CASE

SEA for management plan of upper Nyabarongo catchment - RWANDA

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Strategic Environmental Assessment for Sustainable Development of the Hydropower Sector

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Netherlands Commission for Environmental Assessment (NCEA)

SEA FOR MANAGEMENT PLAN OF UPPER NYABARONGO CATCHMENT RWANDA

François Xavier Tetero

Authorities	Ministry of Environment
Type of plan	River catchment plan of Upper Nyabarongo catchment
Scope of SEA	Integrated river basin approach including all types of land and water use
Key SEA issues	Integrated analysis of the causes and solutions of the main problem in this catchment identified, namely soil erosion. Soil erosion affects the present hydropower capacity of 51.5 MW and the opportunities for new hydropower projects.
Stakeholder engagement	Consultation of all relevant stakeholders, public sector and private sector
Duration and year	24 months; 2016 - 2018
Influence of SEA	The SEA presented four integrated alternatives. Implementation of the preferred alternative started in 2020 consisting amongst others of a series of measures to avoid or minimise soil erosion. A governance structure was legally established to secure the development of future catchment plans by making use of SEA.
Link to SEA report	https://waterportal.rwb.rw/sites/default/files/2019-04/Upper%20Nyabarongo%20Catchment%20Plan_0.pdf

1.1 INTRODUCTION

The purpose of this paper is to describe how SEA supported the development of the Upper River Nyabarongo Catchment Plan, in which different interests including hydropower were approached in an integrated manner. The application of SEA for the river catchment plan was the first SEA in Rwanda.

Rwanda has adopted the Integrated Water Resources Management (IWRM) approach in 2011 by accepting the first National Policy on Water Resources Management (2011). This was followed by the Development of the National Water Resources Master Plan (NWRMP) which was approved by the Cabinet of Ministers in 2015. This master plan divided the country into nine level one catchments (see figure 1).

After the completion of the NWRMP and as a result of the Water for Growth Programme, the Ministry of Environment initiated the development of six-year management plans for four priority catchments which include Upper Nyabarongo (nr. 3) which is the focus of this case study.

The Upper Nyabarongo Catchment Plan was developed in the period 2016-2018 by taking into consideration the following national policies Vision 2020, Vision 2050, the National Strategy for Transformation and the nation's Green Growth and Climate Resilience Strategy.

1.2 BACKGROUND: CONTEXT AND ISSUES

Integrated situation analysis

The Upper Nyabarongo Catchment is within the Nile Basin and runs south to north in the western part of Rwanda. It has a total surface area of 3,348 km², representing 12.7% of the total surface area of Rwanda (26,338 km²).

The Nyabarongo Rivers starts from the confluence of the Mwogo and Mbirurume Rivers and run to the

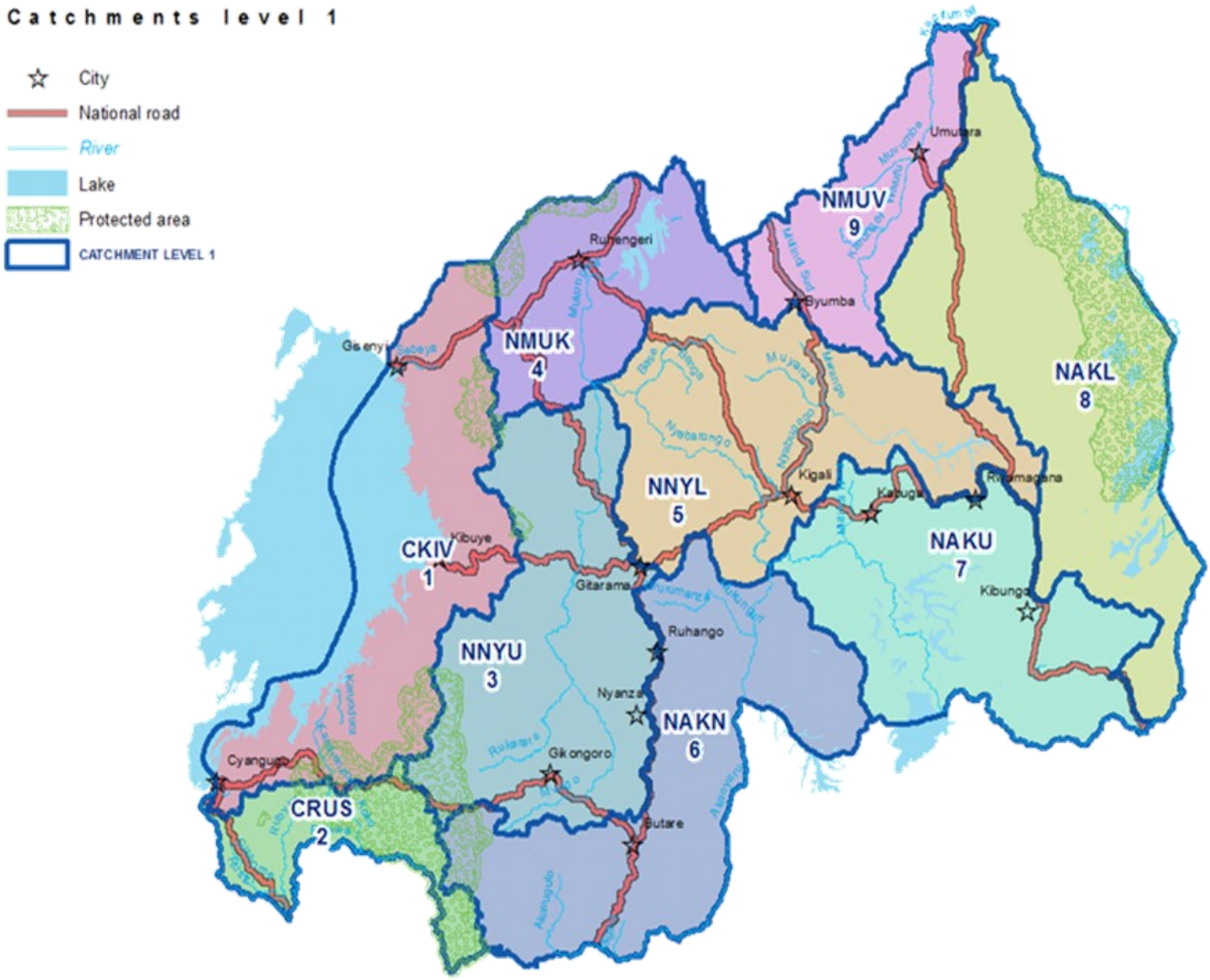


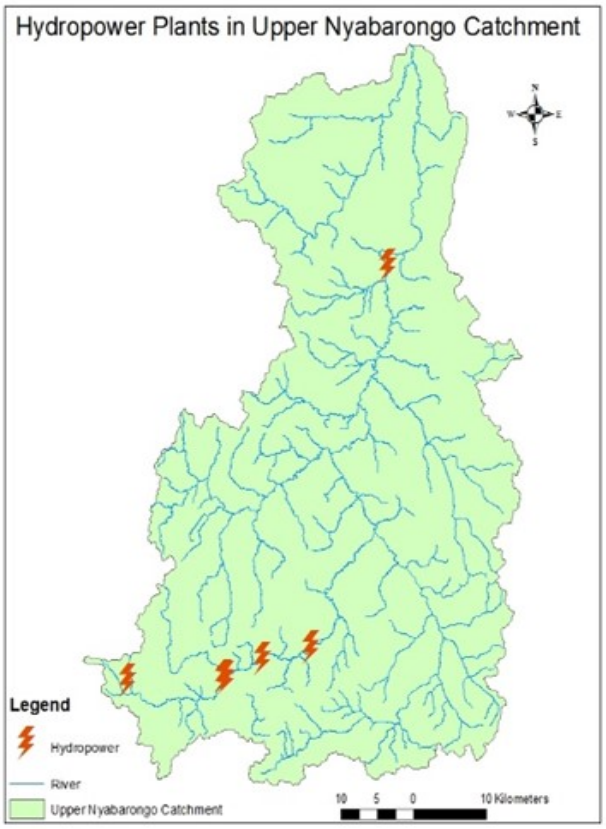
Figure1: Rwanda level one catchments *Explanation of the abbreviations of the nine level one catchments: CKIV- Congo Kivu Catchment,(ii) CRUS Congo Rusizi Catchment, (iii) NNYU Nile Nyabarongo Upper Catchment, (iv) NMUK Nile Mukungwa Catchment, (v) NNYL Nile Nyabarongo Lower Catchment, (vi) NAKN Nile Akanyaru Catchment, (vii) NAKU Nile Akagera Upper Catchment, (viii) NAKL Nile Akagera Lower Catchment, (ix) NMUV Nile Muvumba Catchment*

confluence with the Mukungwa River from where it continues as the Lower Nyabarongo on its way to the Akagera River and Lake Victoria. The catchment is renowned as Rwanda's 'water tower' and has a significant number of large tributaries, such as the Mwogo, Rukarara, Mbirurume River, Munzanga and Satinsyi Rivers. The source of Rukarara River is considered the furthest source of the Nile River.

Upper Nyabarongo is considered a strategic catchment in Rwanda. It has abundant water resources with an average annual rainfall above 1600 mm and an elevation ranging between 1,460-2,950 meters. The predominance of steep slopes and high rainfall within this catchment make it highly potential for hydropower development. Currently, 5 hydropower plants are operational on the Nyabarongo River with a total capacity of 51.5 MW (Figure 2). These include Rukarara I (9 MW), Rukarara II (2.2 MW), Rukarara VI (10 MW), Mushishito/Rukarara V (2.3 MW) and Nyabarongo I (28 MW).

The Upper Nyabarongo Catchment is strongly reliant on rainfed agriculture and produces traditional cash crops like coffee and tea, along with new ones, like honey and horticulture. The main food crops growing in this area are maize, beans, potato, wheat, cassava, banana, fruits and rice. Approximately 70% of households are also engaged in livestock rearing with the most commonly owned species being cattle, goats, pigs, rabbits and chickens. Fish farming is already practised in the Huye and Nyanza Districts and there is a shift to increase productivity in this sector through construction of small dams and fishponds. Agroforestry and forest plantations have been promoted as appropriate land use management systems in the catchment. Mining and quarrying for and of granite, tin, wolfram, colombo-tentalite (coltan) and cassiterite

Figure 2: Map showing the location of hydropower plants in the Upper Nyabarongo Catchment

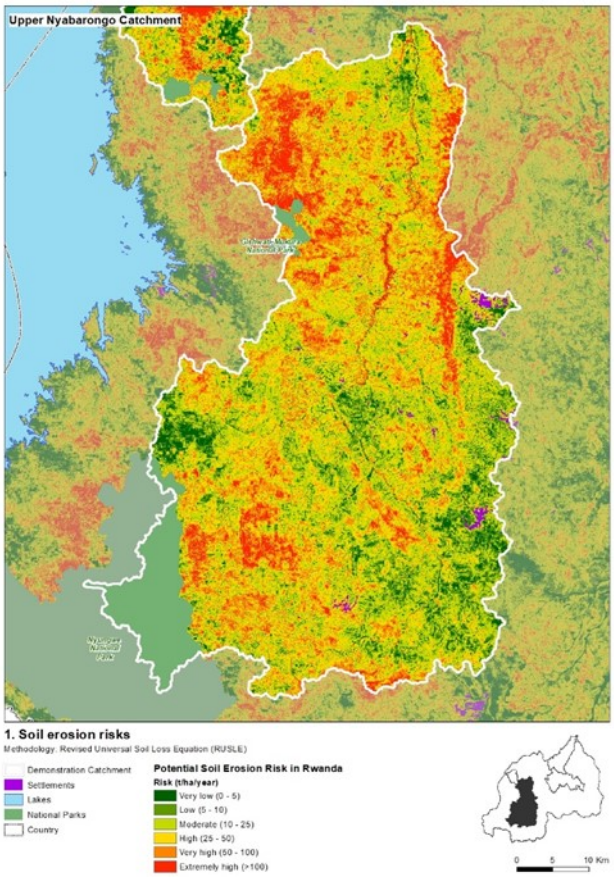


are important sources of revenue and employment. In Rutsiro, Ngororero, Nyamagabe, Muhanga, Karongi and in the Nyungwe Forest. Non-regulated artisanal mining is commonly practiced. Tourism opportunities around the natural forests in Nyungwe, Mukura, Gishwati and Busaga exist, but are still largely underexploited.

The total number of people living within the catchment is around 1.2 million (7% urban, 93% rural). The population density in the catchment is high, with the highest density areas in Muhanga and Nyamagabe and Huye (900 – 1,500 inhabitants/km2). Another densely populated area is Ngororero (600 – 900 inhabitants/km2). Poverty rates in the catchment area are still very high, with approximately 41% classified as poor and 16% as extremely poor. The cause of poverty has often been linked to high population growth and declining soil fertility in a largely agrarian-based economy.

The main sources of pollution of surface water are from soil erosion of hillside agriculture, resulting in high to extremely high river sediment loads and inappropriate mining. The former has an adverse impact on, and high removal costs for, drinking water intakes, as well as turbines and related infrastructure for hydropower stations. Both hydropower and drinking water intakes often need to shut down during periods of extreme sediment loading and operations also suffer regular interruptions as a result of the need to undertake sediment removal from settling basins associated with the intakes. Mining may also lead to contamination with heavy metals from mine ores, or with substances used in ore processing posing a human health risk. The floods are recurrent in the Upper Nyabarongo Catchment, specifically in the Mwogo and Kiryango Sub Catchments. Deforestation is also a threat in the Upper Nyabarongo Catchment as it reduces soil cover and increases siltation of rivers. Inappropriate settlement leads to generation of liquid and solid wastewater

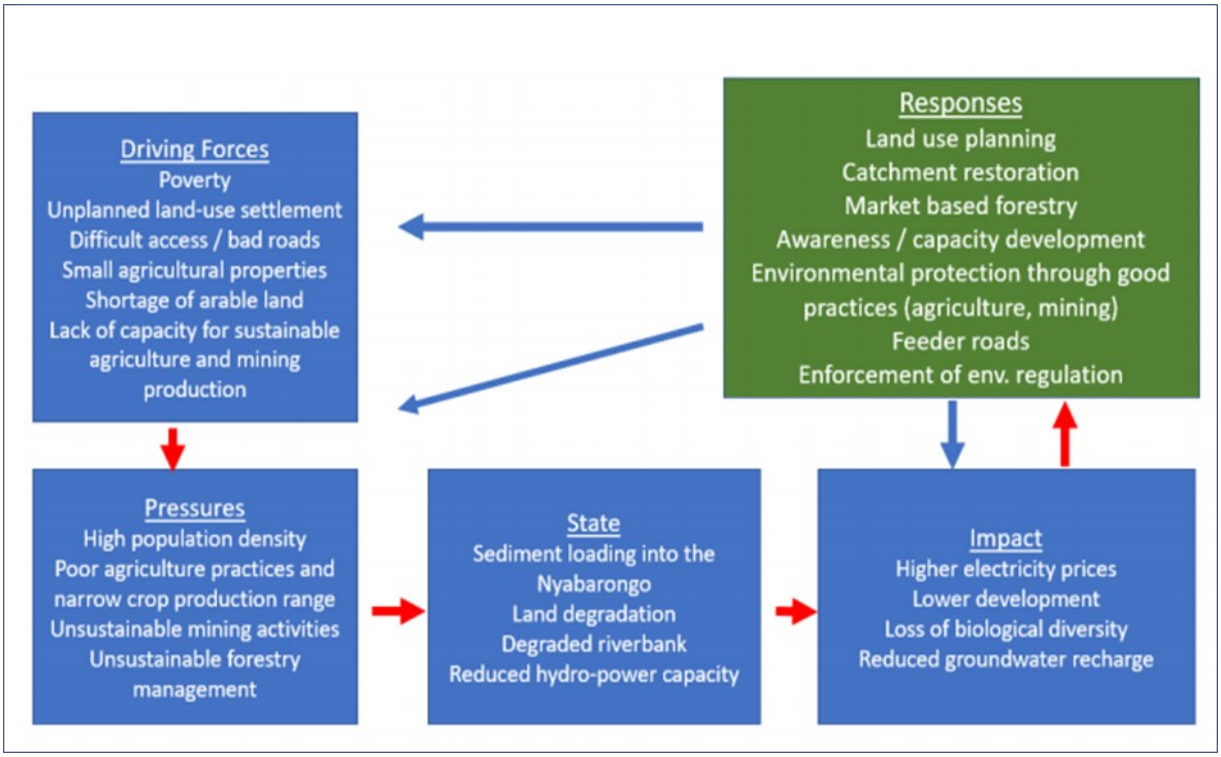
Figure 3: Map showing soil erosion risk areas in the Upper Nyabarongo Catchment



without any prior treatment.

Figure 4 illustrates an analysis of the causal relations in the catchment and it shows how the reduced hydropower capacity is the direct result of high sediment load in the Nyabarongo River. This also effects the lifetime of the Nyabarongo I Hydropower Project that is located in the catchment, see box 1.

Figure 4: Analysis of problems and responses in the most degraded areas of Upper Nyabarongo



Moreover, the high shutdown time of the hydropower facilities is also an important reason for the relatively high electricity prices.

Objectives of the plan

The above-mentioned challenges hinder the sustainable use and further exploration of the opportunities for development. That was the main reason for the development of this Management Plan.

The main objective for the development of the river catchments' plan is to "Effectively manage land, water, and related natural resources, to contribute to sustainable socio-economic development and improved livelihoods. Taking into consideration environmental flow, downstream water demands and resilience to climate change, and minimise water related disasters."

The specific objectives were mainly to:

- improve water quality and quantity in water bodies considering resilience to climate change in the catchment;
- reduce the pressure on natural resources by diversifying alternative livelihoods;
- ensure equitable allocation of available water resources for rural and urban users of current and future generations;
- strengthen the water governance framework to ensure effective implementation of integrated programmes.

Achievement of the specific objectives are conditional for optimisation and lifetime of the present hydropower capacity and further development of new capacity. However, specific objectives for hydropower have not been set. Box 1 provides a brief description of the characteristics of the hydropower sector in Rwanda.

Box 1: Hydropower in Rwanda

The total installed power generation capacity is about 228 MW, hydropower contributing 48% of it. Nearly all operational hydropower projects are medium size and most of these are run of the river type of projects. Scattered though the country micro and mini hydropower project are operational and nearly all are connected to the national grid (see table 1). There are also pico-hydropower plants in the range of 1-10 kW which are either publicly owned or operated by the local communities or entirely private. They are not included in the table.

Rwanda is planning to expand its power generation capacity up to 556 MW in 2024 and hydropower is expected to contribute 74% to it. Therefore, shared regional hydropower projects will be developed with neighbouring countries and many micro and small hydropower projects will be developed with an estimated capacity of 8 MW.

Table 1: List of operational and proposed hydropower plans in Rwanda in 2020.

Hydro-electric station	River	Type	Capacity (MW)	Year completed
Operational – medium				
Mukungwa	Mukungwa	Reservoir	12 MW	1982
Mukungwa II	Mukungwa	Run of river	3.6 MW	2010
Ntaruka	Mukungwa	Reservoir	11.5 MW	1959
Rugezi	Mukungwa	Run of river	2.6 MW	2011
Rwaza-Muko	Mukungwa	Run of river	2.6 MW	2018
Nyabarongo I**	Nyabarongo	Run of river	28 MW	2014
Rukarara I**	Rukarara	Run of river	9.5 MW	2010
RukararaII**	Rukarara	Run of river	2.2 MW	2014
RukararaVI**	Rukarara	Run of river	10 MW	2016
Mushishito(Rukarara V)**	Rukarara	Run of river	2.3 MW	2019
Rusizi I*	Rusizi	Run of river	4.1 MW	1958
Rusizi II*	Rusizi	Run of river	12.0 MW	1989
Gisenyi	Sebeya	Run of river	1.7 MW	1957
Gihira	Sebeya	Run of river	1.8 MW	1984
Keya	Sebeya	Run of river	2.2 MW	2011
Giciye I	Giciye	Run of river	4.0 MW	2014
Giciye II	Giciye	Run of river	4.0 MW	2016
Operational – mini / micro			4.5 MW	
Total operational			118.6 MW	
Proposed – medium				
Rusumo *	Kagera	Run of river	80 MW	2021
Nyabarongo II	Nyabarongo	Reservoir	120 MW	2024
Rusizi III *	Ruzizi	Reservoir	147 MW	2026
Rusizi IV *	Ruzizi	Run of river	200 MW	2028
Proposed – mini / micro			8 MW	2024
Total			555 MW	

*) Developed with neighbouring countries, the capacity indicated is available for Rwanda.

**) Rukarara I, II, V & VI and Nyabarongo I are located in the Upper Nyabarongo Catchment while Nyabarongo II will be located in the Lower Nyabarongo Catchment. Sources : ESSP 2014 ; SEA 2015 ; https://www.mininfra.gov.rw/index.php?id=79

1.3 Approach and methods used

As this concerns a Strategic Plan, carrying out a Strategic Environmental Assessment (SEA) was obligatory according to the Rwandan Organic Law on the Environment (2005). A tailor-made approach was developed supported by the Netherlands Commission for environmental Assessment (NCEA), that advised on integration of plan development and SEA requirements (See table 2).

Table 2: Overview of SEA steps and the integrated approach based upon IWRM and SEA steps

SEA process steps		Integrated approach - IWRM & SEA
Screening 1. Reach consensus on the need for SEA and its link to planning		n.a.
2. Find stakeholders and announce start of the plan process		**Situation analysis:** Develop catchment characterisation report with analysis of important aspects of the catchment: • Physical characteristics; • Water resources characteristics; • Socio-economic analysis; • Stakeholders analysis (of SEA step 2) Consistency analysis of existing policies, plans, programmes (SEA step 4).
Scoping 3. Do a consistency analysis for relevant policies that have consequences for the plan 4. Develop a shared vision on problems & opportunities …		**Vision development:** Creating a vision for the medium to longer term future (SEA step 3) with the Catchment Task Force, kicking off in a joint scoping workshop, and developing ToR for the plan development and assessment (SEA step 5)
…define plan objectives and draft alternatives to reach these objectives 5. Set ToR for the technical assessment, based on scoping results		**Integrated planning: Develop** Catchment Plan considering competing land and water interests and comprising: • water allocation; • water resources protection/conservation; • land use / catchment rehabilitation. Assessment of development alternatives (SEA step 6).
Assessment 6. Assess impacts of alternatives and document this. 7. Organise (independent) quality review (involving stakeholders)		**Independent quality assurance** of documentation by the Catchment Task Force and representatives of key Agencies and Ministries (SEA step 7). Participatory decision making involving local and central levels (SEA step 8)
Formal decision-making 8. Discuss with all stakeholders the preferred alternative 9. Motivate the (political) decision in writing		n.a.
n.a.		**Coordinated implementation**: the implementation of the sector and agency plans respects the time schedules and designs formulated in the integrated plans
Monitoring 10. Monitor the implementation and discuss the results		**Monitoring** of implementation is assured by stakeholders in the catchment, together with regular monitoring procedures of implementing organisations, resulting in annual catchment plan implementation M&E reports (implementation of SEA step 10).

Organisational structure

An organisational structure for the development of catchment plans was set up at national and at catchment level. The lead agency is the Water Resources Management Department (WRMD) of the Rwanda Water and Forestry Authority (RWFA) responsible to guide the development of the plans with the support of a team of experts from the Water for Growth Programme. A steering committee was established, chaired by the Permanent Secretary of the Ministry of Environment and senior representatives of key ministries and agencies namely the Ministry of Local Government (MINALOC), the Ministry of Infrastructure (MININFRA), the Ministry of Agriculture and Animal Resources (MINAGRI), the Ministry in charge of Emergency Management (MINEMA), a representative of Non-Governmental Organisations (WATER AID) and the representative of the Embassy of the Kingdom of The Netherlands (EKN) in Kigali which funded the Water for Growth Programme. The steering committee was responsible for approval of catchments' management plans. They were supported by a technical team of experts from their respective institutions which was called the Focal Group.

Stakeholder engagement

Adoption of a participatory approach is one of the characteristics of the integrated approach applied. In order to ensure a better representation of stakeholders at catchment level, a task force was established for the catchment known as the Catchment Task Force (CTF). The composition of this task force included:

1. the Vice Mayor in charge of Economic Affairs from each district covered by the catchment (one of them was to be elected as the Chair of the CTF);
2. officers in charge of environment from each district covered by the catchment;
3. a representative of the women council from each district;
4. a representative of the private sector from each district;
5. a representative of the youth council from each district; and
6. a representative of Civil Society Organisations (CSOs) from each district.

The consultation process also included representatives of key agencies and ministries like those in charge of agriculture, energy, water and sanitation, mining and disaster management. The members of the task force and the representatives of key agencies and ministries were consulted at each step of the planning process.

Scenarios and alternatives

As a result of the planning process, a programme of measures for the catchment was formulated which consisted of a list of projects or interventions to be undertaken in order to enhance catchment management. Considering that the catchment plan was developed in the context of integrated water resources management and development, such measures were derived from a broad range of technical and non-technical areas and the main focus was on catchment restoration, water allocation and water governance.

As part of catchment restoration, the main objective was to reduce the sedimentation of the rivers which is a serious threat for hydropower use and development. The proposed measures included afforestation on very steep slopes, terracing on agriculture land, protection of buffer zones of rivers.

The other key component of the catchment plan was the development of a water allocation model in order to manage water availability and demand for the current situation and projections in the future. For that purpose, three scenarios were developed:

1. low economic development, low population growth and limited climate change impacts;
2. moderate economic development, moderate population growth and moderate climate change impact;
3. high economic development, high population growth and high climate change impact.

For each of the three development scenarios, the water allocation model assessed the availability of water compared to the demand which was the basis for selecting the best scenario against which management alternatives were to be compared. Through a series of consultations with the Catchment Task Force and the expert group (Focal Group), it was agreed to use scenario number 2 as the reference scenario against which four management alternatives were compared.

The four management alternatives assessed for the catchment were:

A. increased water storage;
B. increased water storage + sustainable land management;
C. increased water storage + sustainable land management + water use efficiency;
D. increased water storage + sustainable land management + water use efficiency + reduced irrigation.

In selecting a preferred alternative, the merits of the two most ambitious alternatives number C and D were compared to each other. Considering the importance of irrigated agriculture for food security in Rwanda and the fact that water availability was found not to be a limiting factor in the Upper Nyabarongo Catchment (even if the full hydropower potential is exploited especially under the selected medium scenario of population growth, economic development and climate change), alternative C was selected as the preferred alternative.

This plan was translated into water allocation plans for all sub-catchments. This alternative has the desired effect of balancing the need for energy security by maximising the potential for hydropower development with food security, whilst avoiding local water shortage. This can be achieved by combining the development of water storage, sustainable land management, and enhanced water use efficiency in all sectors especially in irrigation.

The selected alternative and related Programme of Measures by the Catchment Task Force and the group of experts from key national agencies (Focal Group) was endorsed by the Steering Committee.

Programme of measures

A Programme of Measures was developed for the Upper Nyabarongo Catchment Plan, primarily for the implementation period 2018-2024.This plan consists of four main components:

1. landscape restoration
2. water allocation
3. water governance and
4. knowledge management

1. Landscape restoration

The focus is on reduction of soil erosion and improvement of land and water productivity. It was found that an estimate of 55,000 ha in the Upper Nyabarongo Catchment will be rehabilitated. The following measures are applied to restore the physical status of the catchment: construction of terraces, agroforestry and afforestation, and gullies rehabilitation.

2. Water allocation

This refers to water demand and management measures that need to be implemented. These measures ensure that the amount of water available in the catchment, meets future demands for e.g. agriculture, industry, public water supply and hydropower. The preferred alternative C, was translated into water allocation plans for all sub-catchments, per month, per water user, and for the planning of 2024, 2030, and 2050. These then formed the basis for water permits and operational water resources management following a prioritisation 'ladder', as follows:

- first priority was given to domestic water supply, followed by;
- livestock;
- environmental flow (to provide water to ecosystems and downstream water users);
- industrial water demand (due to its very limited size and the fact that demand is constant throughout the year and independent of rainfall); and
- irrigation.

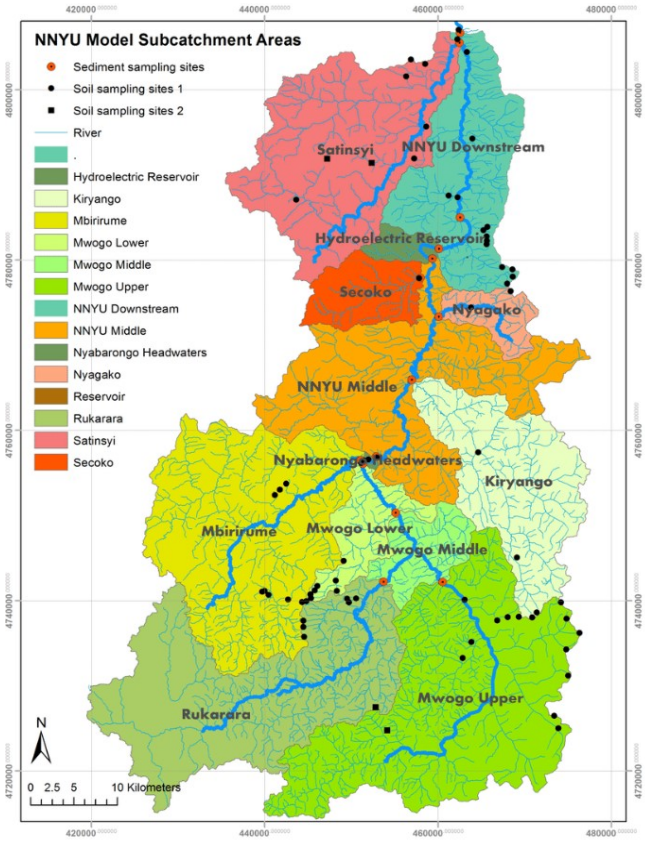
3. Water governance

This refers to institutional, policy and legislative measures that need to be implemented to ensure implementation of all other measures. It refers to the way in which a catchment is 'governed', by whom and how and under which framework. A Catchment Task Force was established to represent catchment stakeholders in the development of this Catchment Plan, within the Water for Growth Programme. The New Water Law (2018) stipulates the creation of Catchment Committees. Following ministerial order, these committees will be established and operationalised.

4. Knowledge management

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

Figure 5: Map illustrating the results from the sediment fingerprinting study in Upper Nyabarongo Catchment



Implementing the Catchment Plan

This Catchment Plan is a joint plan of many stakeholders, each with their own mandate and interests. The plan was, however, the starting point for joint sector and agency planning and subsequent coordinated implementation. As of 2020, feasibility studies for a series of IWRM packages have already been completed and are implemented. In order to prioritise where to concentrate efforts considering the fund's limitations, it was decided to prioritise the upstream part of the Nyabarongo Hydropower dam I. A sediment finger printing study was conducted to determine the sub-catchments that most contributed to the siltation of the Nyabarongo River with special focus on the Nyabarongo dam I. Secoko Sub Catchment was found to be the most contributing one. Its detailed rehabilitation plan which was subsequently developed, is currently implemented.

Figures 5 and 6 illustrate the outcomes from the sediment fingerprinting study and the detailed rehabilitation plan for the Secoko Sub-Catchment.

Figure 6: Detailed rehabilitation plan for the Secoko Sub Catchment which is under implementation.

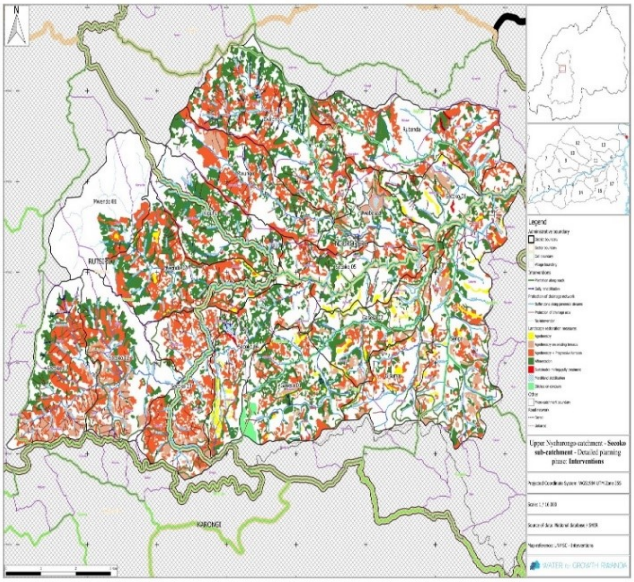


Figure 7: Picture illustrating the rehabilitation works in the Secoko Sub-Catchment with terraces.

Many stakeholders are involved in implementing the Catchment Plan, that requires coordination at catchment level to ensure consistency of individual projects that fall under the Upper Nyabarongo Catchment Plan. A provision for establishing Catchment Management Committees was included during the revision of the law determining the use and

management of water resources in Rwanda in 2018. A ministerial order governing these committees has been drafted awaiting its publication in the official gazette.

The development of Upper Nyabarongo Catchment plan provided an opportunity for all stakeholders to learn about IWRM, SEA and spatial planning. Lessons learnt will be applied in the development of the next series of catchment plans, for 2024-2031 and 2031-2038.

Indirect effects

The integrated SEA – IWRM approach supported the development of four catchment plan simultaneously. The plan for the Upper Nyabarongo catchment was one of these plans. Based upon this experience a manual was prepared by the ministry of water resources how to develop a catchment plan by making use of SEA-IWRM. Presently, catchment plan supported by SEA-IWRM are under preparation in the remaining five category 1 catchments.

1.4 Results and lessons learnt

The Upper Nyabarongo Catchment plan was together with three other catchment plans, the first which were prepared in Rwanda in a truly participatory manner. Innovative was the integration of the SEA process steps into IWRM-based catchment planning approach. Another innovation brought by the SEA was the development of inter-district collaboration around natural resources, based on catchment boundaries, and by establishing a Catchment Task Force comprising of district vice mayors, district technical staff, and representatives of NGOs, National Women Council, National Youth Council and the Private Sector Federation. Innovations were also made at the technical level. GIS was used to map spatial information that is usually only shared through text and tables (information on key features, issues, opportunities, projects, etc.), and surveys were held to collect geo-referenced data on water users.

Considering that the most pressing issue in the catchment is soil erosion which is negatively impacting hydropower development as well as the development of domestic water supply systems; an innovative tool named “Catchment Restoration Opportunity Mapping and Decision Support System” was developed in order to locate areas prone to soil erosion and to define appropriate control measures. This tool was later upscaled at national scale and is now widely used for planning and reporting on soil erosion control interventions primarily by district but also central government agencies.

In addition, as a result of the planning process and SEA, a water allocation model was developed in order to ensure equitable water resources allocation and therefore preventing water use conflicts among competing uses water utilities and hydropower developers.

The preparation of the catchment plan by making use of the integrated SEA inclusive IWRM approach resulted in the following four lessons for future use:

1. IWRM and SEA are both participatory processes. Both are equally valuable in shaping the participatory process. SEA secures quality in the development and approval of catchment plans and has the potential to enhance buy-in of stakeholders at an early stage.
2. The structured process allowed for plan development in a participatory manner, with representatives of national and local government, and of NGOs, the National Women Council, and the Private Sector, with the local level brought together in the Catchment Task Force. Furthermore, primary beneficiaries (the population and businesses in the catchment) participated at field level in the areas where projects were implemented or under preparation. At all levels, the opportunity to participate from the earliest stages of plan and project development was appreciated by stakeholders.
3. The use of GIS and map development is still limited, certainly at district level. Much of the data is only available in tabular or textual form or can only be obtained verbally or on site. Sharing of (spatial) information is not formalised, and in practice often tedious and incomplete. Availability of this information is a condition integrated spatial planning, such as catchment planning.
4. The integrated approach to the catchment development plan resulted in a set of measures that will stop and prevent soil erosion which is necessary to (i) secure the utilisation of the existing hydropower capacity and (ii) find investors who are interested to develop new hydropower projects.

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Colophon

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