IWRM Programme Rwanda

TR23 - Catchment Plan Upper Nyabarongo 2017-2023

March 2017



Kingdom of the Netherlands

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Water for Growth Rwanda is a platform to promote improved management of Rwanda's water resources. A joint Rwanda-Netherlands initiative, Water for Growth is supported by the IWRM Programme Rwanda, implemented by Euroconsult Mott MacDonald (lead partner) in association with SNV and SHER. www.water.rw

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List of Abbreviations

CCPA	Climate Change Programme of Action
CTF	Catchment Task Force
EDCL	Energy Development Corporation Ltd
EDPRS-2	Economic Development Poverty Reduction Strategy - 2
EKN	EKN Embassy of the Kingdom of the Netherlands (in Rwanda).
EIP	Early Implementation Project
EUCL	Energy Utility Cooperation Ltd
GIS	Geographical Information System
GoR	Government of Rwanda
IWRM	Integrated Water Resources Management
M&E	Monitoring and Evaluation
MIDIMAR	Ministry of Disaster Management and Refugee Affairs
MIGEPROF	Ministry of Family and Gender Promotion
MINAFFET	Ministry of Foreign Affairs and Cooperation
MINAGRI	Ministry of Agriculture and Animal Resources
MINALOC	Ministry of Local Government
MINECOFIN	Ministry of Finance and economic Planning
MINEDUC	Ministry of Education
MINICOM	Ministry of Commerce
MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
MIS	Management Information System
NCEA	Netherlands Commission for Environmental Assessment
NGO	Non-Governmental Organization
NWCC	National Water Consultative Commission
NWRMP	National Water Resources Master Plan
PASB	Planning by Administrative and Sectoral Boundaries (alternative)
PCB	Planning by Catchment Boundaries (alternative)
RAB	Rwanda Agriculture Board
RDB	Rwanda Development Board
REMA	Rwanda Environment Management Authority
RMA	Rwanda Meteorological Agency
RNRA	Rwanda Natural Resources Authority
RURA	Rwanda Utilities Regulatory Authority
RWFA	Rwanda Water and Forestry Authority
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessment
WASAC	Water and Sanitation Corporation
WIC	Water Inter-Ministerial Committee

Executive Summary

The need for a catchment plan for Upper Nyabarongo

The Upper Nyabarongo catchment is one of the water towers of Rwanda. The catchment contains the most distant source of the mighty Nile river. Sprawled between high mountain ridges numerous brooks, rivulets, and temporary streams join in its valleys to form a number of the main tributaries such as River Mwogo, River Satinsyi, River Rukarara, and River Mbirurume, which waters eventually join in the Upper Nyabarongo River.

Home to some 1.2 million inhabitants – a mainly rural population- the catchment enjoys abundant water resources that are used for a variety of purposes: agriculture, energy, mining, and water supply to mention just a few. But this is going to change. Developments beyond the control of water managers, such as population growth, climate change, and macro-economic development, gradually but clearly lead to increased water demands, and subsequently to water shortages (Figure 1) that may hamper economic development and jeopardize food security and energy security.

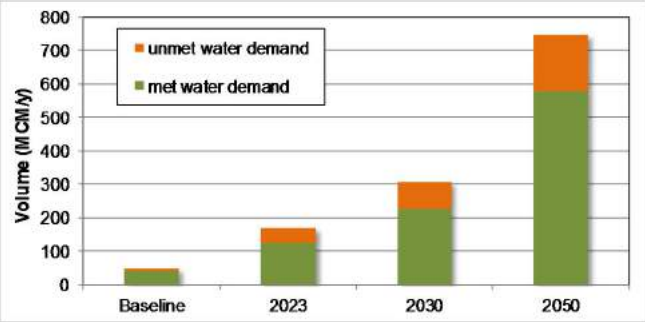


Figure 1: Projections of met water demand and unmet water demand (shortages) up to 2050, if no measures are taken

Such future scenarios call for an integrated approach to land and water management, considering the principles of Integrated Water Resources Management (IWRM). To this end, the IWRM Department of RNRA (now RWFA) embarked on the development of a catchment plan, supported by the Netherlands-funded programme 'Water for Growth Rwanda'.

No time to waste

Even though current water shortages in the catchment are limited in time and space (mainly in the long dry season, in uphill areas), there is no time to waste in the implementation of the catchment plan. Climate change impacts are already occurring in Rwanda – 2016 faced numerous climate change related problems such as long drought in the east, and delayed planting seasons everywhere. And the analyses in this plan show that planning that is not coordinated at catchment level and that is not considering IWRM principles, will lead to more water shortages already in the very near future.

The current catchment plan 2017-2023 therefore includes measures that can be implemented immediately. Some of these are already ongoing, under the auspices of plan partners. Opportunities for

further optimisation of these interventions from a catchment perspective will be explored in several catchment dialogues that are planned to be held in the coming months. Other interventions may be started up already, using existing financing modalities such as the available funds from the IWRM Investment Fund (IIF), a basket fund with a starting capital of 18.6 million Euro contributed by the Government of the Netherlands of which a fair share is earmarked for Upper Nyabarongo catchment. One IIF project has already been started up in the catchment: The Early Implementation Project on landscape rehabilitation and land husbandry in a few sectors of Ngororero and Muhanga Districts.

Programme of Measures

A series of development alternatives, consisting of specific combinations of measures, has been developed, as per the Strategic Environmental Assessment (SEA) process requirements. Their effectiveness and unintentional impacts were assessed using a water balance and allocation model (Figure 2) as well as an expert judgment based multi-criteria assessment. Results were discussed with the Catchment Task Force and the group of Water for Growth's Focal Points from partner ministries. Different sets of weights were defined and tested, and the scores given be expert judgement were refined.

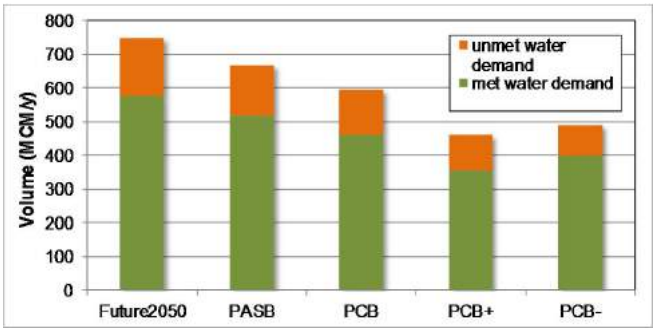


Figure 2: Met and unmet water demand (water shortage) in different alternatives[1]

The alternative Planning by Catchment Boundaries + (PCB+), with much extra storage, enhanced water use efficiency, and measures to accommodate the first 50% of the Irrigation Master Plan has been prioritized for the first time horizon until 2023. Planning by Catchment Boundaries - (PCB-), with implementation of irrigation master plan not exceeding 50% has been selected as a Catchment Plan version 1.0 preferred alternative to be implemented during the rest of 2 time horizons (2030 and 2050). This means a stop on further development of irrigation in wetlands / floodplain areas after 2023, to protect the environmental services provided by the wetlands and floodplains. In the 2017 alignment phase towards version 2.0, a jointly developed final preferred alternative may combine elements of both PCB+ and PCB-, as well as additional elements. In this process, all sectors need to commit to the required water saving targets in order to achieve the common catchment plan objectives.

[1] Legend of Figure 2: Future2050: medium projection scenario incorporating climate change, population growth, and macro-economic development but no catchment planning. PASB: Planning by Administrative and Sectoral Boundaries. PCB: Planning by Catchment Boundaries. PCB+: PCB interventions are implemented at elevated level, with more water storage and enhanced water savings in all sectors, to cater among others to strong irrigation development but also to make more water available to meet water needs of e.g. industry. PCB-: as PCB, with interventions at same level as PCB but with limited (50%) implementation of the Irrigation Master Plan, in order to minimise water shortages in all sectors. The objective for the alignment process for version 2.0 of the catchment plan is to arrive at a newly combined, improved preferred alternative that minimises water shortages, while maximising the contribution of water to economic development and poverty reduction.

Endorsement of the catchment plan

The current catchment plan 2017-2023, developed within the framework of Water for Growth Rwanda, will be endorsed by the Programme's Steering Committee (PSC). This is also the body that decides on selection of Catchment Plan Implementation Projects (CPIPs) to be funded from the IIF. This is a rapid approval process, geared towards expedition of catchment plan implementation. Eventually the official catchment plan 2018-2023, which will be fully aligned with sectoral and district 5 year strategic plans, will have to be endorsed by the Cabinet of the Government of Rwanda. The new Water Law, supported by Water for Growth Rwanda, sets out the legal background of catchment plans, which includes the governmental endorsement process.

Contents of this document

This catchment plan for Upper Nyabarongo first introduces the catchment, the institutional environment for catchment planning, and an explanation of the methodology followed to develop this catchment plan in a participatory manner that fully integrates the process and requirements of a Strategic Environmental Assessment, abiding by the regulations of REMA. In the second chapter, the status of the catchment is described, providing details on physical and socio-economic characteristics, water resources, stakeholders, a consistency analysis of related policies, plans, and programmes, an analysis and prioritisation of issues and opportunities, and an overview of ongoing activities in the catchment. The actual catchment plan is presented in chapter 3, along with a report on its development process and implementation arrangements. A final chapter 4 highlights the way forward: the current catchment plan is ready for immediate implementation of priority measures, yet a full alignment with other strategic plans currently under development is foreseen. Ultimately, an updated version, fully aligned with e.g. the 5 year strategic plans of sectoral ministries and districts in the catchments, will be developed side-by-side with these sectoral and district strategic plans. These will jointly form the basis for joint performance contracts for all stakeholders in the Upper Nyabarongo catchment, thus optimising the implementation modalities for the plan.

Water for Growth Rwanda

Introduction to catchment planning within Water for Growth Rwanda

This document is one in a series of catchment plans for Rwanda. In an effort to introduce integrated land and water management within hydrological units (catchments), the Government of Rwanda, through Water for Growth Rwanda, has commenced the development of catchment plans. Water for Growth Rwanda, a platform to promote improved, integrated management of Rwanda's water resources (IWRM), is supported 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 within the Rwanda Water and Forestry Authority (RWFA)[2].

Water for Growth Rwanda operates along five components and a number of cross-cutting themes (including climate change adaptation and gender) as visualized in Figure 3. Component 3 of the programme is focused entirely on the introduction of catchment planning and management in four so-called *demonstration catchments*. The IWRM Investment Fund, supported in Component 4, is a basket fund, 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. 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).

Figure 3: Programme components of Water for Growth Rwanda

[2] Was up until the 31st of January 2017 the Rwanda Natural Resources Authority (RNRA)

Demonstration catchments in the Programme

As mentioned above, Water for Growth Rwanda incorporates targeted activities in four demonstration catchments (Figure 4). The current document constitutes the first version of the catchment plan for the Upper Nyabarongo catchment. This level 1 catchment, located in the Nile basin, runs from south to north in the western part of Rwanda.

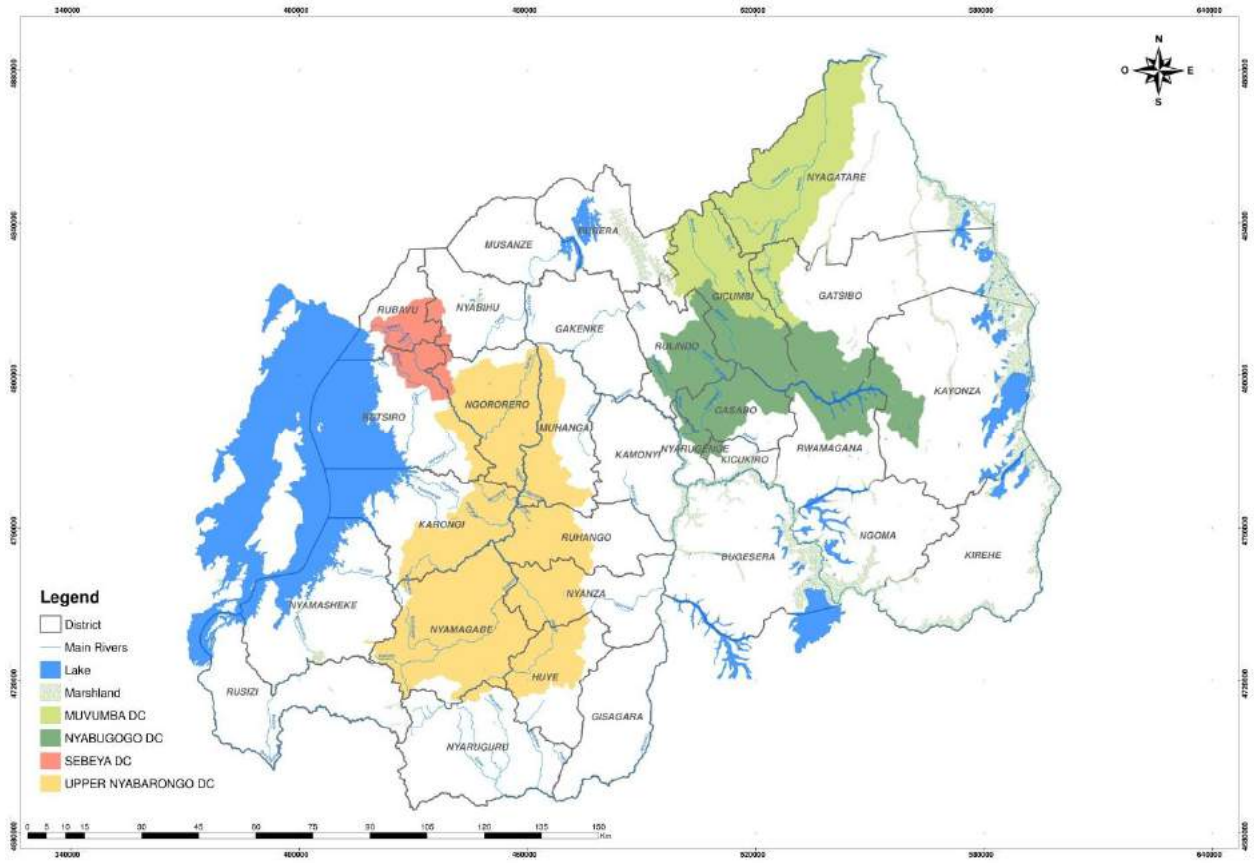


Figure 4: Demonstration catchments of Water for Growth Rwanda

The development process for the Upper Nyabarongo catchment plan (and for the other demonstration catchments) commenced in September 2015. The current version of the catchment plan (this document) represents version 1.0, including the vision, overall objective, and specific objectives of the plan. Version 1.0 forms the starting point of a profound process of wide consultations and alignment. In the remainder of 2017, Water for Growth Rwanda will support a process of alignment with sectoral and district 5 year strategic plans, which will lead to a catchment plan version 2.0. That version will contain a further detailed programme of measures that will be fully aligned with the mentioned 5 year plans. This process, and the resulting catchment plan, will be an important vehicle for the development of joint performance contracts between national level ministries, their agencies, and the districts in the catchment.

1. Introduction to catchment planning process

1.1 Introduction to the catchment

1.1.1 Geography

The Upper Nyabarongo catchment is part of the Nile basin and runs from south to north in the western part of Rwanda. The total surface area of the Upper Nyabarongo catchment is 3,348 km, which represents 12.7 % of the total surface area of Rwanda (26,338 km^2 including water bodies). The catchment is 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)
- Mashiga 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 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 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 sloops, peaking at 2950 m. The elevation ranges are shown in Figure 5. The outflow of the catchment is at 1410 m altitude (the confluence of the Upper Nyabarongo and the Mukungwa River).

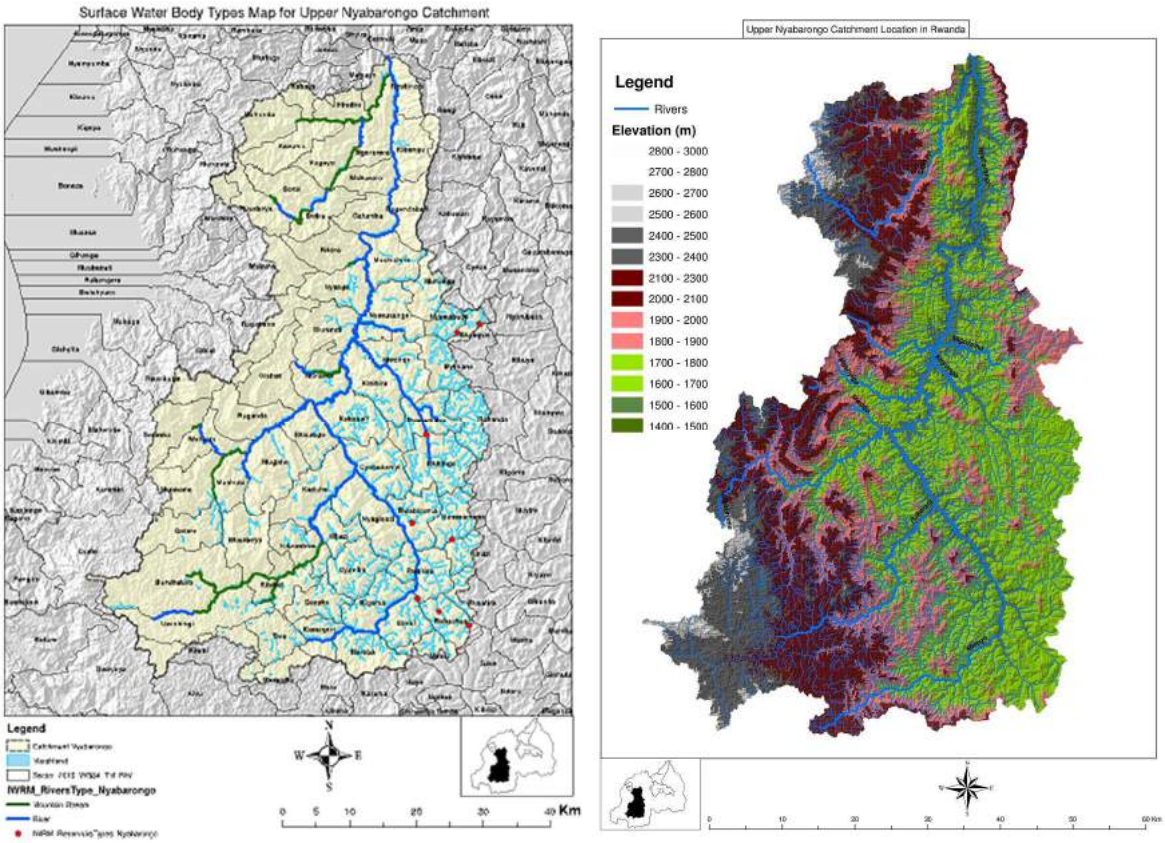


Figure 5: Typology of main water bodies and the elevation range of the catchment

1.1.2 Administrative division

Water, perhaps the most important of all natural resources, does not respect administrative boundaries. A typical aspect of Integrated Water Resources Management (IWRM) is that the hydrological units (catchments, rivers, lakes) frequently (partly) overlay with multiple administrative units. The overlay of the catchment, the districts and sectors is presented in Figure 6. Table 1 provides an overview of the main districts in the catchment. These are: Karongi, Ngororero, Rutsiro, Nyanza, Huye, Ruhango, Muhanga and Nyamagabe. The latter is almost entirely located in the catchment area and contains the largest part of the catchment with 30%. Rutsiro district has a quite a limited catchment cover; less than 100 km^2, or about 8% of the district area. Nyamasheke and Nyaruguru Districts have miniscule part of their territories in the catchment, accounting for less than circa 1% of the catchment area. For reasons of efficiency these districts are not fully involved in the catchment planning process, but included as priority third party stakeholders, who are to receive regular updates on the planning process. They are approached for detailed discussions only for topics that specifically concern their territories in the catchment.

Figure 6: Overlay of administrative and hydrological (catchment) boundaries

Table 1: Overlay of districts and catchment surface areas

Catchment		District		Overlap between district & catchment		
Name	Area km²	Name	Area km²	Area km²	% catchment	% district
Upper Nyabarongo	3,347.60	Karongi	993.03	426.26	13%	43%
		Ngororero	678.99	560.11	17%	83%
		Rutsiro	1,157.29	96.49	3%	8%
		Huye	581.53	293.59	9%	51%
		Nyanza	672.14	295.34	9%	44%
		Ruhango	626.78	316.05	9%	50%
		Muhanga	647.71	319.49	10%	49%
		Nyamagabe	1,090.36	1,016.58	30%	93%
Total:				3,323.91	100%	n.a.

1.2 Enabling Institutional Frameworks, National and local level

1.2.1 Institutional / legal context for catchment plans

The Water Law (2008) and the National Water Resources Management policy (2011) of the Ministry of Natural Resources provide a sound basis for integration of land and water management at the catchment level. The overall goal pursued in 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 decision affecting water resources management."* According to international best practice, this 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

key points of the water law and the water resources management policy is provided in Water for Growth Rwanda Technical Report (TR16) – Consistency Analysis.

Catchment planning is seen as an important instrument to contribute to the achievement of the objectives and goals of Vision 2020[3] and the second Economic Development and Poverty Reduction Strategy (EDPRS2)[4] of the Government of Rwanda, as well as for the implementation of the Green Growth and Climate Resilience Strategy of Rwanda (REMA, 2011), and other relevant sectorial policies, plans, and programmes.

An important aspect of the legal context for catchment planning is that per Article 67 of Organic Law no. 4/2005, 'every project shall be subjected to an Environmental Impact Assessment (EIA), before obtaining authorization for its implementation.' Furthermore, the article mentions 'This applies to plans, programmes and policies that may affect the environment.' For plans, programmes, and policies the instrument of EIA is replaced by the instrument of the Strategic Environmental Assessment (SEA). In the guidelines for SEA (under development by REMA, the Rwanda Environmental Management Authority under MINIRENA) it is obligatory to implement an SEA process and to submit an SEA report to REMA for approval of any plan, programme, or policy. The integration of the SEA principles in the development of the current catchment plan development process is explained in detail in Section 1.3 below. More details on the legal and institutional context for SEA within Rwanda and for Rwanda in the international society, is provided in Section 1.3.3.

1.3 Methodology and approach

1.3.1 IWRM process steps (incorporating SEA)

Both IWRM and SEA can be understood as participative processes to arrive at 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 have been combined into an integrated IWRM-cum-SEA plan process. The process steps of IWRM, as followed within Water for Growth Rwanda, are presented in Figure 7. They are further listed side by side with the SEA process steps in Annex 2. An integrated (IWRM-cum-SEA) catchment planning process is presented in Section 1.3.2 below.

[3] Republic of Rwanda, Ministry of Finance and Economic Planning, Vision 2020, 2000/2012

[4] Republic of Rwanda, Ministry of Finance and Economic Planning, Economic Development and Poverty Reduction Strategy II, 2013

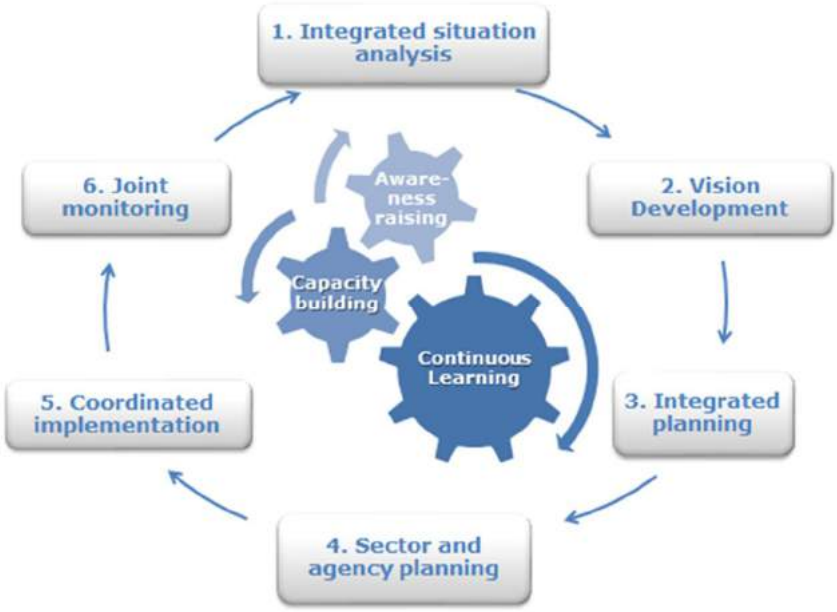


Figure 7: IWRM planning cycle, with integrated elements of capacity strengthening

1.3.2 The catchment planning process

Based on the integration of IWRM and SEA process steps as described above, a step by step integrated and participatory catchment planning process was developed. Up to end June 2016 steps 1 to 4 were completed for all four demonstration catchments. The consistency analysis (step 5) was completed in November 2016 (TR16 – Consistency Analysis). Steps 6 and 7 used a trifold approach. A multi-criteria assessment approach was developed and implemented for the main criteria of ecosystem services, economic development, social development, and water governance / institutional development. Catchment plan alternatives were assessed on these key criteria, by providing scores for each alternative of variation, using expert judgement, and by selecting weights to arrive at weighted final scores per alternative. A second, more quantitative approach, was the development of a series of water balance and allocation models. Results were again weighted to arrive at integrated assessments of each alternative or variation. Last but not least, a cost benefit analysis was developed to explore the costs and benefits of several key (physical) measures within the alternatives. Both steps were completed early February 2017. Step 8 consisted of consultation rounds with the Catchment Task Force (the last one of which was held on 30 January in Nyamagabe) and with the Water for Growth Rwanda Focal Points of sector ministries. This step will be completed during the Programme Steering Committee (PSC) meeting in February 2017. Regular implementation of the plan starts in formally in fiscal year 2018-2019, along with the regular oversight of plan implementation and M&E of its positive and negative impacts. A first so-called Early Implementation Project is already under implementation in Ngororero and Muhanga Districts. Subsequent selection of urgent and no-regret Catchment Plan Implementation Projects by the PSC may further identify projects to be implemented ahead of the official implementation period, starting as early as in the current fiscal year 2016-2017.

Table 2: Detailed catchment planning process, integrating IWRM and SEA principles

Step	Details
1 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
2 Situation analysis	§ Characterisation of the catchment, in terms of land & water systems (technical, social, economic, gender and sustainability aspects)
3 Stakeholder priorities	§ Identification of stakeholder issues and opportunities, and prioritisation of both
4 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
5 Consistency analysis	§ SWOT analysis of existing Policies, Plans, and Programmes § What other policies have constraining or win-win consequences for the catchment? § Which feedback needs to be provided to existing PPPs, from a catchment plan point of view?
6 Terms of Reference	§ Set ToR for detailed assessment of alternatives, including assessment criteria, and for ultimate plan development
7 Planning & assessment	§ Definition of programmes of measures (physical projects and institutional developments) for each of the plan alternatives § 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 § Assessment of social and environmental impacts; compare alternatives on their positive and negative impacts § q Iteration: design the alternative with maximum benefits and minimum negative impacts § Definition of mitigation/compensation measure for remaining negative impacts § Development of the catchment plan in accessible language (in English, with Kinyarwanda summary) with technical annexes
8 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.
9 Review	§ Quality assurance of documentation (by REMA as competent authority, and preferably involving stakeholders)
10 Alignment process	§ Conduct sector dialogues to align the catchment plan and sectoral ministries' 5 year strategic plans § Conduct district dialogues to align the catchment plan and district 5 year strategic plans § 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
11 Formal decision making on version 2.0	§ Support formal decision making by the relevant authorities as per the (likely new) Water Law § Motivate the (political) decision in writing
12 Sector and agency planning	§ Assign tasks to implementing district administrations or sector agencies
13 Coordinated implementation	§ Implementation by competent authorities, within boundaries set by catchment plan § Regular meetings of catchment task force representatives and central and district level

Step	Details
	implementing authorities to oversee plan implementation
14 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

1.3.3 Explanation of embedding of SEA principles

SEAs are applied to policies, plans, and programmes with a broad and long-term strategic perspective (e.g. visionary or conceptual). The 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 (PPP). A good SEA provides guidance for future decision making for any projects that may come out of the PPP.

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

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

More than anything, by combining information, process, and procedures (Figure 8) 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 of negative) of the plan; will provide better understanding of the cumulative impacts of the whole plan, rather than a list of individual impacts of a series of smaller projects that follow from the catchment plan; reduces the need for EIA discussions about strategic choices (e.g. regarding locations selected, or technologies proposed); and will facilitate the implementation of downstream EIAs owing to the wealth of information collected in the plan development process.

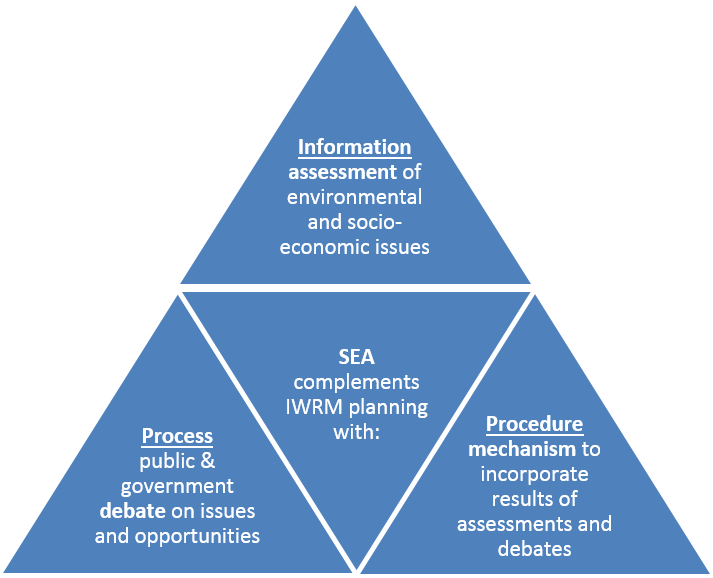


Figure 8: Added value of SEA to the catchment planning process, through information, process, and procedure (Source: NCEA[5])

1.3.1 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. The gender aspects and processes adhered to in the catchment planning process are laid down in the Gender Strategy developed under Water for Growth[6]. In summary, the strategy explains that in the involvement of women and men differs between subsequent stages of catchment plan development.

In the initial stages (steps 1-6 in Table 2) first of all the composition of the Catchment Task Force and of different stakeholder groups included women and their representatives (i.e. of the National Women Council). Considering the functional composition of many stakeholder groups, limited influence could be exerted on the gender balance in each group, resulting in an under-representation of women in several fora and meetings. A recommendation related to this would be to enhance the percentage of women in key positions relating to water management in nearly all governmental entities. In the situational analysis data collection was as much as possible disaggregated for men and women. Women and men jointly developed the vision for the catchment, and influenced the approach (terms of reference) for catchment plan development.

The development of a high level programme of measures (the current Catchment Plan version 1.0) is guided by a combination of a technocratic and a socio-economic approach. The technocratic part focuses on a description of the physical environment, of issues, risks, and opportunities for improvement of the physical environment. The socio-economic part presents information in a gender-disaggregated manner where such data are available. In general though, considering the largely technical approach adhered to in this phase, integration of gender aspects was prominent in the definition of water governance orientated measures and the M&E plan, and less pronounced in the development of catchment plan alternative and the assessment thereof, which was gender neutral.
Full integration of gender aspects will take place in the development of detailed programmes of measures for version 2.0 of the catchment plan, and in the subsequent sector and agency planning, coordinated

[5] 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.

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

implementation, and joint monitoring and evaluation. The way forward is explained in Chapter 4. ; the roadmap for the year 2017 in included in Annex 7.

1.3.2 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. 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 incorporated in different ways in these plan alternatives as will be explained in Chapter 3.

During the alignment phase, climate change considerations will be fully integrated at a more detailed level, resulting in a final programme of measures that will optimally support Rwanda in its ambitions for sustainable development while minimising adverse impacts of climate change.

1.3.3 Legal and institutional context for SEA

Rights to a healthy environment for the inhabitants of Rwanda as provided for in the Constitution of 2003 formed a basis for the Environmental Protection, Conservation, and Management Policy of 2004, which is given effect by the Organic Law No. 04/2005 of 8th April 2005, which determines the modalities for the 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 of 3rd March 2006 that established the Rwanda Environmental Management Authority (REMA) as the regulating agency and determined its organization, 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 of Article 7 in Organic Law 04/2005 stipulates precautionary measures that are informed by the results of both environmental assessments of policies, plans, projects, and development activities and assessment of social well-being. However, although the legal provision for the 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[7] 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), complies with the guidance-under-development, and incorporates best international practice as well as local constraints and opportunities.

In the international legal and institutional context, SEA facilitates adherence to 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 the achievement of the Sustainable

[7] 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.

Development Goals (SDGs), which played a leading role in the development of visions for the catchment plans within Water for Growth Rwanda.

2. Current status of the catchment

2.1 Physical characteristics of the catchment

2.1.1 Lithology and soil charateristics

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. Figure 9 shows the lithology and soil characteristics of the catchment.

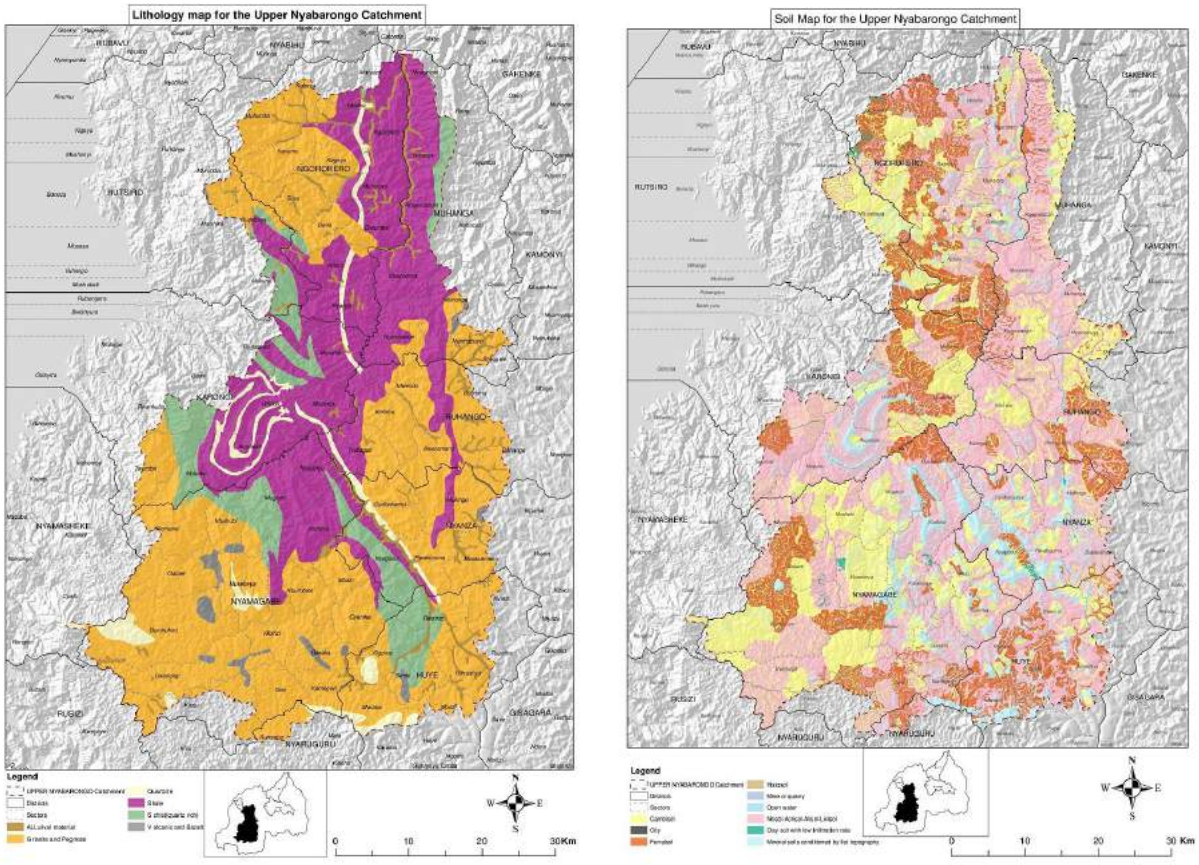


Figure 9: Lithology and soil map of the Upper Nyabarongo Catchment

The soil characteristics in the Upper Nyabarongo catchment show a high infiltration rate, the soils are dominated by deeply weathered, well drained, erodible tropical soils, strongly weathered soils with high content of kaolinite clay with iron and aluminum completed by young mineral soils.

2.1.2 Ecology

The Upper Nyabarango catchment is located in the WWF established classified Albertine Rift Montane Forests Eco region and the Victoria Basin forest-savanna mosaic (Figure 10). The water management proceedings defined for the Upper Nyabarongo catchment must comply along with other catchment areas, with the management practices defined (by REMA) for the Eco regions. Albertine Rift Montane Forests covers the western part of Rwanda. It is an area of exceptional faunal and moderate floral endemism. Although there are a number of National Parks and Forest Reserves in the area, the recent wars have made their management difficult over much of the Eco region. Additional threats include conversion of most forest areas outside reserves into farmland, together with logging, firewood collection, and bush meat hunting within the remaining forest areas. The Victoria Basin forest-savanna mosaic covers much of Rwanda, spreading east from Lake Victoria. The Eco region is most noted for its high species diversity, including several endangered primate species such as chimpanzees, and endemism resulting from the mixture of habitat types and species from both western and eastern Africa. The scattered wetland habitat has an abundance of animals representing different habitat types.

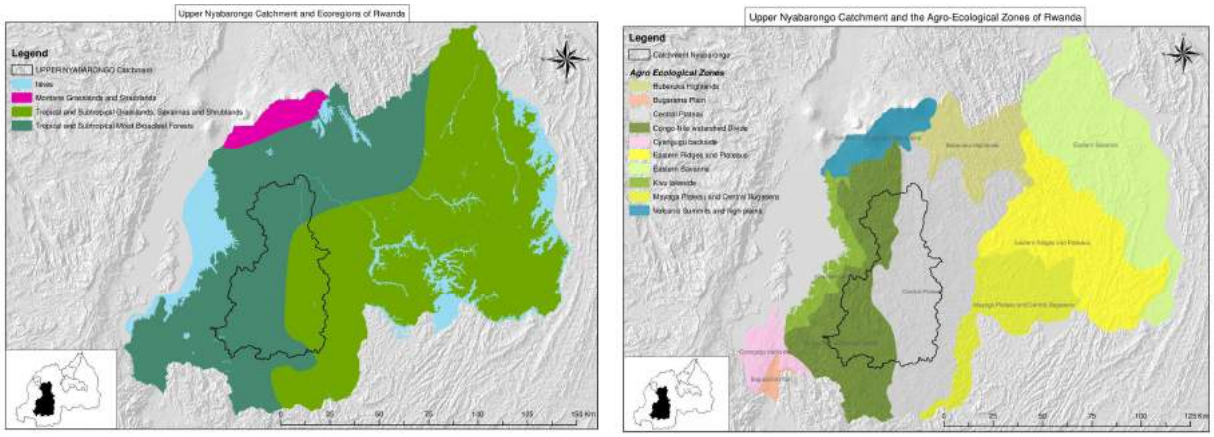


Figure 10: Catchment location within the ecoregions (WWF) and agro-ecological zones of Rwanda

2.1.3 Climate

Countrywide Rwanda experiences a temperate climate as a result of the high elevation. The average temperature for Rwanda is around 20°C and varies little throughout the year. Temperature observation data within the catchment indicates a maximum daily temperature of 25.3 °C and a minimum daily temperature of 14,6 °C in the western part of the catchment and a maximum daily temperature of 23.6 °C and a minimum daily temperature of 14,0 °C in the southern part of the catchment.

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 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.

Recent climate change studies for Rwanda and the Kagera basin have been conducted under the auspices of the Smith School of Enterprise and the Environment of the University of Oxford (SSEE. 2011) and the Feasibility Study for Kagera Integrated Watershed Programme (LTS, 2012).

SSEE (2011)[8] presents an analysis of the observed meteorological data and an assessment of climate change projections for Rwanda. The data available indicates that mean temperatures have increased in Rwanda over the past 40 years (0.35°C per decade) with similar increases in minimum and maximum temperatures. Projections of future climate for Rwanda indicate a trend towards a warmer (increased frequency of droughts) and wetter climate (increased frequency of high intensity rains during the rainy seasons).

2.2 Socio-Economic Analysis

2.2.1 Demography and poverty

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 inhabitants with 6,7% living in urban areas and 93.3% living in rural areas. The population density in the catchment is high (see Figure 11). Sectors with the highest population densities are located in urban areas in Muhanga and 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, recently these communities have been resettled elsewhere. The high population densities exert a lot of pressure on water and land resources which manifests its self 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 55.1% of the population classified as poor while 31.2% are regarded as extremely poor. The statistics relating to poverty are derived from the Household Living Surveys (EICV4)[9] 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 Rugango have the highest poverty rates (Table 3). 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 based economy.

[8] Smith School of Enterprise and the Environment of the University of Oxford, 2011

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

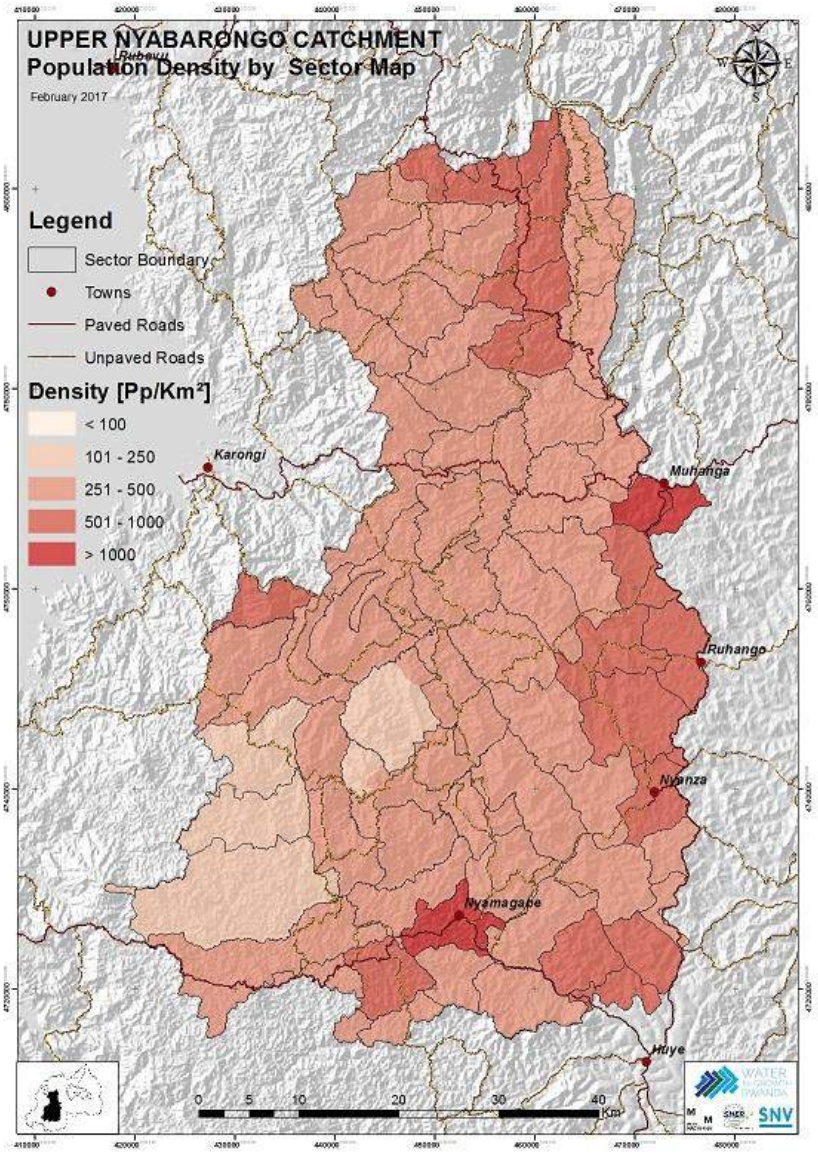


Figure 11: Population density map by sector for the Upper Nyabarango Catchment

Table 3: Population % identified as poor and extreme poor (EICV4 surveys)

District	District population	
	% poor[10]	% extreme poor
Karongi	61,7	39,8
Ngororero	51,9	29,5
Rutsiro	53,0	26,1
Huye	46,6	25,2
Nyanza	49,8	28,0
Ruhango	60,4	32,2
Muhanga	53,6	26,2
Nyamagabe	73,3	45,2
Average	52.45%	27.8%

[10] The percentage poor population comprises the percentage extreme poor population

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 practiced by more than 92% of the population. Alternative sources of energy like biogas, improved cook stoves are still limited.

Access to safe drinking water and improved sanitation and hygiene practises are 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 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 third comply with the international standard definitions of an improved sanitation facility. Very few Rwandan households have installed flush toilets (which requires a house connection to a public water supply network as a pre-requisite). 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 [11]. According to the latest WHO/UNICEF (JMP) report 2015 [12], 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.

2.2.2 Economic activities

Agriculture

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. Rain fed agriculture is generally utilized due to the favorable climate with two rain seasons per year. The main challenges of this type of agriculture is 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 landscape rehabilitation plan for the catchment. Exotic species such as Eucalyptus, Pinus, Cypres, Acacia and Alums 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.

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

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

Mining and industry

Mining and quarrying are considered as an important source of revenue and employment. The main precious mineral resources exploited are: granite, tin, wolfram, colombo-tentalite (*coltan*) and cassiterite. The sites where extraction takes place are in Rutsiro, Ngororero, Nyamagabe, Muhanga, Karongi and in the Nyungwe forest. Nonregulated 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[13].

Tourism

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 paces of the ancient kingdoms, hence there is opportunity to further develop cultural tourism.

Land use

The catchment comprises a significant part of the Nyungwe forest as well as some remnants of the Gishwati forest. Land class data are important used in water evaluation and allocation models to simulate the hydrological relations between the soil, the atmosphere and runoff. For purposes of preparing data for such models, the recent land use cover data set for the year 2015 was obtained from RNRA and adopted with the following sub-classification:

[13] 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").

- agroforestry with progressive terraces;
- agroforestry with radical terraces;
- agroforestry without terraces;
- forest;
- grassland;
- irrigated marshland;
- irrigated hillslope;
- progressive terraces without agroforestry;
- radical terraces without agroforestry;
- rainfed agriculture;
- river buffer zones;
- shrubs;
- urban;
- wetlands.

Land cover areas have been computed for each sub-catchment (Figure 12). As information on terraces and irrigation is lacking from this map, these are added separately. A Google Earth analysis has been performed to quantify the currently terraced areas. Terraces are distinguished in four categories; radical terraces and progressive terraces both either with or without agroforestry. Terraces and agroforestry are forms of soil, water and crop management and therefore will also influence the WEAP soil and water retention characteristics accordingly.

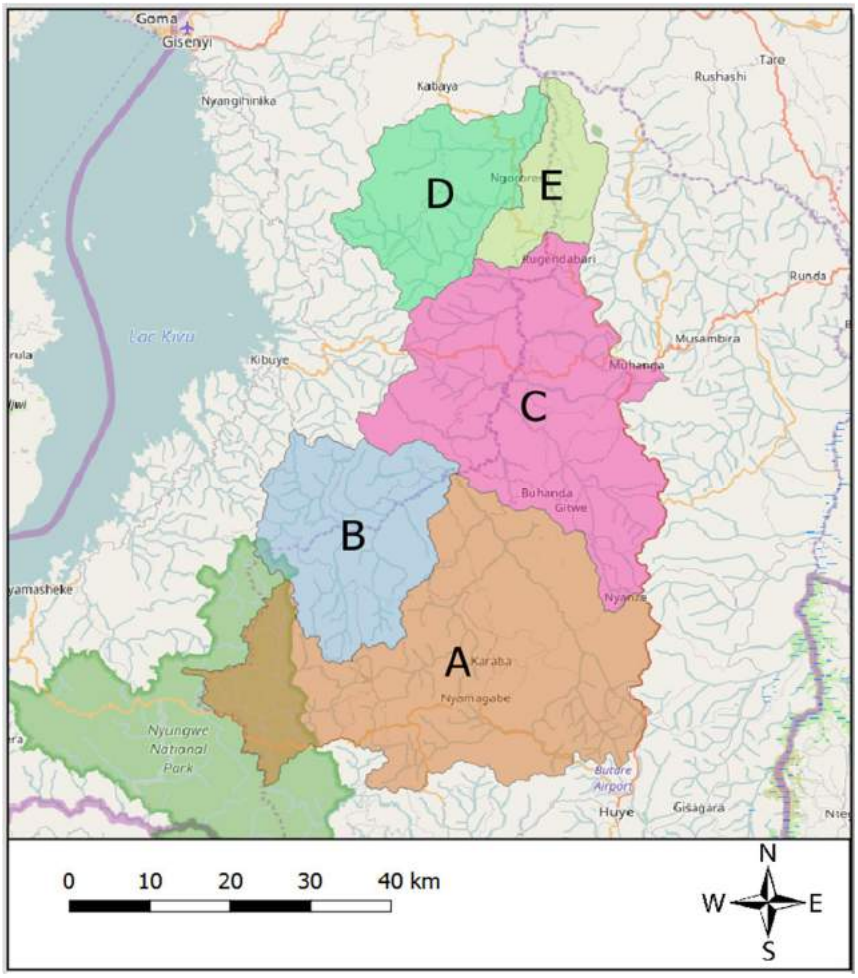


Figure 12: The sub catchment delineation of utilized for water evaluation

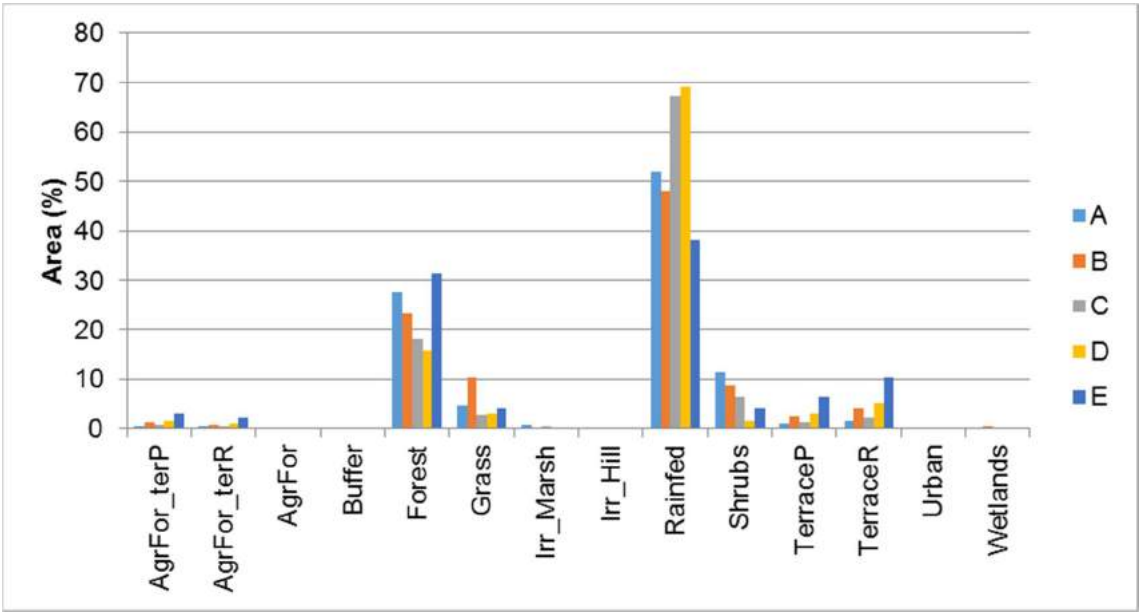


Figure 13: Land cover distribution in the sun-catchments

The dominant land use is rain fed agriculture see (Figure 13), which is a major shift from the original ecoregions (especially compared with the original tropical broadleaf forest) with evident consequences for soil conservation. Agricultural wetland is a significant land use in especially the south and western half of the catchment (total about 260 km^2 or some 8% of the catchment area). The forest cover in the catchment is estimated at 69,293 ha equivalent to 20.7% of the total catchment area (3,347.60 km^2). This covers natural forest in 4 districts Nyamagabe, Rutsiro, Ngororero (degraded) and Muhanga, but is still below the national average of 28.8% and below the national target of 30%.

Currently the average size of agricultural land plots in the catchment is 0.57 ha which is below the national average (0.59 ha). Given the fact that the higher western part of the catchment is characterised by steep slopes, intensive rain fed cultivation and a high population density, these areas are prone to severe soil erosion. The high run off leads to soil loss, which in turn leads to sediments in the rivers and streams. The loss of fertile soils leads to reduced soil fertility, poor agricultural productivity in the higher parts of the catchment, and sediment loading in the waterways. In addition to agriculture, collection of fuel wood has contributed to high rates of deforestation. The removal of trees and vegetation increases the effect of erosion and leads to further land degradation.

2.2.3 Water use

The current status of water resources monitoring (rainfall, surface water, ground water) is limited. A recent Water for Growth water users' survey in the catchment identified the main water users. The observed water users in this survey are: coffee washing stations, hydropower plants, water treatment plants, mineral extraction sites, dams, irrigation schemes, fishing farms, industries, and land parcels above 100 ha. The self-estimates of actual water use by these users appear unreliable as of yet.

A water balance and allocation study was carried out by Water for Growth Rwanda in 2016-2017. This study gathered inputs from the NWRMP, augmented with data from the National Institute of Statistics of

Rwanda, MINECOFIN, results of the water users survey, and other sources. Based on the results of the water users survey and these other supplementary sources, the following water consumption figures have been derived (in the case of domestic water demand the figures have been raised compared to current Rwandan standards, to be more future proof).

- rural water demand, 20 litres/cap/day;
- urban water demand, 80 litres/cap/day;
- mining, 125 litres/cap/day;
- coffee washing stations, 75l litres/cap/day;
- tea factories, 35 litres/cap/day;
- other, 35 litres/cap/day;
- marshland irrigation, 200mm – 250 mm/ha/year;
- hillside irrigation, 600mm – 800mm/ha/year;
- livestock, for each 5 people one animal (excluding chickens) is present. Water consumption was taken as 125 l/head/day;
- environmental flow requirements, 30% of the surplus or available water resources.

Results of the water balance and allocation study are provided in Section 2.3. In general terms, consumptive water use in Rwanda is still very limited and is thought to vary between 1-5% of the annual renewable resources per catchment. The current known water demand locations within the catchment are presented in Annex 3 and further detailed in Water for Growth Rwanda's technical report TR28 – Water Users' Survey (January 2017). These demand locations correspond to existing water related infrastructure e.g. irrigation schemes, hydropower dams, mining areas and urban centres.

The current area of developed irrigated marshland (1,408 ha), as one of the larger water use categories in the catchment, is tabulated below in Table 4 Marshland development was implemented by the Rural Sector Support Project (RSSP), Land Husbandry Water Harvesting and Hillside irrigation (LWH) Project, Quick Wins Marshlands Development Programme (QWMDP) and Support Project to the Strategic Plan for the Agriculture Transformation (PAPSTA).

Table 4: Irrigation in the Upper Nyabarongo catchment

Name of scheme	Type	Water source	Command area (ha)	Project
Rusuli Rwamuginga	Marshland	Dam	164	RSSP 1
Regeramigozi	Marshland	Dam	254	RSSP 2
Ntaruko-Mwogo	Marshland	Stream diversion	576	LWH
Rwondo	Marshland	Stream diversion	79	QWMDP
Gisuma	Marshland	Stream diversion	79	PAPSTA
Rufuha	Marshland	Stream diversion	45	PAPSTA
Busogwe	Marshland	Stream diversion	99	QWMDP
Muzirwantwago	Marshland	Stream diversion	72	QWMDP
Umwaro	Marshland	Stream diversion	40	QWMDP

2.3 Water resources analysis

2.3.1 Hydrology

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. Figure 14 presents the monthly water regime curves for a representative monitoring station in the main rivers (70007, Mwaka - Upper Nyabarongo).

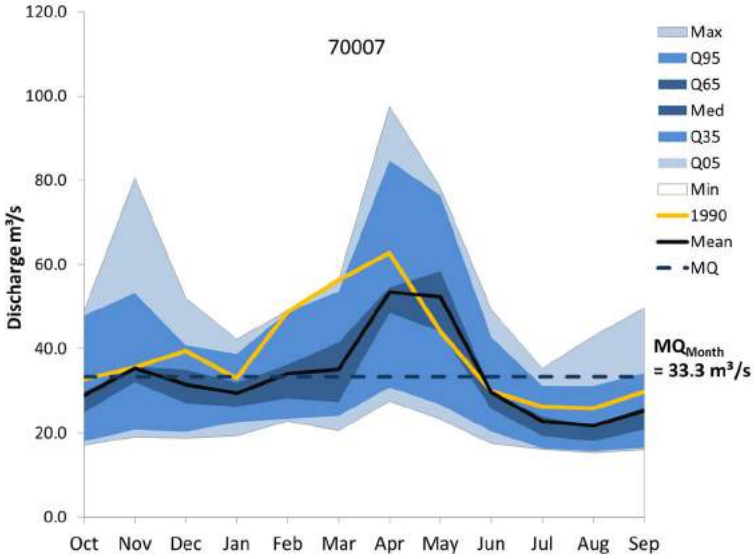


Figure 14: Monthly water regime curves for station 70007 (Mwaka-Upper Nyabarongo)

In the above Figure 14, Q95 refers to average monthly flow exceeding 95% of monthly flow events in m³/sec;(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 are essential for purposes of deriving runoff estimates. Some historical data are 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 has to be performed. On the other hand, global initiatives of various research group 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 utilized as they are accepted as high quality. One such example is the so-called CHIRPS precipitation data set[14].

Additional climate data are required to estimate the potential evapotranspiration. Average monthly values of temperature and humidity at Kigali (elevation 1567 MASL) have been utilized within a Water Evaluation and Planning (WEAP) system model[15] 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 below:

[14] 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 are delivered for the entire continent at a daily based. Using QGIS and python scripting these data were aggregated to monthly values for each sub-catchment.

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

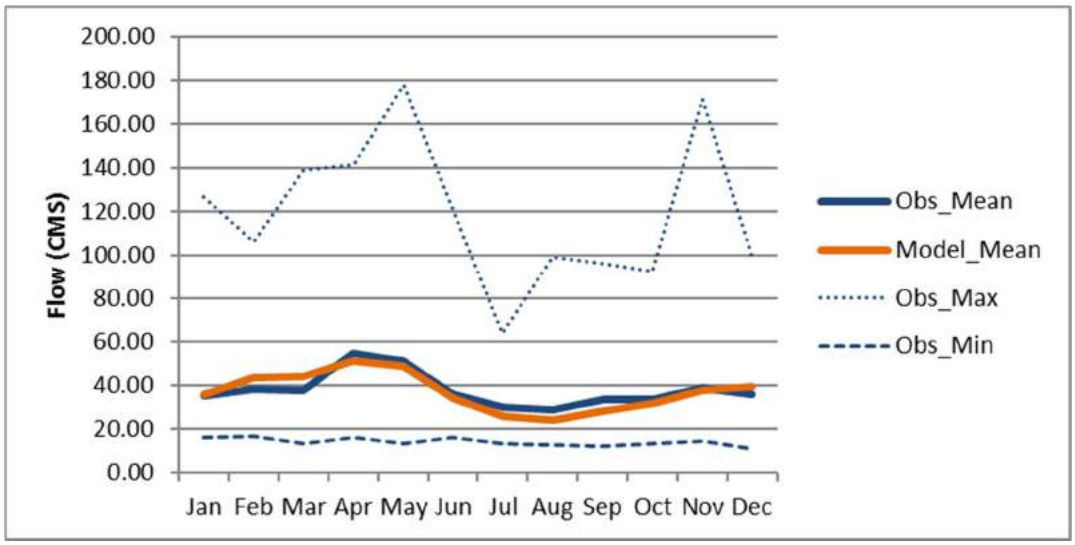


Figure 15: Observed and simulated mean, min, and max flow for station Mwaka

Based on the simulated flows and demand figures obtained from the water user's survey, the National Water Resources Masterplan and other sources Table 5 and Table 6 below show the summarised water balances for the baseline 10-year period.

Table 5: Summarized water balance for the entire basin for the baseline as 10-year average

In	(MCM/y)	Out	(MCM/y)
Precipitation	4,117	Evapotranspiration	2,077
Return flows	25	Withdrawals	42
Storage change	-23	Outflow	1,485
		Groundwater recharge	515
Total	4,119	Total	4,119

Table 6: Summarized water balance for the manageable water components (Blue Water) as 10-year average

In	(MCM/y)	Out	(MCM/y)
Runoff	402	Domestic	3
Baseflow	1,096	Industry	29
Groundwater	4	Irrigation	8
Return flows	25	Livestock	2
		Outflow	1,485
Total	1,527	Total	1,527

From these Tables, it is clear that most of the precipitation is lost to evapotranspiration by vegetation. Outflow from the catchment and groundwater recharge are other important components in the catchment which provide water to sustain environmental flow requirement. It is interesting is that the so-called manageable water (sometimes referred to as Blue Water) is about 30% of total water resources. Only a small fraction is currently withdrawn for domestic, industry, irrigation, and livestock.

2.3.2 Water quality

Systematic monitoring of water quality data in Rwanda has only been taken up recently by the RNRA-IWRM[16] department at a limited number of locations throughout the country. Currently, water quality is

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

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 two water treatment plants at Kadahokwa and Miguramo.

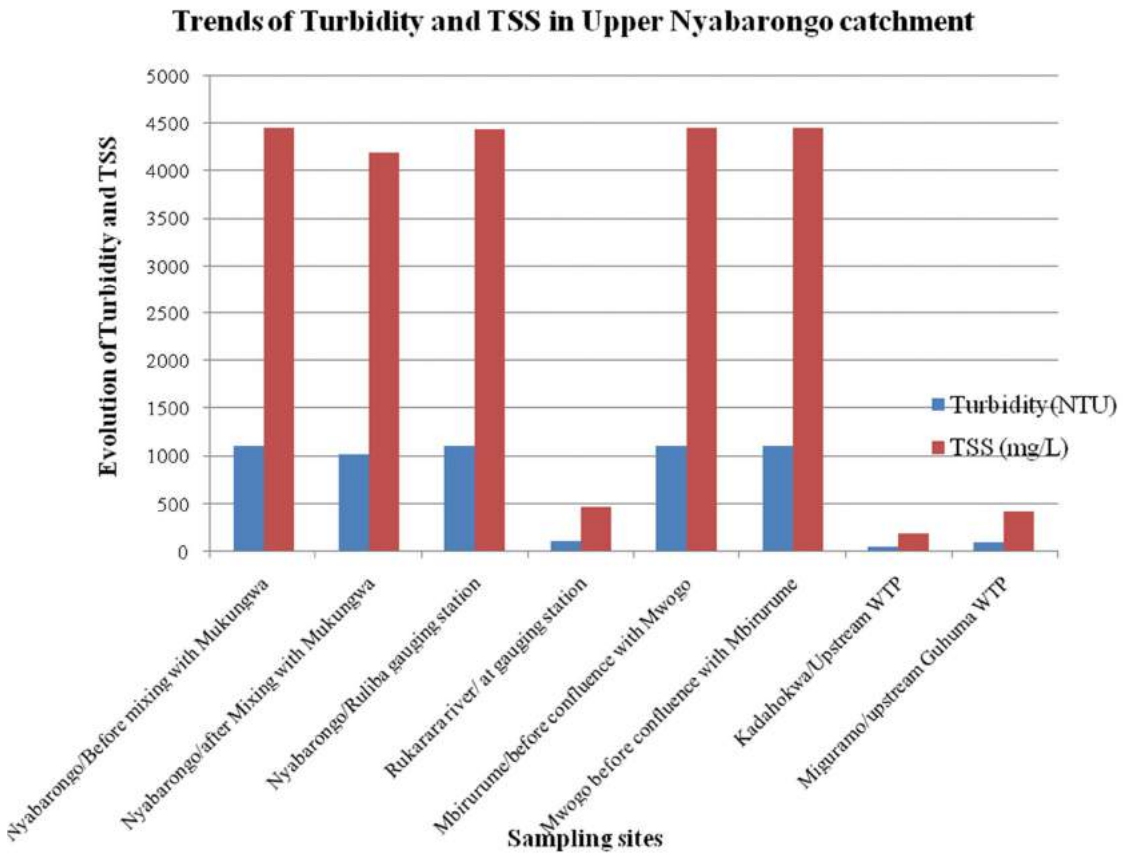


Figure 16: Turbidity and Total Suspended Solids (TSS) measurements in the catchment (RNRA-IWRMD, 2017).

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 16 above shows that Kadahokwa river 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 respectively). All turbidity values recorded in upper Nyabarongo catchment were above WHO and RSB drinking water standards (5-25 NTU). Sediment fingerprinting studies[17] 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 prioritized 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.

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

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.

2.4 Stakeholder analysis

The process followed to identify and analyze stakeholder interests and their roles and responsibilities, contributes to a catchment management plan with broad ownership, enhancing the subsequent joint implementation by all stakeholders. Effective engagement of these stakeholders ensures sustainability of the plan's proposed interventions. During the consultative meetings, stakeholder analysis processes were undertaken to determine who the key stakeholders are, what are their interests, what benefits do they derive from the catchment, and what roles and responsibilities they currently have and can play in the future management of the catchment.

See Annex 4 for the stakeholders list which comprises:

- National Government, in the form of line ministries and their authorities/agencies, including the significant projects and programmes carried out under their auspices;
- Semi-Governmental utilities, such as water supply and electricity utilities;
- Districts;
- NGOs and iNGOs active in the districts;
- Private sector stakeholders.

Stakeholders within the catchment can be classified in 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 the local communities and community groups (the majority of whom are poor men and women), farmers, herders, and fishermen etc. who derive their livelihoods from the water resources of the catchment, or whose activities directly rely on or impact the water resources of the catchments. These would also include water users, water user associations and business entities directly affected by the catchment plan. A long list of these primary stakeholders is included in the various district survey reports. This group of stakeholders should be kept informed, and engaged through participatory implementation so as to guarantee ownership of the project interventions.

2. Secondary stakeholders - are those individuals, institutions or organisations that are intermediaries to who have an interest in the catchment plan implementation projects or outcome, although it is less significant and directly related than that of the primary stakeholders. These secondary stakeholders are "indirectly affected" by outcomes. In the catchment, they would be the local Government or constituent districts, NGOs, WASAC, RURA, EWSA, electricity companies (e.g. REG), and others in the basin such as Kagera Integrated Water Management & Development project under NELSAP, DEMP, LVEMP II, LAFREC. The recently constituted task force committees and hydrographic basin committees are the focal point persons for this category. Whereas these stakeholders are indirectly affected by the outcomes, they are powerful and often highly involved in the catchment planning process, and should remain so (or become so) during catchment plan implementation.

3. Tertiary stakeholders - can also be referred to as external and usually play an advisory, approval or advocacy role to the Project. These include the National Governments, the Embassy of the Kingdom of the Netherlands in Rwanda, potential donors, and technical ministries that formulate the policies, plans and programs relevant for the design of 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.

   For each category of stakeholders, it is important to feel that they are part and parcel of the proposed projects in the catchment plan. Regular communication on outcomes and decisions being made is essential. It is recommended that a dedicated communication strategy for all levels of stakeholders is to be designed at the beginning of the implementation phase.

2.4.1 Stakeholder engagement plan

The stakeholder engagement plan for the implementation phase of the catchment plans is outlined on the next pages:

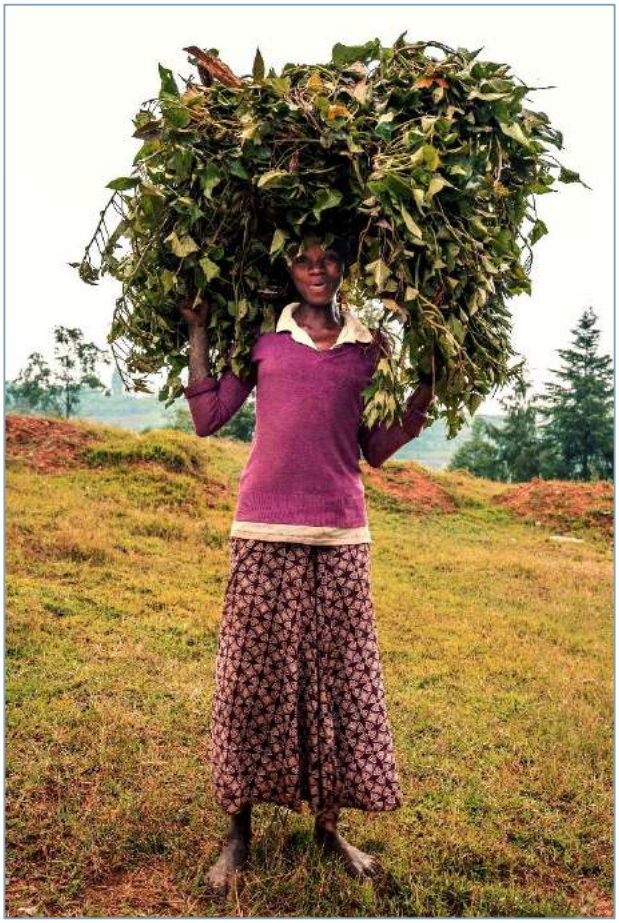


Table 7: Stakeholder engagement during catchment plan implementation

Type of stakeholder	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 mobilization 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 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 e.g. Focal Groups PSC, water sector meetings, exchange visits to the other riparian countries for lesson learning and exchange of best practice	Contribution towards the attainment of sector plans in IWRM due to sub project activities.	It is envisaged that the sub-projects will be part of the sectoral plans
Regional projects	Biannual	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.	It is envisaged that the IWRM Catchment Investment Plan will be in harmony with other

Type of stakeholder	Timing of involvement	Type of participation required	Tools for participation and communication	Outcome of involvement	Comments
				Contribution towards regional environment and economic development goals	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 harmonization 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.
Donors 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.

2.5 Consistency analysis of existing policies, plans and programs

2.5.1 Introduction

The purpose of a 'consistency analysis of existing Policies, Plans and Programs (PPPs)' is to check the consistency of the catchment plan under development with existing policies, plans and programmes, by means of interagency co-operation. The analysis requires an inventory of National, local and sector plans that may have influence on, or that may be influenced by, the catchment plan, to ensure that the four catchment plans are compatible.

During the stakeholder, consultative meetings (with National stakeholders and the Catchment Task Force), a first analysis of existing policies, plans and programs was undertaken to develop an overview of relevant PPPs that have consequences for the catchment plan of the Upper Nyabarongo catchment, see Catchment Plan interim report TR17 – Catchment Characterisation and Vision for the results. The analysis shows the key PPPs that might generate opportunities for the catchment plan; set environmental and socio-economic conditions (criteria), and those that have the potential to conflict with the plans and how these conflicts can be resolved.

The Water for Growth Program commissioned a study to investigate the policy, plans, programs and legislation frameworks in terms of their relevance and alignment to Integrated Water Resources Management (IWRM). The purpose of consistency analysis of policy instruments was to check the extent to which policies are consistent and supportive of each other or policy instruments presenting conflicting objectives. The analysis was conducted by preparing an inventory of relevant policy instruments that may have influence on IWRM. The goals of each policy instrument evaluated to assess the level of consistency so that specific goals and policies contained in one policy are not in conflict with those contained in another. Thereafter, SWOT Analysis framework (Strengths, Weaknesses, Opportunities, and Threats) was applied to unearth inconsistencies and alignment issues. The findings reveal that there are strengths and challenges in the performance of existing policy instruments and legal texts. The sections below provide key findings from the consistency analysis. The full report is available as Water for Growth Rwanda TR16 – Consistency Analysis (November 2016).

2.5.2 Key strengths of existing policy instruments

The first key strength is that 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. To be specific, the principles of IWRM are integrated in an explicit manner in several policy instruments (e.g. national policy for water resources management, environmental policy, green growth and climate resilience strategy, national water resources master plan, etc). For example, law N°62/2008 enacted in 2008, lays out the general framework for the principles of integrated water resources management, including the prevention of pollution, and the principle of "user pays" and "polluter pays," as well as the principle of users' associations for the administrative management of water. It also calls for better integrating the management, development, utilization and protection of land and water resources at the catchment level.

Similarly, Organic law n° 04/2005 of 08/04/2005 determining the modalities of protection, conservation, and promotion of environment in Rwanda 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 of organic law no. 4/2005, 'every project shall be subjected to an Environmental Impact Assessment (EIA), before obtaining authorization 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 n° 08/2005 of 14/07/2005 determining the use and management of land in Rwanda. 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 other most relevant pieces of legislation related to natural resources include No. 58/2008 of 10/09/2008 determining the organization and management of aquaculture and fisheries in Rwanda, law N° 30/2012 of 01/08/23012, law on governing of agrochemics, law N°10/2012 of 02/05/2012 governing urban planning and building in Rwanda and law N°55/2011 of 14/12/2011 governing roads in Rwanda.

There is also an acknowledgement of pressure on water resources and an incorporation of key normative dimensions of IWRM (water as a social and economic good, stakeholder participation, promotion of catchment relevant scale, e.g. basin) (e.g. national policy for water resources management, revised vision 2020, EDPRSS 2, seven year government program, decentralization policy, community development policy, disaster management policy, environmental policy, national strategy for community development and local economic development, etc.).

In similar fashion, 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, thee gender policy sets out the key objectives for ensuring the empowerment of women in various sectors including environment protection and land use management. In terms of management of water resources at a watershed level, key regulations are organic laws nº 04/2005 and 62/2008. Decentralized entities are given responsibility for "efficient management of rivers, lakes, sources of water and underground water", as well as for the 'efficient management and effective use of swamps'.

Hence it is clear from the cited examples that many policy instruments are consistent and supportive of each other with regards to IWRM. Thus, for example, policies on agriculture, environment, land, water resources management and infrastructure emphasize aspects of soil erosion protection and water conservation. Other points of convergence are found in areas such as the promotion of agro-forestry (e.g. five-year strategic plan for the environment and natural resources Sub-Sector, national climate change and low carbon development strategy, SPTA 3, etc.).

In addition, some policy documents (e.g. National fertilizer Policy, irrigation policy, strategic plan for the transformation of agriculture in Rwanda, Rwanda irrigation master plan , master plan for development of fisheries and aquaculture in Rwanda, public policy and strategy for Rwanda, law No. 58/2008 of 10/09/2008 determining the organization and management of aquaculture and fisheries in Rwanda, law n° 30/2012 of 01/08/23012 law on governing of agrochemics, law N°10/2012 of 02/05/2012 governing urban planning and building in Rwanda, law N°55/2011 of 14/12/2011 governing roads in Rwanda) establish objectives and indicators directly relevant to environment and natural resources. Above all, the national decentralization policy, community development policy and national strategy for community development and local economic development deserve to be highlighted, as they establish responsibility

for implementation of actions in environment, natural resources, agriculture, infrastructure for example at the local level. These policy instruments show similar points of convergence with the revised vision 2020, EDPRS 2 and Seven Year Government Program.

2.5.3 Key weaknesses of existing policy instruments

There are specific challenges which might hinder the implementation of IWRM. The first challenge is that some policy instruments lack provisions for IWRM. For example, the environmental policy is less specific in terms of the purpose of conserving wetlands. Instead, the policy acknowledges that traditional wetland use has been poorly conceived and lacks organization 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. There are also limited capacities at decentralized 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 with similar or overlapping roles and responsibilities for natural resources management.

Rwanda's constitution of 2003 amended in 2015 states a right to a clean environment in article 22: "Everyone has the right to live in a clean and healthy environment". However, the legislation does not explicitly expound on the principles of adopting IWRM as a means to secure universal water rights. It is anticipated that the new water law will make such express provisions. With regard to land management, under the ministerial order No 14/11.30 of 21/12/2010, the land consolidation is designed to enable farmers to consolidate multiple parcels under one crop management program and optimize agricultural productivity as well as strengthen connection between buyers and farmers. However, there is no single clause on managing land, water and other terrestrial land and marine resources in integrated way. Furthermore, the order does not provide for the active participation of local people in land management and consolidation.

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

The other weakness of the existing policy and legal framework that were underscored is the existence of some conflicting objectives in the programs for transformation of agriculture (e.g. objectives related to intensification in use of pesticides and fertilizers which conflict with objectives on improving water quality; as well, objectives for marshland reclamation which are potentially in conflict with objectives on wetlands protection) These soil intensive mechanisation measures are prioritised in agricultural mechanization strategies for Rwanda 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.

2.5.4 Implications of findings of consistency analysis for catchment planning

Given this complex context of various policy instruments, the key requirement for effective implementation of catchment plans is to first integrate policies, programs, plans and laws. This will ensure inclusive and accountable decision making and sustainable water resource management. Such integration should be reflected in the local plans. This will give districts the necessary capacity to effectively implement these policies at the local level.

In order apply the principles of IWRM in catchment planning it is necessary to have cross-sectoral cooperation, at catchment scale including both bottom-up and top-down participation in planning, with emphasis on coordination across multiple scales. Cultivation of a network of partnerships is essential to ensure inclusion of diverse stakeholder perspectives within a framework of collective decision-making on water and land resources management. It is increasingly recognized that central governments agencies cannot do everything and that some components of water and land management are better handled by other actors. The emergence of networks involves the redefinition of centralised planning to an alternative catachment boundary planning approach which is much more open thereby allowing for diversity and experimentation between many different stakeholders. This will allow major stakeholders to have common vision and shared understanding of water management issues.

Therefore, it is 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 various constituent district development programs for effective implementation at district level.

2.6 Analysis of issues and opportunities

The scoping workshop for the catchment plan of Upper Nyabarongo, held in May 2016, resulted in a prioritised list of issues and opportunities in the catchment. With thanks to the participation of all members of the Catchment Task Force, as well as the key representatives of the National Government (MINIRENA and partner Ministries) in the scoping workshop, the results in Table 8 provide a solid basis for the catchment plan.

Table 8: Priority issues and opportunities in Upper Nyabarongo catchment as scored by the districts representatives in the Catchment Task Force

Issues	Score	Opportunities	Score
Soil erosion (including riverbank erosion by agriculture & cattle) (8 districts)	22	Water availability (6 districts)	20
Mining exploitation increasing siltation to rivers (6 districts)	16	Reforestation (4 districts)	12
Deforestation reducing the soil cover (4 districts)	13	Implementation of soil conservation projects (3 districts)	8
Waste water management (2 districts)	6	Mineral resources (2 districts)	6
Poor agricultural practises (2 districts)	5	Rules and regulations (1 district)	1

The consultation in the scoping workshop and further analysis of the water resources leads 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 the underlying causes and opportunities are discussed in detail below.

2.6.1 Erosion and flooding

The high population density in the catchment combined with a high use of fuel wood for cooking, in combination with poor agriculture practices, leads to deforestation and over exploitation of agricultural land. Due to a lack of regeneration the soils become depleted of nutrient elements. Especially in the western part of the catchment steep slopes allow for an easy removable topsoil and natural vegetation cover, further aggravating the extremely high rates of soil loss. Once the eroded soils enter the waterways, they contribute to the high sediment loading in the streams of the catchment. Flood risk becomes higher where large volumes of sediment have been deposited along the valleys and in streambeds, where they reduce the flow capacity of the river.

Farmers will need to be encouraged to adopt and utilize agro-forestry, and other preferred 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 on-going and past projects, this can curb the rates of deforestation, soil erosion, stream sedimentation and flood risk.

2.6.2 Poor water quality

Although there is hardly any monitoring data on water quality in the catchment, stakeholders recognize the current surface water pollution as a key problem. The most obvious and visible pollution are caused by watershed degradation and unsustainable mining activities, 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 effort in prevention of pollution and waste water treatment options are needed.

2.6.3 Population pressure

The Upper Nyabarongo catchment is a highly populated area, with highest density in the urban centers 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 increase 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.

2.6.4 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 source of drinking water. Forty percent of the population are still using unprotected springs and rivers for drinking and household water. Due to the poor water quality by high siltation rates and high loads of e. coli and coliform bacteria and organic load, this has a profound negative impact on the general 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. It reduces time spent on fetching water and has a positive impact on school attendance, in particular for girls. Women's life's are strongly affected by unsafe, distant water supply, as women are generally responsible for water collection and handling, for household hygiene and caring of the sick. It is recommended to develop a catchment or (sub) catchment based water supply Masterplan to strengthen the water supply systems and encourage rainwater harvesting initiatives. An outline of a catchment based drinking water supply master plan is presented in the NWRMP. The plan should be complemented with adequate sanitation and hygiene solutions (WASH).

2.7 Ongoing catchment management initiatives at National and local level

On-going key projects linked to catchment management in Upper Nyabarongo catchment include among others: LWH/RSSP project implemented by MINAGRI; LVEMP implemented by REMA; PAGREF and PAREF in RWFA; and projects in the various districts funded by FONERWA. On-going Government projects related to water management currently implemented in the catchment Upper Nyabarongo are listed in Table 9.

Table 9: On-going implementation of National Government projects related to the catchment plan

S/N	Name of the project	Implementing institution	Number of Districts
1	The Lake Victoria Environment management project (LVEMP II)	REMA	2 (Nyamagabe, Ngororero)
2	The decentralization and Environment Management project (DEMP II)	REMA	1 (Rutsiro)
3	The Landscape Approach to Forest Restoration and Conservation (LAFREC)	REMA	2 (Ngororero, Rutsiro)
4	PAREF, progressive terraces, agroforestry, Afforestation	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).

A description of all the national and local current projects related to the catchment plan, including Early Implementation Projects are provided in the subsequent sub-sections. These can be grouped under the following broad categories

- initiatives to reverse land degradation through sustainable use of land resources and agroforestry systems;
- initiatives to manage solid waste and sewerage facilities;
- initiatives to increase coverage of safe water and sanitation facilities;
- initiatives to enhance agricultural productivity through increased water use for irrigation.

2.7.1 Lake Victoria Environmental Management Project (LVEMP) II – APL2:P118316

LVEMP II APL-2 (which covers the two riparian countries – Burundi and Rwanda) began at the start of 2012 and runs until the end of FY 2017. The watershed management protection initiatives under LVEMP II

include establishing radical and progressive terraces on hillside areas, agroforestry, protection of riverbanks, lakes and wetlands, funding of small community driven projects among others with a focus on 12 priority districts in the Lake Victoria Basin in Rwanda. The projects within the demonstration catachments are Rulindo, Muhanga, Ruhango, Nyanza, Huye, Kamonyi, Nyamagabe (South), Ngororero and Karongi (West).

In addition, funds secured from Lake Victoria Water and Sanitation (LVWATSAN) Project Phase II, are currently being utilized to implement improved water supply services to the population living in the Nyanza town through improved water infrastructure. The project will increase access to safe water to 85% while sanitation coverage will be elevated to 80%. The project components are a water supply system, drainage system, land fill and faecal sludge treatment facility for Nyanza town.

Similarly, under implementation of the Lake Victoria Environmental Management Project (LVEMP II), sanitation masterplans have been prepared for the districts of Huye and Muhanga. The Sanitation Master Plan covers physical and institutional aspects for how sanitation services (wastewater, solid waste and storm water) will be developed over a planning period of 20 years. The cities/towns of Huye and Muhanga,
being secondary cities, have the potential to develop rapidly, therefore require due attention to their sanitation facilities. Capital investment costs have been outlined with possible sources of funding mooted to be the World Bank and African Development Bank.

2.7.2 Decentralisation and Environment Management Project (DEMP) Phase II

DEMP Phase II is a UNDP supported initiative in Rwanda to be implemented between July 2008 – July 2018. Its activities in the catchment are mainly geared to focus on capacity development of Ministry of Natural Resources (MINIRENA) / Rwanda Environment Management Authority (REMA) to undertake environmental policy coordination and monitoring and the Districts to be able to integrate environment with development through the district planning, budgeting process, and project implementation.

The project will enable MINIRENA/REMA to fulfil its mandate and effectively implement environmental policies, as well as develop management and operational tools such as EIA guidelines and procedures, SEA training, and environmental awareness educational materials, in addition to in-house capacity building e.g. GIS. The project will also support sustainable livelihoods initiatives by implementing environment priorities identified in the Districts by using innovative practices (e.g. improved cooking stoves, soil conservation technologies, etc.), and by building public-private-civil society sectors in integrating conservation and development and targeting communities in/ around protected areas where degradation threatens livelihoods sustainability.

DEMP has contributed to improving productivity and sustainability of key sectors including land, water resources management and agriculture within the demonstration catchments in all Districts of Western Province, in one Northern Province and City of Kigali and 6 Districts in Eastern Province.

2.7.3 Landscape Approach to Forest Restoration and Conservation (LAFREC)

The Landscape Approach to Forest Restoration and Conservation (LAFREC) for Rwanda was designed to restore and maintain critical landscapes in Rwanda that provide environmental benefits and contribute to enhanced resilient economic development and livelihoods. Project start-up was January 2015 and

implementation is envisaged over 5 years to December 2019. It's source of funding is the Global Environment Facility (GEF) and the Government of Rwanda. The programme is implemented by REMA with support from MINIRENA.

Within the area, drained by Upper Nyabarongo catchment, the project area covers the districts of Ngororero and Rutsiro within the Giswati forest area – Mukura landscape. Implementation was centred around rehabilitating forests and biodiversity within the Gishwati and Mukura Forest Reserves, enhancing sustainable land management in the agricultural lands between them, and introducing silvo-pastoral approaches in the rangelands of the central former Gishwati Reserve. These interventions are to be complemented by livelihoods diversification and the establishment of flood warning and response systems, that will further enhance climate resilience within one of the most disaster-prone areas of Rwanda.

Environmental benefits from improvements in vegetation cover and soil conservation will come in the form of: (i) improved native biodiversity within a global priority ecoregion; (ii) carbon sequestration; (iii) improved watershed function, reducing sedimentation and related costs to downstream water infrastructure and fisheries; and (iv) higher productivity and diversity of natural-resource-based livelihoods.

2.7.4 Project d'Appui à la Reforestation au Rwanda (PAREF Phase 2)

PAREF Phase 2 is designed to focus on supporting the Forestry Sector to implement the National Forestry Policy in Rwanda so as to reverse both quantitative and qualitative degradation of forest resources and restore Rwanda's forestry cover to a target of 30% forest cover by 2018. PAREF covers all the districts of the Eastern, Western and Northern Provinces. PAREF is funded by the Belgian Development Agency (BTC) and the Netherlands Government and implemented by RWFA. The phase 2 of the program commenced in the year 2009 and will end in December 2016. Project interventions include afforestation, agroforestry, and forestry management. Through PAREF, a list of suitable species for each intervention area was developed. Planting interventions of PAREF have predominantly used exotic species, as it is more cost effective than indigenous species. However, some native species have been used and acknowledged by the RWFA for their medicinal products and role in conserving biodiversity. The interventions of PAREF within the catchment located are predominantly in Ngororero and Rutsiro. The dominant species which have been planted are *Eucalyptus ssp*, *Alnus acuminata* and *Acacia melanoxylon* which adapt well in highland regions.

2.7.5 Rwanda Sustainable Woodland Management and Natural Forest Restoration Project (PGREF)

The overall objective of the Rwanda Sustainable Woodland Management and Natural Forest Restoration Project is to contribute to the reduction of deforestation and poverty in the Congo Basin. Its specific objectives are to:

- increase forest cover and improve the living conditions of forest-area dwellers; and
- create basic conditions that would win Rwanda eligibility for carbon market benefits and payment for ecosystem services.

The project was designed to be implemented between November 2011 and December 2015. Within the demonstration catchments, the project has been implemented in Huye, Nyamagabe, Nyanza, Ruhango,

and Muhanga i.e. largely within Nyungwe forest where forest degradation is at an advanced stage owing to poaching and the illegal felling of trees by the generally very poor dwellers near the area.

The direct project beneficiaries are: (i) 600 000 households that will be provided with forest and/or fruit trees seedlings; (ii) 400 vulnerable persons who will benefit from private micro-woodlands; (iii) 1 200 farmers who will be trained, 200 of whom will be supported to form community cooperatives (seven apiarian cooperatives and seven women mushroom growers' cooperatives); (iv) 24 technicians of RWFA and its partners who will receive further training under the project. The direct beneficiaries will also include all those who will have temporary employment during seedling tree production and planting, and implementation of the forest management plan.

2.7.6 Reducing Vulnerability to Climate Change by Establishing Early warning and disaster preparedness systems and support for integrated watershed management in flood prone areas (Rwanda LDCF)

The project "Reducing Vulnerability to Climate Change by Establishing Early Warning and Disaster Preparedness Systems and Support for Integrated Watershed Management in flood prone areas (Rwanda LDCF)" was implemented by the United Nations Environment Programme (UNEP) and the United Nations Development Programme (UNDP) in collaboration with the with the Government of Rwanda's (GOR) Rwanda Environment Management Authority (REMA). The project was implemented from 1 October 2010 to 31 December 2014, and received a no cost extension up to 30 June 2015 enable the completion of a few ongoing activities. The goal of the project was to contribute to climate change risk and flood disaster preparedness in Rwanda. The project had four components (1) Climate risk assessment and forecasting; (2) Climate change adaptation planning and response strategy; (3) Reduction in the adverse effects of floods and droughts; and (4) Knowledge of good practices to reduce vulnerability to climate change based on the Gishwati pilot.

Under component 1, a modern and fully functional Early Warning System (EWS) was put in place and is already delivering climate information and early warnings. In addition, the human (training) and institutional (Meteo Rwanda) capacity was strengthened to effectively utilise the hydro-meteorological network and to conduct climate risk assessment and forecasting. Cluster computers were installed in Meteo Rwanda and seven modern automated weather stations were put in place in the four pilot districts. These weather stations are fully operational. Through the LDCF project and co-financing from UNDP Africa Adaptation Program (AAP), a network of 22 automated weather stations was established across the whole country. A communication and outreach mechanism was agreed upon through which Meteo Rwanda would issue and send forecasts and warnings three times daily by email and SMS to stakeholders, districts and communities.

Under component 2, climate sensitive landuse plans were developed and District Development Plans (DDPs) of the four pilot districts (Nyabihu, Ngororero, Rubavu and Rustiro districts) were climate proofed. Under component 3, climate resilient land use practices were implemented in Gishwati region. A total of 1,373 hectares of degraded land was rehabilitated through tree planting, agro-forestry and establishment of graded and radical terraces. Land rehabilitation was also extended to river banks protection for river. The project put in place and demonstrated alternative livelihood projects, including, mushroom production, bee keeping, poultry and piggery implemented through community cooperatives. Under

component 4, village leaders, disaster management committees, communities and farmers were trained in climate resilient practices.

2.7.7 MINAGRI implemented Irrigation, land husbandry and water harvesting projects

Ministry of Agriculture and Animal Resources (MINAGRI) has implemented a number of programs such as the Rural Sector Support Project (RSSP), Land Husbandry Water Harvesting and Hillside irrigation (LWH) Project, Quick Wins Marshlands Development Programme (QWMDP) and Support Project to the Strategic Plan for the Agriculture Transformation (PAPSTA). The areas developed for irrigation by these projects are shown in Table 4.

The Land Husbandry, Water harvesting and Hillside irrigation (LWH) project is designed to increase productivity and promote commercial farming on the hillsides of Rwanda. The project is introducing sustainable land husbandry measures for hillside agriculture on selected sites in Rwanda, as well as developing hillside irrigation for sub-sections of each site. Appropriate techniques and technologies in construction and management of land have been demonstrated and appropriate land husbandry practices developed for both rain-fed and irrigated agriculture to enhance productivity of annual and perennial crops. Land husbandry practices on hillsides depends on slope categories i.e. soil bunds on 6-16% slope, terraces on 16-40%, narrow-bench terraces on 40-60%, more than 60% slope afforestation. The project uses community participation approach where community members are employed in different land husbandry activities. This has contributed to increased rural incomes. These activities can be up-scaled in other areas.

The Rural Sector Support Program (RSSP) is implemented to ensure reduced poverty in rural areas through increased agricultural production and income. The first phase of the project begun in the year 2011. Current funding arrangements are in place since then for 15 years.

2.7.8 Water supply infrastructure

Access to safe water within the catchment is low and ranges from 25% in Ruhango to 62.1% in Rutsiro (Table 10). Access rates are particularly very low in Ruhango, Huye, Nyanza, Karongi and Ngororero i.e below 50%. This is ironic given the abundance of water. The situation is attributed to poorly developed water supply infrastructure. Existing rural water supply infrastructure is dilapidated and needs to be rehabilitated. A new water supply system for Nyanza town has been constructed with support from LVEMP.

Table 10: Access to safe water (WASAC, 2015)

District	Current water coverage
Muhanga	51.8
Ruhango	25.9
Nyanza	46.9
Huye	35.2
Nyamagabe	52.3
Nyaruguru	38.4
Karongi	43.9
Rutsiro	62.1
Ngororero	29.3
Average	42.8

2.7.9 Early Implementation Projects under the Water for Growth Programme

An Early Implementation Project (EIP) is implemented from the start of the year 2017 in order to address urgent needs of the sector, ahead of the official development and endorsement of the Catchment Plan. In Upper Nyabarongo catchment, the targeted area is located around the Nyabarongo I Hydropower reservoir in Muhanga district (Mushishiro and Nyarusange sectors) and Ngororero district (Nyange and Ndaro sectors). The location and details of the interventions are illustrated in Figure 17 below.

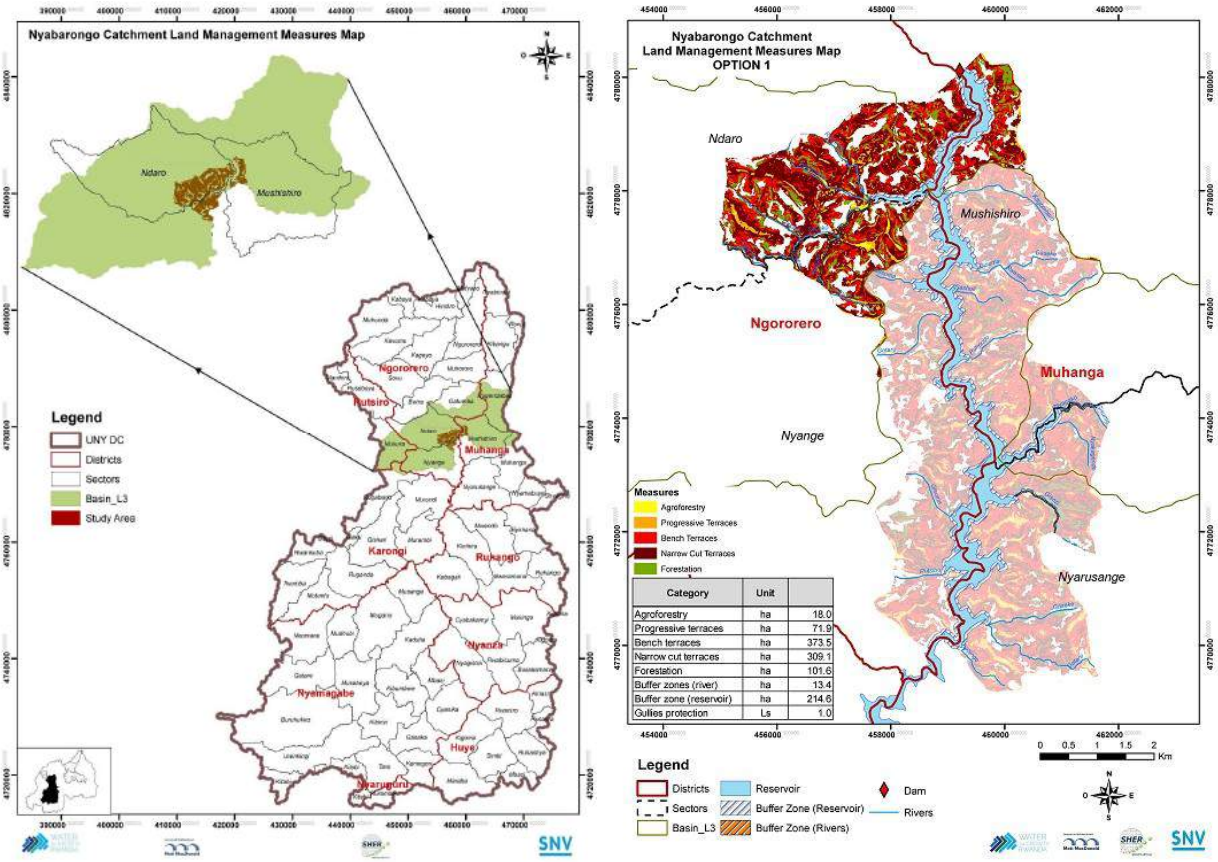


Figure 17: Location of, and Land management measures of the Early Implementation Project of the Upper Nyabarongo catchment

The EIPs are designed to reduce soil erosion by protection the land through interventions promotion of Agroforestry, construction of progressive, bench and narrow cut terraces, re-afforestation, river and reservoir buffer zone protection and gully rehabilitation. The total area to be covered by all interventions is equivalent to 1104.2 ha with 866.7 ha (78.4%) in Ngororero and 237.6 ha (21.2%) in Muhanga District.

3. The catchment management plan

3.1 Introduction

The current document constitutes the Catchment Plan – version 1.0 – for Upper Nyabarongo. In this plan, a detailed report is given of the methodology and process. Moreover, a preferred alternative is selected, based on a multi criteria analysis in which objective quantitative assessments are combined with expert judgement on criteria that are of a more qualitative nature. Version 1.0 of the catchment plan serves as the starting point for a year of intensive sector dialogues and district dialogues, geared towards the alignment between the numerous strategic plans that are being developed this year (5 year strategic plans of ministries and districts, 7-year Government Plan, EDPRS3, Vision 2050, and last but not least, this catchment plan). By the end of this year, all plans should be aligned properly, so as to arrive at a shared development agenda and joint performance contracts. The results of this alignment phase will be laid down in, among others, the Catchment Plan version 2.0.

This chapter presents the vision, objectives, and alternatives for the catchment plan, along with the report on and results of the decision making process, to arrive at a preferred alternative for the catchment plan. Where the definition of the programmes of measures under the alternatives at current is still sometimes abstract, this will be made more specific and detailed in version 2.0.

3.2 Vision, objectives and alternatives

3.2.1 Guiding values and principles

The catchment planning process is guided by the content of the 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[18]. Hence the following guiding principles are taken into account in the process of formulating the catchment plan:

1. Equity - This principle requires that economic, social, and environmental benefits accruing from management and development of the 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, as well as protecting and promoting the interests of vulnerable and socially marginalized groups.

2. 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.

[18] National Policy on Water Resources Management, 2011

3. Economic efficiency - Efficiency is one of the pillars in the Global Water Partnership's definition of integrated water resources management. Economic efficiency entails achieving the greatest benefit to the largest possible number of beneficiaries within the available financial and water resources.

4. 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).

5. Cooperation and participation - Cooperation and coordinated actions are the hallmarks of integrated planning. This principle recognizes 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 construct and outcomes.

3.2.2 Vision statement

Having a common vision for the future is an important first step in developing a catchment plan. 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 the prioritisation of water resources management issues through the lens of water for growth, development, and sustainability, leading to the formulation of a Catchment Vision. Achieving the catchment vision is the ultimate goal of the Catchment Plan. The vision statement has been formulated so as to ensure that it is broad to allow for wider interpretation and buy-in from various stakeholders. A generality has also been incorporated to give it a long lifespan and allow its constituent medium term plans to remain relevant to the long-term goal and objectives of the plan.

At the scoping workshop in May 2016 a broad range of catchment stakeholders reached a common understanding of the water and land resources issues and opportunities and put forward what should be addressed and achieved in the future for the Upper Nyabarongo catchment, taking the United Nations (UN) Sustainable Development Goals (SDGs) as a starting point (see Annex 6 for details). Summarizing the outcomes of the exercise, key aspects mentioned for catchment vision were the following:

- ecosystem and biodiversity management (= sustainable land management), focus on sustainable use of land and fresh water ecosystems, reduce disasters;
- water supply and sanitation, quality and management of water, focus on integrated water resources management;
- food security, focus on sustainable agricultural production.

Participants considered the value of ecosystem and biodiversity management as most important for the Upper Nyabarongo catchment vision. The main issues and opportunities are well addressed in this value. Prevention of deforestation, erosion and flooding are typical measures within ecosystem restoration and sustainable land management.

Experts from the IWRM Department and Water for Growth's consultants subsequently discussed and synthesized the workshop messages and outcomes in a series of work sessions, then formulated an agreed vision for the Upper Nyabarongo catchment as follows:

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.

3.2.3 Objectives

The overall objective for development of the catchment is as follows:

Effectively manage land and water resources to contribute to sustainable socio-economic development and improved livelihoods in Upper Nyabarongo taking into consideration downstream needs.

Specific objectives were also defined for the Upper Nyabarongo catchment, as listed below.

Specific objectives

1. improve water quality and quantity in water bodies and taking into account resilience to climate change in the catchment;
2. ensure equitable and efficient allocation of water resources to all users within the catchment taking into account downstream demands;
3. strengthen the water governance framework to ensure effective implementation of integrated programs;
4. reduce the pressure on natural resources by diversifying alternative livelihoods.

3.2.4 Alternatives

The catchment vision is intentionally aspirational and while it implies trade-offs, it does not indicate the desired state for which these catchments should be managed. In order to clarify possible interpretations of the vision statement, two distinct alternatives were formulated, reflecting different water resources management assumptions and principles.

Planning by Administrative and Sectoral Boundaries (PASB)

The first main alternative is basically a continuation of the current planning practice, which is largely sectoral defined and implemented at district level. Under PASB, all policies, plans, and programmes, as well as prevailing regulations, are implemented unchanged, without a clear IWRM approach. There is, as currently, limited enforcement of environmental legislation.

Planning by Catchment Boundaries (PCB)

In this alternative the only boundary that truly counts, is that of the catchment. Resources are managed in an integrated manner, largely within the confinement of the catchment. Walls between sector ministries or between districts are less relevant – these need to be overcome by joint planning and joint performance contracts, in order to arrive at win-win situations. This alternative concentrates on environmental protection and sustainable ecosystem services, improvement of livelihoods with diversified investments, and maximized exploitation of local potential socio economic opportunities. This alternative is supported by an improved, efficient water governance, comprising the institutional Governmental frameworks at local and national level, as well as the private sector and informal

constituents of water governance. PCB supports an integrated approach on agriculture, water, health, economic development (mining), rural electrification, forestry and land management.

Sub-alternatives or variations of PCB

In the assessment of alternatives for the catchment plan, several extra analyses were done to explore optimisation opportunities for a number of aspects (climate change adaptation, urban development, industrial development, irrigation development, landscape rehabilitation, water productivity and efficiency, and combinations thereof). The most promising combinations were included in the final multi-criteria assessment of alternatives.

3.3 Strategic framework for the development of programmes of measures

The vision statement and subsidiary objectives by themselves cannot bring about the desired change. Multiple and wide ranging actions are required to be taken by numerous actors over many years to deliver the envisioned state. To move from vision to actions, it is necessary to prioritize a limited number (typically three to ten) of core concerns around which to formulate actions. These concerns, which are variously referred to as strategic objectives, strategic areas, or key result areas, represent distinct but intricately interrelated facets of water resources management. In this plan, we refer to these core concerns as strategic areas. The strategic areas make it easier to set objectives for IWRM and develop strategies and specific projects to achieve the catchment plan objectives. The strategic areas group and categorise the issues being faced for water resource management and possible solutions.

By carefully re-examining all study assessments and reviewing the types of issues that arose under each, we can conclude that all catchment issues could be conveniently grouped into five broad areas. These are subsequently adopted as the strategic areas of the catchment plan for integrated management of land, water, and related resources.

The five Strategic Areas or pillars for the catchment plan are:

1. Environmental conservation and protection - This primarily focuses the management of streamflow, water quality, habitat and riparian zones related too riverine, wetland and land resources, to maintain important ecosystem services and biodiversity.

   Activities for the protection of environment (with an impact on water management, but also on water-dependent infrastructure like hydropower plants) such as rivers, lakes, wetlands, forests, and other natural ecosystems are included in this key strategic area. The investments required to protect critical watersheds from erosion (terraces, grass strips, gulley rehabilitation) are envisaged as well. These include investments for rehabilitation of already degraded environments (aquatic and terrestrial).

   Other infrastructure necessary for handling water related waste e.g. storm-water conveyance systems, sewers, and solid waste disposal facilities for existing and emerging urban areas are also envisaged in this strategic area.

2. Water resources development and management for social and economic growth - This primarily focuses on activities related to exploitation of water sources (surface and ground water) – that is increasing water availability to authorized users and improvement of how the infrastructure

developed in the process is operated and maintained. An example under this strategic area would be the increased investment for water supply infrastructure (irrigation facilities, micro hydropower plants etc.).

3. Water sharing for equity and development – This area is less important in a water-rich catchment like Upper Nyabarongo. It covers the process of establishing and protecting water rights and allocating water among competing uses and users, as well as setting priorities for water entitlement during times of shortage. Such allocations will be among sectors (e.g. irrigation, urban water supply, hydropower) or geographically (upstream versus downstream sub catchments). Gender equity is a key aspect of this strategic area. Last but not least, inter-generational equity requires attention, in order to safeguard water rights of future generations of catchment inhabitants.

4. Water governance – This primarily focuses on the management of institutional aspects to enable and facilitate the protection and sharing of water, including the more cooperative stakeholder framework. It also includes the alignment of legislation, policies, plans, and protocols that define the relationships among these organisations. Accordingly, the following activities may be envisaged: facilitating the catchment tasks force, capacity building, and operationalizing water user committees, land use management committees and institutions for participatory irrigation management, water user identification and facilitation to licence or acquire water rights as well as compliance to water permit conditions.

5. Disaster risk management – Within the context of Upper Nyabarongo catchment, the disasters identified are those related to occurrence of landslides and floods. Measures may include prevention, such as better land use planning (taking flood risks and risks of landslides into account) as well as mitigation measures, such as improved dissemination of early warnings to facilitate preparedness.

The vision needs to be supported by appropriate interventions in each of the key areas if integrated water resource management is to be implemented and the vision realised. The vision and strategic framework imply a balance between environmental protection and agricultural and urban development with a focus on the needs and aspirations of the catchment's residents. They highlight the need for adaptation and the possibilities of diversifying the economy through innovative energy and improved mining technologies.

3.4 Programmes of measures under the alternatives and variations

3.4.1 Programmes of Measures for PASB and PCB

The two main alternatives (PASB and PCB) comprise two different programmes of measures, which are presented in Table 11 and Table 12 respectively. Measures of PASB have been introduced in detail already in Section 2.7, as ongoing initiatives in the catchment. Measures of PCB are organised along the strategic areas, introduced in Section 3.3.

Table 11: Programme of Measures of alternative 'Planning by Administrative and Sectoral Boundaries' (PASB)

Measure	Location	Size / magnitude
Developing Terracing and agroforestry (physical only) by PAREF NL, LAFREC, FONERWA, LVEMP II and VUP, LWH/RSSP, ESIRU II, UNICOOPAGI and Districts	All 8 Districts	14,524 ha
Afforestation on the hillside by PAREF, LAFREC, LVEMPII and VUP	Karongi, Rutsiro,Nyamagabe Nyanza ,Huye and Ngororero Districts	973 ha
River buffer zone protection with bamboos and reads	Karongi, Ngororero Muhanga, Nyamagabe, Huye, Ruhango and Rutsiro	482.4 ha
Development and rehabilitation of Water supply treatment plants	Ngororero,Muhanga , Ruhango, Nyanza,	5 plants
Development and rehabilitation of various rural water supply systems by WASAC and MOUSECORE	Rutsiro, Ngororero, Nyanza, Nyamagabe	Beneficiaries not yet evaluated
Development and rehabilitation of various rural water supply systems by the Districts and WASAC	Karongi (in Murundi sector), Ruhango (in Byimana sector) and Muhanga (in Muhanga and Mushishiro sectors)	20 WSS in Ruhango, 3 in Muhanga and one WSS in Karongi
Development of rain water harvesting infrastructures at HH and public institutions	Muhanga, Ngororero, Rutsiro,Karongi,Ruhango and Nyamagabe	Households not yet evaluated
Develop infrastructure for marshlands and hillside irrigation	Muhanga (Shyogwe, Nyamabuye)	224 ha
Promote and disseminate alternative and efficient wood energy	Ngororero, Muhanga , Ruhango , Karongi, Nyamagabe and Rutsiro	% of hh to be evaluated
Protect natural forest with buffer zone demarcation	Rutsiro, Ngororero, Muhanga and Nyamagabe	209 ha
Develop various hospitality and recreation industries	Nyamagabe, Huye, Nyanza, Ruhango, Muhanga	Number of hotels to be constructed (TBA)
Develop Historical and Cultural heritage tourism	Ruhango, Nyanza, Ngororero, Nyamagabe, Karongi, Huye	Number of hospitality and recreative industries to be assessed
Develop Hydropower plants for electricity generation	Muhanga,Ngororero , Nyamagabe	… KW to be installed
Creation of off-farm jobs through vocational training skills	All 8 Districts	Number of off ram jobs created to be assessed
Protect wetland for nature and flood management	Muhanga, Ngororero, Nyanza, Nyamagabe and Ruhango	Area protected against flooding to be evaluated

Table 12: Programme of Measures of alternative 'Planning by Catchment Boundaries' (PCB)

Measure	Location	Quantity
1. Catchment rehabilitation and land conservation		
Improve farming methods for soil protection and conservation with Farmers Field school (FFS)	In all 8 Districts	Area (ha) and % of farmlands with improved farming methods using farmers Field School (FFS) to be assessed
Developing agroforestry & terraces or cut-off drains	In all 8 Districts	134,205 ha
Rehabilitation of old mining sites	Muhanga, Rutsiro Ngororero, Nyanza, Ruhango and Karongi Districts	Area to be assessed (ha)
Afforestation in line with District land use and Forest Master plans	All 8 Districts	61,056 ha
Implementation of model mining concepts	Muhanga, Rutsiro,Ngororero, Ruhango, Karongi,Nyamagabe and Nyanza	Concession (ha) of model mining concepts to be assessed
Rehabilitation of gullies	Muhanga,Ngororero,Karongi, Nyamagabe, Huye, Ruhango and Ritsiro Districts	95 ha
2. Floods control and adaptation to shortage of rainfall		
Roadside protection & road drainage	Nyamagabe, Ruhango, Muhanga, Karongi, Rutsiro and Ngororero Districts	Km and % road rehabilitated and protected with drainage facilities to be assessed
Development and extension of rain water harvesting and drainage infrastructures in settlement areas	Nyamagabe, Ruhango, Nyanza, Muhanga, Karongi and Ngororero Districts	% of residential houses and public building with rain water harvesting facilities (to be assessed)
Protect wetland for nature and flood management	Nyanza, Nyamagabe, Karongi and Muhanga	Area of wetland protected against flooding to be assessed
Relocation of households from high risk zone to IDP model villages	Nyamagabe, Ruhango, Muhanga, Karongi, Rutsiro and Ngororero Districts	Number (%) of households relocated from high risk zone to IDP model villages to be assessed
Construction of water ponds to collect rain water, water from road drainage and settlement sites.	Ruhango and Nyanza Districts	Area vulnerable to short rain irrigated
3. Promote alternative livelihoods around protected and demarcated areas		
River buffer zone protection with Gabions and bamboos	Nyamagabe, Nyanza, Ruhango, Muhanga, Ngororero, Karongi and Rutsiro Districts	1011 ha demarcated around rivers, reservoirs and wetlands
Protect natural forest with buffer zone demarcation	Rutsiro, Ngororero, Muhanga, Nyamagabe	Ha of Natural forest buffer zone to be assessed
Promote off-farm jobs to reduce the pressure on protected areas	Nyamagabe, Nyanza, Ruhango, Muhanga, Karongi, Ngororero and Rutsiro	Off-farm jobs created to reduce the pressure on natural resources

Measure	Location	Quantity
4. Improving the management of forest plantations to reduce deforestation		
Identify and disseminate efficient and alternative wood biomass energy	All 8 Districts	75 % of HHs and big communities with alternative and efficient wood energy (Improved cooking Stoves, biogas and Liquefied Petrol Gaz)
Support Districts to develop Distrcts Forest Management plans	All 8 Districts	All 8 Districts with Forest Management plans
5. Waste water discharge management, pollution control and cleaner production		
Develop and implement solid and waste water treatment plants	Muhanga, Ngororero Karongi,Nyanza and Ruhango	Number HHs with access too solid and waste water treatment plants and sewage systems in urban and rural areas (to be assessed)
Support industries and hotels to adopt resource efficient and cleaner production technologies	Muhanga, Nyamagabe, Huye, Nyanza, Ngororero and Ruhango	Average reduction of waste water from industries in % (TBA) % of processing industries and hotels adopting resource efficient and cleaner production technologies (TBA)
6. Water resources development, management, and sharing		
Delivering water use and abstraction permits	All 8 Districts	25% of water users with water abstraction permits
Implementation of the Water Supply Master plan	All 8 Districts	% oh HHs with access to safe drinking water
Develop infrastructure for marshlands and hillside rrigation	Muhanga, Nyamagabe, Karongi Ngororero , Huye Ruhango, Nyanza	Volume of water ponds and dams constructed (TBA) Command area for hillside and marshland irrigation from 2353.1 ha to 31.588 ha of potential
Construct infrastructure for electricity generation	Muhanga, Ngororero, Karongi and Nyamagabe	Quantity of Power generated (MW) from 33.61 installed capacity to the available capacity of … …MW Volume of water needed for electricity generation per day from 5,609,440 m^3 to …m^3
7. Development and implementation of a Water governance framework		
Improve the management of water resources	All 8 Districts	Functioning DHBCs and catchment task force % reduction of water related conflicts in the catchment (TBA)
Strengthen the capacity in key organizations to assume role in IWRM	All 8 Districts	% of relevant staff in local partner' institutions/catchment committees implementing IWRM principles (TBA)
Conduct and share studies on issues and best practices in the catchment	All 8 Districts	Availability of a database on catchment characteristics and shared with water MIS at central level

Measure	Location	Quantity
Construct Water monitoring stations installed and operational	All 8 Districts	Number of water monitoring stations installed and operational

3.4.2 Incorporation of alternatives and variations in water balance and allocation model

The following alternatives have been analysed in WEAP, the Water Evaluation and Planning model package used to simulate the water balance under different projections and alternatives. Results are presented and discussed for each demonstration Catchment. For a full description of the model, its inputs, and outputs, Water for Growth's technical report TR29 – Water Balance and Allocation Modelling can be consulted.

PASB: Planning by Administrative and Sectoral Boundaries

Continuation of planning and implementation as usual – no integrated water resources management or catchment planning and coordinated implementation. All sector ministries, agencies, and districts, as well as private sector and NGOs implement existing plans in relative isolation. Measures planned run into circa 2020 at maximum. Limited implementation and less coordinated alternatives are implemented. No specific catchment rehabilitation.

In WEAP implemented by: (i) no specific catchment rehabilitation will take place (slopes, infiltration capacity, soil water capacity unchanged), (ii) some minor water savings in irrigation (93% of baseline), (iii) some minor implementation of drought resistance crops (Kc 93% of baseline), (iv) minor savings in industry and domestic water demand (95% of baseline), (v) minor overall improvement of water productivity (5%), (vi) implementation of irrigation master plan by 50% in 2023, 100% in 2030 and even 50% more in 2050.

PCB: Planning by Catchment Boundaries

The catchment plans are developed in a participative and vertically and horizontally integrated manner, resulting in a coherent program of measures for each sub-catchment. Implementation is coordinated between implementing agencies, with support of the Catchment Coordination Office and overseen by RWFA and Catchment Task Forces. Potential maps are used to assess economic development potential.

In WEAP implemented by: (i) catchment rehabilitation will take place (more pronounced terraces, infiltration capacity and soil water capacity higher), (ii) water savings in irrigation (85% of baseline), (iii) implementation of drought resistance crops (Kc 85% of baseline), (iv) savings in industry and domestic water demand (85% of baseline), (v) overall improvement of water productivity (10%), (vi) additional water storage, (vii) implementation of irrigation master plan by 50% in 2023, 100% in 2030 and even 50% more in 2050.

PCB+: Variation of PCB, with elevated levels of water storage and water saving interventions

Further enhanced implementation of PCB, with a strong focus on innovations in water use leading to higher water efficiency and productivity in all sectors, leading to higher water availability for all sector. This aims in particular to meet the high water demands of a fully implemented irrigation master plan, but also to serve the water needs of e.g. industries.

In WEAP implemented by using elevated levels of parameters compared to the regular PCB, e.g. by more pronounced terraces, higher infiltration capacity and higher soil water capacity.

PCB-: Variation of PCB, with reduced irrigation development

Same as the normal PCB but here with limited implementation of the irrigation master plan (50%), to reduce the water demand from irrigation and the ramifications (water shortages) that a strong increase in irrigated area would have on future water availability for other users, as well as for irrigated areas.

In WEAP implemented by using same parameters as PCB, but with irrigation development of only 50% of the irrigation master plan (25% by 2023, 50% by 2050, and no further increase up to 2050).

Additional variations

In order to better understand the relative impact of the PCB Alternatives, additional analyses have been undertaken where only one component is considered and at a more pronounced implementation level:

- PCB_agr: PCB explored by focus on Climate Smart Agriculture only. Only the climate smart agriculture component of PCB is considered to be implemented and in a more intensive way;
- PCB_store: PCB explored by focus on additional water storage only, and in a more intensive way;
- PCB_irr: PCB explored by focus on water savings in irrigation only;
- PCB_ind: PCB explored by focus on water savings in the industrial sector only;
- PCB_cities: PCB explored by focus on water savings in the domestic sector only;
- PCB_wp: PCB explored by focus on increasing water productivity only.

3.5 Multi-Criteria Assessment and prioritization of the proposed alternatives

A multi-criteria assessment was devised to analyse and rank the results of different alternatives. The results of the WEAP simulations of the water balance were assessed along a number of objective, quantitative criteria, as calculated by the software. Weights were given to each criterion in a meeting with the catchment task force[19]. In addition, the alternatives were scored along four key criteria (ecosystem services, economic development, social development, and water governance / institutional development) using expert judgement. These criteria also received weights from the members of the catchment task force. Weighted average scores per alternative were compared in three groups, both for the water balance criteria and the additional key criteria, and a preferred alternative was selected. The three groups arrived at the same conclusion regarding the preferred alternative. In other words, there was consensus among the members of the catchment task force, and a preferred alternative was selected unanimously. The sections below provide a more detailed description of the assessment. The detailed results of one of the groups is included in Annex 5.

Results from the technical process of undertaking a water balance – that is, weighing up the available water resources against the water requirements, for a range of scenarios including the current and likely future situations are presented in this Chapter. The findings are interpreted and applied to Multi-Criteria Analysis (MCA) and expert judgement or stakeholder input to rank the preferred alternative for formulation of the catchment plan as explained in the subsequent sub-sections.

3.5.1 Reconciling water demands against water availability at different planning horizons

Three different types of projections were analysed: climate change, population growth, and macro-economic development. For each of these three Projections a three time-horizons were considered (2023, 2030, 2050). A “Future Medium” water stress scenario has been selected to interpret the findings since it is more likely to occur in the future. This scenario corresponds to medium changes in magnitude with respect to climate change, population growth and macro-economic development. The impacts of

[19] CTF meeting in Nyamagabe, 30 January 2017)

this scenario in terms of % change against the baseline are presented for three criteria. The evaluation criteria are water demand, water shortages (unmet water demand), number of water short months per year, peak flows and low flows are summarised in Table 13. The baseline is taken to be the withdrawals for the period 2009 to 2015.

Table 13: Impact on water resources for the "Future Medium" water stress scenario

Planning horizon (Year)	Water demand increase MCM	Water shortage (MCM/year)	Number of water short months per year (No.)	Peak Flow	Low flow
Baseline (2009 – 2015)	50	8	11	226	71
2023	167	42	11	227	66
2030	306	81	11	240	61
2050	747	170	10	293	51

Table 13 illustrates that water demands and shortages are expected to increase substantially by the year 2013 due to combined impact of population growth and economic development. Significant water shortages (unmet demand) are expected to occur progressively to the year 2050 as water demands increase (Figure 18).

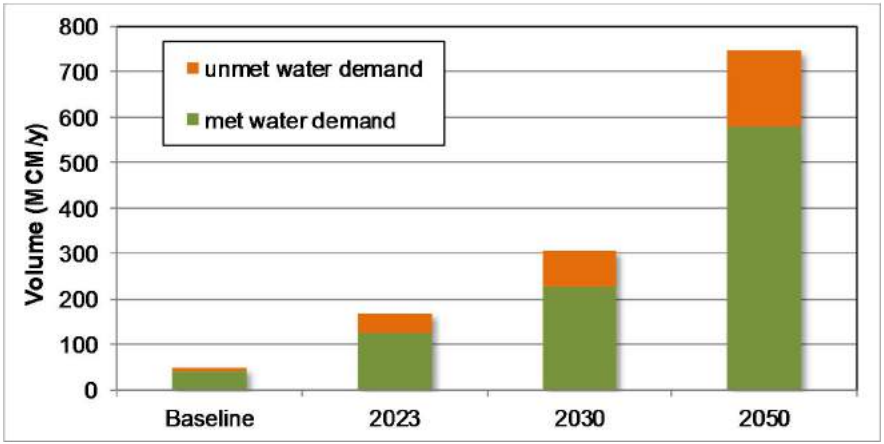


Figure 18: Met and unmet water demands (shortages) in the three target years, compared to the baseline (2015), based on the future medium projection

Peak flows will become higher due to the effects of climate change. At the same time will low flows are likely to be lower, leading to severe water shortages. Fast runoff is also likely to increase hence more erosion and increased flooding, are expected in the future.

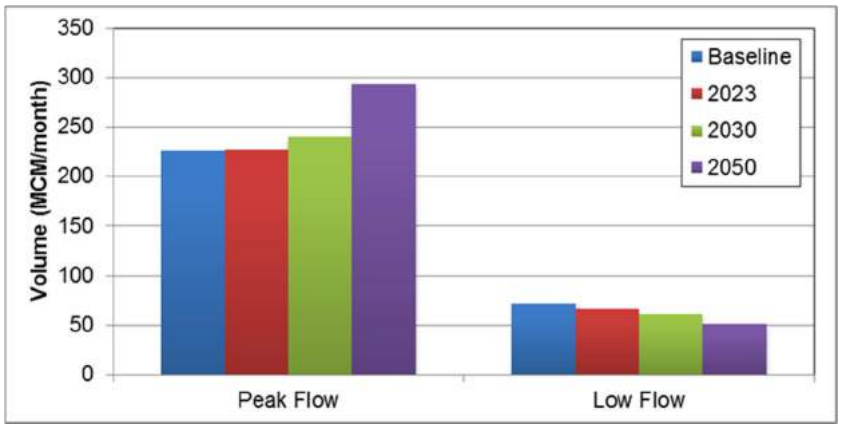


Figure 19: Simulated expected peak flows and low flows by 2050, based on the future medium projection

Two main planning alternatives (with pre-defined packages of measures) designed to address key issues and opportunities were analysed against the projections in Table 13. The first of these two is a continuation of Planning by Administrative and Sectoral Boundaries (PASB), often also referred to as business as usual. The second one is referred to as Planning by Catchment Boundaries (PCB). The PCB approach is further subdivided into selected sub-alternatives or variations (such as PCB+ and PCB-) to evaluate the effects of maximising certain interventions within this integrated package. Consideration of variations is intended inform decision making on the definition of a final 'preferred alternative'. The definition of the selected main alternatives and variations is provided in Section 3.4.2.

The effectiveness of selected alternatives in terms of mitigation or alleviation of the "Future Medium" water stress is summarised in Table 14 and illustrated in Figure 20, Figure 21, and Figure 22.

Table 14: Impact on "Future Medium" water stress scenario by selected alternative

Planning horizon (Year)	Alternative	Water demand (MCM)	Water shortage (MCM/year)	Mean outflow	peak flows	low flows
Future medium 2050		747	170	1524	293	51
2050	PASB	669	151	1612	306	56
	PCB	594	134	1706	320	61
	PCB+	459	102	1540	184	9
	PCB-	490	91	1777	328	65

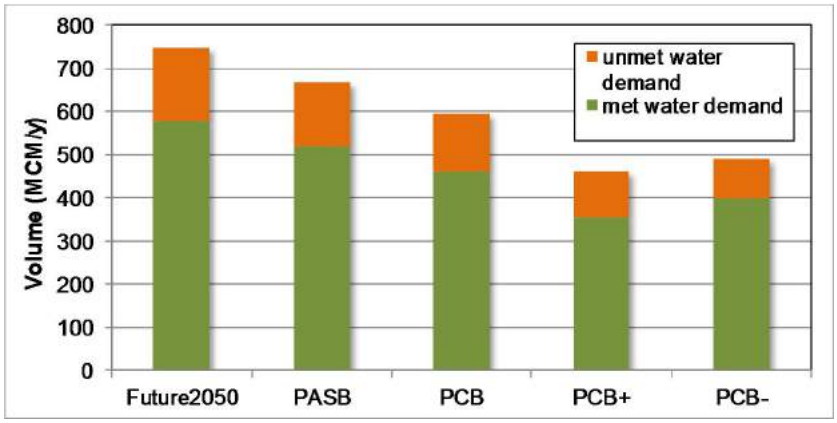


Figure 20: Impacts of implementation of various alternatives on met and unmet water demands (water shortages) based on the future medium projection for 2050

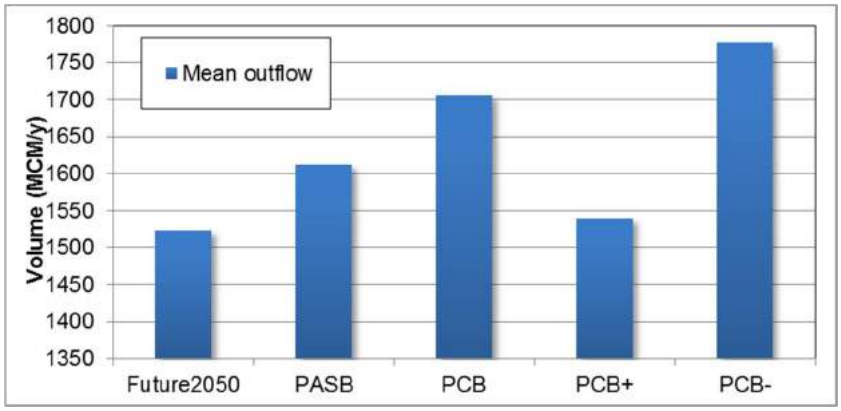


Figure 21: Impacts of implementation of various alternatives on mean outflows based on the future medium projection

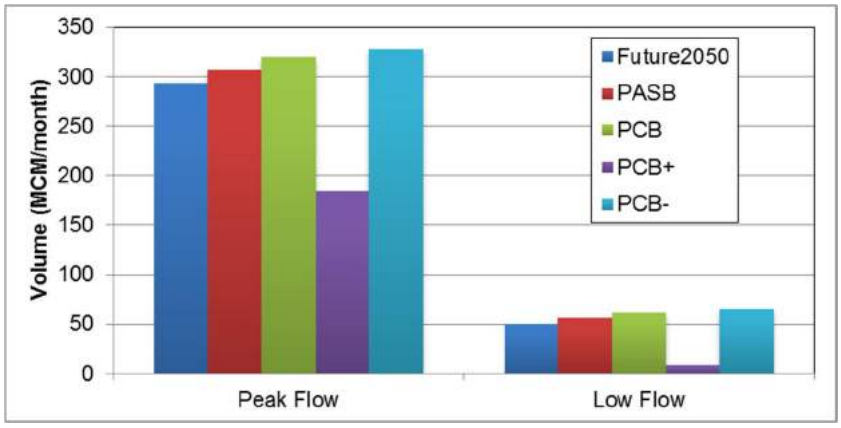


Figure 22: Impacts of implementation of various alternatives on peak flows and low flows based on the future medium projection

Alternative impacts:

- most alternatives have a positive impact on the water demand, water shortage, streamflow, and catchment hydrology;
- the alternative of Planning by Administrative and Sectoral Boundaries (PASB) is less effective compared to other alternatives, especially in the context of alleviation of water shortages and low flows;
- the alternative Planning by Catchment Boundaries (PCB), and its subs PCB+ and PCB- are the preferred alternatives. PCB- looks the most effective one, but is should be kept in mind that for this irrigation development is quite reduced, having impact on food security;
- PCB+ and PCB- are able to reduce projected water shortages by 40% to 45%.

3.6 The consensus catchment plan

The multi-criteria assessment resulted in the selection of the PCB- alternative as preferred alternative. The programme of measures of this alternative incorporated a large set of integrated measures, of which narratives are provided in the following sections.

It needs to be mentioned again here that the preferred alternative in this Catchment Plan version 1.0 serves as the starting point for detailed alignment between all stakeholders in 2017. The final programme of measures of version 2.0 will be the result of negotiations between stakeholders, and will therefore be more explicitly quantified and more precise in locations of measures.

3.6.1 Landscape rehabilitation, re-afforestation, and land husbandry

The core intervention of this catchment plan will be the intensification and diversification of agroforestry techniques; this will involve extending the diversity and intensity of agroforestry trees already used to stabilize the slopes of terraces and improve soil fertility, promotion of perennials and tree-crops (including tea, shade coffee, fruit trees, etc), intercropping or planting of in-field trees, and shelter-belts / live-fences. This will particularly promote the use of local species, such as *Podocarpus, Polyscias fulva, Entantophrama, Croton megalocarpus, Markhamia lutea, Vernonia Amydalina Mytragyna*, and S*ygygium*, in addition to exotics like *Alnus acuminata, Acacia Agustima* and Acacia *melanoxylon*.

Farmlands will be protected by construction of progressive and radical terraces, whereas wetlands and rivers will be protected by buffer zones constructed using vegetative bamboo and natural tree species. Many studies have demonstrated the effectiveness of vegetative buffers in reducing the concentration of nitrates, phosphorous, and pesticides from water running off cultivated fields. Concentrations of nitrogen trapped and assimilated by buffers or wetlands can be reduced by up to 94 percent before entering a stream. Phosphorus runoff can be reduced by 25–95 percent. 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. Figure 23 below illustrates the range of measures and scope over the spatial extent of the catchment.

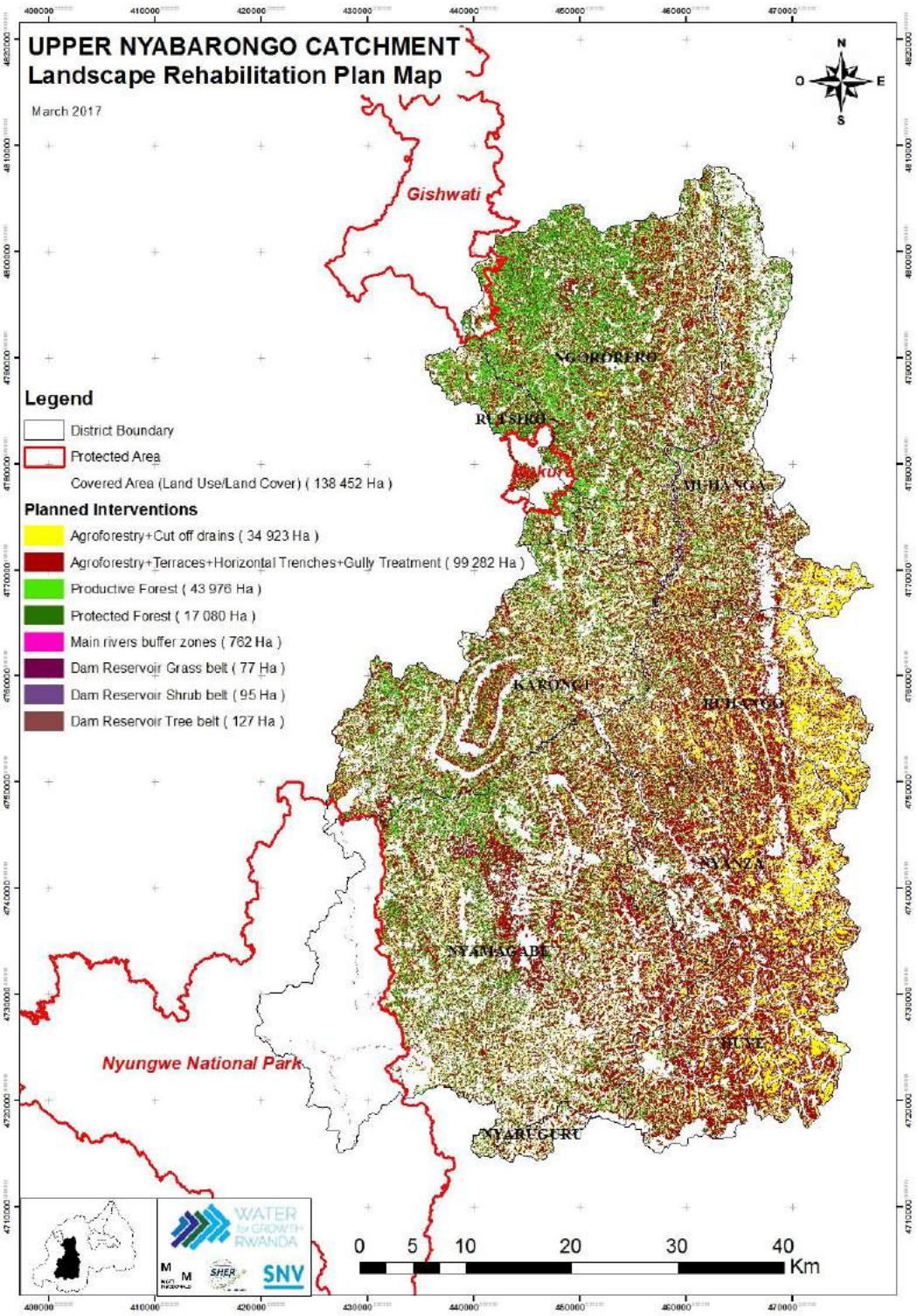


Figure 23: Landscape rehabilitation plan of the Upper Nyabarongo catchment (RWFA/IWRMD & W4GR, 2016)

3.6.2 Climate smart agriculture

Rwanda's climate change vulnerability originates in the mountainous character of the country with an inherent susceptibility to soil erosion, combined with a strong reliance on rain-fed agriculture. This sector represents 34% of Rwanda's GDP (2014) and employs 90% of its inhabitants (both directly and indirectly), leaving the country in a challenging position with regard to climate change adaptation. As the

temperature increases, Rwanda's historically predictable rainy seasons are becoming increasingly unreliable and short, resulting in more frequent droughts and higher intensity rains with the potential of causing progressively significant economic damage to crop yields and infrastructure.

Climate smart agriculture approaches are mainly covered under the term 'conservation agriculture' (CA). This approach to agricultural management is based on three principles: Minimum soil disturbance, ranging from zero tillage to a maximum of 20 to 25%; retention of crop residues or other surface cover; and use of crop rotations to reduce the build-up of weeds, pests, and diseases. The first two principles require a drastic adaptation of the current, traditional farming methods. For the third principle, as farmers in Rwanda often do not have enough land to rotate crops, intercropping is an option.

The benefits of this approach are with regards to climate resilience are:

- stable yields: Increased average yields in the long term due to the water and soil conserving effects of CA, which help to stabilize the crops against weather extremes;
- drought buffering: The approach increases soil water content through increased infiltration and a reduction of runoff and evaporation. Increased infiltration improves water use efficiency and buffers crops against drought;
- reduced field preparation costs: CA allows for timelier planting that supports successful harvest due to the reduction in effort associated with tillage;
- reduced soil erosion: Reducing tillage and maintaining soil cover with crop residues can reduce erosion by up to 80%. CA also generally increases soil organic matter in the top soil, along with an increase in soil biological activity and biodiversity;
- climate change mitigation: Under certain conditions, CA may contribute to climate change mitigation through carbon sequestration and reduced GHG emissions.

An additional approach that supplements conservation agriculture is the 'Push-pull-strategy', promoted in Rwanda's National Programmes of Action. This strategy is a sustainable pest management technique that introduces certain species of plants to the cropping systems, to control plant parasites and pathogens such as stem borers and *Striga* weed. For Rwanda, the plant species for this technique are

Napier grass (push) and Desmodium (pull) to manage pests in e.g. fields of maize, sorghum, millets and raid-fed rice. The technique works by planting the desired crop alongside a 'push' plant (Napier) that repels pests, and planting a 'pull' crop (*Desmodium*) around the perimeter to draw insects out of the plot. The *Napier* grass and *Desmodium* can additionally provide a continuous supply of cattle fodder. Both Napier grass and Desmodium have low water and nutrient requirements, making its implementation accessible even on uncultivated lands.

3.6.3 Alternative sources of energy to reduce dependence on biomass fuels

Biomass energy is predominantly used by at least 86% of households in the demonstration catchments. In the short-term, biomass energy will remain dominant for cooking and other household uses and in this regard, it is imperative that forests and woodlots be more productively managed and charcoal more efficiently produced. Table 15 below indicates the opportunities for enhanced management of forest plantations.

Table 15: Opportunities for improved management of forest plantations

Measure	Area (ha)
Improve management of existing eucalyptus woodlots.	58,695
Improve management of existing Pine timber plantations	6,716
Total	65,411

Other elements of Rwanda's Sustainable Energy for All Strategy interventions focus on efficient stoves and biogas digesters. The most widely used type of biogas digester in Rwanda is the fixed dome variety which comes in two sizes, 6 m^3 and 8 m^3 and costs around Rwf 800,000 and Rwf 900,000 respectively (US$ 1260 and US$ 1410). These systems require two cows to operate and provide 5 hours of cooking gas. The Government of Rwanda already offers a Rwf 300,000 (US$ 450) subsidy to encourage the uptake of biogas technology as well as subsidies for solar water heating systems. In addition to this, the intervention under the catchment plan will be to offer concessional loans to enable households to finance biogas digesters (existing loans are available at 13% interest from Bank Populaire) - low cost loans as well as a subsidy are already available for solar water heating systems. Local SACCOs will host the loan accounts.

Development of hydropower as an alternative clean energy sources to reduce dependence on fuel wood is a key element of the strategy to reverse deforestation. Sites for development of micro-hydropower projects have been identified under the Hydropower development master plan. The 36 sites within the catchment are presented under Annex 1, with most sites identified being rated between 50 kW and 1 MW. Development of these sites will support efforts to reach the set targets of 70% access to electricity by 2017/2018 and 100% by year 2020[20]. Technical and financial feasibility studies will be conducted and thereafter the sites can be tendered out to private developers. Initiatives elsewhere by SNV[21] to strengthen the capacity of local entrepreneurs to run or install such hydroelectric plants with a capacity of less than 50 kW will be replicated and up-scaled. A pilot pico-hydroelectric project is currently being implemented at Mutuntu site in Karongi District where the population had no access to electricity.

Specific activities of the initiative include:

[20] Rural Electrification Strategy, Republic of Rwanda, Ministry of Infrastructure, June 2016

[21] Rwanda Pico Hydropower Development (DPHER), The Netherlands Development Agency (SNV), 2016.

- trainings of local entrepreneurs in turbine manufacture and plants operations and maintenance;
- training on the dimensioning of turbines;
- support to obtain subsidies for pico-hydro equipment, e.g. from the IIF basket fund;
- assist entrepreneurs or village cooperatives to develop financial skills and business development plans.

The total cost of a typical pico-hydropower system and installation in Rwanda is estimated to be approximately $4,500[22]. The potential commercial market for off-grid hydropower plants in Rwanda with a generation capacity of 50 kW or less is promising, owing to strong demand for electricity services by sector offices, schools, health centres, local businesses, cottage industries and of course village communities. In these areas, the demand for different electrification alternatives remains high, with pico-hydropower being the least-cost solution for electrification with around US$ 1.1/kWh compared to diesel generator sets or solar PV systems (US$ 6 and US$ 1.2 per kWh respectively)[23]. Due to the topography found in most of the catchment, characterised by deep valleys and steep hills, a low-head pico-propeller turbine, is not an option for Rwanda. The topography is more suitable for medium to high head pico- and micro-hydro run-of-river schemes. The turbine types used for such schemes are mainly turgo, pelton and cross-flow. In contrast to the off-the-shelf propeller turbines, these types need to be designed and installed by skilled and experienced people and made to the specifications of the site. Figure 24 below illustrates system components for a suitable hydropower package (2kW) from Vietnam. The system components shown are a turbine, generator, load controller, ballast load and installation materials.

Figure 24: System components of the Power Pal T5 Hydropower package Vietnam (Meir and Fisher, 2011)

3.6.4 Resilience to landslides, early warning systems for floods and green villages

Areas most prone to incidences of floods and landslides within the catchment are identified per district[24] and indicated as Rutsiro, Ngororereo, Karongi, Nyamagabe, and Ruhango. Implementation of activities to reduce vulnerability to Climate Change by Establishing Early warning and disaster preparedness systems in these areas is a measure proposed in this catchment plan. The Ministry Disaster and Refugee Affairs (MIDIMAR) has identified the number of households living in high risk areas in each of the districts, these are shown.

Table 16 below. These households have been tagged for resettlement in *imidugudus* where the target is to have 65% of the rural population living in such grouped settlements by the year 2020. This will enable

[22] Scott Gladstone *et al.* (2014). Implementing pico-hydropower sites in rural Rwanda. Procedia Engineering 78 (2014) 279 – 286.

[23] Meir and Fisher (2011). Assessment of the Pico and Micro-Hydropower Market in Rwanda.

[24] National Contingency Plan for Floods and Landslides, Rwanda. Ministry of Disaster Management and Refugee Affairs, 2014.

the Government of Rwanda to achieve economies of scale with respect to providing them with basic services such as access to electricity, water, and sanitation and to reduce pressure on fragile ecosystems. Catchment specific figures for persons eligible for resettlement in land slide and flood prone areas are not readily available but exposure[25] estimates are available by district including analysis by gender, age, and levels of poverty).

Table 16: Exposure assessment in very high risk areas in Upper Nyabarongo that are eligible for resettlement in *Imidugudu*

District	Population exposed to landslides (No. of persons)
Nyamagabe	58,695
Ngororero	42,066
Rutsiro	39,976
Muhanga	31,905
Karongi	28,674
Total	201,316

The Rwanda Government supported Green villages[26] typically serve 100 households, with a typical household having 5 persons. This implies that a total of 400 model villages are required to re-settle population exposed to landslides. Integrated Development Program (IDP) activities/ interventions are proposed to target exposed households in these districts as follows:

- resettle households in flood and landslide prone areas to ensure that they would not be at risk of future occurrences and reduce human pressures on the damaged ecosystem. Utilize IDP model green villages to do so;
- within the green villages, demonstrate energy and water self-sufficiency through the generation of biogas for cooking, lighting from consolidated domestic human and livestock waste, rainwater harvesting for domestic use, and small-scale and household level irrigation for food production;
- building capacity to integrate climate change considerations into the management (see final bullet point) and operation of planned pico-hydropower generation facilities;
- raise opportunities for off farm employment in model villages for women and youth;
- implement climate resilience building interventions against flooding, like spate irrigation (diverting short duration floods, reducing their energy and spreading water gently over the (agricultural) land; diversion ditches (diversion of overland flows away from exposed slopes to safe discharge points like stabilized outlets or a sediment basin); stilling basins (used to dissipate the energy of water exiting the spillway of a dam during peak flows reducing erosion and dam damage); and detention basins (where excess water can be stored during peak flows to protect against erosion, and if the ground layer is made sufficiently permeable these basins also serve as groundwater recharge points, building drought resilience in the area).

3.6.5 Increase and sustain 100% access to safe water and sanitation facilities

An investment plan to support achievement 100% of water supply coverage by 2017 and to ensure 100% sustainable water supply over a planning horizon of the next 5, 10, and 15 years have been elaborated by

[25] MIDIMAR (2015), The National Risk Atlas of Rwanda.

[26] A Toolkit for the Development of Smart Green Villages in Rwanda, REMA, 2015

Water and Sanitation Corporation[27] (WASAC) in the Upper Nyabarongo Catchment. The proposal of solutions to attain 100% coverage so as to guarantee sufficient water provision are as follows:

1. rehabilitation of all existing water supply infrastructure by the year 2020. A breakdown of the rehabilitation requirements for each district is elaborated in separate volumes of the Master Plan. The total cost is 3.5 billion RwF. These costs may be funded from revenue generated by WASAC or subsidies/grants from MININFRA;
2. development of new water supply infrastructure i.e. by phased implementation of four (4) new water supply projects that have been designed to provide all the new water demands by way of constructing new water treatment plants, transmission mains, storage reservoirs and gravity distribution mains. The estimated costs and key components for each of the new projects are tabulated below.

Table 17: Cost estimates for new water supply infrastructure (WASAC, 2015)

Name of the project	Major components	Preliminary cost estimate (USD)
Rwimbeho – Mwogo	- Population served: 238,825 inhabitants - Two intakes, each abstracting 876 m^3/h - Combined treatment plant capacity - 35,220 m^3/day - Distance from electrical transmission line to WTP = 3.7 km - 2 main storage reservoirs @ 4,500 m^3 - 5 km (DN 250) transmission mains, DI - 3 Pumps, Q = 438 m^3h, H = 221m, Power rating = 672 kW - 3 Pumps, Q = 438 m^3h H = 513m, Power rating = 1560 kW - 2 stand by generators - 7 distribution tanks of various sizes - 61.6 km of distribution mains in uPVc & DI - Proposed implementation period: Phase I: 2021 – 2025 Phase II: 2026 - 2030	37,318,772
Mbirurume	- Population served: 138,335 inhabitants - One intake, abstracting 860 m^3/h - Treatment plant capacity - 17,192 m^3/day - Distance from electrical transmission line to WTP = 2.4 km - 1 main storage reservoir @ 3,500 m^3 - 2.3 km (DN, 250) transmission mains, DI - 3 Pumps, Q = 430 m^3h, H = 455m, Power rating = 195 Kw - Booster pump, Q = 50 m^3h H =220m, Power rating = 30 Kw - 1 stand by generator - 5 distribution tanks of various sizes - 46.6 km of distribution mains in uPVc & DI - Proposed implementation period: 2016 – 2020	16,271,252
Rukarara	- Population served: 61,453 inhabitants - One intake, abstracting 392 m^3/h - Treatment plant capacity - 7,840 m^3/day - Distance from electrical transmission line to WTP = 3.9 km - 1 main storage reservoir @ 3,500 m^3 - 5.4 km (DN 200) transmission mains, DI - 3 Pumps, Q = 430 m^3h, H = 455m, Power rating = 195 kW - Booster pump, Q = 50 m^3h H =220m, Power rating = 30 kW - 1 stand by generator - 5 distribution tanks of various sizes	13,827,736

[27] WASAC, 2015. Study for elaboration of National Water Supply Masterplan for Nyabarongo upstream basin

	- 29.2 km of distribution mains in uPVc & DI Proposed implementation period: 2016 – 2020	
Muhembe – Nyamwotsi	- Population served: 236,009 inhabitants - Two intakes, each abstracting 1,037 m^3/h - Combined treatment plant capacity - 41,440 m^3/day - Distance from electrical transmission line to WTP = 7.5 km - 2 main storage reservoirs @ 3,500 m^3 - 6.5 km (DN 300) transmission mains, DI - 4 Pumps, Q = 345 m^3h, H = 760m, Power rating = 2,737 kW - 4 Pumps, Q = 345 m^3h, H = 514m, Power rating = 1,851 kW - 2 stand by generators - 8 distribution tanks of various sizes - 61.7 km of distribution mains in uPVc & DI - Proposed implementation period: Phase I: 2016 – 2020 Phase II: 2021 - 2025	44,359,575
	Total investment cost – new water supply projects	111,777,335

The investment proposal also includes activities for

§ institutionalization of sustainability mechanisms e.g. Water User Committees and District Water Boards to ensure functionality of new infrastructure, improve operational efficiency and reduce water losses;

§ protect drinking water sources through regulation, which involves effluent control in water bodies and land use management to influx of sediment loads. Enact effective supporting water safety plans;

§ develop and implement water source water protection plans including measures for enforcement and drinking water monitoring. Protection plans should address storm water management, private and community sanitation systems, erosion and waste water discharge, solid waste management and disposal. Terms of Reference (ToR) for development of water source plans are outlined separately under Chapter 6 of the National Water Supply Masterplan for Nyabarongo upstream basin.

No funds have been earmarked by WASAC for these investment requirements. These may be a topic for discussion in the catchment plan sector dialogues in 2017.

3.6.6 Rational implementation of the irrigation masterplan to boost agricultural production

The Irrigation masterplan elaborates irrigation plans for each district within the catchment. Figure 25 on the next page illustrates the spatial extent of potential irrigable areas.

The potential irrigable areas are consolidated and outlined below (Table 18). The total irrigation potential has been estimated to be 33,328 ha. However, as confirmed by the members of the catchment task force, the implementation degree of the Irrigation Master Plan is preferably contained to about 50%. In version 2.0 of the catchment plan, the exact locations and sizes of irrigation schemed to be developed, need to be specified.

Table 18: UNY maximum catchment irrigation development opportunities (50% to be selected)

Potential command areas linked to water sources	Area (ha)
Marshland development command area	9,840
Dam/multi-purpose reservoir command area	7,440
Groundwater command area	8,894
River command area	7,154
Lake command area	-
Total	33,328

Expansion of irrigated areas is associated with development of multi-purpose reservoirs. Table 19 below shows a potential irrigation development of 5,711 ha from development of 21 multipurpose dams/reservoirs. The dams require detailed feasibility studies to determine the total cost implications and their impacts on increasing access of water to livestock and utilization for aquaculture.

Table 19: Potential irrigation development from small multi-purpose reservoirs in Upper Nyabarongo catchment

ID	X coordinate	Y coordinate	Catchment area	Command area (Ha)
SB20	474730.51	9785087.79	2960	170
SA066	442503.08	9788202.06	4084	354
SA022	459006.69	9786850.46	2440	325
SA053	455504.66	9770979.82	1136	324
SA023	466254.21	9765813.76	5088	303
SA089	461388.00	9760826.00	594	265
SA024	459107.74	9757409.32	1948	105
SA025	468739.70	9758088.68	2606	318
SA091	464688.00	9754513.00	2400	249
SA078	473005.11	9754057.75	1284	218
SA056	446641.30	9756009.51	3436	347
SA046	446396.46	9748222.25	1902	290
SA031	458870,84	9747790,63	1786	67
SA033	465820.85	9738563.97	1364	95
SA047	437462.08	9736057.62	2173	345
SA051	461314.80	9733517.22	2018	396
SA039	472201.13	9736119.45	2037	362
SA048	433375.81	9730834,53	8365	320
SA050	453147.69	9731224.04	1490	305
SA038	459272,26	9728376.55	2045	212
SA036	460062.34	9721634.69	2436	341

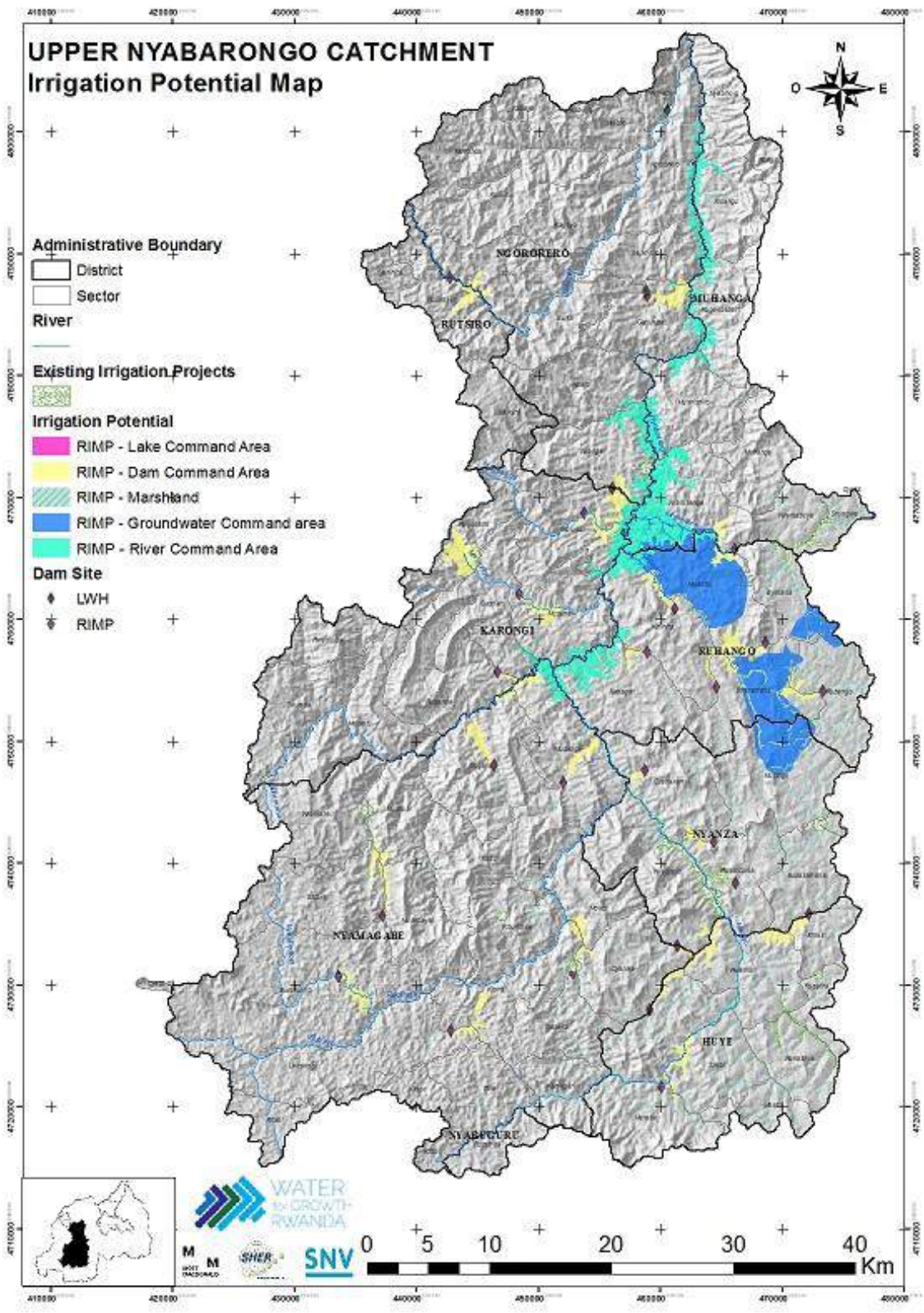


Figure 25: Potential irrigable areas in Upper Nyabarongo catchment

3.6.7 Diversification of rural incomes to alleviate poverty

Rwanda's Vision 2020 is to achieve a GDP per capita of $900 by 2020. This requires a real growth rate averaging 8.1 per cent per year comprising annual industrial sector growth of 12 per cent, services sector

growth of 8 per cent and agricultural sector growth of 6 per cent. These projections assumed at the time that population growth would remain at a modest 2.78%.[28] Actual growth figures should be analysed to reflect on achieved growth figures. These inputs are expected to lead to the key outputs of diversification of livelihoods through promotion of industry such as mining, textiles, pharmaceutical industry, hides and skin processing, dairy products, beekeeping, horticulture and fresh fruit production to reduce dependence on traditional rain-fed agriculture, create more jobs and reduce poverty. Development of these sectors entails the implementation of activities of the mining strategic plan, processed fruit and vegetables strategic plan and the bee keeping strategic plan.

Horticulture, fruit, and vegetables

Development of land required for commercialisation of crops such as cassava, fruits and vegetables is a viable option in the land and water management task. It is estimated that 860 ha are required to develop the horticulture sector in Rwanda, mostly driven by large scale private sector development, with a capacity to create 5,800 jobs[29] (the strategy dates back from 2006 – a fact check may reveal actual achieved numbers and may inform future decisions). Specific examples of sites in advances stages of development are illustrated below in Figure 26.

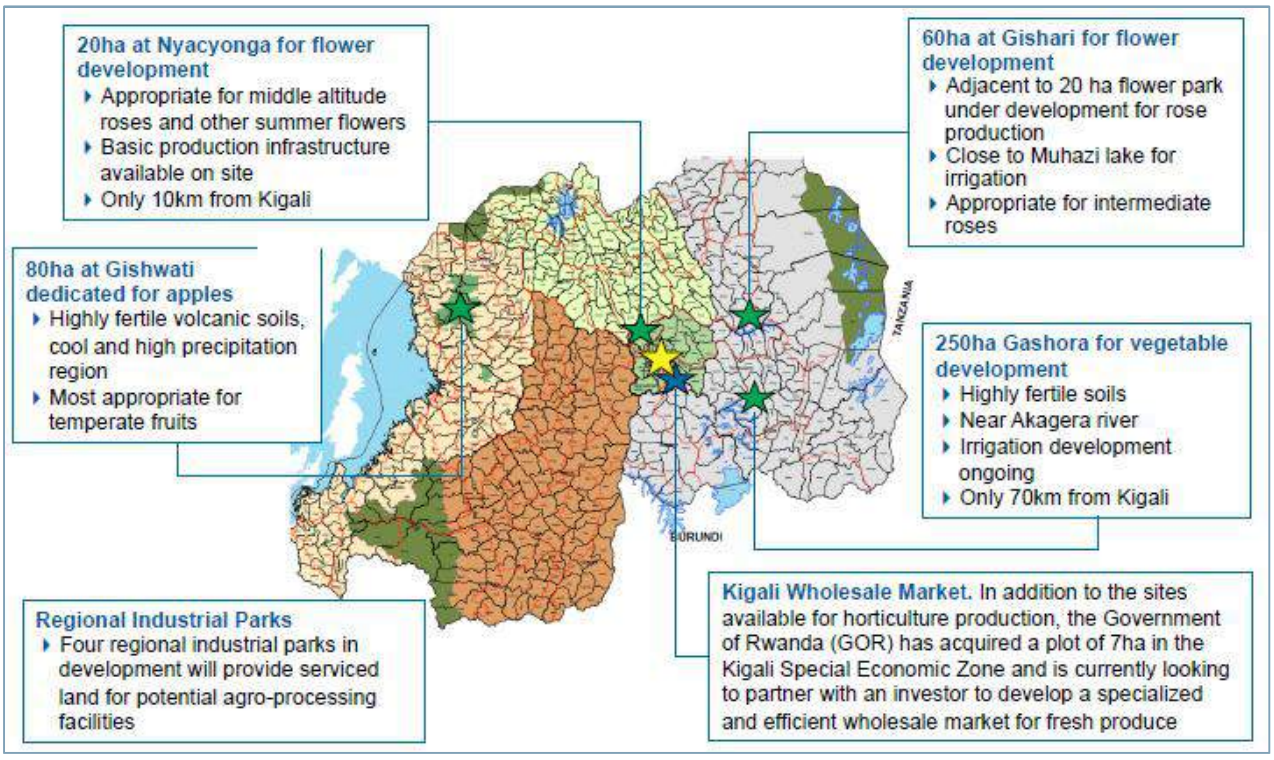


Figure 26: Sample sites for investment opportunities in Rwanda's Horticulture sector (Source: RDB)

Additional sites can be developed and provided with irrigation infrastructure.

[28] Rwanda Industrial Master Plan 2009 -2020

[29] Horticulture Strategy, MINAGRI, 2006.

Bee keeping

Productivity and production of bees have sharply increased and consequently improved rural incomes in areas with marginal land for agriculture. Bee keeping activities have been modernised following the development of a strategic plan[30] document and issuance of guidelines[31] to support utilization of modern equipment and infrastructure for production and processing. The strategic plan aims to contribute to the mechanisms of increased production, sustainable linkages with markets, partnerships with support institutions, well managed beekeeping infrastructures and a well-established domestic and export market for beekeeping in Rwanda. Key elements of the strategy involve mobilizing women and youth, to start beekeeping businesses (modern bee farming techniques, wax processing techniques). The establishment of at least 1 demonstration apiary in each of the demonstration catchments for use as decentralized training facilities is a viable intervention measure. Each of the demonstration apiaries will have at least 20 modern hives (10 Langstroth and 10 Kenya Top Bar) and 10 traditional hives. These apiaries will be used for decentralized training and knowledge development for rural beekeepers by master beekeepers in the districts. Accompanying accessories to include smokers, hive tools, bee-suits with veils will also be supplied to serve these demonstration centres. To enable bulking of bee products by producers in the selected areas, collection centres with adequate facilities for primary processing of bee products will be established by cooperatives.

Fisheries and fish farming

Aquaculture presents a significant opportunity to increase water and land productivity in Rwanda and enhance incomes of rural communities where reservoirs, dams or rivers with sufficient quantity exist to support fish production systems. However, increased depletion and degradation of the fisheries resources as well as highly polluted rivers due to high sediment loads have resulted in diminished fish capture and supply in Rwanda[32]. The Master plan for Fisheries and Fish Farming outlines an action plan to develop the best aquaculture production systems for the various ecological regions in Rwanda. In this plan, cage production is identified as the major option to commercialise aquaculture in Rwanda in view of the constraints imposed by scarcity of land. Cage fish culture is the raising of fish in containers enclosed on all sides and bottom with mesh material that secures the fish inside while allowing relatively free water exchange with the surrounding environment. In this system, fish is raised in low cage water volumes typically 4 m^3 at optimum high stocking densities of 300 – 500 individuals with expected harvest weights from 150 – 250 kg of fish per m^3 of cage. The zones found to have moderate to high potential for cage culture within the demonstration catchments are along the shores of Lake Kivu in Rutsiro and Karongi (Figure 27). Each of these districts should develop at least 5 lake based fish farms over the period of implementation of this catchment plan.

Other locations with potential for cage production are dams and valley tanks that are more than 5 metres deep (Table 20).

[30] National Beekeeping Strategic Plan Document, MINAGRI, 2007-2012.

[31] National Beekeeping Guidelines, MINAGRI, August 2009,

[32] Masterplan for Fisheries and Fish Farming in Rwanda. MINAGRI, Inland Lakes Integrated Development and Management Project (PAIGELAC), 2011.

Table 20: Opportunities cage fish farming in dams/reservoirs (Masterplan for Fisheries and Fish Farming, 2011)

No.	Name of the Dam	District	Sector	Surface area (m^2)	Average depth (m)
1	Nyamagana	Nyanza	Busasamana	63,000	6
2	Agasasa	Nyanza	Kibilizi	65,250	6.5
3	Nyarubogo	Nyanza	Kibilizi	60,000	5.9
4	Misizi	Muhanga	Shyogwe	60,000	6.4
5	Aidr	Muhanga	Shyogwe	60,000	6
6	Rugeramigozi	Muhanga	Shyogwe	60,000	6.8
7	Base	Ruhango	Bweramana	60,000	6.3

Figure 27: Floating fish cage farms on Lake Kivu

Opportunities for tank based aquaculture production (Figure 28), where fish is reared in tanks supplied with clean water have been identified along several rivers flowing from the hills in the districts of Ngororero, Ngororero, Karongi, and Nyamagabe. Since these regions are characterized by high altitude, cold tolerant fish species such as trout are recommended. Useful guidelines on how to farm trout, design of structures for water management and economic calculations of investment and production have been issued by the FAO[33].

Figure 28: Rainbow trout farming in water tanks (FAO, 2011)

Another option is to promote the development of Aquaculture Parks within the catchment. Aquaculture parks are concentrations of fish production units in suitable watersheds that are well supplied with water; with appropriate environmental conditions for culture of the target species in terms of

[33] Small-scale rainbow trout farming. FAO, 2011.

temperature, soil types, and terrain/topography. Aquaculture parks are planned akin to the industrial parks concept. Areas around Rukarara River in Nyamagabe district have potential for aquaculture parks.

Special economic zones and industrial parks

The Government of Rwanda has identified special economic zones (SEZ) and industrial parks as an effective tool for investment promotion. However, in order to be effective, SEZs and industrial parks will need full infrastructural support for water and solid waste management, as well as to pass stringent environmental requirements. Aggressive promotion of industry and mining to create more jobs and achieve a GDP per capita of $900 by 2020[34] requires a corresponding need to adopt a policy for environmental sustainability of industry. The measures required to do so are outlined in the following paragraphs.

3.6.8 Enhanced regulation of the mining industry

Mining and quarrying activities within the catchment are generally characterized by widespread reliance on traditional mining methods involving use of simple manual tools with devastating environmental consequences. In response to these challenges, the Department of Geology and Mines introduced the model mine concept which has a stringent criterion at acceptance level above 60% on:

1. compliance with the legal framework and contract obligation;
2. developing a safety, health and environment policy;
3. developing a mining plan based on sound mineral resources estimation;
4. developing a safe and secure mine with proper extraction methods;
5. optimizing mineral recovery by using the appropriate equipment;
6. develop a solid waste and water management approach, including water conservation, water harvesting, no silting of surface water and no hill erosion;
7. an approved Environmental Management Plan with a post closure rehabilitation plan.

However, there are significant shortfalls in technical capacity which constrain the departments of IWRMD and Geology and Mines within MINIRENA to control pollution from various sources within the catchments, and enforce compliance with environmental regulations and standards. There is also an acute shortage of skills and personnel to effectively engage with the private mining companies. In addition, there is a need to clarify the roles and responsibilities of the districts in the regulatory framework. The critical areas for intervention include:

- drafting, negotiating, and enforcement of mining contracts;
- setting regulatory standards and enforcing them;
- ensuring environment sustainability in mining;
- recruit and train more mine inspectors and develop RWFA and Mining Authority capacity to train artisanal miners to upgrade existing practices in line with international standards;
- rehabilitate degraded landscapes and ecosystems modified by mining and quarrying activities in accordance with pre-established rehabilitation plans;
- treat and safely dispose of all top soil, sludge, waste water and tailings generated from mining sites;
- ensure that all mines design and construct tailings disposal facilities;
- strengthen the monitoring and regulation of mining companies, including the introduction of an information management system;

[34] Vision 2050, under development, aims for an upper middle income of $4,617 (MINECOFIN, January 2017)

- § strengthen the capacity of REMA and RWFA -Geology and Mines Department and district environmental officers to ensure compliance of mining companies to environmental regulations, decommissioning and mine closure procedures;
- § ensure that all mines have qualified environmental managers.

3.6.9 Waste water discharge management, pollution control and cleaner production

Inventory of sources of pollution

To identify the need for pollution control measures, and to assist pollution control regulators i.e. REMA and RWFA in targeting the most significant problems, and propose suitable pollution control measures, a knowledge of the source and type of pollutant is necessary. The sources of point source pollution in the catchment have been mapped and illustrated as Figure 29.

Cleaner production

Given that a reliable inventory of point pollution sources is available, the most logical approach is to prevent the production of wastes that require treatment. Thus, approaches to cleaner production from industry that focus on wastewater minimisation, in-plant refinement of raw materials and production processes, recycling of waste products, should be promoted and adopted. For example, whereas in a conventional tanning process for tanneries 20-40 per cent of the used chrome is lost in the wastewater, in a waste minimisation process 95-98 percent of the waste chromium can be recycled. Examples of waste recycling methods in Rwanda include the making of briquettes from bio-waste.

Similarly, Sulphur dyes are a preferred range of dyes in the textile industry, but cause a significant wastewater problem hence necessitating end-of-pipe treatment technology. To avoid capital expenditure for wastewater treatment, alternative methods are available where hydrol, a by-product of the maize starch industry is utilized with minor adaptations in the textile dyeing process[35]. The introduction of hydrol does not involve any capital expenditure and has been demonstrated to reduce sulphide levels in the mill's wastewater from 30 ppm to less than 2 ppm.

The Pilot Project on Cleaner Production that was implemented by Rwanda Environment Management Authority (REMA) in partnership with UNEP in 2005 demonstrated that there is a significant potential for efficiency improvement within existing industries. Lessons learnt from the Pilot Project need to be taken stock of and activities up-scaled in the four demonstration catchments. Such activities can include the introduction of an environmental reporting requirement for industries and businesses covering basic data on the volume of resources consumed and waste generated and discharged including air emissions. Another key intervention that is applicable is to expand and extend the series of industrial training that led to the development and implementation of cleaner production programmes to known sources of point source pollution in the catchment (Figure 29).

[35] WHO, 1997. Water Pollution Control - A Guide to the Use of Water Quality Management Principles.

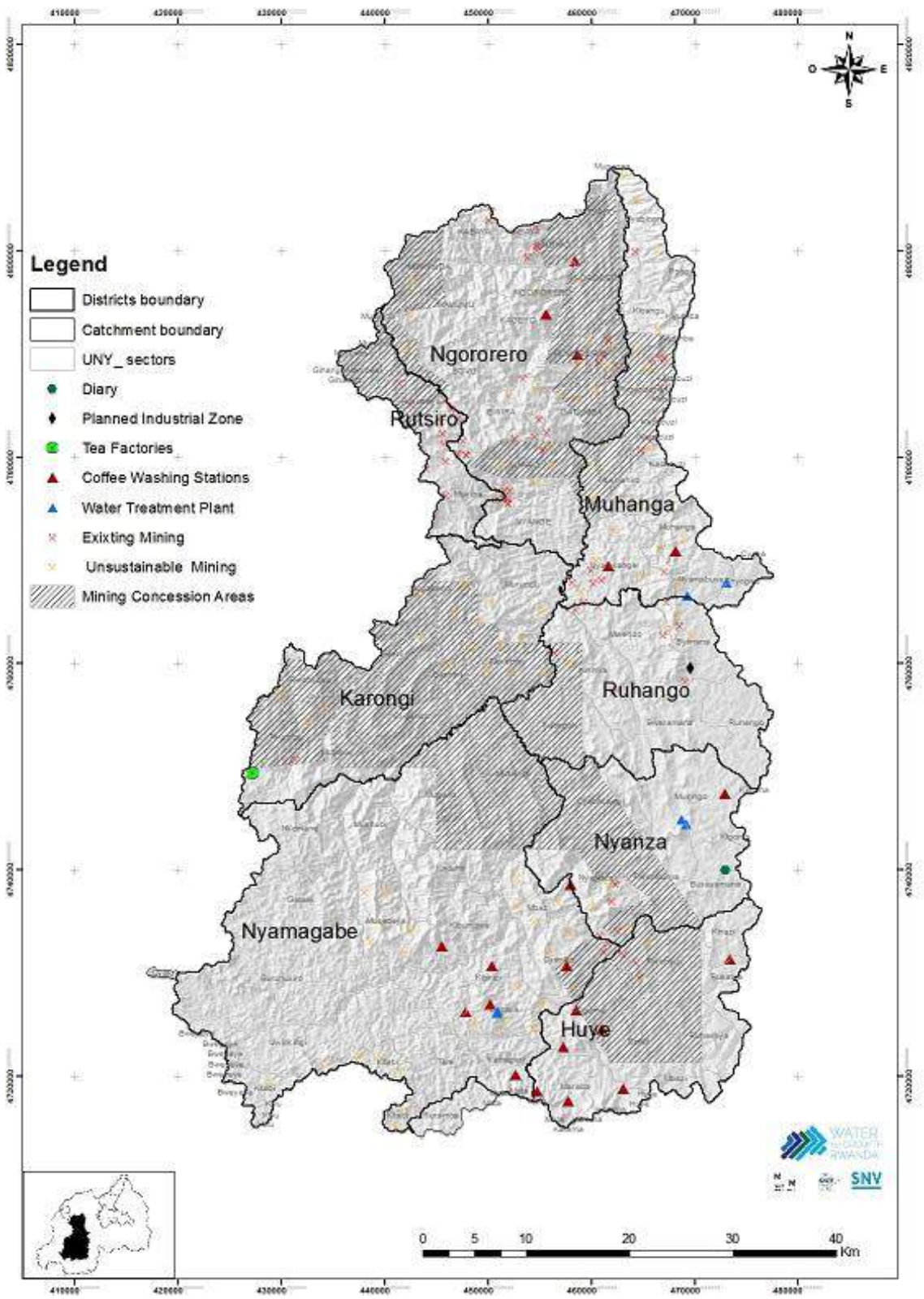


Figure 29: Point source pollution sources of the Upper Nyabarongo catchment

Effective regulation

Realistic standards and regulations for waste water discharge should be enacted. A waste water permit system, and systematic monitoring of water quality in rivers should be introduced. Codes of good agricultural practice that address the causes of water pollution from agriculture, such as type, amount,

and time of application of fertilisers, manure, and pesticides, can give guidance to farmers on how to prevent or reduce pollution of water bodies. These pollution control measures should be promoted at the lowest appropriate level i.e. districts and catchment offices. Attempts to implement the polluter pays principle should include financial charges for industrial wastewater discharges and special taxes on pesticides. The regulatory framework should be strengthened by improved collaboration between REMA and RWFA. A key issue in respect of point source discharge control is the ability of REMA & RWFA to take enforcement action against the discharger when the conditions of the wastewater discharge permits are breached. Legal provisions vary but these should include issuance of violation notices or a prohibition notice requiring the polluting activity to stop, and finally legal action. On the other hand, REMA and RWFA can consider to provide incentives to those industries which are reducing their pollution and environmental pressure through efficient utilization of resources. This capacity needs to be developed.

Many countries have established water quality management schemes for catchment management of surface waters based on classification schemes. The classification systems are typically established on the basis of the water quality requirements for a particular use. For example, industries are routinely not permitted to discharge any effluent in stretches of rivers classified in “Class A” - waters for use as drinking water source, without conventional treatment and/or disinfection. Similar regulatory frameworks could be established in Rwanda.

3.6.10 Water allocation

Water permits

Current and potential water users will need to apply for a permit to use water, for which they will be charged. Each application will be evaluated against this allocation plan. Successful applicants will be issued water permits and Watershed Management Officers will check that permit holders are using the correct quantity of water for the correct purposes in agreed upon ways.

Water conservation and demand management

Uncertain water availability and a climate characterised by recurring droughts and high intensity rains causing flash floods, provides strong motivation for the irrigation sector in Rwanda to strive for continuous improvement in water management. To help ensure the long term viability of irrigated agriculture, increased insight into the performance of the various water management and irrigation systems is needed, together with the development and adoption of strategies, tools and guidelines to improve performance. However, adoption of best management practices depends to a large degree on incentives, especially at the individual or farmer level. If reasonable incentives are not in place, adoption of even the best tools and guidelines will likely be limited. Therefore, an integrated Water Conservation and Demand Management (WCDM) strategy is needed which addresses both tools and guidelines for field level irrigation water management, and also policy and institutional arrangements which provide positive incentives for the adoption of best management practices.

Tools and methods for field scale irrigation management

One way to determine how good irrigation hardware is performing is to have the system evaluated by a Mobile Irrigation performance evaluation Laboratory (MIL). The data and information acquired using a MIL can be used to calculate ‘Irrigation Engineering Performance Indices’ (IEPIs). One such IEPI is the Distribution Uniformity, or DU, which is a performance index that describes how uniformly or non-uniformly water is applied. The DU of applied water can have significant effects on irrigation performance

because even if the timing and average magnitude of water applications is well matched to crop water demand and soil water storage capacity, non-uniformity results in some areas receiving relatively higher water applications and other areas receiving relatively lower water applications. Excessive runoff and deep percolation losses are likely on the areas receiving the relatively higher water applications and reductions in crop yield can be expected on the areas receiving the relatively lower water applications. Depending on how well an area is drained, reductions in crop yields can also occur on the areas receiving excess water.

MILs also check numerous other aspects of a system hardware, from the suction arrangements of a pump through to the performance of emitters in the field. Measurements including: operating pressures, nozzle wear, emitter flowrates and power consumption, are all aimed at ensuring that the system hardware is performing according to design specifications and accepted standards[36] (Koegelenberg and Breedt, 2002). Whilst such measurements are valuable in their own right, use of a systems simulation model to translate MIL data/information into associated impacts on crop yields and water use and then relative profit margins, increases the value of a MIL evaluation considerably. The role of a MIL in a more complete systems evaluation which uses a systems simulation model[37] to translate MIL information and data into predicted impacts on crop yields, water use and thereby profitability, is illustrated diagrammatically in Figure 30.

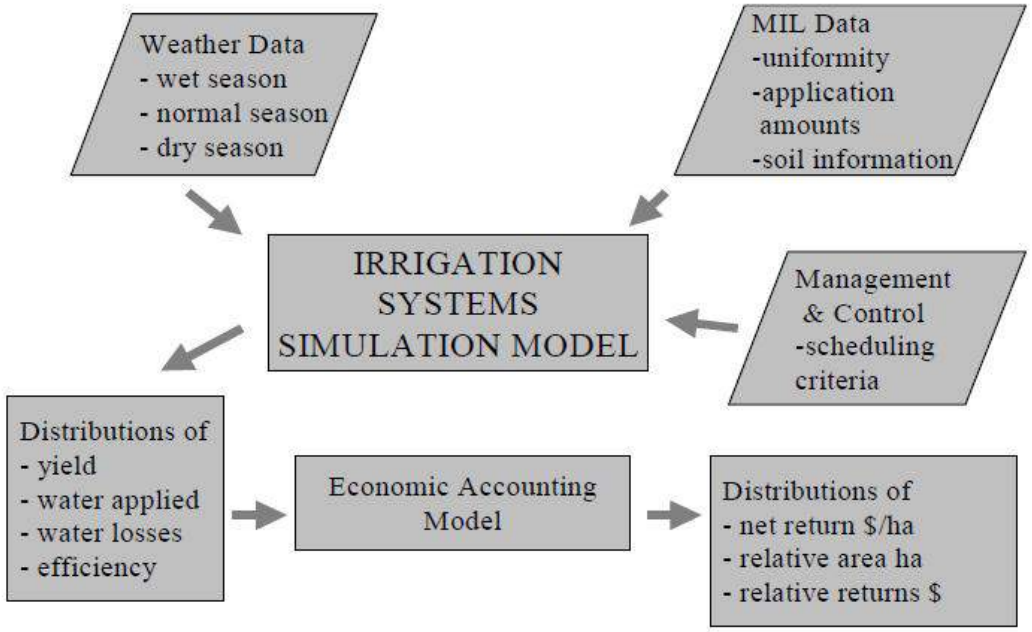


Figure 30: Proposed methodology for evaluation of existing irrigation and water management systems (Lecler, 2003)

Such methodologies are capable of revealing many areas in which the design, maintenance and operation of the system hardware could be improved, resulting in higher land and water productivity.

[36] Koegelenberg, FH, and Breedt, HT. (2003). Manual for the Evaluation of Irrigation Systems. Agricultural Research Council – Institute for Agricultural Engineering, Pretoria, South Africa

[37] Lecler, NL. (2003). A model for the evaluation of irrigation and water management systems in the Lowveld of Zimbabwe I: model development and verification Proc. S. Afr Sug Technol Ass, 77 pp 322-367.

Institutional arrangements for water allocation and management

Since the irrigated agricultural sector uses a major portion of the available blue water resources, facilitating gains in efficiency in this sector is a vital strategic issue. Water allocations can be instituted by volume per time unit, issued at an estimated level of assurance. To prevent conflicts where upstream users may, on occasion, pump a river dry in low flow periods even although the amount pumped may be less than their license entitlements, incentives for individual water use sectors to implement effective water conservation and demand need to be put in place. Detailed water allocation management will be required in dry seasons.

3.6.11 Strengthening of water governance

Catchment Coordination Offices

To ensure closer working relations with the Districts and the Catchment Taskforces (which under the new water law will become Catchment Committees), as well as to offer more access to information to the public, it was proposed under the institutional strengthening component of Water for Growth Rwanda, to establish sub offices or coordination organs of the IWRMD in the field, each dealing with a single catchment. The catchment coordination office will be instituted at the most suitable district headquarters in the catchments, and staffed by the watershed management officers (IWRMD), program officers (ISU) and a few additional staff. The office would then engage in activities such as secretarial support and strengthening of CTFs, District authorities and eventually the District Hydrographic Committee. De-concentration of some IWRM related activities from the centre (RWFA) to a level closer to the districts can also be facilitated in the long-term. These can be envisaged as improved communication, assistance with filling out and completing permit application forms, continuous update of databases for water use and closer interaction and participation in current district planning procedures.

Water User Associations

Water User Associations (WUA) have an important part to play in the process of management, decision-making and administration. The users directly participate in, and are responsible for, water supply and distribution in their own farming area. WUAs need to be supported at formation stage and nurtured through gradual building of capacity to undertake the following activities during implementation of the catchment plan:

- registration of WUAs;
- management, operation, and maintenance of water supply and irrigation schemes;
- water source protection;
- gender responsive design of WUA;
- assist in resolving conflicts over water use in consultations with the Catchment Coordination Offices and/or decentralised MINAGRI staff;
- identify and adopt appropriate Benchmarks for irrigation water use and water management in the WUA area. The primary benchmarks for irrigation water use are firstly the crop water requirement of a specific crop (ETcrop) in a specific area at a specific time of year. The ETcrop benchmark can be used to calculate the irrigation water requirements for a specific crop in a specific area and at a specific time of year by adjusting the crop water requirement for appropriate irrigation efficiency factors such as leaching requirements, irrigation application efficiency, effective rainfall and reasonable transmission losses (mainly evaporation). This Benchmark is a management tool for decision-making within a WUA to calculate the expected irrigation water requirements and irrigation scheduling for the WUA as a whole;

- develop a Water Account of the WUA's water resources and uses for auditing purposes. The Water Account is essentially a record of data for water abstracted and supplied by the WUA. Automatic registering flow control valves, pump records, parshall flumes or weirs can be used to support measurements;
- develop access to subsidies and grants.

3.6.12 Summary of program of measure under the preferred alternative (PCB-)

The summary of interventions under each objective and strategic area is summarized under Table 21.

Table 21: Programme of measures under the preferred alternative (PCB-)

Catchment Specific objectives	Components	Integrated Activities	Key partners
Improve water quality and quantity in water bodies and taking into account resilience to climate change in the catchment	1. Catchment rehabilitation and land conservation	1. Restore and protect degraded hillsides of sub catchment to reduce soil erosion and enhance resilience to climate change with: - agroforestry/cut of drains and horizontal trenches 34,923ha, - agroforestry, progressive terraces, and horizontal trenches on 35,283 ha, - agroforestry, radical terraces, and gully treatment on 93,999 ha - horizontal trenches in existing forests on 10,254 ha, - forest plantations on 43,976 ha and - natural forests restoration on 17,080 ha 2. Adopt appropriate land use and agricultural practices to minimise erosion on all farm lands and enhance agricultural productivity 3. Improve rangelands through restoration of vegetative cover, introduce improved forage species. 4. Regulate mining activities and implement model mining concept. 5. Rehabilitation of gullies with biological measures	RWAFA, MINIRENA, LVEMPII, MINAGRI, Communities, Districts
	2. Disaster risk management and water storage for multipurpose use (small scale irrigation, domestic use)	1. Put-in place an effective disaster preparedness plans for floods and landslides. 2. Prepare designs and construct appropriate structural protection works in place to minimise the physical impacts of land slides 3. Design 8 model villages to resettle affected population from effects of floods and landslides 4. Protect feeder roads with drainage facilities and develop water collection and storage infrastructure (10 small dams) for small scale irrigation (5,711 ha) and domestic use.	MIDMAR, MININFRA, MINIRENA, MINAGRI
	3. Waste water discharge management, pollution control and cleaner production	1. Develop and implement solid and waste water treatment plants 2. Support industries and hotels to adopt resource efficient and cleaner production technologies	MININFRA, MINICOM, REMA (LVEMP III)
Ensure equitable allocation and efficient use of water resources to all users within the catchment taking into account downstream demands	1. Water source protection	1. Protect river buffer zones, springs and dams with trees and grass to increase the discharge for domestic water supply	MINIRENA, MININFRA, Districts
	2. Water resources infrastructure development and management	1. Promote programmes for harvesting storage and use of rainwater. 2. Prepare feasibility studies for 11 multipurpose reservoirs or dams. 3. Implement the masterplan for water supply encompassing 4 bulk water reservoirs which	MININFRA, MINIRENA, WASAC, NGOs,

Catchment Specific objectives	Components	Integrated Activities	Key partners
		ensures all people in the catchment to have access to adequate water supply and sanitation. 4. Improve operational efficiency and reduce water losses (unaccounted for water). 5. Improve water management of the constructed systems. 6. Rational implementation of the irrigation master plan (50% of 31,588 ha.) 7. Prepare feasibility studies for 10 micro hydropower plants.	Districts
Reduce the pressure on natural resources by diversifying alternative livelihoods	1. Diversification of rural income to alleviate poverty	1. Reduce the demographic pressure on natural resources by diversifying community livelihoods' (men, women, and youth) by setting up beekeeping, horticulture, and fruit farms around Natural forests (Nyungwe, Giswhati and Mukura) and river buffer zones 2. Increase the water productivity stored in the dams to set- up tank based aquaculture production units at identified locations starting with the two-common species of Tilapia and African catfish and Trout. 3. Construct 7 cage fish farms in dams with a depth exceeding 5 m. 4. Provide hands on training for fish farmers and integrate crop and livestock production. 5. Provide vocational training and business planning to the population (men, women, and youth) around protected areas to innovate off farm jobs	MINAGRI, MINIRENA, MINICOM, WDA, BDF, SACOOs
	2. Protect natural resources to maintain biodiversity and ecosystem services	1. Protect river, reservoirs, wetlands buffer zone with grass, shrub, and trees belt on 1061 ha 2. Protect natural forest with trees belt on 99.2 ha 3. Implement a payment for ecosystems services as an incentive for farmers to implement conservation measures.	MINIRENA (RWAFA, REMA), WASAC, REG, Districts
	3. Improve management of existing forests	1. Support Districts in developing Districts Forest Management Plans 2. Improve the management of 65,411 ha. of forest plantations 3. Promote diversification of alternative sources of energy (methane, biogas, improved cooking stoves, liquefied petrol gas, hydropower) by subsidies and loans to reduce the use of biomass wood energy	MINIRENA, Districts
Strengthen the water governance framework to ensure effective implementation	1. Institute and operationalize the Catchment Office (CO)	Institute a catchment co-ordination office to provide all stakeholders with opportunity and forums to participate meaningfully in the planning and management of the water resources of the catchment.	MINIRENA, Districts

Catchment Specific objectives	Components	Integrated Activities	Key partners
of integrated programs	2. Institutional strengthening and Community Empowerment	1. Defined responsibilities and working partnerships with other stakeholders for the catchment. 2. Put in place effective regulatory (licensing) mechanisms for mining activities, surface and groundwater utilisation and waste water discharge, 3. Raise the level of awareness of local communities about conservation, utilisation, and protection of natural resources (including their rights and responsibilities) in the catchment. 4. Put in place enabling conditions (institutional, financial and capacity) for local community involvement in provision of local water supply and sanitation services, watershed management and waste management 5. Strengthen the capacity in key organizations to assume the role in IWRM 6. Support Districts and central institutions to mainstream priorities of the approved catchment plan in the District Development plans, sector strategic plans and annual work plans. 7. Support the operationalization of catchment management committees. 8. Implement the capacity building plan relevant to IWRM in local organisations	MINIRENA, Districts, CTF
	3. Water sharing	1. Clearly define water rights for all authorised water users, 2. Resolve all conflicts over utilisation of the water resources of the catchment quickly and satisfactorily, 3. Prepare a framework where economic returns from water used in productive activities is improved 4. Provide adequate water sharing for ecological maintenance (environmental flows), for example, minimum dry season flow to support riverine habitats, recreation areas and ensure correct functioning of protected wetlands.	
	4. Regular Update of water Management Information System (MIS) with data, information and DSS	1. Design and implement effective data sharing arrangements among agencies within the catchment and with central agencies. 2. Mainstream the use and maintenance decision support tools (WEAP, GIS, DSS,) 3. Design research programs and fund them to fill gaps in knowledge about water related processes and scenarios. 4. Install, rehabilitate, and operationalize water monitoring stations	MINIRENA

3.7 Budget estimates and available financing options

3.7.1 Cost-Benefit Analysis of main alternatives

An initial overview of investment costs and benefits (expressed as Financial Internal Rate of Return (FIRR) and Net Present Value (NPV) was developed for the agricultural and industrial measures in the main alternatives PABS and PCB, and for variation PCB-. The draft results are provided in Table 22. Within these sub-programmes of measures, the highest FIRR rates are calculated for hillside (pumped) irrigation, using high value crops, and for forest plantations.

Table 22: Cost-Benefit Analysis of main alternatives

Parameter	PABS	PCB-	PCB
Agricultural Areas & Industrial (Q)	100,286	106,735	102,021
Investment Costs 2017-2023 (RWF Billion)	54.77	71.93	89.50
FIRR for Catchment Measures (%)	23	25	28
NPV (RWF Billion)	111.01	118.21	125.11

3.7.2 Financing options and prioritization

Finances for the catchment plans are to be sources from an IWRM Investment Fund (IIF), which can function as a Basket Fund to be fed by different sources e.g. GoR, donors, international climate funds and others as part of its bilateral development cooperation on IWRM. The GoN is willing to contribute to this and has reserved an amount of EUR 18 million for the period from 2016 to 2019, to be used for investments in 4 Demonstration Catchment Areas (DCAs) in Rwanda. The IIF will be established and managed by the GoR under MINECOFIN. The responsibility will be delegated to the Director General of the Rwanda Water and Forestry Authority (DG RWFA).

Given the limited amount of funds currently available, it is necessary to prioritise and implement a limited number of measures in an integrated manner and demonstrate the implementation in micro-scale catchment level hotspots. Selection of the hotspot high level priority level was guided by findings of the Sediment Finger Print studies which indicated that most sediments are generated within the level 3 and 4 catchments immediately up stream of the Upper Nyabarongo hydropower reservoir (Figure 31). These are Secoko, NNYU Middle and Nyagako. These areas are characterized by large swathes of unprotected agricultural land with several unsustainably operated mining sites and large potential for issuing future mining concessions. Similarly, comparably high volumes of sediment are generated further upstream on River Mwogo but these could be controlled using check dams and sedimentation basins.

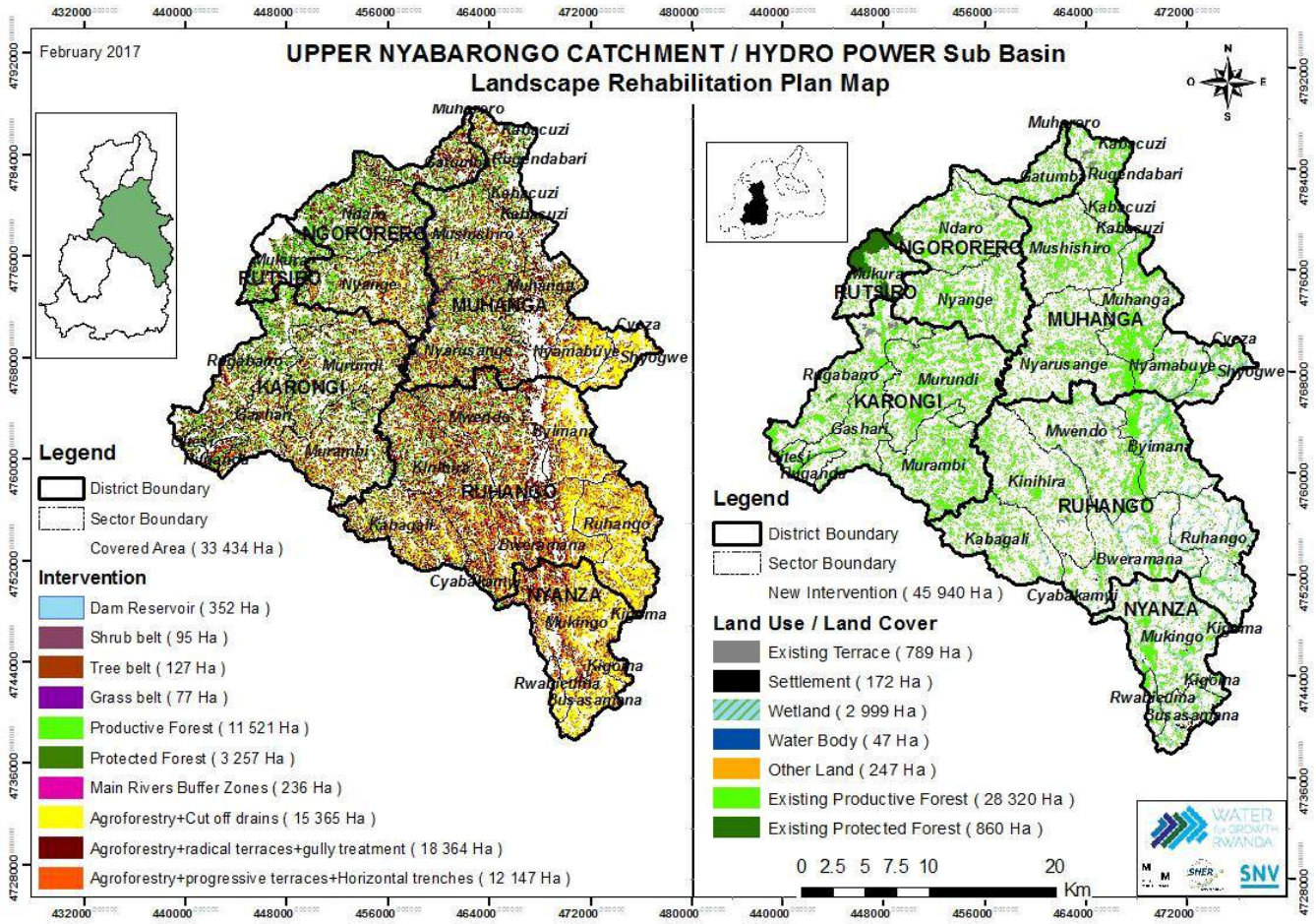


Figure 31: First priority areas to be rehabilitated upstream of upper Nyabarongo dam

Implementation of the programme has already commenced with the Early Implementation Project for Landscape Rehabilitation in Ngororero.

3.7.3 Time frame and phasing of activities or program of measures

Implementation of the programme of will commence as soon as possible. Some implementation projects have even already started (like the Early Implementation Project for Landscape Rehabilitation in Ngororero and Muhanga). Some activities such as instituting and operationalisation of the catchment coordination office can be immediately implemented in 2017-2018. Detailed designs and feasibility studies will be conducted for the micro-hydropower, small multi-purpose reservoirs and proposed aquaculture systems in the period 2017-2018. A detailed road map of activities to be undertaken during the year 2017-2018 is provided as annex 7. Others can commence in the core plan period of 2018-2023.

3.8 Proposed institutional arrangements for the catchment

3.8.1 Institutional roles and responsibilities

A Catchment Coordination Office will be instituted as an extended arm of the IWRM-department to support the alignment process in 2017, and to support the implementation of the catchment plan. The office will support the districts to integrate the catchment plans into the district's 5 year strategic plans, provide additional technical support (water resources monitoring and licensing) where needed and

become an office that will be more accessible to the various stakeholders in the catchment (Districts, water user associations, Private sector, NGOs, utilities, etc.).

For the time being, the staff of the IWRM department is all based in Kigali and travels with various frequencies to the field. The current proposal is based on the new scenario, to have a permanent presence in each catchment. In the institutional assessment report of Water for Growth Rwanda[38], an assessment was made of the various institutions and organs that play a role in IWRM processes. As can be derived from the matrix below (Figure 32), the CO intervenes at two levels, the Catchment level, and the district level. While this role is of a coordinating nature at the level of the catchment, there is a more technical support role to focus on in collaborating with the district level actors. The CO will support translating catchment plans into district plans and guide interventions from the various sectors in combining efforts to move from curbing catchment degradation into sustainable management of the resources. The CO must also become an information hub for the various interested stakeholders and the public at large.

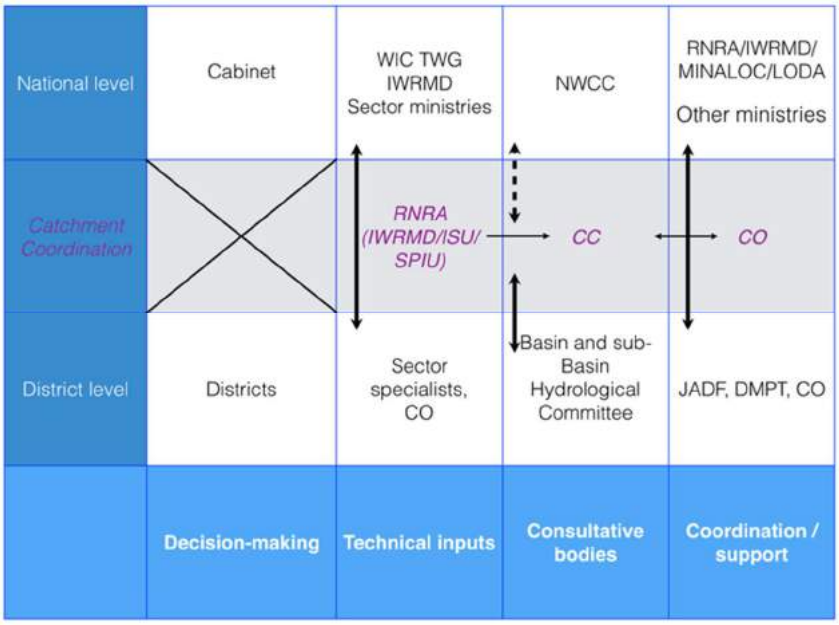


Figure 32: Matrix presenting coordination, consultation, technical input, and decision-making at various levels[39]

Being a coordination office and a technical support entity, it is expected that the CO will:

- § be involved in a continuous process of further improvement of the catchment plans;
- § integrate new thinking and disseminating successful practices for replication in the same catchment or in neighbouring pilot catchment;
- § be a linking pin between sector ministries and local partners, especially in promoting best practices and disseminate learnings;
- § support the districts in translating the Catchment plan into district implementation plans and translate the district measures for the larger public;

[38] Water for Growth Rwanda technical report TR03 – Institutional Frameworks (January 2017)

[39] CC stands for Catchment Committee, the successor of the Catchment Task Force under the new Water Law under development

- support the Districts in monitoring the effects of the Districts' implementation plans in relation to the overall catchment implementation plan;
- provide technical inputs to the Catchment Committee and the District Committees for Hydrographic Basins, including capacity building support;
- support the districts in organizing stakeholder events;
- assist in meetings organized by the Districts to provide technical inputs and advice;
- develop into a resource and information centre for the districts and the public;
- be an extended arm of the IWRMD and the Water and Forest Authority (RWFA, the applicable successor of RNRA);
- support the (decentralized) activities of the IWRMD (water permits and water resources monitoring).

Location of the CO

Given the tasks of the CO, such a role can only be correctly performed if the CO ensures a local presence in the selected catchments. Catchment boundaries are not identical to administrative boundaries, and consequently, multiple districts can be physically represented in the same catchment, either in full or partly. The CO will be hosted in the catchment area and will liaise with all stakeholders that rely on the same catchment. From a pragmatic point of view, it is proposed to locate the office in a district that is well accessible from within the catchment, and from Kigali. For Upper Nyabarongo the Catchment Task Force unanimously voted for Muhanga district, where the vice-chairperson of the CTF is located.

The most suitable options to set-up the new CO

The ideas around the local presence have further matured and can be as well linked to the likely new structure of agencies in MINIRENA. The proposed structure includes a new Water and Forest management Authority, dealing with the Departments of IWRM and of Forestry Management, managed by a Director General. Given this closer link to the forestry department, merging the CO office with the District Forestry office seems to be an ideal construction. Although the CO will deal with more than one single districts in the catchment, using the forestry office will pave the way to establish an easy stronghold in the catchment. This option will also allow linking catchment interventions to forestry, agroforestry, and environment.

Given that the new water law is not yet endorsed by the Cabinet it is proposed that the ISU will be the catalyst behind the initiative and provide the financial resources to start as soon as possible the CO office. Having this local presence is opportune since the implementation phase of the catchment plans is to start soon. Monitoring the performance and functioning is important and additional guidance, and capacity strengthening might be required. The POs and the IWRM-watershed managers should provide coaching roles to these new staffs as well. However, it will not be sustainable for the CO if their funding for staff and operational costs will continue to be provided by the IWRM Programme funds. Being recognized in the law, staff and their costs need to be budgeted for by the IWRM Department and the WFA, and a transfer of costs can be proposed in a gradual manner. Concerning the operational costs, the different districts in the catchment can contribute to the operational costs, most likely based on the activities that are implemented for a specific district. Otherwise, based on the percentage of each district within the catchment area, a distribution of running cost can be based on these percentages.

Composition of the CO

The size and composition of the CCO are not static since it will depend as well on the development stage of the basin plan in the respective basins, or specific needs during the implementation of the plan. In general, it would be good to have at least two full-time staff, possibly reinforced with interns for specific tasks. Also, as mentioned, the POs and the watershed managers are to spend around 50% of their time in the CCO office. Possible profiles which can further elaborated could include:

- a water resources planner/ water economist 1 FTu;
- climate-smart agricultural expert, 0.5 FTu;
- agroforestry expert, 0.2 FTu;
- communication/stakeholder engagement expert 1 FTu.

The staffing of the CO can evolve over time and collaboration will be sought with the sector experts in place. This will require discussions at various levels, how sectors can be more and better implicated in the IWRM agenda.

3.8.2 Memoranda of understanding and service contracts

Through Memoranda of Understanding (MoUs), the implementation of some of the technical activities of catchment plan implementation will be the responsibility of partner agencies and institutions working in collaboration with MINIRENA.

1. landscape rehabilitation activities, irrigation development, water supply infrastructure, model mining, green villages, water quality regulatory framework, micro hydropower development and other initiatives to alleviate poverty will be implemented through cooperation of a number of agencies according to their mandates. Hydrological models for flood forecasting will be developed between Meteo Rwanda and the Integrated Water Resources Management Department of RWFA. Local disaster preparedness planning will be carried out by Ministry of Disaster Management and Refugee Affairs (MIDIMAR). Irrigation development will be implemented by RAB and MINAGRI while WASAC will implement the proposals for improvement of water supply and sanitation infrastructure. The City of Kigali will be supported to implement relevant programs of measures in the city master plan;
2. research activities will be carried out through partnerships with key research institutions, which are expected to include the University of Rwanda;
3. depending on the scope of activities, to be determined under the landscape rehabilitation component, the RWFA & Nature Conservation and Geology & Mines Authority may also directly implement activities under MoUs related to enrichment of plantation forests with native species and environmental management of mining activities. Otherwise, these will be implemented through district-level joint project teams, involving RWFA-staff;
4. components of the catchment plans relating to poverty alleviation, fish farming, beekeeping, horticulture, agroforestry, strengthening community participation etc. will be implemented through the District level under MoUs, in accordance with national decentralization policies;
5. capacity-building and joint micro-watershed / silvo-pastoral and livelihoods planning activities with communities and cooperatives will be overseen by District and Catchment Coordination Office Staff but due to the significant time required for these interactions, they will be supported by local teams of service providers / NGOs depending on the local circumstances;
6. the output of participatory planning processes may involve contracts signed between the Water for Growth program and communities / cooperatives committing support for specified livelihood and landscape restoration activities, ecosystem service provision, carbon sequestration in return for the beneficiaries' active involvement in implementing various elements of the catchment plan. This

support will be bolstered where necessary with additional specific technical Government experts, and consultants. Implementation on the ground will also be supported by peer learning structures involving demonstration plots and local knowledge exchanges.

3.8.3 Incentives – Payment for Ecosystem Services

Ecosystems produce valuable goods and services for society like clean water, air, nature. However, ecosystem services are usually for free and not valued in the conventional accounting systems. Natural resources and ecosystems are under pressure and so are the services they deliver. Payment for Ecosystem Services (PES) is a market based mechanism where the consumers of the good or service pay for the preservation of the ecosystem that is providing the good or service. An opportunity for such a market-based mechanism has been identified in the Upper Nyabarongo catchment around the Nyabarongo Hydro-electric Power Dam. The reservoir and power generation suffer from the sediment carried by the river. Building sediment traps near the reservoir or regular flushing the reservoir from its sediments is costly and complicated for the power company. Instead, the power company would be willing to pay land users and the miners in the catchment for measures that reduce erosion. Possibilities to set up contractual arrangements between the power company and land users to reduce the erosion are explored.

Other possibilities for PES exist around the Nyungwe National Forest located in the upstream part of the catchment. The Nyungwe forest harbours a unique flora and fauna of international importance. It also produces clean drinking water for the people living downstream in the catchment for example in the city of Kigali. Populations around the forest depend for their livelihoods on the forest abstracting products while damaging nature. Land users are increasingly viewed as guardians of the environment that fairly receive a compensation for protecting the ecosystems. A PES pilot experience has been established in the Nyungwe forest (2009- 2012) including the Rwanda Development Board (RDB) Tourism & Conservation, the Wildlife Conservation Society (WCS) and East Anglia University and local communities around the forest.

It is expected that as economic development in Rwanda advances, consumers will have more financial resources and willingness to pay for the conservation of the natural ecosystems and its environmental services.

3.9 Monitoring and Evaluation mechanisms

A Monitoring and evaluation (M&E) framework was developed to keep track of implementation progress and of the achievement of intended and unintended outcomes and impacts. M&E is a way of tracking and reporting on the accountability of various stakeholders during the plan implementation.
Monitoring: Regular tracking of progress should be conducted by the W4GR and SPIU team and should compile monthly and quarterly reports on the physical implementation on ground.

A logframe matrix has been developed, providing a list of key performance indicators (impacts, outcomes, and outputs) to be used in the progress reports. Data collected regularly should be analysed to enrich and update the Water MIS of the IWRMD as well as the production of regular reports to the PSC, MINECOFIN and relevant Stakeholders.

Evaluation: During the monitoring process, lessons and best practices will be documented as basis for implementation improvement and catchment plan review.

A midterm review is to be conducted in 2020, around mid-term of the plan implementation period. The four standardized criteria for evaluation namely relevance, effectiveness, efficiency, and sustainability should be applied in order to convince the beneficiaries and decision makers on the achievement of catchment plan objectives and to guide eventual adaptation of the catchment plan if needed.

The M&E framework / log frame for the implementation phase of the catchment plan is provided in Table 23.

Table 23: Preliminary Catchment Plan M&E framework

Hierarchy of results	Key Performance Indicator	Baseline 2015/2016	Target 2022/2023	Means of verification	Assumptions
General objective: Effectively manage land and water resources to contribute to sustainable socio-economic development and improved livelihoods taking into consideration downstream needs					
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)	0	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	TBA	75%	IWRM Annual survey reports	
	Water demand per capita (CM/capita/Y)	183.44	TBD	IWRMD Annual survey reports/WEAP	
Impact 2: Water and land productivity increased	Yield per ha of main crops in the catchment	TBA	TBD	Districts Imihigo Reports	
	Water productivity (RWF/m^3)	TBA	TBD	IWRMD Annual survey 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 restored and protected to reduce soil erosion	Area of degraded catchment rehabilitated (ha and %)	128,775 (39.6%)	325,097 (100%)	W4GR/IWRMD Reports	The districts, Ministries and agencies 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 (bench, horizontal trenches, radical and progressives) in combination with agroforestry (ha)	5,716	150,175	MINIRENA Quarterly reports	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 DFMP	Area of forestry plantations cover (ha) % and %	102,536 :30% (Draft Land cover map 2015)	146,512(43% of the catchment area)	Forest Department Quarterly reports	District to have updated their District Forest Master plans with the support of RWFA.
Output 1.1.3. Gullies and degraded old mines rehabilitated	Area and % of gullies and old mines rehabilitated (ha)	TBD	95 ha (100%)	IWRMD Quarterly reports	Gullies and old mines rehabilitation mainstreamed in the new DDPs.
Output 1.1.4. Mining companies adopt the application of sustainable mining practices	Number and % of mining companies applying sustainable mining practices	0	100%	IWRMD Quarterly reports	Mining companies are willing to comply with mining low and their mining licenses

Hierarchy of results	Key Performance Indicator	Baseline 2015/2016	Target 2022/2023	Means of verification	Assumptions
Output 1.1.5. Agricultural practices driving soil erosion in the catchment are decreased and replaced with climate smart agriculture	Area (ha) and % of farmlands with improved (climate resilient) farming methods using Farmer Field Schools (FFS).	TBA	100%	MINAGRI Quarterly reports	The Ministry of agriculture cooperates to adopt improved farming methods protecting land in Farmers Field Schools
Outcome 1.2. Floods and drought hazards reduced.	Area of high risk zones protected against flooding (ha)	TBA	TBA	IWRMD Quarterly reports	Feasibility studies conducted
	Command area for marshlands and hillside irrigation from various sources of water (Dam, reservoirs, Groundwater, and rivers)	2353.1 ha	14,362 ha	MINAGRI Quarterly reports	
Output 1.2.1. Rural roadsides protected with drainage of excess water	Proportion of feeder roads rehabilitated and protected with drainage facilities (% of KMs)	TBA	60%	MININFRA / RTDA Quarterly reports	
Output 1.2.2. Households in high risk zones relocated to IDP/green Model villages	Number (%) of households relocated from high risk zone to IDP/green model villages	4144 hh	80%	Districts Imihigo reports	
Output 1.2.3. Rain water harvesting facilities increased to residential houses and public buildings	Proportion of residential houses and public buildings with rain water harvesting and drainage facilities	TBA	TBD	IWRMD Quarterly reports	
Output 1.2.4. Water ponds and dams constructed to collect and conserve water for hillside irrigation in area for short rainy seasons	Volume of water ponds and dams constructed to collect rain water for hillside irrigation	2,691,419.7 m^3 (Water storage report MINIRENA)	TBD	MINAGRI Quarterly reports	
Outcome 1.3. Water pollution from urban and villages areas caused by solid and liquid waste reduced	% reduction in solid and wastewater discharges into rivers	TBA	80% 80%	MININFRA Annual reports	Catchment plan mainstreamed in relevant sectoral plans

Hierarchy of results	Key Performance Indicator	Baseline 2015/2016	Target 2022/2023	Means of verification	Assumptions
Output 1.3.1. Waste water treatment plants and landfills constructed	Number HHs with access to solid waste collection and nr of HH connected to sewerage systems and subsequent wastewater treatment facilities in urban cities	TBA 0		MININFRA Quarterly reports	
	Number HHs with access to solid waste collection and nr of HH connected to sewerage systems and subsequent wastewater treatment facilities in rural villages	TBA 0		MININFRA Quarterly reports	
Output 1.3.2: Industries and Hotels are supported to adopt resource efficient and cleaner production (RECP) technologies	Number and % of Industries and hotels adopting RECP technologies	121 industries and hotels	100%	LVEMP II quarterly report MINEACOM quarterly report	
Specific objective 2: Ensure equitable allocation and efficient use of water resources within the catchment taking into account downstream demands					
Outcome 2.1: Equitable allocation of water resources ensured to sector users.	% of water users satisfied with water allocation framework (Disaggregation by gender)	TBA	80%	IWRMD Annual water users survey reports	Water allocation aligned to the National Land Use Master Plan
Output 2.1.1: Water users with water abstraction permits increased	% of water users with water abstraction permits (Disaggregation by gender)	25%	100%	IWRM Quarterly report	
Output 2.1.2 Water demand for main economic sector is met (Domestic, industry, irrigation, electricity)	% of rural and urban households with access to safe drinking water	TBA	100%	MININFRA and WASAC Quarterly reports	
	% of industry with access to water	TBA	100%	MININFRA and WASAC Quarterly reports	
	Volume of water demand for irrigation (MCM/Y)	8	305	IWRMD Quarterly reports	
	Volume of water demand for electricity generation per day	5,609,440 CM	TBD	Water for growth Quarterly reports	

Hierarchy of results	Key Performance Indicator	Baseline 2015/2016	Target 2022/2023	Means of verification	Assumptions
Outcome 2.2 Efficient water use increased in main economic sectors	Water balance (MCM/Yr) for key economic sectors (Domestic, Agriculture, industry)	1,527	TBD	Annual WEAP Model simulations	
Output 2.4. Increased quantity of Water consumption per household	Average water demand per household connection (Mm^3/yr)	3	168	WASAC and other water supply companies	
Output 2.5. Water consumption in industries is regularly monitored	Average demand of industries per year (MCM)	29	139	Annual water users survey report	
Specific Objective 3: Strengthen the water governance framework to ensure effective implementation of integrated programs					
Outcome 3.1: Institutional framework strengthened at catchment and District levels	% of districts mainstreaming approved catchment plans in their DDPs and Annual work plans	0	100%	IWRMD Quarterly reports	IWRM Mainstreaming guidelines available and endorsed by the Ministry of finance and economic planning
	% of central institutions mainstreaming approved catchment plans in their strategic and annual work plans	0	100%	IWRMD Quarterly reports	
Output 3.1.1. Catchment management committees are established and operational	Average level of participation in catchment Task Force meetings (%)+disaggregation by gender	0	>80%	IWRMD Quarterly reports	
	Number of regular reports produced by CTFs.	0	Quarterly reports	IWRMD Quarterly reports	
	Number and % of DHBCs operational + disaggregation by gender participation	100%	100%	IWRMD Quarterly reports	
Outputs 3.1.2. Conflicts among water users identified and solved	% of water conflicts raised and solved	TBA	80%	IWRMD Quarterly reports	
Outcome 3.2. Capacity strengthened in key organizations to assume role in IWRM	% of relevant staff in local partner' institutions/catchment committees implementing IWRM principles	TBA	100%	IWRMD Quarterly report	
Output 3.3.1. The skills gap assessment relevant to IWRM conducted in local organizations (GR,	Availability of the skills gap assessment report	N/A	The skills gap assessment report available	IWRMD Quarterly report	

Hierarchy of results	Key Performance Indicator	Baseline 2015/2016	Target 2022/2023	Means of verification	Assumptions
NGOs, CBOs, Private Sector)					
Output 3.2.2. The capacity building plan relevant to IWRM in local organizations (GR, NGOs, CBOs, Private Sector) elaborated	Availability of the capacity building plan relevant to IWRM in the catchment.	N/A	The capacity building plan available	IWRMD Quarterly report	
Output 3.2.3. Relevant staff in local organizations (GR, NGOs, CBOs, Private Sector) are trained in various skills relevant to IWRM	% of relevant staff trained	TBA	100%	IWRMD Quarterly report	
Outcome 3.3. Knowledge and best practices documented and shared	Availability of data related to catchment characteristics to update the water MIS at central level.	Catchment characterization reports December 2015	All data related to catchment characteristics to updated and incorporated in the water MIS	IWRMD Quarterly reports	Availability of local skills for systematic data collection
Output 3.3.1 Water monitoring stations installed and operational	Number of water monitoring stations installed and operational	TBA	Tbd	IWRMD Quarterly reports	
Output 3.3.2 Water related surveys and studies conducted	% of needed survey and studies conducted		100%	IWRMD Quarterly reports	
	Number of best practices documented and shared	TBA	Tbd	IWRMD Quarterly reports	
Specific Objective 4: Reduce the pressure on natural resources by diversifying alternative livelihoods					
Outcome 4.1. Protected areas to maintain biological diversity	Proportion of protected area to maintain biological diversity (%)	442.3 ha	505 ha	IWRMD Quarterly reports	Business opportunities in the catchment are known by the communities

Hierarchy of results	Key Performance Indicator	Baseline 2015/2016	Target 2022/2023	Means of verification	Assumptions
increased					
Output 4.1.1. Buffer zone around reservoirs demarcated and protected	Area of buffer zones around reservoirs protected(ha)	79.3	429	IWRMD Quarterly reports	
Output 4.1.2. Buffer zones along rivers and wetlands demarcated and protected	Area of buffer zones along rivers and wetlands protected (ha)	364.3	582	IWRMD Quarterly reports	
Output 4.1.3. Natural forest boundaries demarcated and protected	Area of Natural forest buffer protected (ha)	TBA	TBD	IWRMD Quarterly reports	
Output 4.1.4. Off-farm jobs created to reduce the pressure on natural resources	Number of off-farm jobs created to reduce the farming pressure on protected and high risk areas	TBA	TBD	IWRMD Quarterly reports	
Outcome 4.2. Reduced the fire wood demand in households and industries	Balance between the supply and demand of wood biomass (Oven dry Tons of wood per year)	TBA		Forest Department Quarterly report	Alternative wood biomass source of energy are available and certified by the Rwanda Bureau of Standards
Output 4.2.1. Efficient and alternative wood biomass energy identified and disseminated to relevant households	Number and % of HHs with alternative and efficient wood energy (ICS, biogas and Liquefied Petrol Gaz)	29.69%	75%	MININFRA Quarterly report	
Output 4.2.2 Increased management of existing forest resources	Number of Districts with Forest Management plans	TBA	8	Forest Department Quarterly report	

4. Way forward towards version 2.0

As mentioned earlier in this catchment plan, the current Catchment Plan version 1.0 is only the starting point of a year-long alignment process, in which mutual negotiations take place between sectoral stakeholders at the central level, as well as between national stakeholders and districts, and NGOs, private sector stakeholders, and others. The process towards an officially endorsed Catchment Plan version 2.0 that is completely aligned with sectoral and district 5 year plans, the new Government Seven Year Plan, the Vision 2050 and EDPRS3 under development, is depicted in Figure 33. A detailed planning will be drawn up for sectoral dialogues and district dialogues, in order to jointly developed a detailed and specific programme of measures.

In parallel to this alignment process, the official review of the catchment plan documentation by REMA can take place, and ample time will be available for the wider public and third party stakeholders to respond to the plan. This allows for a continuation of the integrated process of plan development and SEA plan assessment.

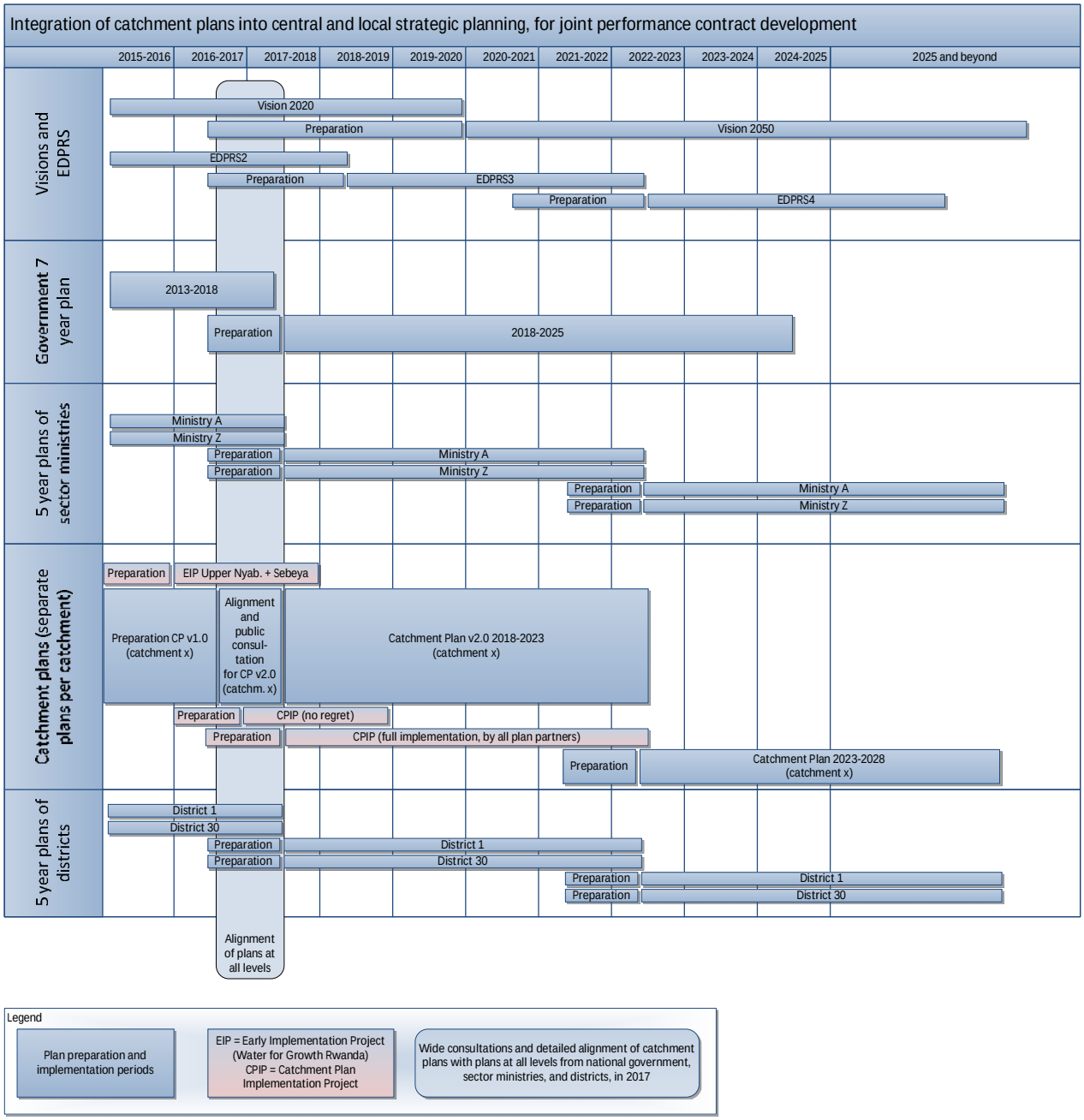
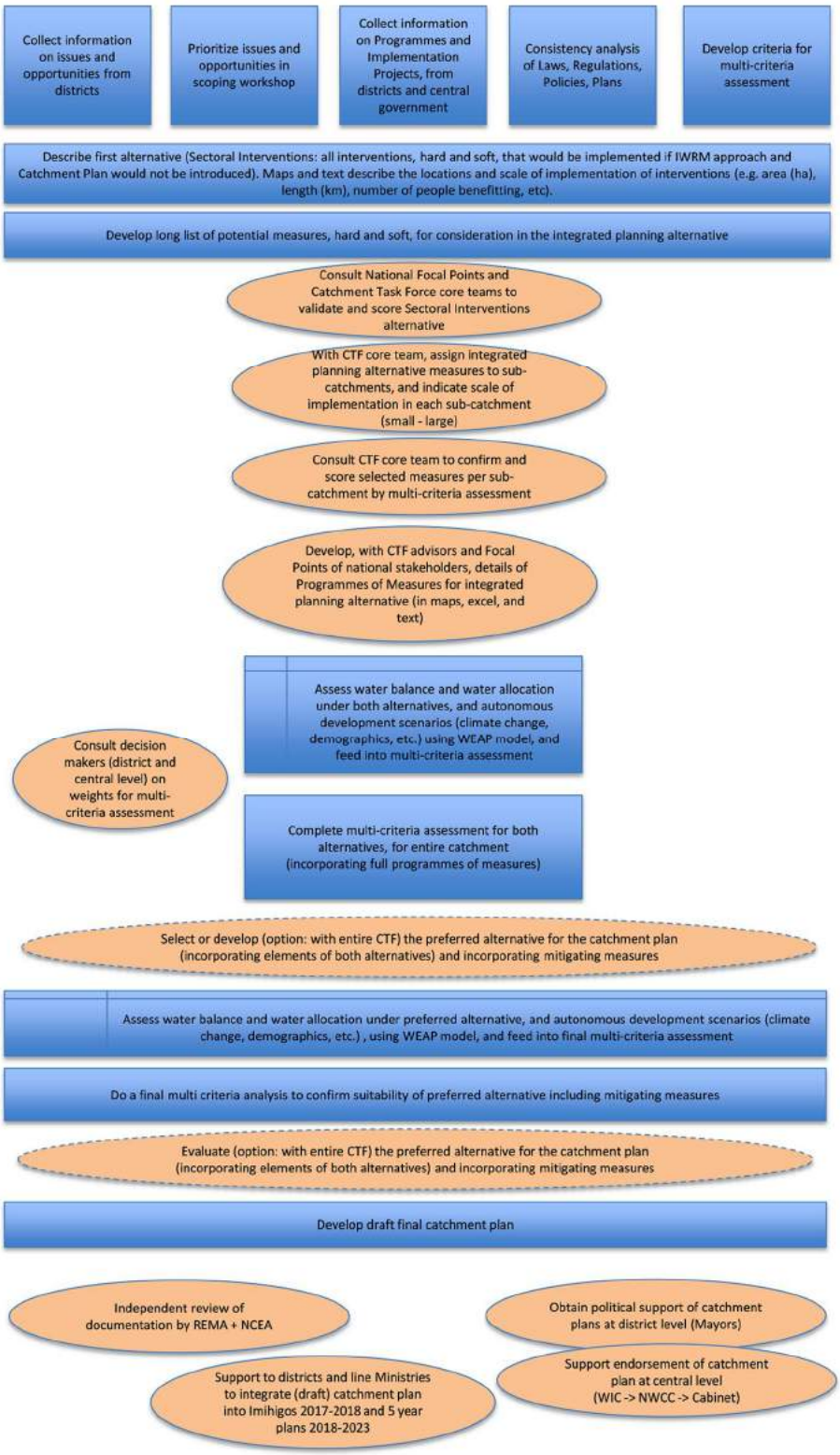


Figure 33: Alignment process between Catchment Plan, National Plans, Sector plans, and District plans

Annex 1. Potential hydropower sites

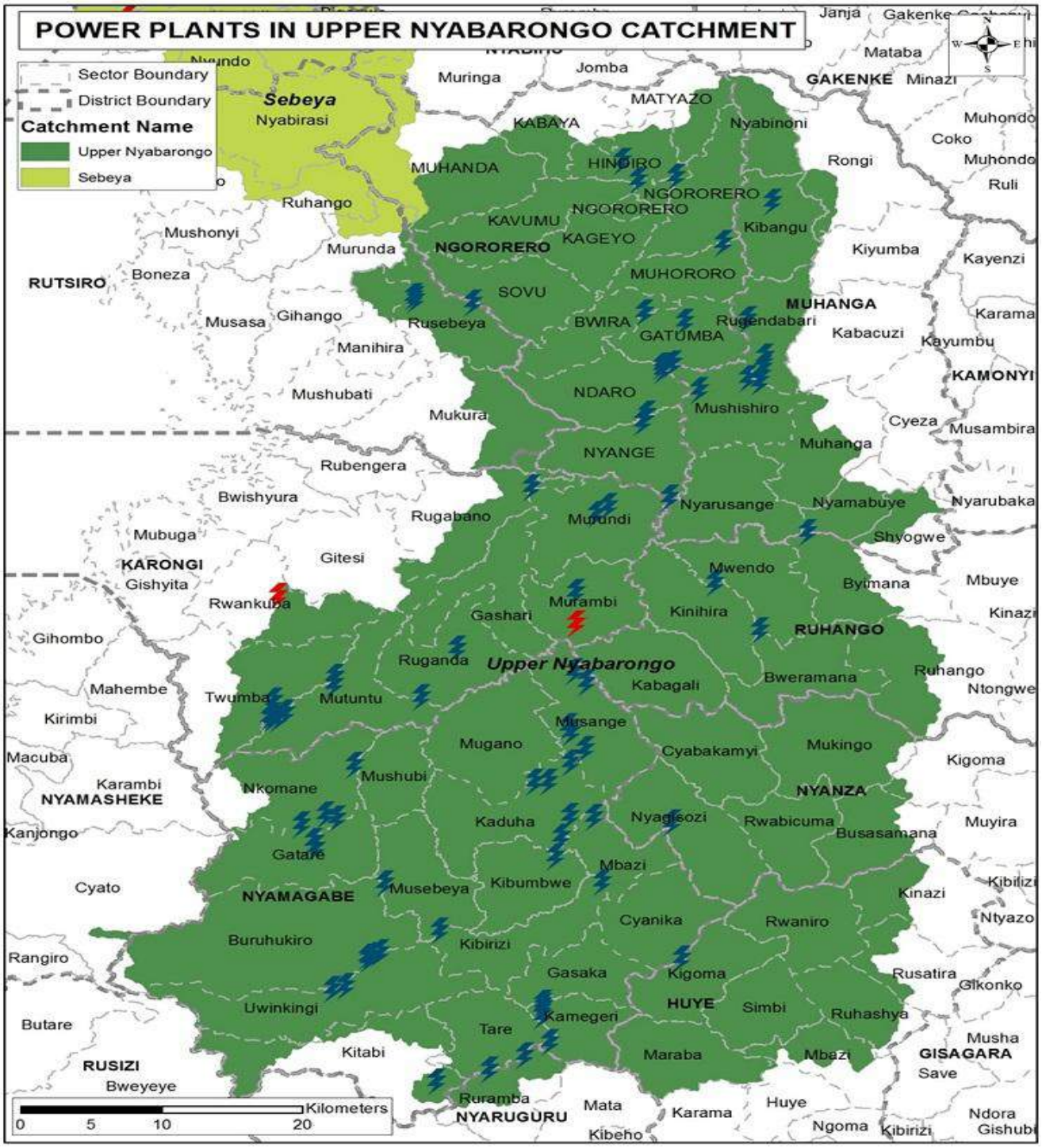
No.	Site_name	District	Sector	Est.Max_Capacity (kW)
1	Cyintiti	Muhanga- Ngororero	Mushishiro-Gatumba-Ndaro	100
2	Mbirurume	Karongi	Mutuntu	395
3	Gisuma	Ngororero	Gatumba	250
4	Kabavu	Nyamagabe	Gatare-Nkomane	250
5	Muregeya	Rutsiro	Mukura	1522
6	Karumbi	Karongi	Mutuntu-Twumba	100
7	Muhembe	Ngororero	Kavumu	499
8	Kibilira	Ngororero	Bwira-Gatumba	100
9	Kirasa	Karongi	Ruganda	100
10	Macu	Nyamagabe	Kitabi	272
11	Masango	Ruhango	Kabagali	105
12	Mashyiga	Karongi	Murambi	140
13	Mazimeru	Nyamagabe	Muganza	500
14	Mbirurume A	Karongi	Mutuntu-Twumba	100
15	Mbirurume B	Karongi	Mutuntu-Twumba	100
16	Mbirurume D	Karongi	Mutuntu-Twumba	100
17	Muhara III	Nyamagabe	Kaduha	100
18	Mwogo	Huye	Maraba	194
19	Ntaruko	Ngororero	Kabaya	139
20	Nyabarongo	Muhanga-Ngororero	Mushishiro-Gatumba	28000
21	Range	Nyamagabe	Nkomane	539
22	Rorongora	Nyamagabe	Mushubi	287
23	Rubyiro II	Nyamagabe	Buruhukiro-Uwinkingi	100
25	Rukarara II	Nyamagabe	-	2000
26	Rukarara III	Nyamagabe	Buruhukiro-Uwinkingi	250
27	Rukarara IV/Mushishiro	Nyamagabe	-	5000
28	Rungu	Ngororero	Hindiro-Kabaya-Matyazo	100
29	Runyombyi	Nyaruguru	-	250
30	Ruramba	Nyaruguru	Ruramba-Tare	500
31	Rwondo	Nyamagabe	-	1000
32	Rwondo	Nyamagabe	Mushubi	537
33	Sanzare	Rutsiro-Ngororero	Rusebeya-Sovu	250
34	Satinsyi	Ngororero	Hindiro-Kageyo-Ngororero	250
35	Secoko	Ngororero	Ndaro-Nyange	250
36	Uwintobo	Karongi	Twumbwa	1662
			Total	46041

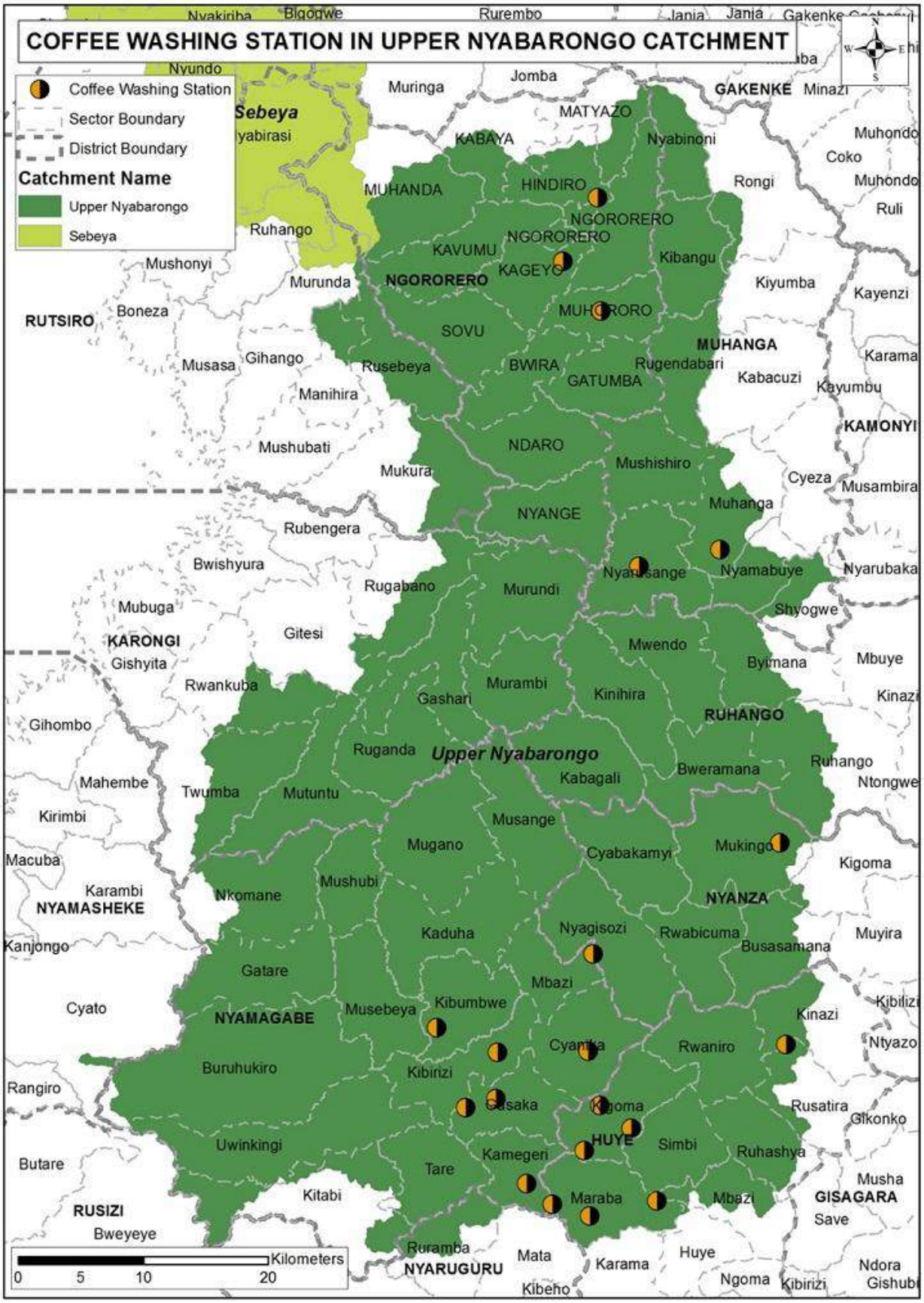
Annex 2. IWRM and SEA process steps



Annex 3. Water users in the catchment

The maps on the following pages were derived from a water users' survey implemented by Water for Growth Rwanda in November-December 2016.




COFFEE WASHING STATION IN UPPER NYABARONGO CATCHMENT
Coffee Washing Station
Sector Boundary
District Boundary
Catchment Name
Upper Nyabarongo
Sebeya
Upper Nyabarongo
Sebeya
Nyakiriba
Bigogwe
Rurembo
Janja
Gakenke
Nyundo
Muringa
Jomba
GAKENKE
Minazi
MATYAZO
KABAYA
Nyabinoni
Muhondo
Coko
Rongi
MUHANDA
HINDIRO
NGORORERO
Ruli
Ruhango
KAVUMU
KAGEYO
Kibangu
Mushonyi
Murunda
NGORORERO
Kiyumba
Kayenzi
RUTSIRO
Boneza
MUHORORO
SOVU
MUHANGA
Karama
Musasa
Gihango
Rusebeya
BWIRA
Rugendabari
Kabacuzi
GATUMBA
Kayumbu
Manihira
KAMONYI
Mushubati
NDARO
Mushishiro
Mukura
Cyeza
Musambira
Muhanga
NYANGE
Rubengera
Nyamabuye
Nyarubaka
Bwishyura
Rugabano
Murundi
Nyarusange
Shyogwe
Mubuga
Gitesi
KARONGI
Mwendo
Gishyita
Byimana
Mbuye
Rwankuba
Murambi
Gashari
Kinihira
Kinazi
RUHANGO
Gihombo
Ruganda
Upper Nyabarongo
Bweramana
Ruhango
Mahembe
Twumba
Mutuntu
Kabagali
Ntongwe
Kirimbi
Musange
Mugano
Cyabakamyi
Mukingo
Macuba
Kigoma
Karambi
Mushubi
NYAMASHEKE
Nkomane
NYANZA
Kaduha
Nyagisozi
Rwabicuma
Muyira
Kanjongo
Busasamana
Gatare
Mbazi
Cyato
Musebeya
Kibumbwe
Kibilizi
NYAMAGABE
Kinazi
Cyanika
Rwaniro
Ntyazo
Buruhukiro
Kibirizi
Rangiro
Gasaka
Kigoma
Rusatira
Gikonko
Uwinkingi
HUYE
Simbi
Ruhashya
Kamegeri
Butare
Tare
Musha
Kitabi
Maraba
Mbazi
GISAGARA
RUSIZI
Save
Bweyeye
Ruramba
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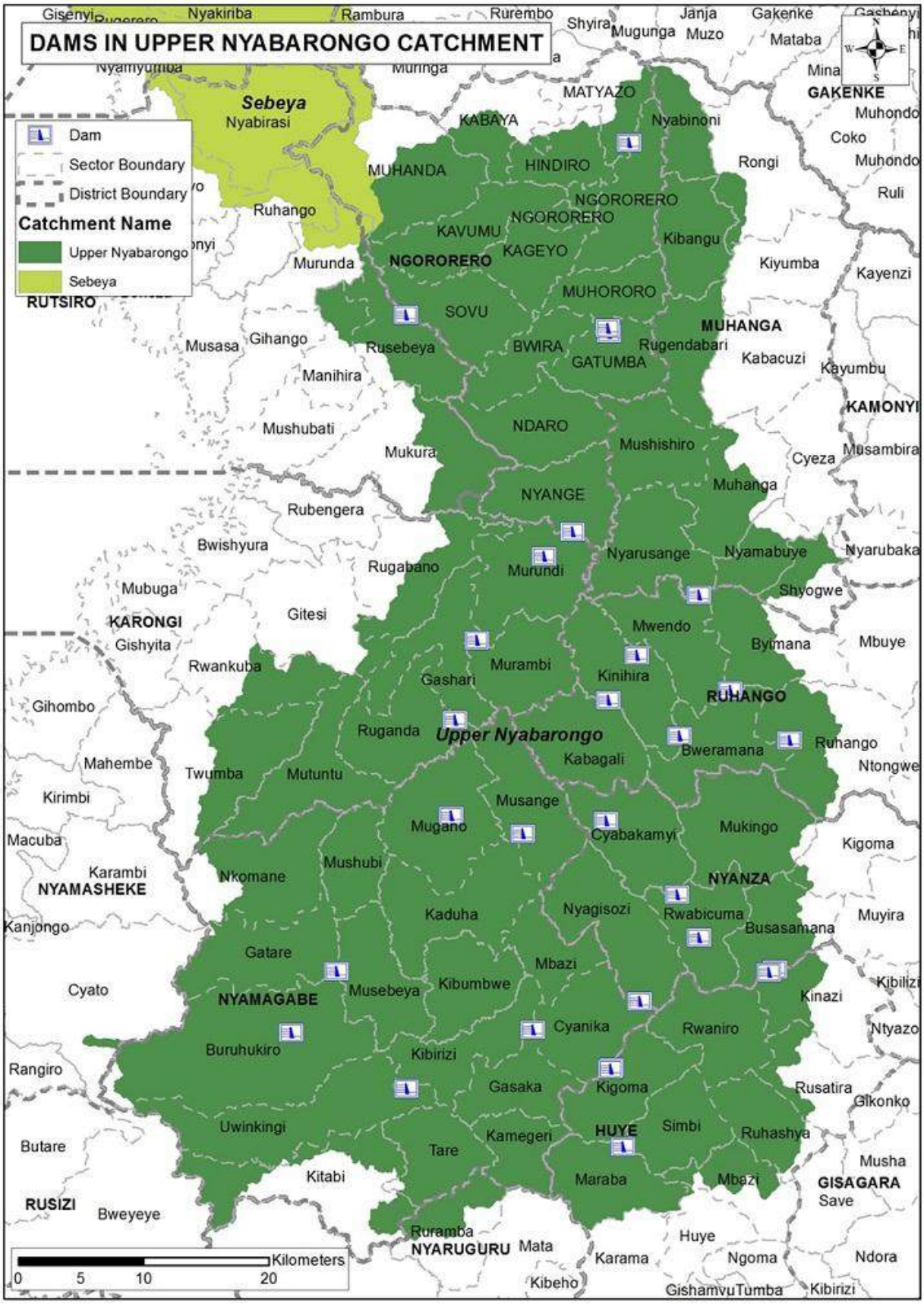
DAMS IN UPPER NYABARONGO CATCHMENT
Dam
Sector Boundary
District Boundary
Catchment Name
Upper Nyabarongo
Sebeya
Sebeya
Nyabirasi
Upper Nyabarongo
Gisenyi
Nyakiriba
Rambura
Rurembo
Shyira
Janja
Gakenke
Mugunga
Muzo
Mataba
Mina
GAKENKE
Muringa
MATYAZO
KABAYA
Nyabinoni
Muhondo
Coko
Rongi
Muhondo
Ruli
MUHANDA
HINDIRO
NGORORERO
NGORORERO
KAVUMU
KAGEYO
Kibangu
Kiyumba
Kayenzi
Ruhango
Murunda
NGORORERO
MUHORORO
SOVU
MUHANGA
Rugendabari
Kabacuzi
Kayumbu
RUTSIRO
Musasa
Gihango
Rusebeya
BWIRA
GATUMBA
Manihira
KAMONYI
Mushubati
NDARO
Mushishiro
Musambira
Mukura
Cyeza
Muhanga
NYANGE
Rubengera
Bwishyura
Nyarusange
Nyamabuye
Nyarubaka
Rugabano
Murundi
Mubuga
Shyogwe
KARONGI
Gitesi
Mwendo
Gishyita
Byimana
Mbuye
Rwankuba
Murambi
Kinihira
Gashari
RUHANGO
Gihombo
Ruganda
Upper Nyabarongo
Bweramana
Ruhango
Ntongwe
Mahembe
Twumba
Mutuntu
Kabagali
Kirimbi
Musange
Mugano
Cyabakamyi
Mukingo
Kigoma
Macuba
Karambi
NYAMASHEKE
Mushubi
Nkomane
NYANZA
Kaduha
Nyagisozi
Rwabicuma
Muyira
Kanjongo
Busasamana
Gatare
Mbazi
Cyato
Musebeya
Kibumbwe
Kibilizi
NYAMAGABE
Kinazi
Cyanika
Rwaniro
Ntyazo
Buruhukiro
Kibirizi
Rangiro
Gasaka
Kigoma
Rusatira
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Ruhashya
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Mbazi
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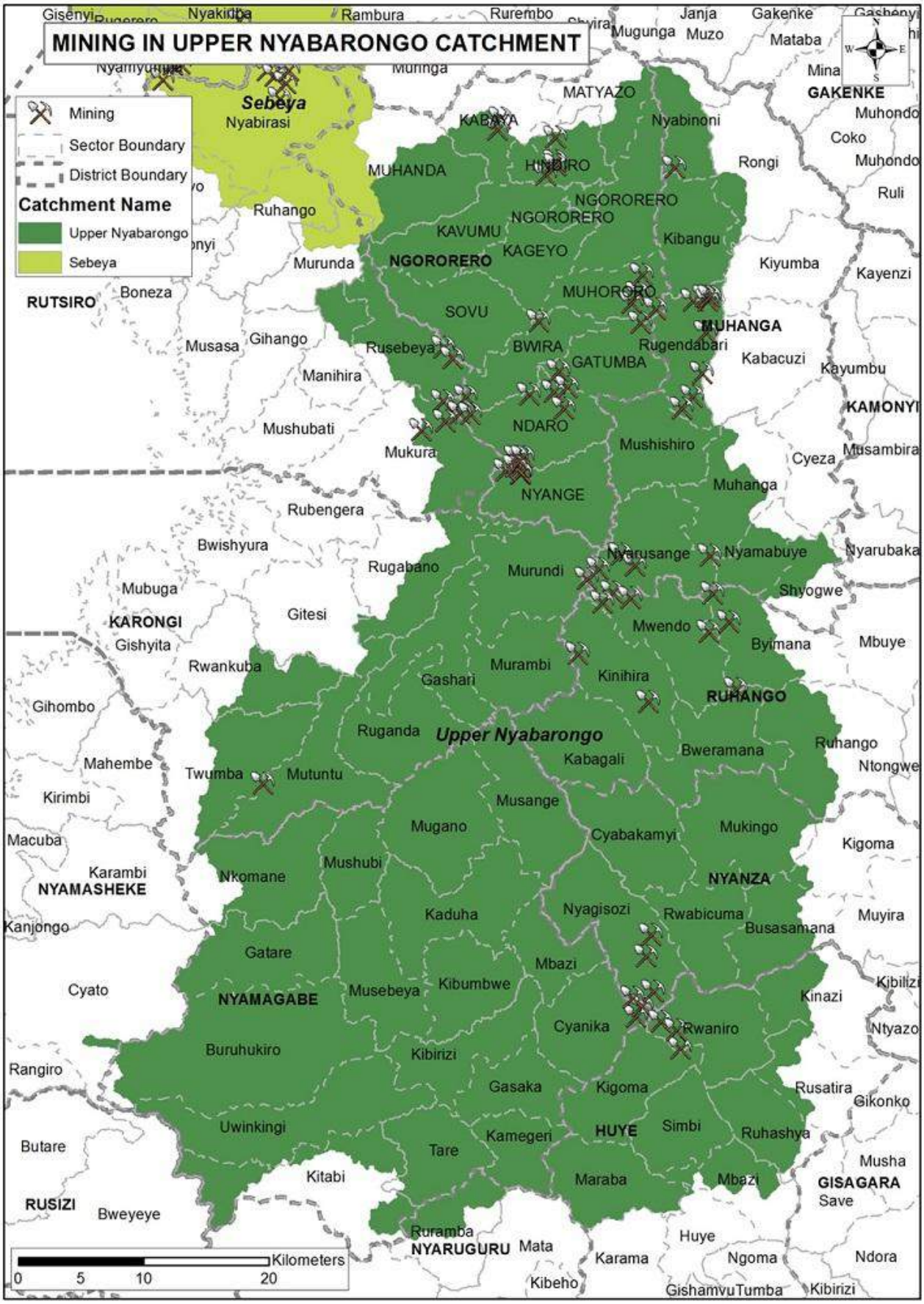
MINING IN UPPER NYABARONGO CATCHMENT
Mining
Sector Boundary
District Boundary
Catchment Name
Upper Nyabarongo
Sebeya
Upper Nyabarongo
Sebeya
Nyabirasi
Ruhango
Murunda
Boneza
RUTSIRO
Musasa
Gihango
Manihira
Mushubati
Rusebeya
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MATYAZO
Nyabinoni
HINDIRO
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KAGEYO
NGORORERO
MUHORORO
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GATUMBA
NDARO
NYANGE
Rubengera
Bwishyura
Rugabano
Murundi
Mushishiro
Muhanga
MUHANGA
Rugendabari
Kabacuzi
Kayumbu
KAMONYI
Cyeza
Musambira
Nyarusange
Nyamabuye
Nyarubaka
Shyogwe
Mwendo
Byimana
Mbuye
Rwankuba
Murambi
Gashari
Kinihira
RUHANGO
Gihombo
Ruganda
Upper Nyabarongo
Kabagali
Bweramana
Ruhango
Ntongwe
Mahembe
Twumba
Mutuntu
Musange
Mugano
Cyabakamyi
Mukingo
Kigoma
Kirimbi
Macuba
Karambi
NYAMASHEKE
Mushubi
Nkomane
NYANZA
Kaduha
Nyagisozi
Rwabicuma
Busasamana
Muyira
Kanjongo
Gatare
Mbazi
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Mbazi
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Bweyeye
Ruramba
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Mata
Karama
Huye
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Ndora
Kibeho
GishamvuTumba
Kibirizi
Kilometers
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Gisenyi
Nyakiliba
Rambura
Rurembo
Janja
Gakenke
Mugunga
Muzo
Mataba
Mina
GAKENKE
Muhondo
Coko
Muhondo
Rongi
Ruli
Kiyumba
Kayenzi
Kibangu
Rugendabari
Kabacuzi
Kayumbu
Cyeza
Musambira
Muhanga
Nyarusange
Nyamabuye
Shyogwe
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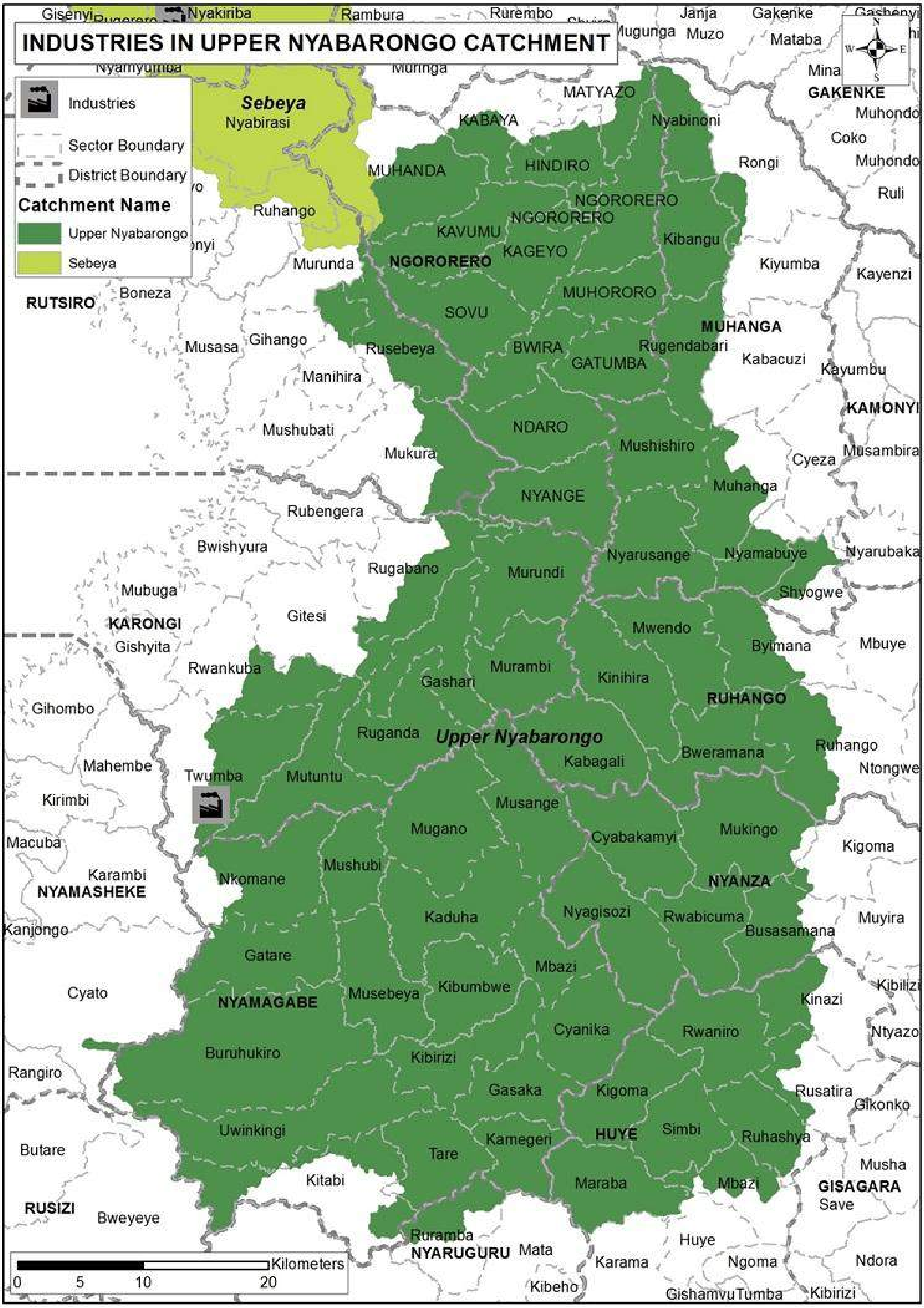
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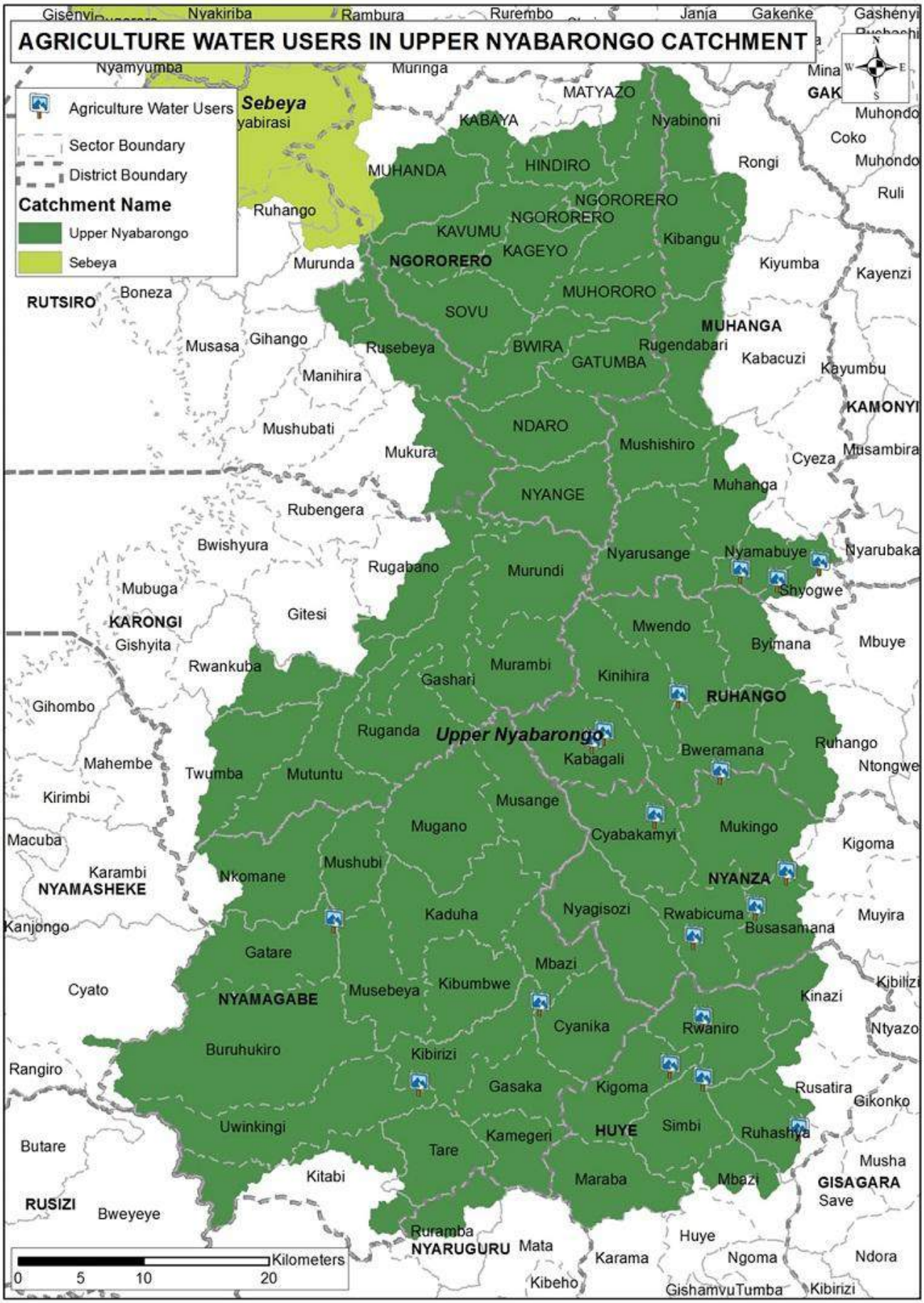
AGRICULTURE WATER USERS IN UPPER NYABARONGO CATCHMENT
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KARONGI
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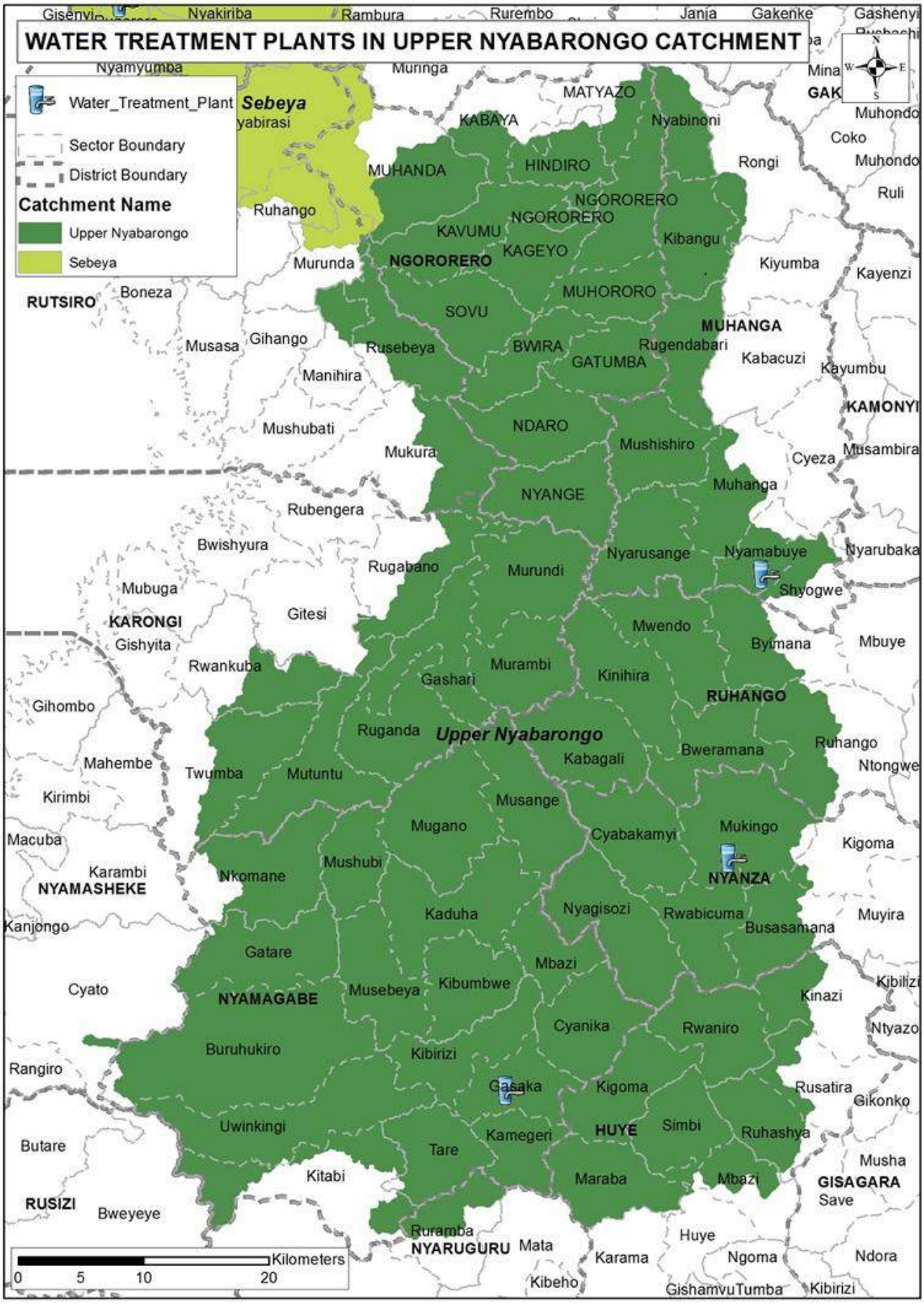
WATER TREATMENT PLANTS IN UPPER NYABARONGO CATCHMENT
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Annex 4. Authorities and stakeholders

Most of development partners operating in 8 Districts of Upper Nyabarongo catchment are in the category of International and Local NGOs as well as government projects operating in 15 sectors of socio-economic development. Among those sectors of intervention, 10 are in close relation with water sector while others: justice & Governance, communication, ICT, social and education have no direct relationship with water. Among the sectors with close relation to water sector, Agriculture has the majority of stakeholders (16.7% of all stakeholders and 26.2 % in water domain), followed by Environment and land protection (16% of all stakeholders and 16.1% in water domain).

With regards to government projects implemented in the catchment with close relation to water sector, 9 major projects have been identified and are implemented by 7 government institutions: REMA (3 projects), MINAGRI (2 projects), RDB (1 project), RWFA (1 project), LODA (1 project) and NAEB (1 project).

The mandate of those institutions to be involved in the implementation of the preliminary catchment is as follows:

- MINAGRI: Ministry of Agriculture and Animal Resources is focused on increasing agricultural and animal production, modernizing 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 rods improvement and fertilizers 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 his responsibilities related to the LED potentialities and their exploitation including processing factories, it will be involved in the implementation of the catchment plan;
- MININFRA: The Ministry of Infrastructure will play a key role in supporting the development and rehabilitation of infrastructure that will facilitate the implementation of the catchment plan at national and local level especially in policy and standards formulations and participation in the programme steering committee;
- 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 to environment, including through destruction or depletion of natural resources, and should work towards promoting innovation and green enterprises;
- RWFA: Rwanda Water and Forestry Authority is an authority that leads the management of promotion of water and forests. It shall be entrusted with supervision, monitoring and to ensure the implementation of issues relating to the promotion and protection of these natural resources in programs and activities of all national institutions. Given the close link between water and forestry, and two other authorities (Rwanda Mines, Petroleum and Gas Board, and the Rwanda Land Management and Use Authority) under the responsibility of MINIRENA;
- 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 with staff at the district level and which provides funding to improve the development of Rwanda at the local level, LODA has a key opportunity to support the LED potentialities identified. 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. RDB's role relates to developing the private sector, including through addressing the needs of companies and investors. In the catchment plan implementation, RDB will be consulted with regards to Tourism Projects and approving EIAs and mitigation plans for all projects having a negative impact on water resources;
- WASAC: Water and Sanitation Corporation is responsible for ensuring access to clean water and adequate sanitation infrastructure. As assessed during the district surveys, access to water supply for people, animal and industries are among the top priority of 87.5% of the districts. WASAC is then a key player of catchment plan implementation with regard to the growing demand of safe water in most economic activities in the catchment.

Table 24: Metadata from Water for Growth Rwanda overview of stakeholders

S/N	Sector	Number of Stakeholders	Stakeholders with close relation to water sector
1	Social	33	0
2	Agriculture	26	26
3	Health and Nutrition	21	21
4	Environment protection and land	16	16
5	Water and sanitation	14	14
6	Education	9	0
7	Justice and Governance	8	0
8	Livestock	7	7
9	Infrastructure	6	6
10	Energy (Electricity& Alternative)	5	5
11	Tourism	3	3
12	ICT	2	0
13	Communication	2	0
14	Agro-processing	2	2
15	Settlement	1	1
	Total	155	99

Table 25: Projects directly or indirectly pertaining to land and water management in the catchment

S/N	Name of the project	Implementing institution	Number of Districts
1	The Lake Victoria Environment management project (LVEMP II)	REMA	2 (Nyamagabe, Ngororero)
2	The decentralization 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).

Annex 5. Multi-Criteria Analysis of alternatives

On the following page, the detailed results of the MCA are provided from the group work exercise on MCA of the catchment plan alternatives, during the catchment task force meeting of 30 January 2017.

The criteria from the water balance (WEAP) and the expert judgement based multi-criteria analysis both point in the same direction for the preferred long term alternative: PCB-. For reasons of food security and rapid growth, the full maximum of (50% of the Irrigation Master Plan) new irrigation schemes will be fast tracked before 2023, i.e. by starting off with PCB+.

			CRITERIA Water Balance (WEAP)												Multi-Criteria Assessment					
			Water Demand (% improvement versus projection)	Water Shortage (% improvement versus projection)	Water Short Months (% improvement versus projection)	Evaporation Demand (% improvement versus projection)	Evaporation Shortage (% improvement versus projection)	Mean Flow (% improvement versus projection)	Peak Flow (% improvement versus projection)	Low Flow (% improvement versus projection)	Fast Runoff (% improvement versus projection)	Slow Runoff (% improvement versus projection)	Groundwater Recharge (% improvement versus projection)	technical/environmental feasibility	total weighted change (pos/neg)	Ecosystem Services	Economic Development	Social Development	Water Governance & Institutional Development	total weighted score
2023 =		weights	6%	7%	5%	1%	4%	11%	2%	12%	3%	8%	12%	30%	100%	33%	32%	25%	10%	100%
	Alterna	13_23_Alter_PASB	11%	11%	1%	4%	5%	5%	-4%	6%	-5%	4%	1%	-50%	-12%	6.33	7	5.67	3.333	5.11
	Alterna	21_23_Alter_PCB+	40%	41%	2%	16%	20%	2%	26%	39%	65%	27%	8%	-50%	2%	7.67	8	6.67	5.67	7
	Alterna	22_23_Alter_PCB-	37%	46%	2%	8%	10%	11%	-10%	15%	-10%	9%	2%	0%	9%	8.33	6.67	6.33	5.67	6.75
2030	Alterna	35_30_Alter_PASB	11%	11%	0%	4%	5%	5%	-4%	7%	-5%	4%	1%	-50%	-12%	4	4.33	5	2.67	4
2030	Alterna	43_30_Alter_PCB+	40%	41%	4%	16%	20%	2%	28%	45%	65%	27%	8%	-50%	2%	6.33	7.33	6.33	7	6.75
2030	Alterna	44_30_Alter_PCB-	38%	48%	2%	9%	11%	13%	-10%	19%	-11%	10%	2%	0%	10%	9	7	6.67	7.333	7.5
2050	Alterna	57_50_Alter_PASB	10%	11%	0%	4%	5%	6%	-4%	10%	-5%	4%	1%	-50%	-11%	2.33	2.67	3	2.33	2.58
2050	Alterna	65_50_Alter_PCB+	39%	40%	1%	16%	20%	1%	37%	-83%	66%	28%	8%	-50%	-12%	5.33	6.67	6.33	7.667	6.5
2050	Alterna	66_50_Alter_PCB-	34%	46%	1%	10%	12%	17%	-12%	29%	-12%	11%	2%	0%	12%	9	7.67	6.67	7.333	7.67

Annex 6. SDGs informing catchment vision

The United Nations have recently (2015) adopted the Sustainable Development Goals (SDGs). To support participants in their thinking of the values for IWRM in Rwanda, Session 2 contained an exercise to show how the SDGs could apply to catchment planning. To allow people to step away from thinking from their won angle and prevent direct problem solving and think about priorities for development of catchment sector district perspective, the participants were asked a very broad question:

- what do you find important for the future of your catchment?
- what are your values for future development?
- in that respect, which SDGs are most important to you?

Above questions resulted in three Session steps identifying a vision for the catchment:

1. identification of three SDGs from 14* main categories per thematic group. VM = vice mayors/economy; E/RN = environment and natural resources; A = Agriculture; Privé = Private Sector; CNF = National Women's Council/gender & social; ONG = Non-Government Organisations. The group at the bottom represent the vision of the catchment planner and Program Officer for Sebeya;
2. aggregation of selected SDGs for the entire group;
3. individual voting after having heard the motivations of all groups.

Participants divided into 7 Groups (National water, National non-water, Environmentalists, Agronomists, Private sector, NGOs and Gender) reviewed the 16 SDGs relevant to Rwanda and the catchment against their values and identified the 3 most important for the future of the catchment. After the presentation in plenary by all 6 groups, the 7 SDGs that appealed in many groups are:

1. SDG 15: Ecosystems protection, combating desertification and reverse of biodiversity loss: 31 scores;
2. SDG 6: Ensure availability and sustainable management of water and sanitation for all: 29 scores;
3. SDG 2: End hunger, achieve food security improved nutrition, and promote sustainable agriculture: 13 scores;
4. SDG 5: Achieve gender equality and Empower all women and girls: 9 scores;
5. SDG 11: Make cities and Human settlement inclusive, safe, resilient and sustainable: 8 scores;
6. SDG 16: Promote peaceful and inclusive societies for sustainable development and inclusive institutions at all levels: 6 scores;
7. SDG 13: Take urgent action to combat climate change and its impacts: 5 scores.

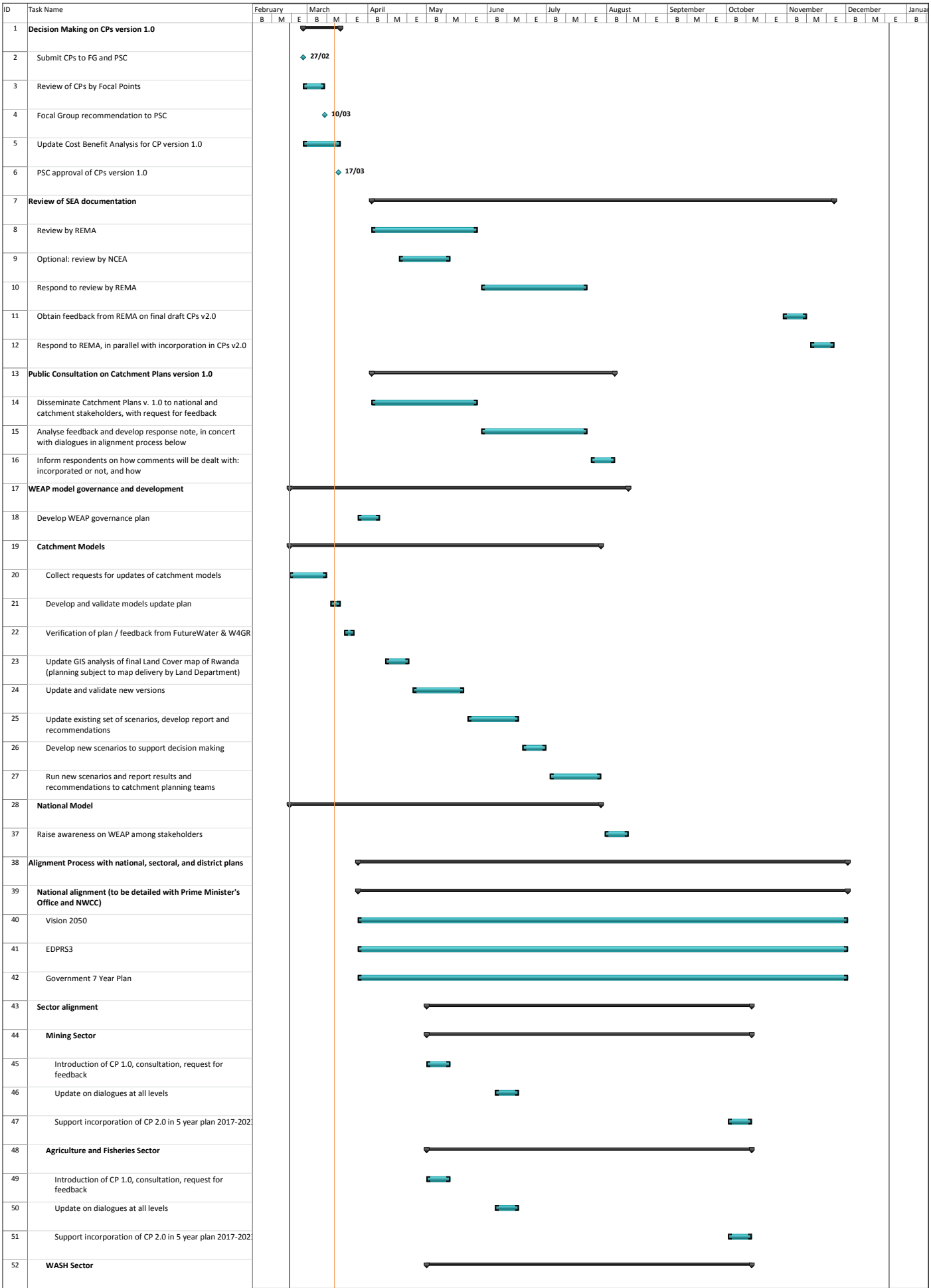
Summarizing the outcomes, the group came to a selection of three SDGs, which were indicated as most important for identification and formulation of the vision of the catchment. SDG 15: Ecosystems protection, combating desertification and reverse of biodiversity loss: SDG 6: Ensure availability and sustainable management of water and sanitation for all. SDG 2: End hunger, achieve food security improved nutrition, and promote sustainable agriculture.

Participants considered the value of ecosystem and biodiversity management as most important for the catchment vision. The outcomes of the main issues and opportunities of session 1 are addressed in this value; soil erosion caused by poor agriculture practices and lack of anti-erosion measures, deforestation caused by wood energy use and land use change for settlements; flooding and landslides. Sustainable

management of water and sanitation for all and food security are also addressed as important issues but not as highly important as the value of ecosystem protection.

Annex 7. Roadmap 2017 – alignment and endorsement of the Catchment Plan

The Gantt chart on the following pages presents the draft roadmap for the full process of alignment, quality review, and endorsement of the final catchment plan 2018-2023. A final roadmap will be developed jointly with the plan partners.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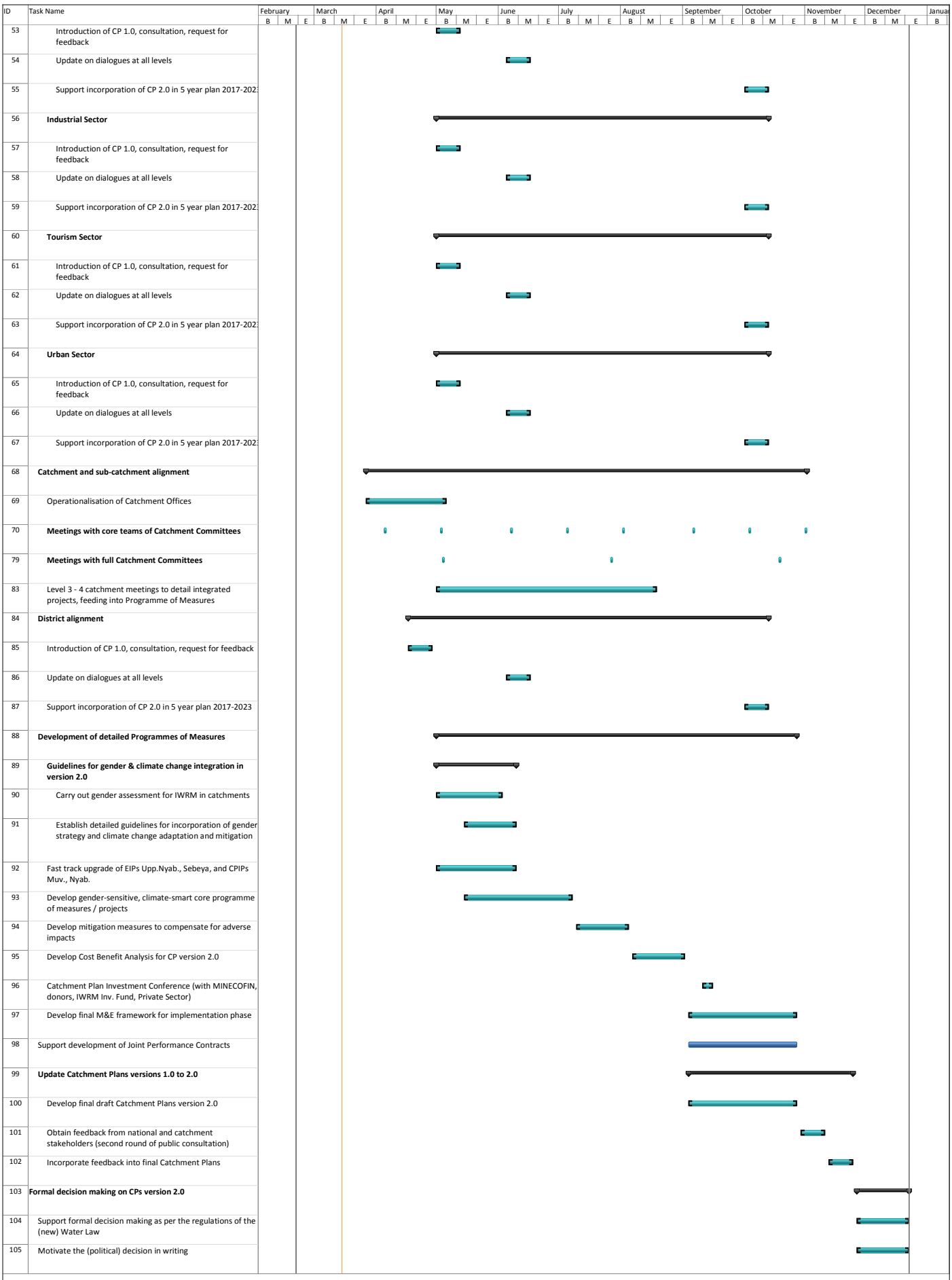
Task Name
February
March
April
May
June
July
August
September
October
November
December
1 Decision Making on CPs version 1.0
2 Submit CPs to FG and PSC
27/02
3 Review of CPs by Focal Points
4 Focal Group recommendation to PSC
10/03
5 Update Cost Benefit Analysis for CP version 1.0
6 PSC approval of CPs version 1.0
17/03
7 Review of SEA documentation
8 Review by REMA
9 Optional: review by NCEA
10 Respond to review by REMA
11 Obtain feedback from REMA on final draft CPs v2.0
12 Respond to REMA, in parallel with incorporation in CPs v2.0
13 Public Consultation on Catchment Plans version 1.0
14 Disseminate Catchment Plans v. 1.0 to national and catchment stakeholders, with request for feedback
15 Analyse feedback and develop response note, in concert with dialogues in alignment process below
16 Inform respondents on how comments will be dealt with: incorporated or not, and how
17 WEAP model governance and development
18 Develop WEAP governance plan
19 Catchment Models
20 Collect requests for updates of catchment models
21 Develop and validate models update plan
22 Verification of plan / feedback from FutureWater & W4GR
23 Update GIS analysis of final Land Cover map of Rwanda (planning subject to map delivery by Land Department)
24 Update and validate new versions
25 Update existing set of scenarios, develop report and recommendations
26 Develop new scenarios to support decision making
27 Run new scenarios and report results and recommendations to catchment planning teams
28 National Model
37 Raise awareness on WEAP among stakeholders
38 Alignment Process with national, sectoral, and district plans
39 National alignment (to be detailed with Prime Minister's Office and NWCC)
40 Vision 2050
41 EDPRS3
42 Government 7 Year Plan
43 Sector alignment
44 Mining Sector
45 Introduction of CP 1.0, consultation, request for feedback
46 Update on dialogues at all levels
47 Support incorporation of CP 2.0 in 5 year plan 2017-202
48 Agriculture and Fisheries Sector
49 Introduction of CP 1.0, consultation, request for feedback
50 Update on dialogues at all levels
51 Support incorporation of CP 2.0 in 5 year plan 2017-202
52 WASH Sector
Project: 20170310 CP plan proces
Date: Wed 15/03/17
Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress



Project: 20170310 CP plan proces
Date: Wed 15/03/17

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	