25,095**	81,452
Dec	**117,644**	67	48	23,529	25	3,650	**27,319**	90,325

Table 64:Nyabarongo Upper 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	**123,250**	191	171	24,650	114	3,006	**28,132**	95,118
Feb	**133,974**	174	156	26,795	103	0	**27,228**	106,746
Mar	**137,304**	191	171	27,461	114	0	**27,937**	109,367
Apr	**144,089**	185	166	28,818	110	0	**29,278**	114,811
May	**134,408**	191	171	26,882	114	6,012	**33,370**	101,038
Jun	**109,379**	185	166	21,876	110	12,025	**34,361**	75,017
Jul	**98,058**	191	171	19,612	114	15,031	**35,119**	62,939
Aug	**93,000**	191	171	18,600	114	12,025	**31,101**	61,899
Sep	**95,053**	185	166	19,011	110	6,012	**25,484**	69,569
Oct	**101,577**	191	171	20,315	114	0	**20,791**	80,786
Nov	**109,210**	185	166	21,842	110	3,006	**25,309**	83,901
Dec	**128,008**	191	171	25,602	114	3,006	**29,084**	98,924

Annex 10. Gender mainstreaming guidelines

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 65: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 **Error! Reference source not found.** is to be used in the assessment of all actions / i mplementation 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 66:Gender mainstreaming checklist for catchment plan implementation projects

Programme of Action	Actions[67]	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			
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.

[67] National Gender Policy (2010), Agriculture Gender Strategy (2010) and Gender Profile in Agriculture sector (GMO, 2016), MINIRENA, 5YR SSP, (2013)

Programme of Action	Actions[67]	Situation analysis summary	Added value on gender output/outcome
Topic: Agriculture			
	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[68].	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. 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%.	Equity in division of labour, and gender pay gap addressed.
	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[69].	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	The MINIRENA sector working group allows for coordinated effort from various partners, including government, and development partners. GBS are also planned every fiscal year.	Joint implementation for gender sensitive projects in IWRM measures.

[68] Protocol to the African Charter on Human and People's Rights on the Rights of Women in Africa (2003).

[69] NEPAD Gender, Climate change and Agriculture Support Program Report, August 2014.

Programme of Action	Actions[67]	Situation analysis summary	Added value on gender output/outcome
Topic: Agriculture			
	development partners and integrate appropriate actions to respond to practical and strategic gender needs in the agricultural sector.	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.	
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 planning and management processes for improved and sustainable land use (MIGEPROF,	Women in Rwanda enjoy the same land rights as men. According to the law governing land in Rwanda, land owners are required to 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.	Strategic Needs and interest of women and men considered in planning and management process.

Programme of Action	Actions[67]	Situation analysis summary	Added value on gender output/outcome
Topic: Agriculture			
	NGP, 2010 & Agr Gender Strategy, 2010).	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).	
	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 committees (MINIRENA, 5YR SSP, 2013).	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. 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.

Programme of Action	Actions[67]	Situation analysis summary	Added value on gender output/outcome
Topic: Agriculture			
	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 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).	Access to technology and alternative energy source to reduce the household energy burden and less forest degradation for cooking energy.
	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 67: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	Reduce GHG emissions from fertiliser manufacturing processes

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
		provides an excellent way to manage the huge volume 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

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
	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 , 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.**	Efficient use of irrigation water 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**	Reduced GHG emissions as a result of using low carbon energy sources and reduced transport distance.

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
		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.	
3. Sustainable Forestry, Agroforestry , and Biomass Energy	3.1. Promote afforestation/reforestation of designated areas through enhanced germplasm and technical practices in planting and post-planting processes;	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 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.**	Reduced GHG emissions through sequestration
	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	4.1. Maximise business tourism (the largest source of export revenues) through strategic conference	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,**	Unspecified

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
Services Promotion in Protected Areas	management in order maximise the distribution and volume of business travellers throughout the year	**Rwanda expects business and leisure tourists to increase from 545,000 people in 2012 to 1,262,000 people in 2030.**	
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	Rwanda will establish a comprehensive National Water Security Plan to expand water storage and irrigation infrastructure, rainwater harvesting, water	Unspecified

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
	employ water storage and rain water harvesting, water conservation practices, efficient irrigation, and other water efficient technologies.	conservation and water efficiency practices. This strategic action brings together the national policies and 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 Managemen t	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**	This strategic action will result in better estimations of GHG emissions from land use, land use change and forestry thus improving planning and

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
		the National Spatial Data Infrastructure will be operational by 2030.	implementation 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	**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.**	Unspecified

Programme of Action	Actions	Descriptions and Goals / Targets	Mitigation Benefit
Topic: Agriculture			
	economic conditions, to mobilise local capacity in emergency response, and to reduce locally-specific hazards	**In addition to households previously relocated from high risk zones, Rwanda will relocate additional 30 000 households by 2030.**	
	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 68: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.
	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.

Theme	Criteria	Explanation
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).
	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 69: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.
	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;

Theme	Criteria	Criteria scoring rules
		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; **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.

Theme	Criteria	Criteria scoring rules
	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:

- UNY01 - Catchment restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed (LWAPES);
- UNY02 - Rehabilitation and protection of Kiryango catchments for sustainable agriculture exploitation;
- UNY03 - Catchment restoration and protection of waterbodies in Mwogo watershed (LAPROM);
- UNY04 - Catchment restoration supporting sustainable and efficient investments in agribusiness, mining and hydropower generation in the most degraded areas of Upper Nyabarongo.

The concept notes of the IWRM packages are presented on the following pages.

IWRM Package 1: Title IWRM Package: Landscape restoration and water resources protection for the viability of ecosystem services in Mbirurume watershed (LWAPES)

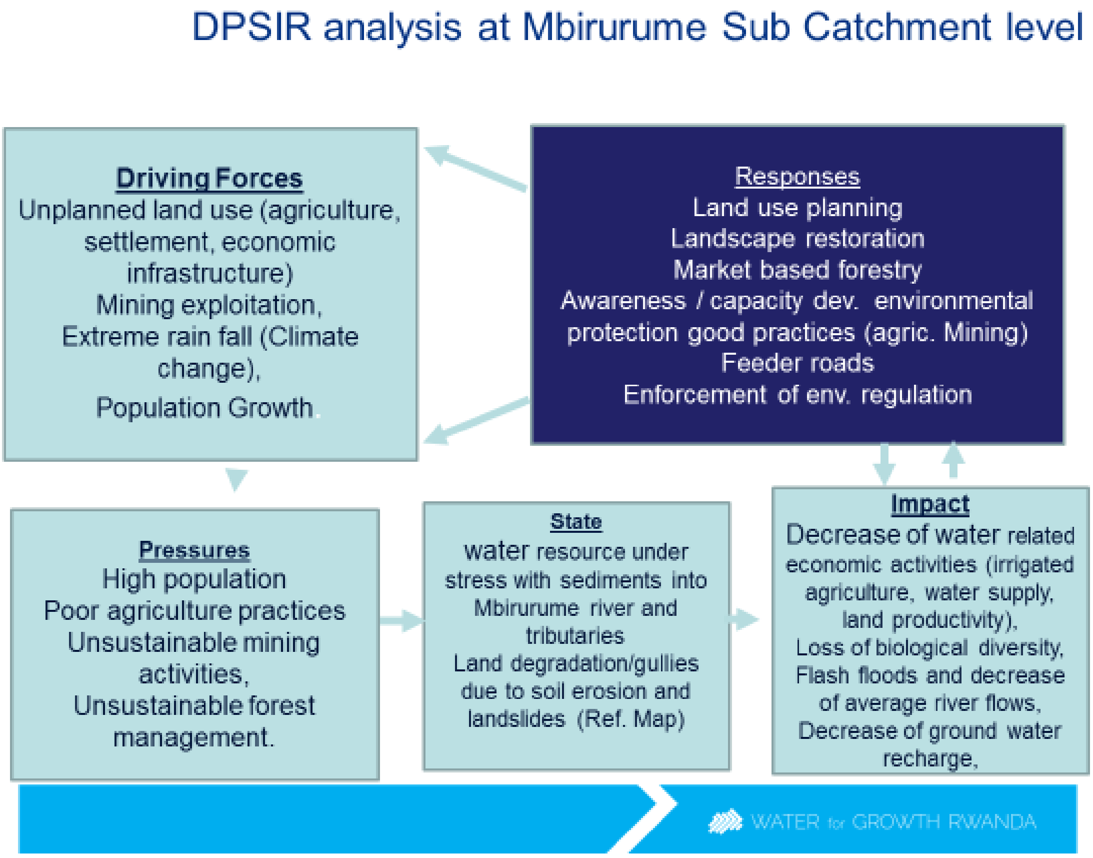
Potential Implementing partners: W4GR, Karongi and Nyamagabe Districts, MIG, MINAGRI, MININFRA, Duterimbere, UNICOOPAGI, New Forest Company.

Project rationale

Mbururume river, before its confluence with Mwogo River is one of the major sources of sediments and floods that disrupts the Nyabarongo River hydrology.

The water resource used for economic purposes is often under stress due to pollution with sediments from soil erosion, landslides and floods. This continual erosion also reduces the ability of the soil to store the water required for the ground water recharge to constitute the necessary reserve for future socio-economic development.

More particularly, marshlands suitable for irrigated agriculture are often flooded with sand-laden sediments, rendering these marshes unusable if upstream hills are not protected. The DPSIR analysis presents the interactions between the society and the environment in the sub-catchment as follows:



Local economic drivers are:

- Abundance of water resources and a dense hydrological network;
- Agro-ecological areas suitable for tea, coffee and forest plantations, as well as horticulture, wheat, maize, Irish potatoes and beekeeping;
- Tourism: Nyungwe Natural Forest;
- Significant hydropower potential.

A lack of suitable maintenance and management of the catchment by beneficiaries of its ecosystem services, combined with limited investment in modern agriculture, irrigation, value chains for cash crop and hydropower generation, has led to steady catchment degradation, combined with a decrease in agricultural productivity and a decline in economic productivity.

Important drivers of socio-economic development can be combined with key responses to identified issues to design sustainable IWRM interventions.

In the Upper Nyabarongo Catchment plan, this package will serve to reach the two specific objectives of:

- Improved water quality and quantity in waterbodies, taking into account resilience to climate change, and;
- Reduced pressure on natural resources by creation of diversified and alternative livelihoods.

- **Objectives**

The overall objective is "*To improve the quality and quantity of water in the Mbirurume River and its tributaries through sustainable land management, water productivity and improved livelihoods by reducing the pressure on natural resources in the catchment*"

- Specific objectives

1. Rehabilitate degraded catchments through control of soil erosion and flood mitigation;
2. Protect water resources to enable investment in irrigation and hydropower generation;
3. Build capacity of farmers, district officers and mining operators in climate smart agriculture and environmental laws.

- **Activities specific for projects linkage to a package**

To contribute to achievement of the above-mentioned objectives, and based on information provided through participatory consultation with stakeholders during the feasibility studies, three sites have been chosen for works that offer a good concentration of IWRM issues:

1. Gatare sub-catchment (Karongi District / Mutuntu and Rwankuba sector)
2. Nzavu sub-catchment (Nyamagabe District / Mugano sector)
3. Rurongora sub-catchment (Nyamagabe District / Musebeya, Kaduha and Mushubi sectors)

The following interventions will be implemented in these areas:

- Rehabilitate and protect farmland against soil erosion with terraces, agroforestry (horticulture trees) and fodder grass on ~4,535 ha;
- Support fertility management through implementation of the Girinka program with ~3,200 cows;
- Provide training and capacity building for ~5,780 farmers on climate smart agriculture;
- Rehabilitate degraded forests and afforest new areas unsuitable for agriculture on ~1,245 ha;
- Rehabilitate and prevent creation of gullies in an area of 19 ha using 3.7 km of live check dams;
- Protect riverbanks against erosion by creating or rehabilitating buffer zones along rivers and mountain streams on 150 ha;
- Protect ~ 35 km of drains downstream of roads cross-drainage structures;
- Promote installation of rainwater harvesting on rooftops of 1,492 Ubudehe #2 households and 11 schools;
- Provide improved cook stoves to 2,420 Ubudehe #1 and #2 households and 11 schools;
- Promote diversification of rural livelihoods and protection of forests through beekeeping.

These main activities will be coupled with three cross-cutting issues:

- Disaster management;
- Capacity building in the critical areas of IWRM concepts and practices;
- Gender as a cross cutting area during all the project components for inclusiveness, equitable benefits, women in decision making and their economic empowerment. Gender needs will also be addressed for effective mainstreaming, and;

- Climate change adaptation: promoting uptake of climate smart agriculture through use of farmer field school (FFS) and introduction of improved farming methods and resistant crops varieties.

- Beneficiaries and impacts

The project will directly benefit local farmers whose land is at high risk of erosion and flooding.

Specifically, the project will target rural subsistence farmers' (Ubudehe #1 and #2). Indirectly the project will benefit potential investors in horticulture value chain, irrigation development and hydropower generation.

The main expected outcomes and impacts are:

- An increased area of farmland rehabilitated against soil erosion with terraces, agroforestry (Horticulture trees) and fodder grass;
- An increased area of the catchment protected against flooding.
- A reduction in the sediment levels in the Mbirurume River and tributaries (Gatare, Rurongora and Nzavu) as a result of catchment restoration;
- An increase in the amount of annual groundwater recharge;
- An increase in land productivity for targeted crops in the project area, and;
- An increase in household incomes allowing investment in off-farm income generating activities and diversification away from reliance on subsistence agriculture
- Improved gender equality.

- Budget for the proposed measures

Table 70:Budget for the proposed works

Sub-catchment	Budget (RWF)
Gatare sub-catchment	***2,657,962,093***
Catchment Restoration	*1,433,892,076*
Pilot Incentive for ecosystem services	*1,224,070,017*
Nzavu sub-catchment	***815,071,347***
Catchment Restoration	*482,463,544*
Pilot Incentive for ecosystem services	*332,607,803*
Rurongora sub-catchment	***3,098,536,087***
Catchment Restoration	*2,129,894,090*
Pilot Incentive for ecosystem services	*968,641,997*
Total Upper Nyabarongo Mbirurume Package (RWF)	**6,571,569,527**
Total (EUR)	**6,619,895**[70]

[70] Exchange rate 1 Euro = 992.7 Rwandan Franc

- **Project management**

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 logframe 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.).

IWRM Package 2: Rehabilitation and protection of Kiryango watersheds for sustainable agriculture exploitation

Potential Implementing partners: W4GR, Ruhango and Nyanza Districts, MINAGRI and MININFRA.

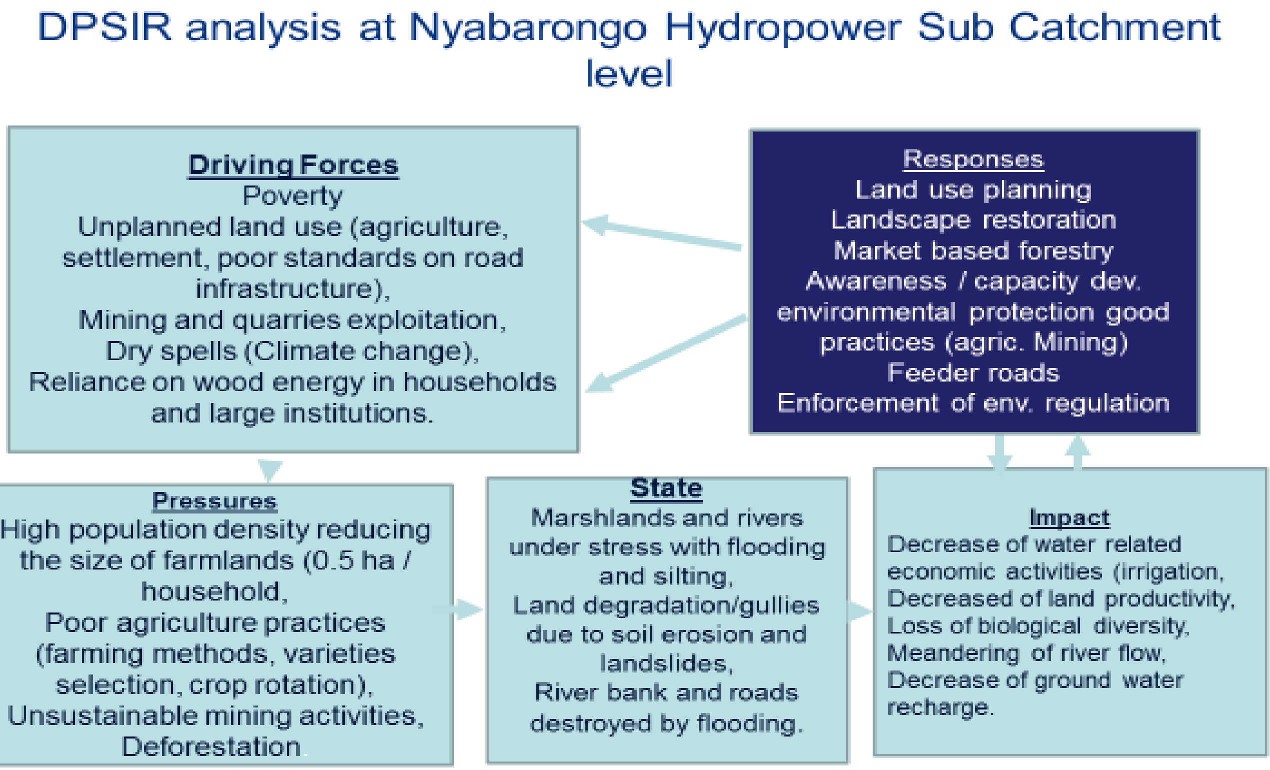
Project rationale

The Main objective of the current irrigation Master Plan (IMP) in Rwanda is to develop and manage water resources to promote intensive and sustainable irrigated agriculture and to improve food security. Specifically, the plan's objective is to provide Rwanda with a planning tool for rational exploitation of its soil and water resources.
The water Evaluation and Allocation Model (WEAP) conducted in the framework of Water for Growth Rwanda Program revealed that in the Upper Nyabarongo Hydropower Sub-Catchment, the overall water balance offers ample opportunities for enhanced allocation of water to productive sectors within the sub catchment and downstream in the catchment. The selected alternative to implement the Upper Nyabarongo Catchment plan using the Planning by Catchment Boundary (PCB) and implementation of IMP at 50% (PCB^-) is implementable in the sub-catchment since the water demand for irrigation is still below 50% of available water.

However, this opportunity is not fully exploited due to unfavorable conditions including siltation of marshes from soil erosion and floods, unsustainable mining activities and poor management of developed marshlands and their entire watersheds in the Nyabarongo Hydropower Sub-catchment. This affects particularly Kiryango, Base, Nkubi and Nyamigogo marshes and related dams: Kiryango, Base and Bishya in Ruhango and Nyanza Districts. Bishya dam has the particular function of supplying water in Nyanza and Ruhango Districts from Mpanga Water treatment plant under the management of WASAC.

The District efforts to rehabilitate the watershed and to manage the marshlands are limited due to the severity of the constraints above mentioned especially due to the combined effects of climatic hazards and landscape degradation

The DPSIR analysis provides the interactions between the society and environment in Nyabarongo Hydropwer sub-catchment as follows:



Local economic drivers are:

1. Coffee and horticulture value chains,
2. Mining and quarries,
3. Irrigated marshlands for rice and maize cultivation

Objectives

The general objective of the project is to **contribute to the water quality and quantity for socio-economic development and improved livelihoods** in the sub-catchment.

In the Upper Nyabarongo Catchment plan, the proposed solutions will serve to implement the two specific objectives of the catchment plan namely:

1. Improve water quality and quantity in water bodies, taking into account resilience to climate change in the catchment and landscape restoration,Ensure equitable and efficient allocation of water resources for all users within the catchment taking into account downstream demand.

Specifically, the project intends:

1. To address erosion and floods issues in the watershed of the targeted marshlands,
2. To increase water storage through rain water harvesting and storage in ponds for small scale irrigation and/or groundwater recharge,

3. To increase capacity of local farmers and miners in compliance with environmental laws and climate smart agriculture.

Activities specific for projects linkage to a package

To achieve the above-mentioned objectives, the following activities components should be implemented:

CPIP1 - Land husbandry and landscape restoration in Base, Nkubi, Nyamigogo and Kiryango watersheds

Development of terraces on the hillsides of the watershed,

Plant agroforestry trees including fruits and fodder grass on the new terraces developed,

Apply FFS to targeted farmers for climate smart agriculture on the new terraces developed,

Protect the riverbank with bamboos and fodder grass,

Re-afforestation in line with District Forest Master plan: Mukingo, Bweramana and Mwendo,

Provision of Livestock to farmers around protected areas of the targeted rivers as IES.

CPIP 2 - Rain water harvesting, water drainage and storage for floods mitigation

Rain water harvesting, water drainage from settlement areas and large institutions,

Feeder roads cross drainage structures protection using bio-engineering techniques,

All those components will be coupled with 2 cross cutting issues:

Gender consideration during all cycles of the project for equitable decision making and economic empowerment,

Capacity building in the critical areas of IWRM concepts and practices.

Beneficiaries, outcomes and impacts

The project will directly benefit local farmers whose land is at high risk of erosion and floods. Local mining companies will also benefit from capacity building in sustainable mining for their compliance with environmental regulation. Local users associations will benefit capacity building in IWRM and water sharing in the catchment.

Indirectly the project will benefit potential investors in horticulture value chain and irrigation development

Outcomes are

1. Increased area of farmlands rehabilitated against soil erosion with terraces, agroforestry (Horticulture trees), fodder grass,
2. Increased area of the watershed of targeted marshes protected against soil erosion and floods,
3. Increased area for forest plantations,
4. Increased area of river buffer zone protected on Base, Kiryango Nkubi and Nyamigogo,
5. Increased number of farmers, water users associations and district staff trained in climate smart agriculture.
6. Increased volume of water collected and stored in ponds from the rooftops of Households.

Impacts are

1. Reduced Total Suspended Solids (TSS) in Nyabarongo: mg/l
2. Increased annual groundwater recharge in the sub-catchment: m^3/year
3. Increased land productivity for targeted crops in the project area: T/ha
4. Increased household's income with gender equality in the targeted area: Rwf/Year.

Project 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 maximize its impact, create economies of scale and optimize 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 logframe 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

Table 71:Estimated budget by component:

Components /Activities	Unit	Quantities	Unit cost	Total cost
CPIP 1 - Land husbandry and landscape restoration in Base, Nkubi, Nyamigogo and Kiryango watersheds				
1.1. Terracing on medium slopes with agroforestry and fodder grass belt	Ha	3200	603,600	1,931,520,000
1.2. Protect riverbanks of Kiryango, Nkubi and Nyamigogo with fodder grass and bamboos	ha	120	209,600	25,152,000
1.3. Re-afforestation in line with District Forest Master plan: Bweramana, Mwendo and Mukingo Sectors	Ha	500	750,000	375,000,000

Components /Activities	Unit	Quantities	Unit cost	Total cost
1.5. Incentive for ecosystem services around protected marshlands and rivers	Cows	100	500,000	50,000,000
1.6. Cross cutting issues				
1.6.1. Training of farmers, water users associations and district staff in climate smart agriculture and environmental laws	Persons	200	100,000	20,000,000
1.6.2. Training of mining operators on sustainable mining concept	Number	50	100,000	5,000,000
Total CPIP 1				**2,406,672,000**
CPIP 2 - Rain water harvesting, water drainage and storage for floods mitigation				
1.Rain water harvesting on the roof tops of settlement area	Households (2.5 m³)	100	200,000	20,000,000
2.Rain water harvesting on the roof tops of boarding schools	Classrooms (5 m³)	20	400,000	8,000,000
3.Rain water harvesting on the roof tops of public institutions	Buildings (5m³)	4	400,000	1,600,000
4.Rain water harvesting on the roof tops of HHs in trading centres	Buildings (5m³)	60	400,000	24,000,000
5.Feeder roads cross drainage structures downstream protection	Km	13	30,000,000	390,000,000
6.Construction of ponds for water storage	Pond	5	800,000	4,000,000
7.Construction of canals linking the road drainage ditches to infiltration ponds	m	1,000	30,000	30,000,000
Sub Total CPIP 2	**-**	**-**	**-**	**477,600,000**
Total Package 2	-	-	-	**2,884,272,000**

IWRM Package 3: Landscape restoration and protection of water bodies in Mwogo watershed (LAPROM)

Potential Implementing partners: W4GR, Nyamagabe, Huye, Ruhango and Nyanza Districts, New Forests Organisation in Rwanda, Nyanza tree growers savings and Loans Associations.

Project rationale

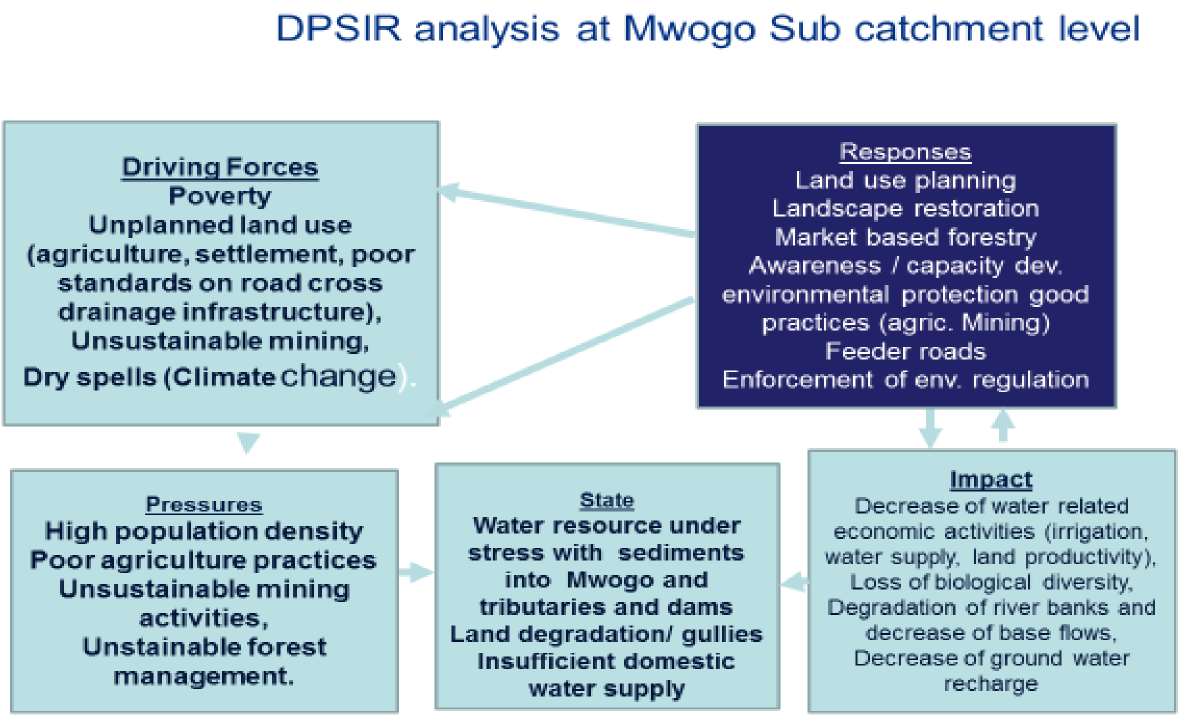
The Main objective of the current irrigation Master Plan (IMP) in Rwanda is to develop and manage water resources to promote intensive and sustainable irrigated agriculture and to improve food security.

Specifically, the plan's objective is to provide Rwanda with a planning tool for rational exploitation of its soil and water resources.

The water Evaluation and Allocation Model (WEAP) recently conducted in the framework of Water for Growth Rwanda Program revealed that in Mwogo Sub-Catchment, the overall water balance offers ample opportunities for enhanced allocation of water to productive sectors within the sub catchment, and in downstream catchment. The selected alternative to implement Upper Nyabarongo Catchment plan using the planning by Catchment boundary and implementation of IMP at 50% (PCB-) is implementable in the sub-catchment as the water demand for irrigation is still below 50% of available water.

However, this opportunity is not exploited to the maximum due to unfavourable conditions including siltation of marshes from soil erosion and floods, poor management of developed marshlands and their entire watersheds in Mwogo Sub-catchment. This affects particularly Mwogo river, tributaries and 2 Dams (Kabakobwa and Cyarubare).

The interaction between the society and the environment using DPSIR approach in the package area, together with the drivers for economic development are developed in the following lines for a sound definition of objectives and project interventions.



Local economic drivers are:

- Coffee and tea value chains
- Ecotourism mainly through private companies (Huye Mountain Coffee, MIG, Cooperatives);
- Banana value chain;
- Milk value chain (Busasamana, Cyabakamyi, Nyagisozi);
- Irrigated rice and maize in marshlands;
- Tourism: natural park of Nyungwe and historical sites (Kunyu);
- Mining and quarries;
- Hillside irrigation for horticulture: avocado and other fruits, vegetable, maize;
- Hydropower production.

Objective

The overall objective is "*To contribute to the improvement of water quality and quantity in and of waterbodies in Mwogo sub-catchment, combined with sustainable land management, improved water productivity and diversified livelihoods, through reduction of the pressure on natural resources in the catchment*"

Specific objectives

1. Improve water quality and quantity in waterbodies through catchment restoration 2. Reduce pressure on natural resources by creating diversified alternative livelihoods taking into account resilience to climate change and with emphasis on women and youth;

3. Rehabilitate degraded catchments for erosion control and floods mitigation;

4. Protect water resources to enable sustainable investments in irrigation and domestic water supply;

5. Build capacity of farmers, district officers and mining operators in climate smart agriculture, environmental laws and water resource management.

Activities specific for projects linkage to a package

In order to contribute to the achievement of the above-mentioned objectives, and based on information provided by participatory consultations of stakeholders during feasibility studies, three sites that present a good concentration of IWRM issues, have been selected for implementation within this package:

1. Muhura Sub-catchment (Nyamagabe District / Kaduha sector)
2. Nyakigezi and Nyamiseke sub-catchments (Nyanza and Ruhango Districts / Cyabakamyi and Kabagari sectors)
3. Butamu and Rundazi sub-catchments (Huye District / Simbi, Mbazi and Maraba sectors)

The following activities will be implemented in the three sub-catchments

- Rehabilitate and protect farmlands against soil erosion with terraces, agroforestry (horticulture trees) and fodder grass on ~5,575 ha;
- Support fertility management through introduction of the Girinka programme with ~ 3,610 cows / small cattle;
- Providing training and capacity building for ~ 6,100 farmers on climate smart agriculture;
- Rehabilitate degraded forests and afforest new areas unsuitable for agriculture on ~530 ha;
- Rehabilitate and prevent creation of gullies on 6 ha using 1.6 km of live check dams;
- Protect riverbanks against erosion by creating or rehabilitating buffer zones along rivers and mountain streams on 160 ha;
- Protect ~ 70 km of drains downstream of roads cross-drainage structures;
- Promote installation of rainwater harvesting on rooftops of ~3,480 Ubudehe #2 households and 17 schools;
- Provide improved cook stoves to ~7,315 Ubudehe #1 and #2 households and 17 schools;
- Promote the diversification of rural livelihoods and protection of forests through beekeeping.

These main activities will be coupled with three cross-cutting issues:

- Disaster management;
- Capacity building in the critical areas of IWRM concepts and practices;

- Gender as a cross cutting area during all the project components for inclusiveness, equitable benefits, women in decision making and their economic empowerment. Gender needs will also be addressed for effective mainstreaming, and;
- Climate change adaptation: promoting uptake of climate smart agriculture through use of farmer field school (FFS) and introduction of improved farming methods and resistant crops varieties.

Beneficiaries and impacts

The project will directly benefit local farmers whose land is at high risk of erosion and flooding. Specifically, the project will target rural subsistence farmers (Ubudehe #1 and #2). Indirectly the project will benefit potential investors in horticulture value chain, irrigation development and hydropower generation.

The main expected outcomes and impacts are:

- Increased area of farmlands rehabilitated against soil erosion with terraces, agroforestry (Horticulture trees), fodder grass;
- Increased area of the watershed protected against floods.
- Sediments potentially reduced in Mwogo river through the global improvement of Muhura, Kibande, Nyakigezi -Nyamiseke and Butamu - Rundazi sub-catchments;
- Increased annual groundwater recharge in the sub-catchment;
- Increased land productivity for targeted crops in the project area;
- Increased household's income with gender equality in the targeted area.

Budget for the proposed measures

Table 72:Budget for the proposed works

Sub-catchment	Budget (RWF)
Muhura-Kibande sub-catchment	***1,746,400,887***
Catchment Restoration	*926,066,837*
Pilot Incentive for ecosystem services	*820,334,050*
Nyakigezi - Nyamiseke sub-catchment	***2,492,643,761***
Catchment Restoration	*1,698,997,324*
Pilot Incentive for ecosystem services	*793,646,437*
Butamu - Rundazi sub-catchment	***5,184,507,957***
Catchment Restoration	*3,468,502,227*
Pilot Incentive for ecosystem services	*1,716,005,730*
Total Upper Nyabarongo Mwogo Package (RWF)	**9,423,552,606**
Total (EUR)	**9,492,850**[71]

[71] Exchange rate 1 Euro = 992.7 Rwandan Franc

Project management

Implementation modalities will be defined at 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 maximize its impact, create economies of scale and optimize 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 logframe 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.).

IWRM Package 4: Landscape Restoration supporting sustainable and efficient investments in agribusiness, mining and hydropower generation in the most degraded sites of the Upper Nyabarongo watershed.

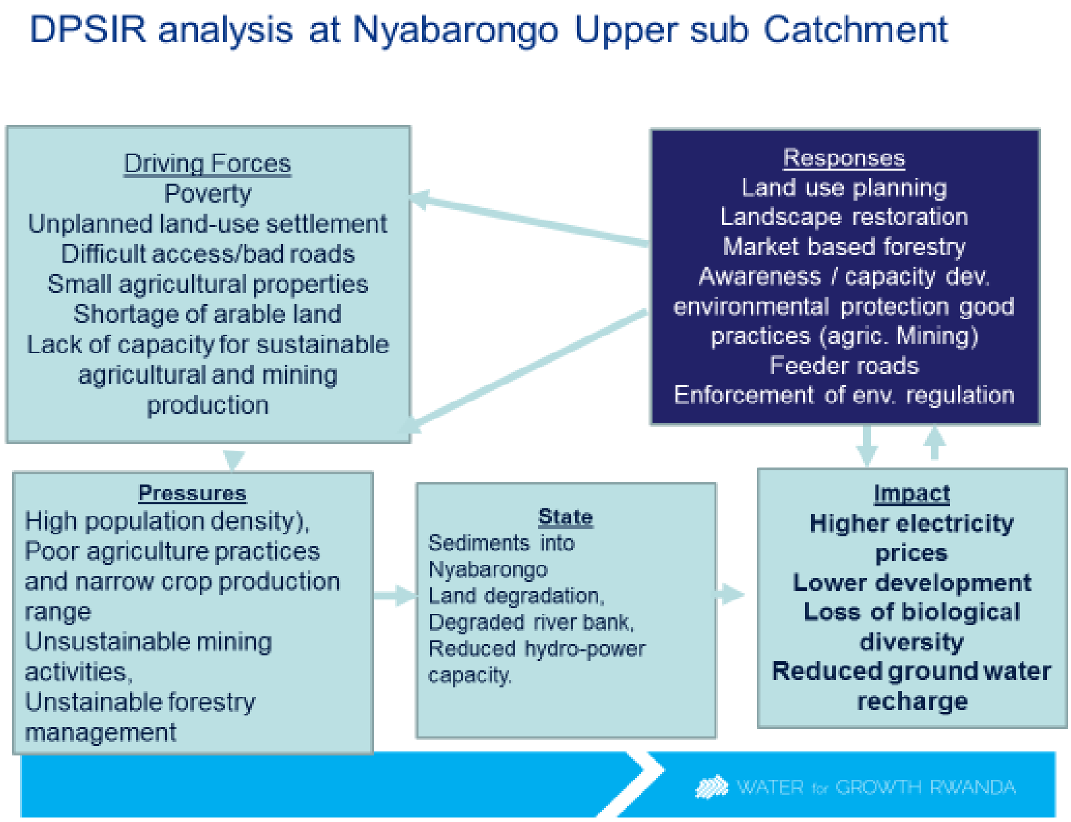
Potential Implementing partners: W4GR, Karongi, Rutsiro, Ngororero, Muhanga and Ruhango Districts, Rwanda Mining Board, ININFRA, Rwanda Mining Association (RMA),The Wood Foundation Africa (TWFA) & Rugabano Outgrowers Services Company (ROS),Gatsby Charitable Foundation, DFID (co-funding through TWFA) Luxmi Tea (tea factory and core estate establishment

Rationale

The origin of the Nyabarongo River, formed by the confluence of the Mwogo and Mbirurume Rivers, is affected by intense siltation resulting from significant sediment loads carried downstream by these two tributaries. Even if catchment rehabilitation measures are implemented upstream of the Nyabarongo, sedimentation will not reduce unless the same actions are not also undertaken all along its course. This is especially true where anthropogenic impacts, such as mining, poor agricultural practices on steep slopes, poor road drainage and landslides, continue unabated.

Rehabilitation of the Nyabarongo catchment, a watercourse considered to provide enormous potential for the promotion of sustainable development for local populations in particular, and the country in general, is a necessity. This IWRM package is aimed particularly at creating good conditions for investment and the development of sustainable operation in the agribusiness, mining and hydropower sectors.

As part of this overall restoration requirement, the Secoko sub-catchment has been identified as one of the most critical areas for urgent attention as it contributes a significant sediment load, in particular to the reservoir formed upstream of the Upper Nyabarongo hydropower scheme. Secoko has, therefore, specifically been selected for feasibility studies.



Local economic drivers are:

- Mining and quarries run by private companies;
- Hydropower through PPP with a potential to generate 31 MW on 11 sites including Nyabarongo 1 with 28 MW already developed;
- Tourism: cultural and historical, Mukura Natural forest, Ndiza Mountain;
- Agro-ecological area suitable for afforestation.

Objective

The overall objective is "*To contribute to improving the quality of the water, and developing a more normal hydrological regime (reduced floods and increased base flows) in the Nyabarongo Catchment, through implementation of sustainable land management, improved water productivity and more diverse and productive livelihoods*"

Specific objectives

1. To reduce water pollution from mining sites and minimise the quantity of hazardous chemicals and material in the environment;

2. To increase the area of land protected against soil erosion

3. To reduces flood and sediment loads thereby enabling sustainable and profitable hydroelectricity production.

Activities specific for projects linkage to a package

To contribute to the above-mentioned objectives, based on information provided through participatory consultation with stakeholders during the feasibility studies, through delivery of a package of work in the Secoko sub-catchment that presents a good concentration of IWRM issues.

It is proposed to implement the following generic activities in the Secoko sub-catchment:

- Rehabilitate and protect farmlands against soil erosion with terraces, agroforestry (horticulture trees) and fodder grass on ~2,580 ha;
- Support fertility management through introduction of the Girinka program with ~1,680 cows / small cattle;
- Providing training and capacity building for ~ 4,510 farmers on climate smart agriculture;
- Rehabilitate degraded forests and afforest new areas unsuitable for agriculture on ~1,930 ha;
- Rehabilitate and prevent creation of gullies covering 26 ha with 5.6 km of check dams;
- Protect riverbanks against erosion by creating or rehabilitating buffer zones along rivers and mountain streams over ~140 ha;
- Protect ~ 40 km of drains downstream of roads cross-drainage structures;
- Promote installation of rainwater harvesting on rooftops of ~2,385 Ubudehe #2 households and 13 schools;
- Provide improved cook stoves to ~4,190 Ubudehe #1 and #2 households and 13 schools;
- Promote diversification of rural livelihoods and protection of forests through beekeeping.

Bespoke activities to this package are:

- Provide technical assistance and capacity building (sensitisation, best-practice sharing and enforcement support) and implement upslope clear water diversion and settlement ponds in five licensed mining companies' sites, one informal mine site and rehabilitate three old mine sites.

These main activities will be coupled with three cross-cutting issues:

- Disaster management;
- Capacity building in the critical areas of IWRM concepts and practices;
- Gender as a cross cutting area during all the project components for inclusiveness, equitable benefits, women in decision making and their economic empowerment. Gender needs will also be addressed for effective mainstreaming, and;
- Climate change adaptation: promoting uptake of climate smart agriculture through use of farmer field school (FFS) and introduction of improved farming methods and resistant crops varieties.

Beneficiaries and impacts

The project will directly benefit local farmers whose land is at high risk of soil erosion and flooding. Specifically, the project will target rural subsistence farmers (Ubudehe #1 and #2). Indirectly the project will benefit potential investors in horticulture value chain, irrigation development and hydropower generation. Artisanal mining cooperatives and companies will also benefit from training and improvement in the efficiency of their operation and indirectly, the project will benefit potential investors in horticulture (banana) value chain and hydropower generation.

The main expected outcomes and impacts are:

- An increased number of mining companies complying with their license requirements by using cleaner production and resources efficiency in mining sites;
- An increased area of farmlands rehabilitated against soil erosion with terraces, agroforestry (horticulture trees) and fodder grass.
- Reduced sediment loads in the Secoko River and therefore downstream in the Upper Nyabarongo Reservoir;
- Greater, annual groundwater recharge, and;
- Increased rural investment with sustained electricity generation.

Budget for the proposed measures

Table 73:Budget for the proposed works

Sub-catchment	Budget (RWF)
Catchment Restoration	2,859,485,846
Pilot Incentive for ecosystem services	1,904,447,970
Mine remediation	176,700,000
Total Upper Nyabarongo Secoko Package (RWF)	**4,940,633,816**
Total (EUR)	**4,976,966**[72]

[72] Exchange rate 1 Euro = 992.7 Rwandan Franc

Package management

Implementation modalities will be defined at 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 logframe 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.).

Costs for mining pilot are subject to economies of scale being achieved in the pilot co-operative/partnership group, with co-financing arrangements to be agreed between the service beneficiaries and the project’s sponsors. Prices and process requirements were benchmarked and determined on 2014 study into innovation and modernisation of the mining sector.

Annex 14. Concept notes of typical CPIPs

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 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%[73] 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.

[73] 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).

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. 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 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.[74]

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 Organisation (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.

NFO's 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."[75]

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) abd 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)forestry is possible under sustainable forestry management. Using (rest) wood from (agro)forestry and buffer zones can be part of nature-based business proposals.[76]

[74] Sources: National Forestry Inventory; 2015: District Forestry Management Plans 2017; Forestry policy 2017; National Forest Management Plan 2017-2024.

[75] Source: NFC Newsletter 2017 and personal communication.

[76] Sources: MINIFRA, Saferrwanda.org; Inyenyeri.com; delagua.org; Nots.nl; SNV.org; GIZ.de

14.2 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 centres. 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.

14.3 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.

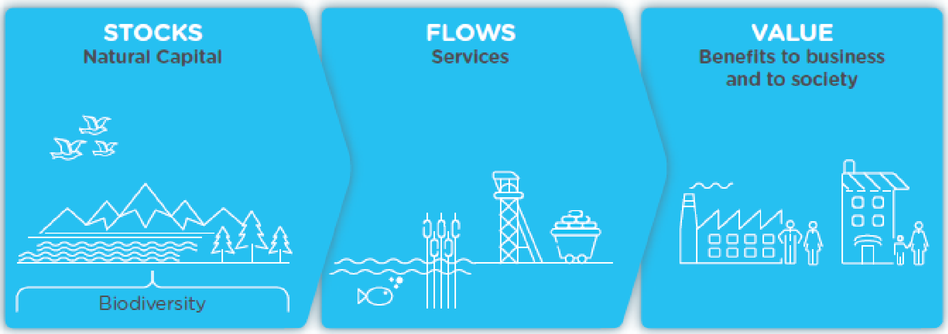


Figure 77: Natural Capital: Stocks, Flows and Value[77]

[77] Source: Natural Capital Protocol: A primer for Business 2016.

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. 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.

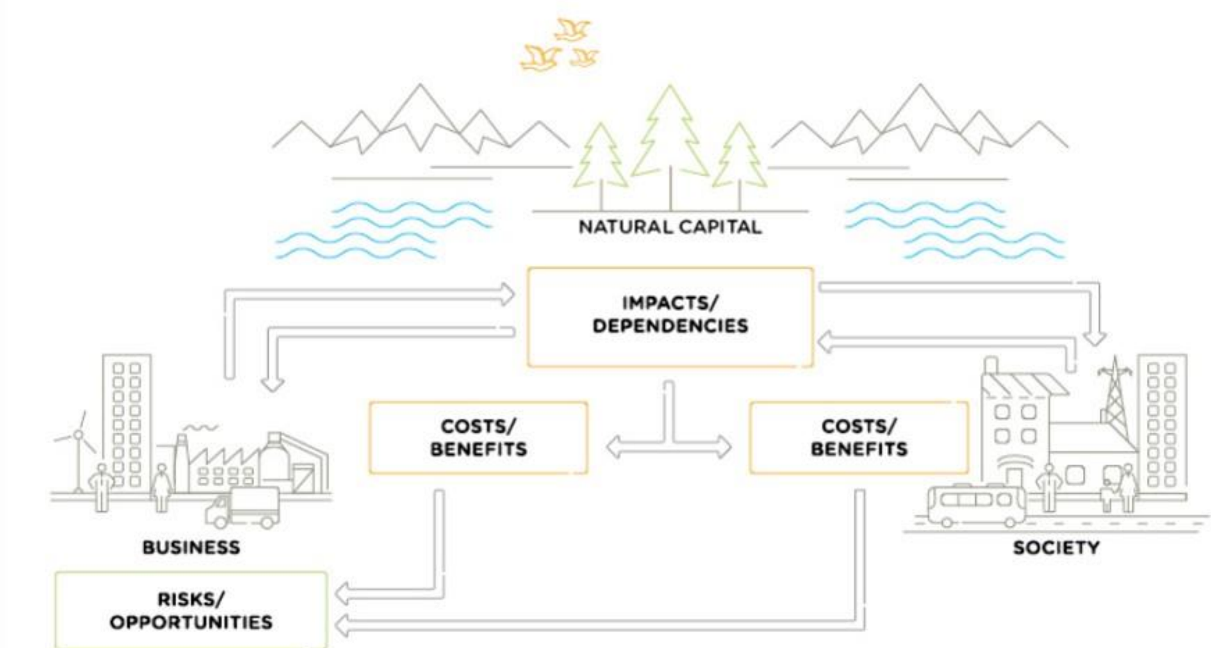


Figure 78: Natural Capital Model[78]

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 downstream 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;

[78] Source: Natural Capital Protocol: A primer for Business 2016.

- Participation in a sustainable forest management (and harvesting) plan;
- 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.

14.4 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 are 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 m3 (1 m^3 is 1,000 litres). In other countries farm ponds have storage capacities up to a 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 10m^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 5m^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 could not 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 peoples 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.

14.5 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.

Annex 15. Stakeholder analysis and engagement plan

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 whom 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, animals 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 **Error! Reference source not found.**. In addition, it is recommended that a dedicated c ommunication strategy for all stakeholders be designed at the beginning of the CP implementation phase.

Table 74:Table76: 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, Catchment Task Force	Quarterly meetings	Interactive participation.	Advisory committees, formal meetings, project monitoring visits.	Enhanced ownership and sustainability of sub-project outcomes. Contribution towards attainment of catchment plans in Imihigos.	Interventions in the catchment plans can be streamlined into joint Imihigo.
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.

Type of stakeholders	Timing of involvement	Type of participation required	Tools for participation and communication	Outcome of involvement	Comments
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 and economic development goals.	It is envisaged that the IWRM Catchment Investment Plan will be contributing to the goals of regional bodies.
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 the catchment are in the category of International and Local NGOs as well as government projects operating in 7 sectors of socio-economic development. Among those sectors of intervention, 4 are in close relation with water sector while others: Justice & Governance, microfinance 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 nine major projects implemented by five government institutions: REMA (3 projects), MINAGRI (2 projects), Rural Development Board (1 project), LODA (1 project) and NAEB (1 project).

Table 75:Projects directly or indirectly pertaining to land and water management in the catchment

S/N	Project name	Implementing institution	Number of districts
1	The Lake Victoria Environment management project (LVEMP II)	REMA	2 (Nyamagabe, Ngororero)
2	The decentralisation and Environment Management project (DEMP II) implemented	REMA	1 (Rutsiro)
3	The Landscape Approach to Forest Restoration and Conservation (LAFREC)	REMA	2 (Ngororero, Rutsiro)
4	PAREF	RWFA	3 (Karongi, Ngororero, Rutsiro)
5	Land husbandry, water harvesting and hillside irrigation project (LWH)	MINAGRI	2 (Karongi, Nyanza)
6	Feeder roads improvement project	MINAGRI	1 (Karongi)
7	Road infrastructure project	LODA	2 (Rutsiro, Nyamagabe)
8	Tourism and environment protection around Nyungwe Natural Forest	RDB	1 (Nyamagabe)
9	Promotion of coffee and local products to be exported	NAEB	3 (Muhanga, Rutsiro, Ruhango)

Table 76: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	21.3	0
2	Agriculture	26	16.8	26
3	Health and Nutrition	21	13.5	21
4	Environment protection and land	16	10.3	16
5	Water and sanitation	14	9.0	14
6	Education	9	5.8	0
7	Justice and Governance	8	5.2	0
8	Livestock	7	4.5	7
9	Infrastructure	6	3.9	6
10	Energy (Electricity& Alternative)	5	3.2	5
11	Tourism	3	1.9	3
12	ICT	2	1.3	0
13	Communication	2	1.3	0
14	Agro-processing	2	1.3	2
15	Settlement	1	0.6	1
	Total	**155**	100%	**99**

Annex 16. W4GR 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 **Error! Reference source not found.**. The DSS process is largely automated in ArcGIS[79]. 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 80 - **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 **Error! Reference source not found.**. 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 **Error! Reference source not found.** 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.
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

[79] 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.

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 (**Error! Reference source not found.**), used to support d ecision 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 77: 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.	**Moderate 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**

Land slope↓	Soil erosion control measures	Erosion risk
5: (> 60)	**Class V** ▪ Forestation (Biological measures) + trenches / ditches; ▪ Perennial crops, coffee, tea, banana, fruit trees.	**Extremely high risk**

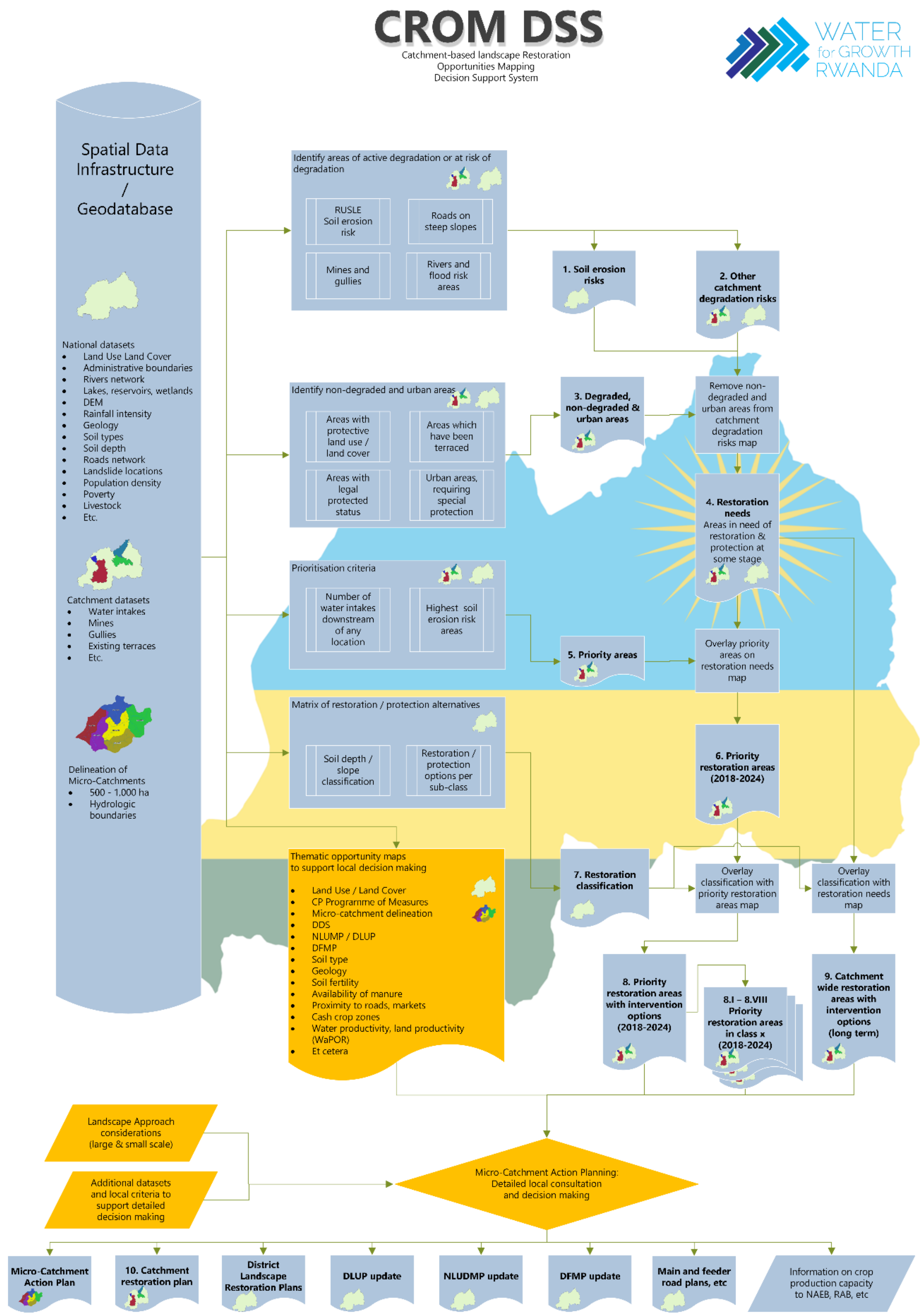


Figure 79:CROM DSS flow chart (W4GR, 2018)

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.

- **Other catchment degradation risks (map 2)**

Locations of current landscape degradation by e.g. mines, gullies, or flooding; augmented with the rivers network (representing a risk related to scouring of river bed and banks as well as a transportation network for eroded soils) and roads on steep sloped (>15%), which are prone to uphill soil erosion and landslides, and which often lack suitable drainage networks to evacuate runoff without causing downstream erosion in areas where runoff water is concentrated in time and space.

- **Degraded, non-degraded, and urban areas (map 3)**

Areas with non-degraded land cover (dense forest, wetlands, open water, or perennial crop land) do not need to be restored, but rather protected. Similarly, urban areas will not be subjected to the same measures as available for rural catchment restoration. Areas at risk of degradation need to be analysed for the presence of protective measures, either in the form of physical protection (e.g. existing terraces, good practice / sustainable land management), or legal protection (National Parks). Protected areas can be considered 'non-degraded' and capable of providing ecosystem services, whereas unprotected areas may be considered 'degraded', not or less capable of providing ecosystem services. The distinction is used to report on the RBM and W4GR indicators on degraded / non-degraded catchment area, capable or not capable of providing ecosystem services.

- **Restoration needs (map 4)**

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.

- **Priority areas (map 5)**

Not all areas need to be restored at once. This is not feasible or affordable. Map 5 presents areas that have a higher priority for restoration, because they are subjected to very high to extremely high soil erosion risks, and because water from a specific area (a point on the map) runs off and discharges to water intakes along rivers downstream. Priority areas for 2018-2024 are identified as those areas that combine very high to extremely high soil erosion risk (as presented in map 1) AND 3 or more water intakes (for any use, including hydropower) located downstream of the area. A detailed analysis of specific watersheds was carried out for each individual water intake, and these were overlaid on top of each other, and adding these up renders the number of downstream water intakes, from any point in the map.

- **Priority restoration areas (2018-2024) (map 6)**

Overlaying the priority areas (map 5) on top of the restoration needs (map 4), renders the priority restoration opportunities for the first catchment plan implementation period (2018-2024). In this map, no information is provided yet on what to do, but only where to intervene.

- **Restoration classification (map 7)**

A new decision support matrix (**Error! Reference source not found.**) was developed by the joint teams of W 4GR 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.

- **Priority restoration areas with intervention options (2018-2024)[80] (map 8)**

A combination of the areas requiring restoration measures to minimise soil erosion (classified as per the CROM matrix), and locations of existing landscape degradation, as well as roads at risk, rivers, and flood inundation zones, to be targeted in the period 2018-2014. Maps 8.I – 8. VIII provide Priority restoration areas in class x (I – VIII) (2018-2024) (one map per class), to highlight areas where the same restoration opportunities exist.

- **Catchment wide restoration areas with intervention options (long term) (map 9)**

This map is based on a classification (map 7) of areas highlighted in the restoration needs map (map 4), to provide information on the intervention options for the long-term restoration needs.

- **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.

[80] Water for Growth Rwanda developed maps of priority restoration areas for all districts of Rwanda. Priority areas need to be restored during the Catchment Plan and DDS implementation period of 2018-2024. The maps were made available alongside target values per district, corresponding to the areas identified in these maps. GIS files were also made available to all districts, and/or can be provided upon request by email or other means.

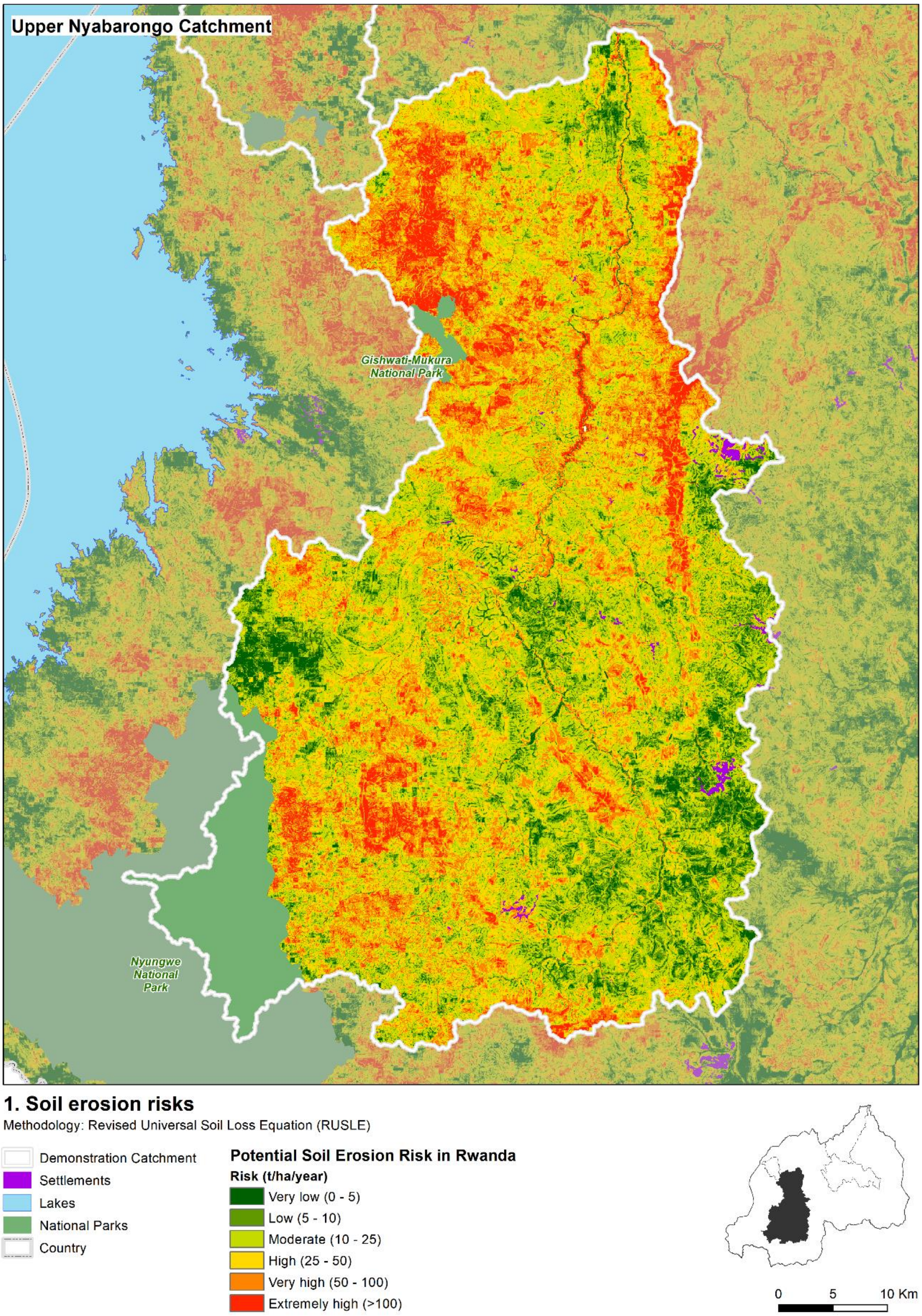


Figure 80: Soil Erosion Risks according to the Revised Universal Soil Loss Estimation model (RUSLE)

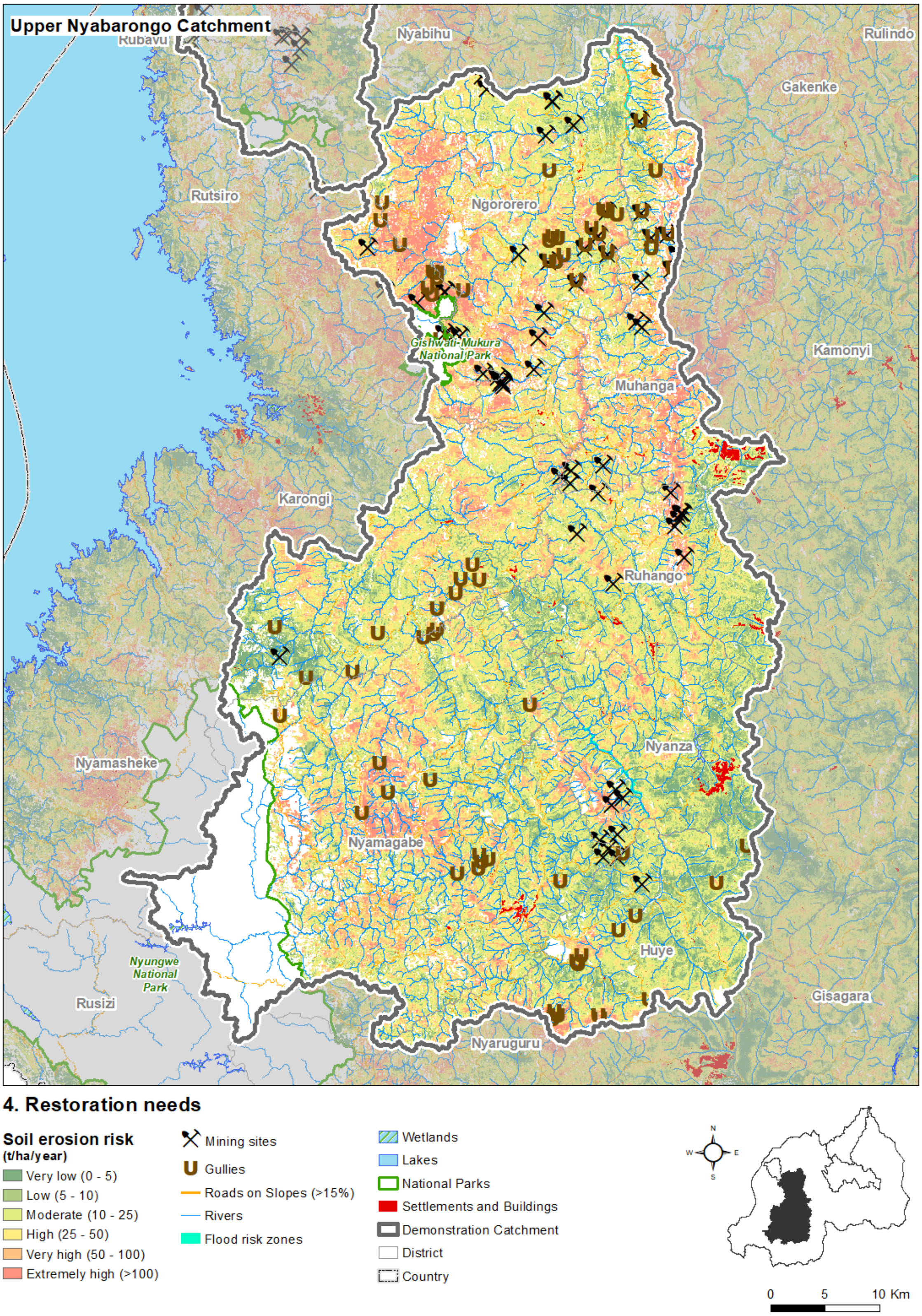


Figure 81: Map 5 – Priority areas for catchment restoration

Annex 17: Summary of Micro Catchment Action Planning Manual

1. Rationale

The Government of Rwanda (GoR) has been working with its development partners to bring about economic growth and alleviate poverty in the country. One of the initiatives in this regard is the Water for Growth Rwanda (W4GR) programme, a flagship (given the importance of conservation of natural resources) Embassy of the Kingdom of the Netherlands (EKN) financed activity for Rwanda.

In 2016, physical and biological catchment measures (Early Implementation Projects/EIPs) were initiated in the catchments of Upper Nyabarongo (Ngororero and Muhanga districts) and in Sebeya (Rutsiro and Rubavu districts) on approximately 2,050 ha. Subsequently, similar projects have also been designed and are now being implemented in Nyabugogo and Muvumba catchments.

The main objective of these interventions is to address urgent needs in terms of landscape management and soil conservation under supervision of the Integrated Water Resources Management/IWRM Support Unit (ISU) with the financial support of the EKN and the works procured in accordance with GoR procurement rules and regulations.

The works in Sebeya and Upper Nyabarongo started in the third quarter of 2016 and are almost completed (*circa* 95%). The techniques implemented include catchment restoration interventions, based on physical and biological measures. The works in Muvumba and Nyabugogo are at the early stage, at about *circa* 20% implementation.

The development and implementation of these projects, funded from the IWRM Investment Fund (IIF), and implemented in the districts, was done in several stages as follows:

- Following up on a high level participatory IWRM process at catchment level, district authorities, the RNRA (now RWFA) and the Integrated Water Resources Management (IWRM) Department (now the Water Resources Management Department [WRMD]) and the Water for Growth (W4G) IWRM Support Unit (ISU) team, in coordination with the RWFA/SPIU, identified EIPs; developed concept notes (CN) and got approval from the Programme Steering Committee (PSC);
- After approval of the CNs, pre-feasibility studies and detailed designs were done and, after project approval, tender documents were prepared;
- RWFRA/SPIU procured works in accordance with GoR procurement rules and regulations and a contractor was hired, and;
- The services of a supervisory company (SC) were also procured, for it to supervise the contractor and measure progress of the physical works. Monthly progress reports are submitted to the RWFA/SPIU.

In addition, 12 IWRM packages were developed and high-level pre-feasibility studies prepared for 10 of these; with the 10 again selected and approved by the Focal Group and Programme Steering Committee.

Intensive consultations of stakeholders at all levels during field work, coupled with initial conclusions of the evaluation exercise carried out on the completed EIP in Sebeya and Upper Nyabarongo catchments, show that substantial improvements are needed regarding the involvement of beneficiaries (farmers and community members who’s land the work is undertaken on) and local authorities before actual work starts, for example in planning and agreement of actions to be implemented, and that such involvement of communities and local authorities should continue once work has started.

Among other things, the studies and assessment found that no organisational structures had been established in either of the EIPs for those benefitting from the catchment restoration work. The assessment also found that farmers were not involved in either the planning or implementation of the activities, and there was no structured training or any extension programme for farmers on important follow-up management activities, such as: Improved agricultural production; continuation of soil fertility maintenance; maintenance of the infrastructure like check dams and drainage structures, nor; management of planted trees.

To ensure sustainability and a sense of ownership, it is important to establish institutional and organisational structures before commencing with actual catchment management works. This will help in mobilising farmers, creating better awareness during the planning phase, coordinating farmers' contributions, coordinating training work and establishing effective structures that will assist with maintaining the works after completion.

It was also noted that the EIPs focused on solely on physical, catchment restoration in specific sites, but without consideration of the need to also ensure implementation of 'supporting measures'. Supporting measures are actions that are needed to ensure sustainability of physical catchment restoration actions and include activities and interventions such as: Implementation of rainwater harvesting (RWH) structures; promotion of alternative income generating activities for agricultural land given over to buffer zones and/or forestry, e.g. through beekeeping; effective management of existing and new forests through promotion of usage of fuel efficient improved cook stoves etc.

To ensure more effective implementation of catchment restoration and their supporting measures, currently those outlined in the IWRM packages chosen by the PSC for implementation during the remaining period of the W4G programme, this planning manual presents a more participative, community-based approach to planning catchment restoration work. This approach puts communities, and local leadership, at the centre of a detailed, participatory planning process that will be conducted by W4GR/ISU. W4G will deploy a team of technical assistance, supported by continued and strong involvement of sector and district authorities, its counterparts in the WRMD, catchment committees, and RWFA/SPIU.

Procurement, implementation and supervision of works will, however, still need to be done according to the IWRM Investment Fund's (IIF) Manual of Procedures (MoP), the contract of W4GR with the Embassy of the Netherlands and GoR procurement rules. Accordingly, and at this early stage, it is suggested that works and services should be implemented as shown in Figure 1.

The controlling company recruited will be responsible for checking the contractors' work and of notifying them of any defects that are found, the need to change physical works, and/or the way they engage the community. The ISU, RWFA, the relevant District Council and the communities themselves will also play a supervisory role to ensure that things progress as they should.

Stage of work	Responsible institution	Funding source
Feasibility studies	W4G ISU	W4G ISU TA budget
Detailed planning (design)	W4G ISU with communities Preferably joined and supported by contractor/s	W4G ISU TA budget With contractor/s involvement funded from the IIF through RWFA/SPIU
Implementation works	Contractor/s with communities	IWRM Investment Fund
Control of implementation	Control company with "supervision" by ISU / communities, RWFA and relevant District Council	IWRM Investment Fund - With ISU funded by own funds

2. Objective of this implementation strategy

The objective of the implementation strategy is to guide and oversee the participatory implementation of the planned IWRM packages to the highest standard possible by the communities living in the targeted areas. It clarifies the stage of work, responsible institution, the funding source, and the community approach model.

As seen before, detailed community participatory micro-catchment planning is key to effectively addressing IWRM issues, smooth implementation and sustainable benefits of investments made.

3. Micro Catchment Action Planning

The key rationale behind the development of Micro-Catchment Action Plans (MCAPs) is that they are plans "***by the community, for the community***". MCAPs are operational documents that are easy to read and visual in nature to allow for meaningful interaction with communities. The follow a set structure (see Annex X) and are in Kinyarwanda for ease of use at the local level.

The primary purpose of the MCAPs is that they will be the documents that the communities themselves, as well as their contractor/s, turn to and use to guide them in the physical work that must be done to improve the way in which their part of the catchment is restored and then used and managed.

All MCAPs will be developed by those communities who reside within, use resources within, and/or work within the respective MCAP areas, and facilitated by W4GR ISU. The main agreed issues of the plans focus on the what, why, how much, when, where, how and by whom aspects of the physical interventions that need to be developed and implemented to deliver effective natural resources and catchment management. An example of an action plan table from a similar planning process in Malawi is presented in Annex 1.

These physical and biological interventions might include a combination of terracing (radical and progressive), riverbank protection, afforestation, development of multipurpose tree nurseries, agroforestry, soil and water conservation work (such as contour ridge markers, check dams, swales), and gully rehabilitation. They will also include guidance on implementation of supporting measures, such as rainwater harvesting, beekeeping and improved cookstove use, as well as guidance on how to maintain and manage the physical interventions, such as maintenance and improvement of soil fertility on terraces, as well as effective management of trees etc. The plan sets out the actions that the communities in the MCAP areas agree are needed, but also as based on advice and guidance from technicians so as to avoid issues like creation of terraces in unsuitable areas.

It is proposed that the detailed planning process should be joined by the contractor that will eventually implement the agreed works. The planning and stakeholder participation will be led and facilitated by the W4G ISU, technical staff from districts and ISU counterpart staff from the WRMD.

Micro-catchment action planning incorporates the following principles:

- Community driven local control;
- Collaboration between technicians, local politicians and communities, with each group bringing their own different knowledge and skills;
- Inclusion, with a range of opportunities for involvement of local community members and others;
- Integrity, with all partners (W4G ISU, WRMD, communities, catchment/district authorities, local authorities etc.) working together in good faith;

- Innovation, encouraging development and them implementation of creative, collaborative and innovative solutions to problems;
- Flexibility in planning and implementation, as far as possible within the constraints of the programme, and;
- Development of specific solutions for specific areas.

a. Levels of catchment management/planning

Management and planning of and for micro-catchments is complicated as they can cross administrative boundaries, such as village, Cell, Sector and even District (although not in this instance). Micro-catchment management planning must, therefore, be done at various levels from community, to cell, to sector and district level. This must be a combined approach so that everyone is working towards achieving the same goals.

Although level 2.5 sub-catchments were introduced for the development of water balance models, these still remain at too high a level for the development and implementation of participatory micro-catchment plans. For this reason, W4GR will implement its strategy for the delivery of IWRM packages at the level of 3 or 4 for sub-catchments, as this will allow better engagement of their communities. Level 3 or 4 sub-catchments correspond with micro-catchments. We have, therefore, divided each main area identified for work in the IWRM packages, into hydrologically defined areas, i.e. that centre on and around small watercourses and their local catchments, and that are approximately 500ha in size.

b. What is a micro-catchment action plan?

A micro catchment action plan (MCAP) is a written document which includes drawings depicting the micro-catchment, its infrastructure and natural resources. These drawings are supported by GIS maps, prepared before fieldwork and based on satellite images and then updated during the MCAP through visual checking of the sites.

The MCAP identifies issues of concern at Village, Cell and Sector level, particularly in terms of land and water resources. The plan identifies opportunities, strengths, threats and weaknesses within the micro-catchment. It also provides practical actions that will result in improved catchment management at the micro-catchment. It identifies opportunities for resource mobilisation.

A MCAP does three essential things:

1. It provides a vision of what the local stakeholders would like their micro-catchment to look like;
2. It sets clear goals to achieve that vision, and;
3. It provides an action plan, comprising the activities necessary to reach those goals.

c. Who is involved in micro-catchment action planning?

Everyone stands to gain from sustainable catchment management and everyone should, therefore, participate. All those who farm, live, work, attend school and play in the village can benefit from an MCAP - but levels of participation should vary according to the capacity of everyone in the village. For example, a frail, elderly woman may only be able to sow tree seeds in the nursery, whereas a fit young man can dig terraces, and both should be considered equally as a contribution to the implementation of the plan.

More specifically:

- The plan will allocate, utilise, develop and conserve resources in a more efficient and sustainable manner that will benefit the community.
- The planning helps the district, civic society and NGOs better understand the priorities of the community so that they can assist it efficiently and effectively, not just through this project but also through other mechanisms and processes.

Participants typically fall into one of two categories, role player or stakeholder, but may often fall into both. These categories are defined as shown in Figure 2.

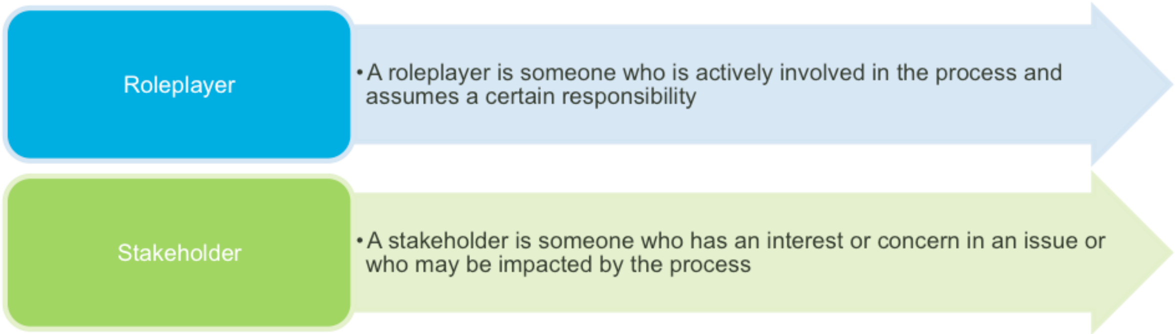


Figure 82 Role player and stakeholder definition

These include cell/village heads, water management committees, water user associations (where they exist), community members, women/youth groups, private sector, farmers, NGOs, district hydrographic basin committee, catchment committee and contractor facilitators.

Since collaboration and inclusion are key principles, however, everybody in the community is a stakeholder who should be involved. Representation from a broad range of local stakeholders will help strengthen support for the MCAP and make implementation easier.

d. What are the benefits of the micro-catchment action plan process?

The benefits of planning at the micro-catchment, and using the approach elaborated here, are that:

- It brings residents, business communities, local authorities and civil society organisations together to **share ideas and work together** on issues that are important to everyone.
- It **improves information** collection, sharing, communication, focuses ideas and builds consensus.
- It helps a villages or communities **identify their strengths** and weaknesses and evaluate their own resources;
- It **increases the level of concern and interest** in villages for the problems that affect the community;
- It helps to **translate community concerns into action**;
- It **encourages creativity and builds partnerships**, both within and outside villages;
- It **enables others to become more informed** and responsive about what is needed;
- It can **influence policy and financial decisions** of local government, development partners and the business community;
- It helps communities to **build their capacities** in implementation and monitoring of their activities in a sustainable manner;
- It helps communities **identify and mobilise local and external resources**, and;
- It creates a **sense of commitment, ownership and belonging** in the community and at village level.
- It helps set up and reinforce **community organisations** for specific tasks such as maintenance works, supervision, and collective action for acquiring services, obtain inputs, organise access to markets, etc.

e. Steps in the micro-catchment action planning process

These are the typical steps that a village should follow in developing a micro-catchment action plan. Once a Catchment Development Committee is established, it takes stock of what is in the community and the strengths and weaknesses of the area. Through open communication with residents and business owners, the team develops a vision of what the community would like itself to be within a given time frame (perhaps five or ten years). To achieve that vision, the plan will include actions to reach those goals. To monitor progress, these actions and accomplishments need to be reviewed from time to time (e.g. every semester), to measure and celebrate the successes of the plan; or where necessary, changes can be made to better suit the current situation.

The steps of compiling the MCAP are:

- Initiate the process;
- Confirm who to work with;
- Undertake planning:
  - Understand the micro-catchment
  - Develop a Vision;
  - Develop the MCAP;
  - Establish a Project Implementation Committee
- Approve the MCAP;
- Implement the MCAP;
- Monitoring and evaluation MCAP implementation.

i. Initiate the process

A facilitator, most likely the relevant Programme Officer, will drive the process from the W4GR ISU. It must be clear to all involved that the plan is '*by the community, for the community*' and thus has, in most part, to come from the people in the relevant community/ies, guided and advised by technical experts as and where necessary and possible.

Success will depend on the extent and nature of involvement by local leadership and participation by the relevant community/ies.

ii. Confirm who to work with

Leaders and facilitators must firstly agree who needs to be involved, e.g.

- Which villages are in the micro-catchment?
- Is there anyone that doesn't live in the micro-catchment but who still uses land or undertakes work, or collects natural resource etc. within it and who needs to also be involved?

They must then agree on, and communicate to the relevant leaders and authorities, as well as community/ies, about the nature, location and timing of the forthcoming planning meeting/s. Particular care should be taken to ensure the involvement of a relevant proportion of the genders, as well as youth, disabled etc

iii. Undertake planning

This is a planning approach based on active and detailed community participation as has been used in other projects, such as VUP and LWH, as well as on good practices applied in similar projects, such as the Shire River Basin Management Programme, catchment management component, in Malawi[81].

Planning work will be facilitated by members/staff of W4GR, accompanied by District field extension workers and technical experts recruited for the purpose.

Ideally, the future contractor/s and controller/s[82] for catchment management works, as well as any additional/separate contractors/controllers needed for implementation of supporting measures work, such as beekeeping, rainwater harvesting and cookstoves, should also be involved at this planning stage.

[81] Work done by Mott MacDonald on a World bank funded project with the same Team Leader as that for W4GR now has

[82] Formally referred to as a Supervisory company

Relevant members of any existing community based committees within the micro-catchment, such as water management committees, Water User Associations etc., should also be invited and involved.

The key steps to be taken during the planning meeting are as follows:

1. Introduce the planning team;
2. Get to know the community;
3. Remind/Inform communities of the existence of the bigger Catchment Plan and what it contains;
4. Remind/teach communities of trends related to Land degradation and Climate change;
5. Remind/Inform communities of the IWRM package/s for their catchments and how they relate to the current work;
6. Set the 'technical/political boundaries' for discussion and planning, and explain process and mechanism to deal with issues that fall outside these boundaries;
7. Understand the micro-catchment – agree on the physical boundaries, location of features etc;
8. Undertake a 'situation analysis' (e.g. using the problem tree technique – see Figure 3), that includes agreeing on a Vision for the micro-catchment;
9. Undertake resource/issue mapping and identify what interventions are needed to address these;
10. Map actions and issues on large-scale maps, and;
11. Create the MCAP including action tables, maps[83];
12. Identify and agree on a 'Project Implementation Committee[84]'

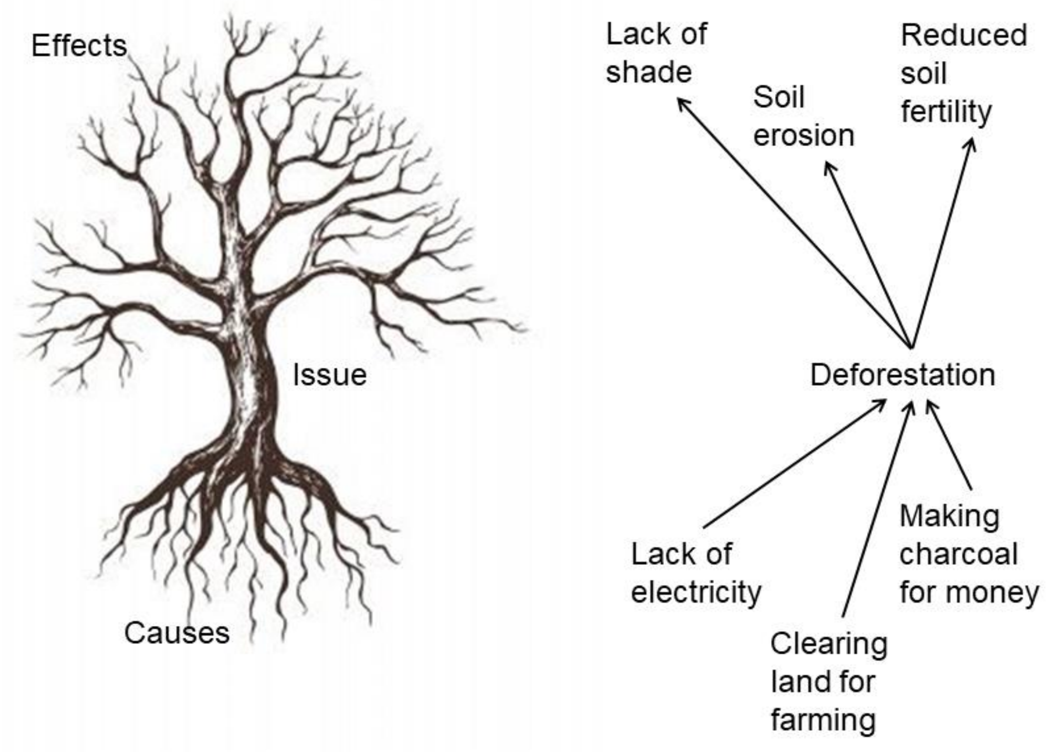


Figure 83 Problem tree – an approach used to identify Issues, Causes and Effects

[83] A template MCAP document will be produced ahead of the meeting for all micro-catchment areas and this will be completed at the meeting

[84] This is a group of people drawn from local community and officials and who are given responsibility for overseeing delivery of the MCAP

The vision and proposed actions must be agreed upon and widely known by those in attendance. A member of the relevant Catchment Task Force should be involved, as well as members of the Cell, Sector and District Authorities. The more closely they are involved in, and informed about, the proposed plan, the greater the acceptance of the plan is likely to be. It is also critical that they both approve and support the plan.

Understand the micro-catchment

The boundaries of the micro-catchment will be defined 'externally', i.e. not by the community but by GIS and hydrological boundaries (as this is a catchment management planning approach). They will be based on catchment levels (hydrological sub-divisions) and preferred planning size (approximately 500 ha). The micro-catchment boundary and the rationale for its 'choice' need to then be explained to the relevant communities.

Undertake a situation analysis

In order to undertake the situation analysis, the planning team should lead a participatory planning session/s that involves asking and answering the following key questions:

- Facilitate a discussion on what the key issues and opportunities are in the micro-catchment (with regard to catchment management);
- Understand and agree on what was the micro-catchment like before;
- Understand and agree on what the micro-catchment is like now;
- Agree and what 'we' want the micro-catchment to be / look like after implementation of the plan, i.e. agree on a **Vision;**
- Determine what actions are needed to achieve this;
- Determine and understand why these actions are needed;
- Agree where different actions are needed;
- Understand and agree on when different actions need to be implemented – are some more important than others? Do some need to be done at certain times of year etc?
- Agree on what is needed to implement the actions, e.g. tools, seeds, labour etc?
- Agree on who will do what work, and;
- Agree on when and how the agreed actions be implemented, monitored and evaluated.

To answer these questions, a clear picture of the catchment's key characteristics, past and present, will need to be 'created' and agreed. This is called a catchment profile and should include aspects such as:

- Micro-catchment assets and resources – an inventory of existing natural resources, such as forests, watercourses, water sources, boreholes, forests (including agroforestry, bamboo etc), and of threats to these, such as gullies, areas of erosion, areas of deforestation etc., as well as location of assets, such as roads, bridges, villages etc;
- Land use mapping – established in a participatory manner, this defines the location of current micro-catchment land use, such as forestry, agriculture, villages etc;
- Population characteristics – an assessment of the number of people and villages in the micro-catchment including its evolution in the near future;
- Community perceptions – what people are saying about the natural resources and catchment management in the community?
- Perception of the effects of Climate change and other external factors.
- etc

Any physical aspects, items and issues should be identified and mapped on large-scale (A0) satellite / Google Earth images of the micro-catchment (that will be printed and used at the meeting) and digitised in GIS by the GIS expert in the planning team.

Form a Project Implementation Committee (PIC)

The PIC is a group of people, selected by the attendees of the micro-catchment planning meeting, who are responsible for overseeing, encouraging implementation of the MCAP, as well as for assessing the extent and quality of implementation. They are also responsible for providing, or sourcing (from the W4G ISU, from the Districts or the Water Resources Management Department etc) advice on emerging issues. The PIC will use the agreed MCAP as their tool to measure and encourage progress and implementation and they will work closely with the contractor/s and the controller/s in this role.

Reviews of progress, preferably assisted by members of the catchment committee, should be conducted as the plan progresses to assess whether it is on track or not and propose any adjustment if needed.

At the end of the plan, a plan evaluation should be completed, and a completion report produced. The former will evaluate achievements, and measure impact with key indicators. The report will assess and document the efficiency, effectiveness and lessons learnt to allow them to be duplicated in other micro-catchments. In addition, the project completion report will include photos, maps and shapefiles of the intervention areas to enable the district to populate its database and prepare the district performance contract accordingly.

The PIC will monitor and evaluate (M&E) work, both during and after implementation. Cell stakeholders, government, donors and other communities will also all benefit from the information that is obtained from this M&E. issues that PICs may focus on might include:

- Did/Do some activities need more attention than others?
- What new, unexpected issues arose?
- What worked, what didn't work, and why?
- Were the expected results achieved and if not, why not?
- Did implementation contribute to deliver of the broader Catchment Plan and was this reported accordingly?
- etc

f. Remuneration to communities

Ideally, all community members engaged during the detailed planning and implementation should be paid for their contribution to the process and as an incentive for them to take part.

In the Malawi catchment management project, such payment was made by way of the delivery of a grant, known as the Community Environment Conservation Fund, at micro-catchment level, managed by the PIC. A payment of USD 500 was made to for engagement in the initial planning process and creation of the MCAP. A second tranche of USD 500 was then made once the PIC could demonstrate to the programme that they had reached a certain number of, pre-determined, targets, e.g. 50% of all actions completed, in plan implementation. A final payment of USD 500 was made for similar attainment of pre-agreed targets over and above, e.g. 90-100% completion of all activities, those already referred to.

Such a system could be used here if possible – this still needs to be agreed.

An alternative approach will be for the contracting companies that will implement the works on the ground to 'employ' community members in plan delivery.

Either way, community members that receive payments will be encouraged and supported to start up associations/saving groups to save and grow the cash they receive, using the experiences of other similar approaches, rather than just to spend the money.

Example of Action Table

Table 1 is an example 'action plan' table taken from a Malawian micro-catchment plan. The details may need to be adapted to the Rwandese context, e.g. focussed on delivery by a contractor rather than directly by communities themselves, but the general idea is valid here.

Table 78:Example micro-catchment action plan

	Issue	Activity	Why activity is needed	Interventions to be implemented	Target	Year	TIMEFRAME												Where interventions will be implemented	Who will do it	Materials needed	
							J	F	M	A	M	J	J	A	S	O	N	D			From community	Project
1	Soil erosion and water loss	Soil and water conservation	To prevent soil erosion To increase crop yields	Construction of contour marker ridges	85 fields (42.5 acres)	2016 - 2017						✓	✓	✓	✓	✓			All fields in villages of: Nkasala Asika Masangula 2	Community members Extension workers Committees PIC VDC Village heads	Hoes Sticks Crop residues Grass Maize brim Ashes Animal dung Waste Materials	Strings Line levels Hammer Vetiver *Faidherbia abilda* seed Legumes such as pigeon peas Sacks with plastics Fertiliser for demonstrating manure making Maize brim
				Planting Vetiver along CMR	42.5 acres	2016 - 2018	✓	✓														
				Planting Trees	42.5 acres	2016 - 2018	✓	✓														
				Managing regenerants in the fields	42.5 acres	2016 - 2018	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
				Conservation agriculture	20 acres	2016 - 2018				✓	✓	✓	✓	✓	✓	✓	✓	✓				
				Mulching	85 fields (42.5 acres)	2016 - 2018					✓	✓	✓	✓	✓							
				Planting soil fertility improving crops	85 fields (42.5 acres)	2016 - 2018	✓											✓				
				Application of manure	85 fields (42.5 acres)	2016 - 2018	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
2	Gullies	Gully reclamations	Retaining soil fertility	Making check dams out of	170 gullies	2016 - 2018										✓	✓		All fields in villages of: Nkasala Asika Masangula 2	Community members Extension workers Committees PIC VDC Village heads	Sand Stones Elephant grass Sugar cane Wood/sticks	Hoes Shovel Wheel barrow Panga knives Banana suckers Bamboo Vetiver Sickle
				Wood											✓	✓	✓					
				Bamboos											✓	✓	✓					
				Stones								✓	✓	✓	✓	✓	✓					
				Planting bananas, vetiver, sugarcane, trees, Napier /elephant grass and reeds		2016 - 2018	✓	✓														
3	Depletion of trees/forests	Establishment of tree nurseries	Conserving natural resources/ trees	Fences construction	2 Nurseries	2016 - 2018								✓					Asika Village borehole Chigono River water well	Community members led by: Committees VDC PIC VNRMCs	Wood Bamboos Grass Ropes	Polythene tubes Watering canes Tree seed Wheel bar Hoes Shovel Rake Pails Panga knives Ropes Knives Nail cutter Slasher
				Pot filling										✓								
				Sowing seeds										✓								
				Caring/ watering seedlings										✓	✓	✓	✓	✓				
				Procurement of nursery equipment									✓									
		Management of regenerates	Conserving natural resources Maintaining soil fertility	Weeding / firebreaks to prevent fire out breaks	Asika 1 VFA 4 Individual forest areas	2016 - 2018						✓							Asika VFA Masangula 2 homesteads	Community members led by committees VDC PIC Village heads VNRMCs Individuals owning forest areas		Hoes Panga knives Slasher
				Pruning								✓										
				Guarding			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
		Tree Planting	Conserving natural resources/trees	Clearing land	Homesteads Fields	2016 - 2018										✓	✓		Homesteads and fields	Community members led by: Village heads VDC PIC VNRMCs Individuals owning VFAs		Hoes Slasher Knives Panga knives
				Digging pits													✓					
				Out planting trees			✓	✓										✓				
				Caring for trees			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
4	Drying up of rivers/ siltation of rivers	River bank rehabilitation	To conserve water for irrigation farming	Planting trees along riverbanks	Chigono River and 4 other streams	2016 - 2018	✓	✓										✓	Chigono River and 4 other streams	Community members led by: Village heads VDC PIC VNRMCs		Hoes Panga knives Slasher
				Managing regenerants along riverbanks			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				
				Observing the buffer zone for fields along the riverbanks						✓	✓	✓	✓	✓	✓	✓	✓	✓				