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MINISTRY OF NATURAL RESOURCES

Rwanda Natural Resources Authority

NATIONAL RAINWATER HARVESTING STRATEGY

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ACRONYMS

CKIV	Congo Kivu Catchment
CRUS	Congo Rusizi Catchment
DRWH	Domestic Rainwater harvesting
EDPRS	Economic Development and Poverty Reduction Strategy
ERHA	Ethiopia Rainwater harvesting Association
FONERWA	Environment and Climate Change Fund
GoR	Government of Rwanda
GWP	Global Water Partnership
IRHA	International Rainwater Harvesting Alliance
IWRM	Integrated Water Resources Management
KRA	Kenya Rainwater Harvesting Association
LWH	Land husbandry, Water Harvesting and Hillside Irrigation
M&E	Monitoring and Evaluation
MIDIMAR	Ministry of Disaster Management and Refugees Affairs
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 Trade and Industry
MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
MINISANTE	Ministry of Health
NAKL	Nile Akagera Lower Catchment
NAKN	Nile Akanyaru Catchment
NAKU	Nile Akagera upper Catchment
NGO	Non Governement Organisation
NISR	National Institute of Statistics of Rwanda
NMUK	Nile Mukungwa Catchment
NMUV	Nile Muvumba Catchment
NNYL	Nile Nyabarongo Lower catchment
NNYU	Nile Nyabarongo Upper catchment
PSTA	Strategic Plan for Agriculture Transformation
RAB	Rwanda Agriculture Board
RBS	Rwanda Bureau of Standards
RDB	Rwanda Development Board
REG	Rwanda Energy Group
REMA	Rwanda Environment Management Authority
RGGCRS	Rwanda Green Growth and Climate Change Resilience Strategy
RAIN	Rain Foundation
RHA	Rwanda Housing Authority
RNRA	Rwanda Natural Resources Authority
RTDA	Rwanda Transport Development Authority
RURA	Rwanda Utilities Regulation Agency
RWH	Rainwater harvesting

SDGs	Sustainable Development Goals
SEARNET	Southern and Eastern Africa Rain Network
SWOT	Strengths, Weaknesses, Opportunities, Threats
URHA	Uganda rainwater Harvesting Association
WASAC	Water and Sanitation Corporation
WRM	Water Resources Management

1. INTRODUCTION

1.1. Rationale for the development of the Strategy for Rain Water Harvesting

With Rwanda's relatively substantial amount of rainfall of 1200 mm annually, rain water harvesting (RWH) may prove to be an alternative source of water which will help to meet ever increasing and conflicting demands for human needs, socioeconomic development as well as environmental protection. Depending on the location and the availability of alternative water resources, RWH becomes the cheapest option locally available. RWH techniques can be used as exclusive or as complementary supply source for economic activities in the form of hill side irrigation, cattle watering and for industrial processes. These techniques also provide environmental benefits in the form of erosion and flood control.

The recently designed National Water Resources Master Plan that was approved in 2015 clarifies the situation under which Rwanda falls. In technical terms if a country is below 1700 cubic metres per person per year that country is said to be experiencing water stress. If this quantity falls below 1000 cubic metres then the country is experiencing water scarcity. The worst case is if the level is below 500 cubic metres which is referred to as absolute water scarcity. Today Rwanda's water availability per capita is 670 cubic metres per person per year which classifies it as a water scarce country.

This revelation implies changes in water resources management. As rainwater harvesting is dedicated an important role in achieving water security, it is assumed that these changes can only be better addressed in the framework of a comprehensive Rainwater harvesting Strategy. The overall objective of this strategy will be contributing to socio-economic development and environmental protection through sustainable water security. This shall be through looking at the horizon and comparing all the main water demand to the water availability. The strategy will promote water storage development through construction of infrastructures with special emphasis on multi-purpose dams. The strategy will also strengthen rain water harvesting from roof-tops and water run-off from road networks. The other aspects of the strategy will include soil and water conservation measures as well as techniques for ground water recharge through seepage in both rural and urban areas. All these measures will contribute significantly to the reduction of floods and drought risks with resultant resilience to climate change.
It is against this background that MINIRENA is developing an inclusive and holistic strategy for rainwater harvesting that will eventually lead to attaining national water security.

1.2. National and international context

1.2.1 Vision 2020

Rainwater harvesting strategy is in line with the target of the Vision 2020 related to access to water for all Rwandans by 2020. Rainwater harvesting and water storage development will contribute to the achievement of this target. Collecting rain water from the roof tops and storing rainwater in dams, valley dams and water ponds will increase access to water and water storage per capita. Thus contributing to water security and water multiple use in different development sectors especially for domestic consumption, agriculture and livestock production, industrial production and environmental protection.

1.2.2 The Economic Development Poverty Reduction Strategy.

One of the key outcomes of this strategy is increased access to water and sanitation .The goal for EDPRS2 is to ensure universal access to water and sanitation. The aim is to ensure that households across rural areas in Rwanda are within 500m of an improved water source. Rainwater harvesting strategy will contribute to the goal of EDPRS 2 of managing water resources according to IWRM approach.

1.2.3 Sustainable Development Goals (SDGs)

The seventeen (17) Sustainable Development Goals (SDGs) were adopted in September 2015 as the new Post-2015 global agenda. Six (6) out of the proposed seventeen (17) SDGs are directly addressing the challenges affecting our planet related to climate change and environmental degradation with implied water harvesting and storage strategies to meet water security demands for water supply to various water users. The six SDGs related to water harvesting strategic objectives are shown in the table below.

Table 1: Link between SDGs and rainwater harvesting Strategic Objectives

Sustainable Development Goal	Corresponding Rainwater Harvesting Strategic Objectives
✓ Ensure availability and sustainable management of water and sanitation for all (goal 6)	✓ To increase rain water harvesting infrastructures for effective multiple use ✓ To promote infiltration and groundwater recharge in urban and rural areas for minimized surface run-off and floods to reduce vulnerability to climate change and environmental degradation. ✓ To strengthen policy, legal and regulatory framework for improved water harvesting coordination and management
✓ Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all (goal 8)	✓ To increase rain water harvesting infrastructures for effective multiple use ✓ To promote infiltration and groundwater recharge in urban and rural areas for minimized surface run-off and floods to reduce vulnerability to climate change and environmental degradation.
✓ Take urgent action to combat climate change and its impacts (Goal 13)	✓ To promote infiltration and groundwater recharge in urban and rural areas for minimized surface run-off and floods to reduce vulnerability to climate change and environmental degradation. ✓ To promote research, innovation and creativity for improved water harvesting and storage systems and technologies
✓ Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss; (goal 15)	✓ To promote infiltration and groundwater recharge in urban and rural areas for minimized surface run-off and floods to reduce vulnerability to climate change and environmental degradation.

	✓ To promote research, innovation and creativity for improved water harvesting and storage systems and technologies ✓ To strengthen policy, legal and regulatory framework for improved water harvesting coordination and management
✓ Make cities and human settlements inclusive, safe, resilient and sustainable (goal 11)	✓ To increase rain water harvesting infrastructures for effective multiple use ✓ To promote infiltration and groundwater recharge in urban and rural areas for minimized surface run-off and floods to reduce vulnerability to climate change and environmental degradation.

Source: Adapted from MINECOFIN and MINIRENA, 2016

1.2.4 Rwanda Green Growth and Climate Resilience Strategy.

The need for water storage development and rainwater harvesting is highly pointed out in the third program of action of the green growth and climate resilient strategy. It is stated that, considering that climate change is bringing uncertainties in future water supply, *Rwanda will develop a National Water Security Plan to employ water storage and harvesting, water conservation practices, efficient irrigation, and other water efficient technologies.* Also one of the indicators under the same program of action is related to *water storage per capita.* Rain water harvesting strategy will contribute to proper implementation of the green growth and climate resilience strategy by increasing water storage per capita , favoring infiltration and ground water recharge and reducing adverse impacts of climate change especially floods and droughts .

1.2.5 Strategic Plan for the Transformation of Agriculture (Phase III).

PSTA III identifies rainwater harvesting as a significant source of water especially for small scale irrigation. It also focuses on soil conservation through land protection structures and planting of agroforestry trees. The Sub-programme 1.1 on Soil conservation and land husbandry proposes lines of action for land protection structures that involves construction of progressive and radical terraces and agro-forestry practices. The Sub-programme 1.2 on Irrigation and water management provides for lines of action related to public and private Sector Irrigation Development through hillside, marshland and small scale irrigation and integrated watershed management.

1.2.6 Rwanda Water Resources Master Plan.

The Rwanda Water Resources Master Plan defined nine level 1 catchments which are listed in Annex1. Rwanda Water Resources Master Plan summarises outstanding issues and recommended actions for each of the nine catchments. These are mostly related to rainwater harvesting and they are presented in the following table.

Table 2: Issues and recommended actions for the nine catchments

N^0	Issues	Catchments	Priority actions
1.	Soil erosion	All catchments	Soil erosion control measures
2.	Difficult access to groundwater	CKIV, CRUS, NNYU, NMUK and NAKN	Promote appropriate technology to exploit groundwater
3	Population increase high rate	All catchments	Increase water storage per capita and access to water
4	Very low current use of water	All catchments	Promote multiple use of water
5	Conflict over water use	CKIV and CRUS	Equitable water allocation
6	Insufficient water supply services in the rural domains	All catchments	Water supply for domestic use, industry, agriculture, mining and non-hydro power plants.
7	Predominance of rain fed agriculture	All catchments	RWH for livestock and irrigation ponds
		CKIV,CRUS,NNYU, NAKLNNYL,NAKN, NAKU,NMUV	Irrigation marshland
		CKIV,NNYU,NMUK, NNYL, NAKN, NAKU, NAKL, MUV	Irrigation dams
		CKIV,CRUS,NNYL, NAKN, NAKU, NAKL, NMUV	Irrigation from lakes and rivers
		NNYU,NNYL,NAKN, NAKU,NAKL, NMUV	Hillside irrigation
		NNYU,NNYUL, NAKN,NAKL,	Irrigation from groundwater

Source: Adapted from MINIRENA, 2015

Recommended actions are related to soil erosion control and water supply services in rural domains particularly domestic use, industry, agriculture and mining. For priority action related to soil erosion control**,** key areas for rainwater harvesting include the development of soil erosion control structures such as progressive and radical terraces, contour bands, ridges, agroforestry practices, gabion construction and storage of water from roads network.

1.3 Governance, policy and legal framework for Rain Water Harvesting

1.3.1 Governance of Rain Water Harvesting in Rwanda

Rainwater harvesting is under the mandate of the Ministry of Natural Resources (MINIRENA) directly falling under the supervision of the Department of Integrated Water Resources Management. MINIRENA coordinates IWRM as one of the six subsectors under the Environment and Natural Resources Sector together with (i) Lands and Mapping; (ii) Environment and Climate Change; (iii) Forestry and Nature Conservation; (iv) Mining and Quarries; (v) Meteorological Services.

Rwanda Natural Resources Authority is a body that manages the natural resources which consist of land, water, forests and mines. In particular, RNRA is responsible for implementing national policies, laws, strategies, regulations and government resolutions in matters relating to the promotion and protection of natural resources. The Department of Integrated Water Resources Management (IWRMD) is in charge of implementation of the Policy and Strategies for sustainable water management in order to meet Rwanda's socio-economic and ecological development needs. Key priorities to achieve this vision and mission include strategic actions related to rainwater harvesting with a clear aim to ensure water availability and water security. The IWRMD operates through its two Units in charge of Water Resource Monitoring and Water Regulation.

1.3.2 Policy framework for Rain Water Harvesting in Rwanda

Rainwater harvesting mainly refers to policies related to water supply and sanitation and water resources management. In the ***National Policy and Strategy for Water Supply and Sanitation Services*** adopted in 2010 some references have been made on the promotion of RWH. The policy states that Rainwater catchment systems will be promoted as a complementary source of water for both households and public buildings and as another means to decrease risks of runoff impacts and to increase water availability for hygienic purposes especially for locations that could otherwise only be supplied by diesel pumping (for instance, parts of the lava region).Water quality is assumed to be acceptable for improved water sources but shall be tested for compliance with national and World Health Organization (WHO) standards for potable water. Related to the financing modality types of non-government and private sector investments to be encouraged and co-financed among others is community self-help initiatives to be financed through micro-finance schemes.

The ***National policy for water resources management*** adopted in 2011**,** under the statement on water resources conservation states that "*The water resources of Rwanda will be conserved, protected and managed in order to secure and enhance its availability for, and utility to, the present and future generations*". One of the strategic actions is "*To promote water conservation techniques and technologies, including rainwater harvesting, water recycling and other appropriate technologies*". The policy also provides to institute measures for managing water related disasters and stresses, arising from climate change, floods, droughts and demographic trends. It also calls for the establishment of systems for enhancing water security by developing water storage and reservoir facilities and systems.

1.3.3 Legal framework for Rain Water Harvesting in Rwanda

In its Article 57, the **law n°62/2008 of 10/09/2008** putting in place the use, conservation, protection and management of water resources regulations stipulates that collective sanitation shall mean an act of putting in place a collective network named "*collective sanitation network*", in order to ensure collection of water used in homes, factories, and rain water for treatment in order to meet public health standards, preservation of water resources and the environment. In addition to this, article 71 provides that "Public works meant to bring water to people including treatment, distribution be it for domestic or industrial use shall be done in accordance with the law and the same shall apply to rain water".

According to article 11 of **Law No 20/2011 of 21/06/2011** governing human habitation in Rwanda, it is mandatory to put in place water collection and drainage systems in urban areas. For the purpose of environmental protection, preservation and promotion, each urban human settlement area must be equipped with an adequate rainwater collection and drainage system that is in compliance with hygiene and sanitation legislation. Following article 14, the same applies in each rural human settlement. The **Ministerial Order N° 04/Cab/015 of 18/05/2015** determining urban planning and building regulations provides for guidance of storm-water management and soil erosion control measures (article11).

1.4 Rain Water Harvesting Strategic Priorities

Considering the importance of rainwater harvesting regarding its contribution to water security, key actions to be undertaken aim at setting up a **policy, legal and institutional framework** that proposes an effective legal (regulatory) and policy framework for promotion of RWH and creates appropriate incentive regime to augment existing rainwater harvesting activities.

The strategy will also encourage the d**evelopment of infrastructure for rainwater harvesting and storage.** Equipping public buildings and households with basic RWH system, harvesting run-off water from the road network and constructing dams, ponds and irrigation channels will increase water availability and security in order to meet the targets set by the National water resources management plan in 2020, 2030 and 2040.

The strategy will contribute to **increasing of infiltration and ground water recharge in urban and rural areas** through the greening of the cities and the development of artificial groundwater recharge infrastructures in urban areas. At the same time, soil conservation and ground water recharge activities will be undertaken in rural areas to reduce vulnerability to climate change, risks to floods and droughts and ensure environmental protection through soil erosion control structures like progressive and radical terraces, contour bands, ridges, agroforestry practices, the construction of check dams, gabion, multipurpose dams, water ponds, up scaling hillside, marshland and small scale irrigation.

Research, innovation and capacity building for rainwater harvesting will focus on initiating and strengthening research and conducting technical and feasibility studies for RWH applications. Trainings and technical exchanges will be organized for the community and the IWRM staff and key stakeholders. Modern Information and Communication technologies and media production will also be used to promote rainwater harvesting activities.

2. RAINWATER HARVESTING SUBSECTOR STATUS/ACHIEVEMENTS

2.1 The contribution of rainwater in accessing water for households and Institutions

The international definition of an improved water source includes: protected springs, public standpipes, water piped into dwelling/yard, boreholes, protected wells and rain water collection. According to EICV4, 2013/2014 the proportion of households using rainwater as the main drinking water source is 0.2% for both urban and rural households against 2% for urban and 0.4% for rural households in EICV3, 2010/2011.The highest rate is 0.6% for the Western Province and the lowest is 0% for Kigali City and the Southern Province.

The baseline survey carried out for the RNRA project[1] in 2014 interviewed 1200 users in 6 districts in Rwanda (Gasabo, Kicukiro, Nyarugenge, Musanze, Nyabihu and Rubavu) and found that 28.6% of the population uses RWH as their source of water. But the survey also mentions that over 60% of those use jerry cans for storage. The harvested water is insufficient for the majority of people interviewed (about 72%). It lasts one month on average. Once depleted, many people use piped water or springs. About 62% of the surveyed institutions and businesses use RWH and they get over 50% of their water from RWH against around 25% from WASAC. The main use of the water was for washing and cleaning (about 70%). Plastic and metal tanks account for 61% and 8% respectively. Jerry cans are also very popular with 21%

2.2. Status of rainwater harvesting collection systems on households

EICV4, 2013/2014 shows the percentage of households with rain water management system. 17% of households in Rwanda have a way of managing rain water. Households in Rwanda use mostly ditch (13%) compared to other used types of rainwater management system. Only 2% of households use rain water tanks in 2013-14. Underground storage of rainwater using ditches is most practiced in the City of Kigali (27.4%) and the Western Province (24.6%).

Table 3: Percentage of HHs with rainwater catchment systems, by province, urban/rural

EICV4	Total % of HHs with rainwater harvesting systems	HHs with types of rainwater catchment systems				Total number of HHs (in 000s)
		Rain water tank	Ditch	Piped away	other	
All Rwanda	**17.4**	**2.1**	**13.4**	**1.8**	**0.3**	**2,493**
Province						
Kigali City	35.2	4.5	27.8	2.9	0.0	295
Southern	8.6	0.5	6.1	1.9	0.0	597
Western	29.0	1.4	24.6	2.4	0.6	559
Northern	14.2	2.9	10.6	0.7	0.2	394
Eastern	9.5	2.6	5.5	1.2	0.4	647
Urban/Rural						
Urban	32.1	4.3	25.27	2.32	0.17	426
Rural	14.4	1.6	10.95	1.65	0.26	2,067

Source: NISR, 2016

[1] RNRA RWH Baseline draft Report Presentation 11 November 2014

2.3 Current Rainwater harvesting technologies in Rwanda

2.3.1 Major types of rainwater harvesting technologies in Rwanda

There are mainly two types of rain water harvesting that are commonly used in Rwanda as briefly described here below.

2.3.1.1 Roof top rainwater harvesting technologies in Rwanda

Traditionally RWH used to be done by collecting rainwater from roofs using banana sheaves. This has been improved to placing loosely attached corrugated iron gutters on the roof edges. The water then gets collected in various storage structures. Among others, various Roof top RWH technologies promoted in Rwanda include aboveground tanks made of reinforced concrete, bricks, masonry wall and aboveground plastic tanks as well as plastic sheets. Underground tanks are also used for rooftop rainwater harvesting. The rainwater stored on surface is usually for immediate or future use.

2.3.1.2 Ground water recharge technologies in Rwanda

Groundwater recharge techniques include multipurpose dams, check dams, gullies plugging, ditches and water ponds. Agricultural practices like radical and progressive terraces across the country also play significant role in in-situ RWH and contribute to ground water recharge and soil moisture. Live-fencing, mulching, composting, pitting, kitchen-garden favour in-situ moisture conservation and also contribute to ground water recharge. Irrigation techniques, agroforestry practices and other hillside and land husbandry techniques contribute to groundwater recharge and to the reduction of adverse impacts of climate change.

2.3.2 Costs of RWH technologies

The MININFRA feasibility study of 2010 and the RNRA project document of 2014 provide information on the costs of RWH systems for public building and domestic houses respectively. These documents show a large variation in costs for different types of water storage reservoirs as illustrated in the table below. There are some differences between the two sources but these are not large. Actual prices also depend on location, availability of building material and craftsmen. Costs cover the reservoirs and the gutters and eventual accessories.

The reservoirs can be divided into those that are constructed in situ from blocks, stones, cement and reinforcement bars and pre-fabricated tanks from metals and plastic materials. These are manufactured mostly in Kigali in small industries. The water tanks made out of polyethylene (PE) are available in different sizes from a range of suppliers[2] and have become increasingly popular over the last years. For these pre-fabricated tanks, a simple foundation is recommended and these costs are extra.

[2]See for instance Roto www.rotorwandatanks.com

Table 4: Types and unit costs of different storage reservoirs

	Description	Costs range in Frw	Observations
In situ	Ferro cement tanks from 10 – 100 m3	150 – 200,000/m^3	▪ Risk of cracking but can be repaired easily ▪ Known technology. Larger ones will require good artisans.
	Brick/masonry tanks from 5 – 30 m^3	150,000 /m^3	▪ Long life ▪ Known technology, used for larger and smaller tanks ▪ Can be repaired easily
	Artisanal tank with plastic liner 6 m^3	20,000/m^3	▪ Well established technology in some rural areas ▪ Local artisans can construct them ▪ Easy to repair
Pre-fabricated	Metal tanks 1- 10 m3	160,000 / m^3	▪ Locally manufacture ▪ Corrosion protection needed
	Fibre glass tanks 2- 75 m3	220,000/m^3	▪ Long lasting ▪ Easy to repair ▪ Limited number of suppliers
	Polyethylene tanks 0.5 – 10 m^3	130,000 /m^3	▪ Widely available in urban areas ▪ Light and quick installation ▪ Requires foundation or other support construction ▪ Scalable, start with one and expand
	Jerry cans 20 litres (used ones for Rwf 2500 each)	125,000/m^3	▪ Widely available ▪ Easy start up with few jerry cans and scaling up over time if funds are available ▪ Labour intensive (filling) ▪ Space needed inside house.

Source: FONERWA, 2015

The prices of PE water tanks need further verification against actual market prices. RNRA documents show costs ranging from Rwf 450,000 to 600,000 for 5 m^3 model (excluding costs of plumbing etc) which would be Frw 90 – 120,000/m^3. The other important requirement for a rain water harvesting system is the guttering system to collect the water from the roof and the pipes to bring it to the storage tank. The most common systems use metal or plastic gutters. In some cases people select the cheaper option of cutting and bending iron roofing sheets which works well for shorter distances. No separate costs are given for bends and connectors and it is assumed that these are included in the prices per unit of 1 meter shown below.

Table 5: Indicative Costs of Gutters

Type of material	Cost Frw/m
Metal gutter	8,500
Plastic gutter	6,000
Iron sheet (roofing material)	4,500

Source: FONERWA, 2015

For a small house of 120 m^2 floor space about 30 m length of gutter will be required which would be 135,000 to 250,000 Frw for a complete system, using the unit prices above. Other accessories might be installed depending on the needs and wishes of the users. A water diversion valve can be installed to reduce the contamination of the initial water flows coming from the roofs. Water filters can help remove sand and other dirt before the water flows into the buildings. While many households will bring the water into the house using buckets and jerry cans, higher income groups and public building may want to install an electric pump and overhead tanks. Costs of the required plumbing and electrical materials are not further included but can be assumed affordable.

2.4 Rainwater harvesting applications

2.4.1 Roof top rainwater harvesting for households

Typical domestic system using plastic water tanks

Most of households use plastic water tanks (PE) in size of 2 – 5 m^3 because of their costs, availability and ease of installation and maintenance. For houses of small and medium sizes of 120 and 300 m^2 covered surface respectively, the costs are estimated at 0.7 and 1.3 m Frw respectively. Additional investments are needed if the RWH is equipped with water filter, electric pump and piping to conduct the water into the house.

Domestic systems using low cost storage reservoir

The low cost storage technology is a simple design that uses predominantly local materials like bricks, cement, and heavy duty plastic as liner, metal sheets and timber for the roofing. The costs for a storage capacity of 6,000 litres vary between 80,000 to 100,000 Frw or around 15,000 Frw per m^3water storage capacity. This type of RWH facility is reported to be well adapted to the local conditions.

2.4.2 Roof top Rainwater harvesting for Communal Systems

The first communal rainwater harvesting system was constructed in 2008 in Rubaya, Gicumbi demonstration project which covered 43 households. More recently a larger system was completed in the Muyebe Green Village in Muhanga District which collects water from the roofs of 100 individual houses. Pipes conduct the water to the lower end of the village where it runs through a sand/gravel filter before entering in the underground reservoirs which have a total capacity of 1500 m^3. That results in 15 m^3storage per household which appears very high.

The total costs for the water harvesting and biogas systems were Rwf 600 million which would be Rwf 6 million per household. In the communal system for Kimonyi Village in Musanze District,a pre-feasibility study[3] carried out in 2013 estimated the unit costs for the tanks and conveyance systems were at 220 – 250,000 Frw per m^3 which would be 2,2 to 2.5 million Frw for 10 m^3. The RNRA project document provides a price of 1.2 m Frw for the plastic water tank of 10 m^3 (excluding the costs of foundation and plumbing), which is about ½ of the costs reported in the above mentioned study.

[3]Consultancy support to the CKDN project funded by Rwanda FONERWA capacity building, Biogas REC, 2013

Table 6: Pros and cons of communal RWH systems

Pros	Cons
➢ Solid design with long life expectancy if maintained properly ➢ Includes water filter to reduce contamination ➢ Easier to check water quality than for individual systems ➢ Contributes towards community spirit in the village	➢ Investments costs are higher than for individual units ➢ Need for strong management system to ensure maintenance and equitable division of water ➢ Water has to be carried back to the house

Source: FONERWA, 2015

2.4. 3 Roof top Rainwater harvesting for public buildings

As regards public buildings, a feasibility study of Rainwater collection systems on Public buildings in Kigali City and Other towns in Rwanda conducted by MININFRA in July 2010, classified public buildings in 3 categories as follows: 23 buildings (2.9%) were classified in category 1, 390 buildings (49.0%) in category 2 and 383 buildings (48.1%) in category 3.

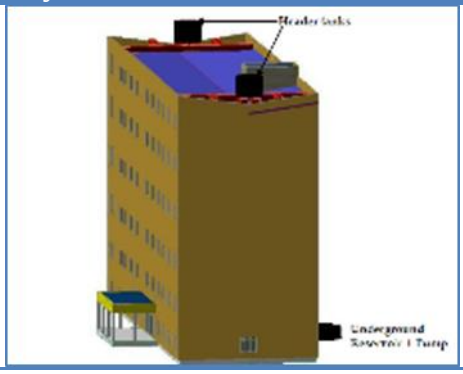
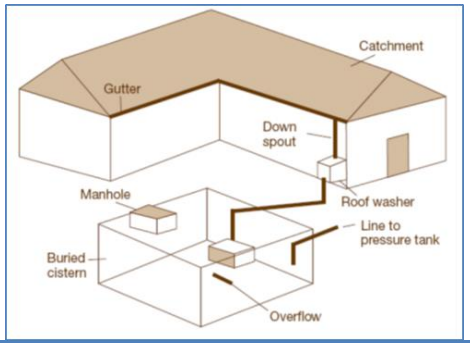
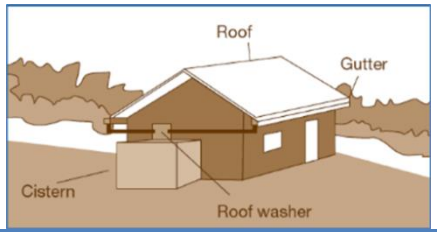
Category 1 refers to High-rise buildings and includes one and above storied buildings with strong structural elements that can support rooftop tanks whenever necessary. This might be made of one isolated or twin high buildings concentrated at the same location so that their catchment is within the range of small to medium surface area (500 to 1,000 m2) and the collection can be easily centralized to one reservoir. Within this category were put buildings of ministries like MININFRA, MINEDUC, MINAFET, etc. which are stored with reinforced concrete structures that can support a rooftop tank.

Category 2 refers to larger buildings and includes buildings of educational institutions, hospitals, stadiums, airports, and other large facilities. They can be compounds made of simple buildings, with one floor, or storied buildings with many houses spread at different locations which make a total larger catchment area. This large roof area imposes to have a large storage reservoir in which water from each individual building is conveyed. The catchment area is in the range of 1,200 to 6,000 m2 and above.

Category 3 refers to Simple buildings and includes simple houses with small roof areas ranging from 100 to 500 m2like offices of cells, sectors, etc. They have few users and few sanitary facilities which are often installed outside the building. A simple system of tank and pipes will be sufficient for collection and distribution of rainwater.

The study identified 17 high rise, 380 large and 380 small public buildings which needed rain water collection systems. The report has three annexes i) an inventory of public buildings, ii) bill of quantities for sample RWH systems and iii) plans for the storage tanks. The table below provides an overview of the three categories of public buildings and their main characteristics.

Table 7: RWH for public buildings

Type and main characteristics	Layout
High rise buildings (17 reported) ➢ Roof area 500 – 1,000 m2 ➢ Flat roofs, cemente ➢ Underground reservoirs ➢ Pump to bring water to header tank on the roof ➢ Estimate average costs;Rwf 50 million	
Large buildings (380 reported) ➢ Roof area 1,200 to 6,000 m^2 ➢ Iron sheet roofs ➢ Schools, health centres, markets, district offices ➢ Large storage; under of above ground ➢ Water pumped back to roof tank or direct throuhg pipe network ➢ Estimates average costs: Rwf 65million	
Small buildings (380 reported) ➢ Roof area 100 – 500 m2 ➢ Iron sheet roofs ➢ Above ground tanks: cement or plastic ➢ Estimated average costs: Rwf 10 million	

Source: FONERWA, 2015 and MININFRA, 2010

This study also shows that nearly 74% of public buildings do not have any RW collection system and 24% of them had partial RWH System, leaving a tiny 2.4% equipped with such RWH systems. Moreover, the study uses a software package (Rain Cycle) to come to an optimal design of collection/ storage systems that takes into account rainfall data, roof areas, losses, daily demand for water, construction and operating costs and other factors. The study estimated that it would require an investment of 28 billion Frw (US$ 40m) to equip all identified public buildings with rain water storage systems.

2.4.4 Rainwater harvesting for ground water recharge

2.4.4.1 Rainwater harvesting using multipurpose dams and irrigation ponds

Multipurpose dams mainly used for irrigation have been constructed and others are under construction and /or planned for construction throughout the country. More than 20 irrigation dams are being used for marshland and hillside irrigation. The table below shows existing dams, their locations and capacity.

Table 8*:* List of existing dams, leur location and volume

Province	District	Type	Dams	Volume(m3)
EASTERN	Bugesera	Marshland	Gatare-Rwabikwano	150,000
EASTERN	Bugesera	Marshland	Kiruhura- Rwintare	70,000
EASTERN	Gatsibo	Marshland	Kanyonyomba	600,000
EASTERN	Gatsibo	Marshland	Rwagitima Ntende	480,000
				850,000
EASTERN	Kayonza	Marshland	Gacaca	2,500,000
KIGALI CITY	Gasabo	Marshland	Kajevuba	180,000
SOUTH	Huye	Marshland	Cyili	950,000
SOUTH	Huye	Marshland	Cyarubare	70,000
SOUTH	Huye	Marshland	Rusuri-Rwamuginga	180,000
SOUTH	Huye	Marshland	Rwasave	60,000
SOUTH	Huye	Marshland	Mwogo	0,000
SOUTH	Muhanga	Marshland	Rugeramigozi I	270,000
SOUTH	Muhanga	Marshland	Rugeramigozi Ii	60,000
SOUTH	Nyanza	Marshland	Nyarubogo	520,000
SOUTH	Nyanza	Marshland	Agasasa	450,000
SOUTH	Nyanza	Hillside	Nyanza 23	1,900,000
SOUTH	Ruhango	Marshland	Base	120,000
EAST	Kayonza	Marshland	Rwinkwavu	4,200,000
EAST	Gatsibo	Marshland	Rwangingo	3,700,000
SOUTH		Marshland	Mushaduka	450,000
EAST & KIGALI	Rwamagana & Gasabo & Kicukiro	Marshland	Rugende	1,300,000
Total				**26,510,000**

Source: MINAGRI, 2016

Rain water harvesting for small scale irrigation has been tested and promoted in Rwanda since 2010. Presently, the total number of irrigation ponds in the country is given as 1376 out of which 735 are working, 171 requiring repair, 350 planned/implemented and 120 ponds are under construction. These are in 16 relative drier Districts of the country. The ponds are of the storage capacity of 120, 250, and 480 m^3 irrigating 0.25ha, 0.5ha and 1ha respectively. The investments costs of these plastic lined water reservoirs are given as Frw 1 m for 120 m^3, Frw 1.5 m for 250m^3 and Frw 2,2 m for 480 m^3.

Land Husbandry, Water Harvesting and Hillside Irrigation (LWH) project designed in March 2008 to improve the agricultural system in Rwanda has so far achieved 1663 ha of watershed protected with land husbandry technologies in the Districts of Karongi, Nyanza, Rwamagana, Kayonza and Gatsibo. The summary of land irrigated under different types of irrigation is given below.

Table 9: Status of land under irrigation

Project Type	Land Type	Baseline (2014/15)	Target (2017/18)	Potential	
		Area (Ha)	Area (Ha)	Size (Ha)	Cost (Billion RwF)
Large & Medium Scale	Marshland	30,753	40,000	220,000	985.27
	Hillside	4,807		248,000	2,563.08
Small Scale	All	450		121,000	125.05
Total	**All**	**36,010**	**40,000**	**589,000**	**3,673.40**

Source: MINAGRI, 2015

2.4.4.2 Rainwater harvesting for soil moisture and increase of infiltration

Rainwater harvesting through terracing and other techniques of land management contribute to surface runoff minimization, soil erosion control, soil moisture and increase of infiltration of water into the ground. Terracing is the most popular technique used to reduce run-off on arable land.

Table 10: Status of land under terraces

Type of Terraces	Baseline (2014/15)		Target (2017/18)	Potential	
	Area (Ha)	Area (%)	Area (Ha)	Size(Ha)	Cost (Billion RwF)
Radical	92,882	37.9	165,596	245,163	490,326
Progressive	901,752	80.2	1,054,661	1,124,326	1,349,191
Total/Average	**994,634**	**72.6**	**1,220,257**	**1,369,489**	

Source: RAB, 2015

Mulching, greening, fencing are important in soil and water conservation and contribute to soil moisture and encourage infiltration. Mulching with crop residues (mainly with banana leaves. sorghum stalks and various tree leaves) is the best solution under banana, tea, coffee and cassava plantations and leguminous cover crops are also useful under permanent plantations. This improves infiltration of water into the soil and prevents evaporation out of the soil as shown on the table below.

Table 11: Erosion and runoff on some very steep slopes plots (23-55%)

Vegetal cover and management	Erosion (t/ha/year)	Run-off (% of annual rainfall)
Bare soil. cultivated along the slopes	300-700	10-40
Traditional crops Cassava and sweet potatoes Maize+ beans or peas and sorghum	20-150 (300)	10-37
Agroforestry		
Traditional. crops + 200 trees/ha	30-50 (111)	5-7
Id.+ trees +living hedges each 10 m: first *year*	7-16	10-15
4th year (3 to S kg/in/year)	1-3	1-3
Id. + trees + 1.h. +covered ridges each 5m	1-4	0.1-2
Permanent crops ' Banana: open, residues exported (10 t/ha/year)	20-60	5- 10 (45)
dense, mulch spread or on lines	1-5	1-2
Coffee p1antation(or cassava) + mulch (20 r/ha/year)	0.1-1	0. 1 - 10
Pine forest (5 to 10 t/ha/year of litter) *or* old fallow, grassland not degraded	0.1-1	1 - 10

Source: ISAR, Butare, 1997

2.4.4.3 Rainwater harvesting for reducing water related disasters and climate impacts

RWH to reduce water related disasters and climate impacts also contribute to soil erosion control and favor infiltration of water into the ground especially in the regions of high altitude and with high intensity rainfall. It is against this background, IWRMD has carried out such activities in the District of Musanze in the Northern Province and Nyabihu District in the Western Province:

- ✓ 180ha have been planted with Agro-Forestry trees
- ✓ Bench terraces have been established on 150 ha.
- ✓ 25.5 ha have been planted with bamboo
- ✓ 400 m^3 of ponds excavated to manage storm water
- ✓ 1000 Check dams established

2.4.4.4 Rainwater harvesting for Livestock water consumption

Valley dams have been introduced in Eastern Zone of Rwanda to face water scarcity challenges for a significant number of cattle and domestic use where other sources of water were not available. Valley dams collect rainwater for livestock consumption and most of them are located in the drier Districts of Eastern Province namely Nyagatare,Gatsibo and Kayonza.

Table 12: Existing valley dams in Eastern Province

District	Number of existing valley dams	Number of valley dams to be rehabilitated	Number of Valley dams under construction
KAYONZA	22	07	6
GATSIBO	09	04	1
NYAGATARE	52	08	6
TOTAL	83	19	13

Source: RAB, 2016

3. CHALLENGES AND OPPORTUNITIES IN RAIN WATER HARVESTING

3.1 Challenges in RWH

The main barriers to achieving rainwater harvesting objectives include (i) lack of a clear policy for RWH, (ii) insufficient knowledge and dissemination of RWH techniques, (iii)) low efficiency of water use, high water losses, (iv) lack of integrated management for harvesting run-off water from the road networks, (v) weak coordination, monitoring and evaluation of interventions at different levels, (vi) growing water demand amidst high population growth and adverse climate change (vii) limited involvement of research and (viii) inadequate and unreliable financing.

3.1.1 Lack of clear policy for Rain Water Harvesting

There is no clear Policy framework for Rain Water Harvesting in Rwanda. The existing Policies concerning water resources focus on other water related issues with no specific emphasis on rain water and its harvesting and storage. The National Policy on water and sanitation focuses on Water Supply and Sanitation services. Even if some references have been made on the promotion of RWH, this policy emphasizes the sanitary aspects of the available water but does not indicate how the option of rain water can be tapped to augment water resources. The National Policy for Water Resources Management is mainly concerned with protecting and conserving the available water resources but does not clearly lay out strategies for increasing these resources and hardly mentions Rainwater harvesting as an option for increasing the water resources.

Given these gaps indicated above it is therefore deemed imperative that a specific Policy for Rain Water Harvesting be designed to specifically address this alternative source of water which is relatively a low-cost option. The envisaged Rain Water Harvesting Policy should be specific and clearly indicate the principles of Rain Water Harvesting, objectives of the Policy for Rain Water Harvesting, policy statement which among other things will make RWH mandatory in specified cases, roles and responsibilities in implementing the RWH policy and implementation Strategy for RWH including relevant stakeholder.

3.1.2 Insufficient knowledge and low dissemination of Water Harvesting techniques

RWH techniques uses are not yet mastered and disseminated in Rwanda. The national assessment on RWH practices in Rwanda conducted by SHER in 2012 revealed that there are significant capacity gaps for installation and operation of RWH systems. Building contractors are familiar with tank construction given the past experience of RWH. However, the knowledge on specific design criteria for low cost tanks and the use of the stored water for non-potable purposes is generally lacking among building contractors. Instances of where poor cistern design has rendered adequate maintenance problematic are commonplace.

More to this, a report on water ponds and underground tanks from all agricultural zones of Rwanda Agriculture Board (RAB), revealed that from a total number of completed 1114 in 2013, there was no record on the status of 200 water ponds. At the same time, 50 water ponds had their dam sheet damaged while two were stolen. Water ponds users complained against unrepaired or dried water ponds either because of insufficient knowledge or because of the high cost of the dam sheet they could not replace themselves[4]

[4] RAB, 2013, Batabase of SSIT final report. Kigali.

3.1.3 Low efficiency of water use and high water losses

Rwanda is a mountainous country which is also known as a country of thousand hills. Topography varies from 900 meters above mean sea level in the East to 4,507 meters at the Kalisimbi peak in the North. More than 40% of the area is located at elevations of between 1,500-1,800 m. This topography favors water runoff in a country where it rains with high intensity. About 4.3 billion cubic meter of water is lost as runoff every year; 30-40% is lost in inefficient supply systems; most irrigation systems are inefficient (RNRA, 2015).

The use of water has been very low over the past years but this is expected to change rapidly due to the on-going plans related to irrigation development, development of industries, expansion of domestic water supply, etc. The estimated current water use by catchment is illustrated in the following table.

Table 13: Overview of current water use in the different catchments of Rwanda

Level 1 basin code	Surface area level 1 basin [km²]	renewable resource ['000 m³]	Potable water supply use ['000 m³]	Irrigation water use ['000 m³]	Total water use in ['000 m³]	% 2012 Total water use over resource
CKIV	3,425	898,000	5,917	440	6,357	0.71%
CRUS	1,005	432,000	954	890	1,844	0.43%
NNYU	3,348	1,290,000	8,400	1,193	9,593	0.74%
NMUK	1,887	905,000	3,659	0	3,659	0.40%
NNYL	3,305	899,000	11,983	7,983	19,967	2.22%
NAKN	3,402	798,000	10,815	21,195	32,010	4.01%
NAKU	3,053	504,000	9,776	16,034	25,809	5.12%
NAKL	4,288	907,000	880	8,404	9,284	1.02%
NMUV	1,565	193,000	875	9,742	10,617	5.50%

Source: MINIRENA, 2015

Therefore, the collection of rainwater for different uses such as cleaning, watering, toilets flushing, becomes necessary for several reasons, in particular the prevention of possible flooding due to rainwater causing erosions in the surroundings and the destruction of the infrastructures like roads and buildings.

3.1.4 Lack of integrated management for harvesting run-off water from the road network

Currently, there is no integrated management of water runoff after it has left road impervious areas. As a consequence, the heavy runoff is left to cause gully erosion. The main reason for failure to use this resource is the inadequate awareness among planners of both the common infrastructure as well as development, that water from the drainage system can be utilized in a much better way, instead of being allowed to cause soil erosion that is evident today. Integrating RWH with road drainage will reduce erosion caused by water drained from the road, as well as the cost of supplying water for different uses such as for domestic and crop production.

3.1.5 Weak coordination, monitoring and evaluation of interventions

There are various institutions involved in Rain water harvesting and water storage. The Ministry of Natural Resources (MINIRENA) raises awareness on rainwater harvesting, develops strategic directions for RWH and designs and constructs pilot rainwater harvesting systems for floods control and efficient use of water. MININFRA/REG deal with the design, construction and

management of dams to avail consistent water for hydropower and domestic water supply. MININFRA/RHA develop building regulations that include RWH for efficient use of water. MINAGRI deals with the design, construction and management of dams to avail consistent water for large scale irrigation and valley dams for livestock watering as well as water ponds for small scale irrigation. The Districts deal with the design, construction and management of ponds to avail water for small scale irrigation

Although Rwanda has developed IWRM Plan, the management of water resources is still fragmented and poorly coordinated. The same applies to RWH. So far, each institution has been defining independently where to construct a dam and this for only the purpose related to the institution's mandate whereas in some cases there were possibilities for making them multi-purpose. This resulted in conflicts between institutions and. in a situation where RWH falls under every and each institution but without any specific portfolio. Until now there is no specific budget allocated to RWH. Limited activities have been implemented through some projects but without a responsible institution with dedicated enough resources to lead RWH activities in the country.

Moreover, limited specialized staff in RWH is still a handicap for the development of this sub-sector. The IWRMD only counts two staff dealing with rainwater harvesting at the National level. Since 2015, they are supported by a two years Rain water harvesting project in six Districts with high population density. This personnel is insufficient to coordinate, monitor and supervise all activities related to Roof top rainwater collection and underground water recharge.

3.1.6 Growing water demand amidst high population growth and adverse climate change

According to the Rwanda National Water Resources Master Plan approved in 2015, Rwanda has a very low water availability per capita estimated to 670m3/annum and is classified as a water scarce country and some areas of the Eastern and Southern Provinces are below 500 cubic meters and are experiencing absolute water scarcity mainly in Muvumba, Akagera Upper and Akanyaru Catchments. The comparison between water availability and water demand by catchment and with time considering time horizon by 2040 shows the following details summarised in the table below.

Table 14: Water availability and water demand by 2040 in (, 000m3)

Basin code	Renewable water resources	Total DWS	Industries	Coffee WS	Live stock	Fish Ponds	Total Irrigation	Other Power	Grand Total
CKIV	898,000	115,633	34,690	38	3,047	1,245	151,403	6,421	312,475
CRUS	432,000	26,070	7,821	10	676	1,230	9,881	473	46,161
NNYU	1,290,000	119,166	35,750	8	4,600	6,915	189,875	0	356,313
NMUK	905,000	100,974	30,292	1	3,034	1,530	13,490	2,523	151,844
NNYL	899,000	172,942	51,883	20	5,405	9,045	367,594	580	607,469
NAKN	798,000	112,007	33,602	10	4,598	17,775	370,092	3,075	541,158
NAKU	504,00	89,009	26,703	9	3,017	10,770	527,848	0	657,356
NAKL	907,000	41,503	12,451	2	2,925	9,840	409,882	0	476,604
NMUV	193,00	47,578	14,274	0	1,946	7,860	144,839	0	216,497
SUM	6,826,000	824,882	247,465	97	29,249	66,210	2,184,904	13,072	3,365,878
%Dem.		24.5%	7.4%	0.0%	0.9%	2.0%	64.9%	0.9%	100%

Source: MINIRENA, 2015

Rapid urbanization, as well as geographic and temporal disparities in water availability, make it difficult to supply water to certain areas. While overall the population is expected to increase by a minimum 55 to more than 100% over the planning period and depending on the growth scenario,

there is overall a very significant increase in urban population from less than 20% as of 2012 to about 50% by 2040. This seems to be particularly significant at the lower Nyabarongo and upper Akagera catchments that host the predominantly urban Districts of Gasabo, Kicukiro and Nyarugenge. By 2040, about two thirds of the population of these catchments will be city dwellers! In addition, climate change in Rwanda is already having serious impacts on water resources and other sectors. Erratic rains, destructive floods, landslides, and strong winds have led to lost lives, property, and infrastructure.

3.1.7 Limited research in RWH.

There is a clear lack of research information on technical and management aspects of RWH technologies. Besides, poor linkage with research and learning institution, private sector and concerned bodies are the major constraints to the development of new and appropriate RWH and complementary technologies. Therefore, building the research and documentation capacity of universities, high learning technological institutions and Research Centers is required in terms of RWH. Conducting an action and local-specific research for the innovation of new and adoption of RWH technologies is needed.

Presently there is inadequate linkage (networking, partnership and collaboration) with relevant research and learning institutions at national and international levels. Linking the promotion of RWH with educational and research is important and necessary. One of the higher learning and research institutions can be considered as a center of excellence as far as research in RWH is concerned. RWH and its linkage with management of smaller watersheds for maximum moisture conservation and excess runoff management are essential. Standardized approach and manageable micro-watershed size for promoting effective local runoff management need to be identified and assessed.

3.1.8 Inadequate and unreliable financing

Funding for WRM functions is very low and consequently this extends to RWH as well. This constrains the GoR's ability to harvest, protect, conserve and rationally allocate water resources to different needs. Most public investments in the water sector have focused on water supply infrastructure, irrigation and hydro-power development, while little funding has gone to WRM including RWH.Until now there is no permanent budget line dedicated to RWH in the National budget. The support from FONERWA to the Rainwater harvesting project only started in the fiscal year 2015-2016 with a small budget of 101,787,347 Frw. Even if this budget increased in 2016-2017 up to1,062,701,534 Frw.[5] it is highly recommended to keep the pace and do more in the coming years. FONERWA should continue its support and other partners should come on board.

3.2 Opportunities in Rainwater Harvesting

3.2.1 Relatively abundant though unequally distributed rainfall

The potential for RWH in Rwanda is made obvious by statistics of rainfall. Rwandan rainfall averages 1400 mm but variation is high from about 2000 mm in the north-western to around 700 mm in South Eastern plains (MINIRENA, 2011). From the assessment done on the availability of renewable water resources by catchment which is the average annual flow of rivers and recharge

[5] MINECOFIN, State finance Law,2016

of aquifers generated from precipitation, the statistics on water availability are illustrated in the following table.

Table 15: Overview of water availability in Rwanda

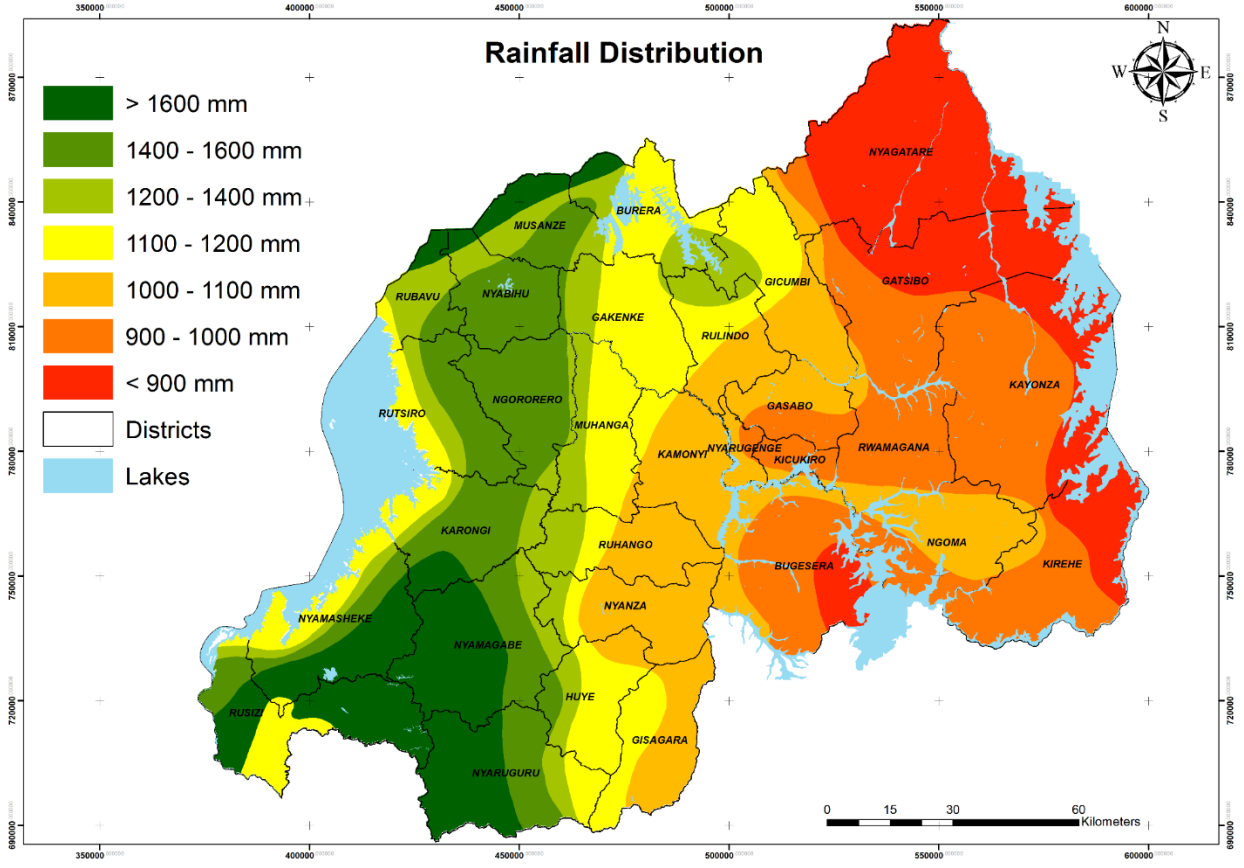
Parameter	Quantity
Rainfall	27.505 BCM/annum
Ground water recharge	4.554 BCM/annum
Total renewable water resources	6.826 BCM/annum
Water availability per capita	670 m^3/annum

MINIRENA, 2015

From this table, despite considerable rainfall Rwanda is short of water and underscores the need to change practices and increase water storage through rainwater harvesting at large scale. If rainwater were harvested and utilized, more water would be available for economic activities especially during shortage periods and more hazards and degradations would be mitigated.

In addition to this, there are disparities in rainfall distribution across the country. As shown on the map below, the northern and western parts of the country have more rainfall than the rest of the country. The eastern regions of the country receive the lowest amount of rainfall.

Figure 1: Rainfall distribution in Rwanda



Source: RNRA, 2016

The Northern Province has relatively abundant rainfall with high intensity and is threatened by, high run-off causing, soil erosion, flooding and landslides while most of the Eastern and Southern Provinces with low rainfall face water scarcity causing droughts and risks of hunger. Strategies to

overcome these extreme situations should be diversified and specifically addressing the concerned issues and have been put into consideration in a later section of this document.

3.2.2 Strong recognition of the potential contribution of RWH to human well-being

A growing number of cases that describe the multiple benefits of rainwater harvesting are emerging. Evidence of increased human well-being, and sustained or enhanced ecosystem services by rainwater harvesting intervention range from developing countries (India, various sub-Sahara African), transition countries (China, Brazil) to developed countries (Australia, USA). The Government of Rwanda recognises that water resources have a central place in achieving the poverty reduction and economic transformation goals, outlined in the Vision 2020, EDPRS and various sectorial plans.

In recent years the Governments of Rwanda and its partners carried out different activities in effort to develop rainwater harvesting. RWH is more and more appearing in different policies, programs and action plans. As a case of support for rainwater harvesting, Government has set up internal mechanism of funding through the Rwanda Environment and Climate change Fund, FONERWA, which provides financial support for rain water harvesting. With this funding, RNRA promotes the use of plastic water tanks (PE) in size of 2 – 5 m3for domestic houses because of their costs, availability and ease of installation and maintenance. The project provides a 40% subsidy on the costs of the tank to the income groups previously ranked Ubudehe 3 and 4 or Ubudehe1 and 2 according to the new categorization and also facilitates access to credit for those who can afford. The households themselves have to arrange for the foundation, the gutters and other accessories to complete the system.

Over 4,000 water tanks were installed by the end of July 2016 in six districts under the Rainwater Harvesting Project (RNRA, 2016).To justify such support, a good understanding is needed of the other additional benefits of RWH including improved health and sanitation, reduced workload for women and children, impacts on education and opportunities for income generation through kitchen gardening.

3.2.3 Availability of various willing stakeholders in developing Rainwater Harvesting

The presence of many stakeholders (Multilateral, bilateral, NGOs, the Civil Society and the Private Sector) and donor commitments to support RWH activities is an immense opportunity that will without doubt enhance fast development towards water security. The existence of RWH based International and neighboring organizations (SEARNET; RAIN Foundation; GWP; IRHA; UN-FAO; ERHA; KRA; URHA) further augments the success of rain water harvesting.

The other stakeholders include direct users of harvested rain water among them domestic, both rural and urban, institutional as well as farmers. There is also government that plays policy making and regulatory roles. In addition there are service providers including private contractors, manufacturers and researchers.

3.2.4 Applicable practical experience in RWH from other countries

The practice of rain water harvesting is common in the countries of the region and has attained certain levels of success. Country studies carried out in different areas indicate that around a third of Africa is deemed suitable for rainwater harvesting. In Ethiopia the rainwater harvesting potential is estimated at over 11,800 cubic metres per person per year compared with annual renewable river

and ground water supplies of only around 1,600 cubic metres. In Kenya the rainwater harvesting potential is estimated at over 12,300 cubic metres per person compared with the current annual renewable water availability of just over 600 cubic metres. In Uganda, the rainwater harvesting potential is estimated at over 9,900 cubic metres per person compared with the annual renewable water availability of 1,500 cubic metres while in Tanzania the rainwater harvesting potential is estimated at over 24,700 cubic metres per person when compared with the annual renewable availability of around 2,200 cubic metres.

The aspect of in-situ water collection and storage increasing and stabilizing agricultural yields in semi-arid areas of Burkina Faso, Kenya and Sudan, thus, providing three-to-fourfold increases in yields, appropriate and low cost methods of rainwater collection and storage in and around the farm has been stressed. Also in situ moisture conservation measures, to enhance soil productivity and crop production and reduce runoff thereby minimizing serious soil erosion problems. There is a big range of techniques for rainwater harvesting in terms of retention, recharge and reuse of water.

Table 16: Retention, Recharge and Reuse techniques

Retention method	**Recharge method**	**Measures**
A.Closed tank storage	Rainwater interception	Roof top harvesting
	Fog harvesting	Fog harvesting
B. Groundwater storage	Runoff reduction: riverbed infiltration	Riverbed modification
		Gully plugging
		Sand dams
		Recharge dams
	Land surface infiltration	Infiltration ponds
		Spate irrigation
		Ditches and drains/Furrows
	Direct aquifer infiltration	Wells
		River bank infiltration
C. Soil moisture storage	Runoff reduction	Terracing
		Contour bunds
	Land surface infiltration	Deep ploughing
		Spate irrigation
	Evaporation reduction	Mulching
D.Open water storage	In the riverbed	Check dams
	Outside the riverbed	Storage pond

Source: RNRA, 2016

Apart from some in-situ techniques for soil erosion control and groundwater recharge applied in Rwanda, techniques like recharge dams, riverbank infiltration, and spate irrigation need to be tested and disseminated for use in the country. Techniques for greening cities and increase of infiltration in urban area also need to be tested and disseminated for use in cities and large agglomerations under the framework of Integrated Development Programmes (IDPs).

4. RAINWATER HARVESTING STRATEGIC FRAMEWORK

4.1 Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis

In the process of developing the RWHS, the MINIRENA and RNRA-IWRMD staff with some other key stakeholders carried out a Strengths, Opportunities and Threats (SWOT) analysis. The salient features related to the strengths and opportunities of the institution were mainly based to the strong political will and support provided by the Government of Rwanda; the existence of clear coordination mandate of the RWH activities; recognition of RWH as alternative source of water for multiple uses; adequate annual rainfall and best practices in RWH from other countries. Integrated Water Resources Management approach also has basic legal and policy framework that creates a favourable environment for the coordination and management of RWH interventions.

On the weak side and terms of threats, the Rainwater Sub-Sector has some challenges associated with attracting, motivating and retaining highly skilled staff, identifying and implementing adequate RWH systems and technologies, weak coordination of stakeholders, inadequate and unreliable financing and increasing adverse impacts of climate change. The following table presents a detailed account of Strengths, Weaknesses, Opportunities and Threats. The main challenges will be addressed in the strategic planning that follows this SWOT analysis.

Table 17: Strengths, Weaknesses, Opportunities and Treats (SWOT) Analysis

	Strengths	**Weaknesses**
Internal Factors	✓ Political will (well set policies and legal and institutional frameworks). ✓ Availability of media for communication ✓ A pilot phase has been implemented ✓ Available best practices at national level ✓ Availability of National Environment and Climate Change Fund (FONERWA)	✓ Low awareness of the local population ✓ Poor institutional coordination ✓ Low community involvement ✓ Limited research ✓ Limited data ✓ Limited incentive schemes ✓ Limited finances/funds ✓ Scattered households ✓ Limited number of skilled people in RWH
	Opportunities	**Threats**
External factors	✓ Relatively abundant rain fall ✓ Local and international research institutions ✓ Low cost existing technologies ✓ International donors may finance ✓ Experiences from other countries	✓ Vulnerability to Climate change ✓ Severe environmental degradation ✓ Dependency to external financing ✓ Mountainous topography ✓ High investment cost

4.2 Strategic positioning

Rainwater Harvesting strategy is aligned to the Government of Rwanda's development agenda towards sustainable water security.

4.3 Vision

Rainwater Harvesting is recognized as an alternative source of water to fulfill multiple uses, improve community livelihood and cope with climate change.

4.4 Mission Statement

Promote, coordinate Rainwater Harvesting to address water scarcity for domestic water use, agriculture, livestock and ecological uses through green infrastructures, advocacy, research, capacity building and networking.

4.5 Overall Objective

To contribute to socio-economic development and environmental protection through sustainable water security.

4.6 Strategic objectives

1. To strengthen policy, legal and institutional framework for improved rainwater harvesting coordination and management
2. To increase rain water harvesting infrastructures for effective multiple use
3. To promote infiltration and groundwater recharge in urban and rural areas for minimized surface run-off, floods and reduced vulnerability to climate change and environmental degradation
4. To promote research, innovation and capacity building for improved water harvesting and storage systems and technologies

The strategic objectives of RWHS can be summarized into four strategic pillars that will guide RWH strategic intent to 2022. These are:

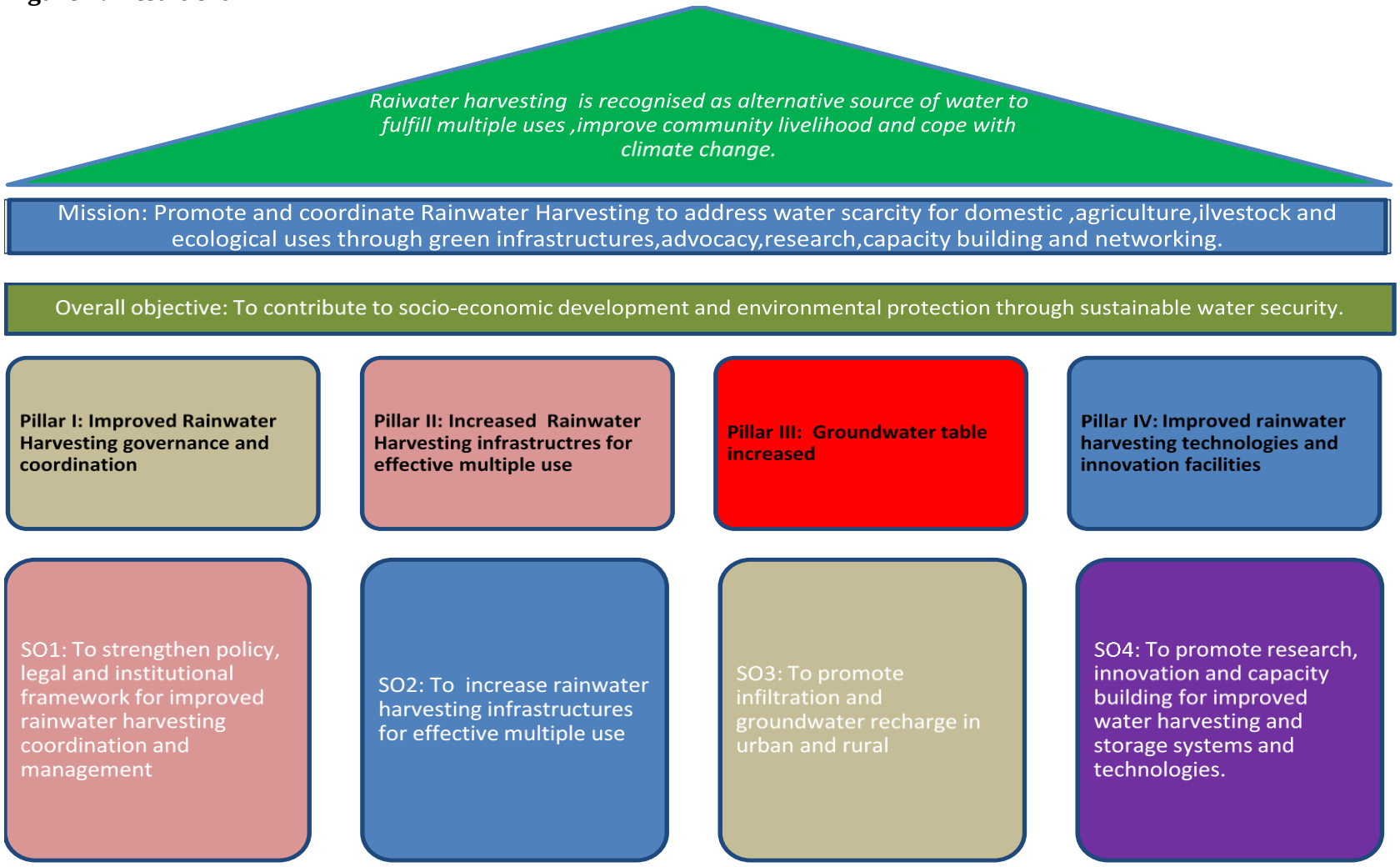
- Improved RWH governance and coordination framework.
- Increased RWH infrastructures for effective multiple use.
- Increased groundwater table recharge.
- Improved RWH technologies and innovation facilities.

4.7 Results chain

The RWHS will work for achieving its vision, mission and strategic objectives. For this to happen, the Strategy contains activities that will transform the vision and mission into tangible results according to its strategic interventions provided for in the strategic plan.

Four strategic objectives are part of the strategic framework of this Strategy of which two have been dedicated to issues related to coordination and improvement of the policy, legal and institutional framework , research, innovation and capacity to effectively coordinate and promote Rainwater Harvesting. The rest of the challenges are addressed through other two pillars on infrastructures, infiltration and groundwater recharge, soil moisture and surface runoff reduction through soil and water conservation measures, rainwater harvesting and storage. This strategic framework was conceived in response to the issues identified by SWOT Analysis.
The framework is summarized in the ***Results Chain*** below:

Figure 2: Result chain



4.8 Strategic interventions for 2017-2022

Based on the results of the situation analysis, documents review, stakeholder consultations and the results chain with respect to RWH the following four key areas of interventions and corresponding strategic interventions for 2017-2022 have been outlined.

4.8.1 Policy, Legal and Institutional frameworks for rainwater harvesting.

Strategic objective

The strategic objective of this key area is to strengthen policy, legal and institutional frameworks for improved rainwater harvesting coordination and management. RWH is recognized as a key strategy for enhancing water security in an environment where water is a scarce resource. The prevailing policy environment favors continued investment in surface water exploitation. On the other hand, unless the catchment conditions are well protected and conserved, the sustainable water supply and groundwater augmentation is at risk.

Strategic interventions

1. **Reviewing existing legal and policy instruments to propose an effective legal (regulatory) and policy frameworks for promotion of RWH**

A comprehensive review of the existing legislative and policy frameworks will need to be undertaken to determine the extent to which existing legal and regulatory instruments meet the requirements for promoting RWH within a structured program. As is typically the case, many of the instruments exist. However, amendments will be required to ensure that proper synergistic relationships are established to facilitate the promotion of RWH.

2. **Design appropriate incentive regime to augment existing rainwater harvesting measures**

An appropriate suite of incentive measures need to be developed to encourage water conservation from the individual household level to the large-scale commercial development level. Existing rainwater harvesting measures include facilitating the poorest of society with water storage structures such as tanks. There is also a loan scheme whereby government contributes 40% of the cost of rainwater storage structure and the beneficiary contributes 60% which is paid in a period of one year.

In a well-designed incentive regime, investors should be able to obtain concession for supplies and materials that are used specifically to harvest and conserve rainwater (guttering, tanks, weld mesh, pumps, etc.), however creative ways may need to be sought to include generic (general-purpose) material. Investors should be rewarded for implementing rainwater harvesting measures through rebate or tax reduction/refund mechanisms. This will have to be done in conjunction with the Ministry of Finance and Economic planning (MINECOFIN), the lead agency charged with the preparation of Investment and taxation Policy and legislation

3. **Resource mobilization**

During the implementation of the rainwater harvesting strategy, Rwanda will need a multiform and varied assistance from international and regional cooperation institutions including UN agencies and development partners. The Government has already included rainwater harvesting and management in its national, multilateral and bilateral cooperation priorities.

Rainwater harvesting will receive special attention in the allocation of domestic resources earmarked for development and will be mainstreamed in different sectors of activity. The State, the local authorities, private economic operators and the homeowners are called upon to contribute to the cost of rainwater harvesting and management deriving from their responsibilities in this field. The investment fund predicted in the Water for Growth Rwanda Programme will enhance this resource mobilization for funding of all IWRM projects to be implemented under RNRA/IWRMD.

4.8.2 Development of infrastructure for rainwater harvesting and storage

Strategic objective

The objective of this key area is to increase rainwater harvesting infrastructures for effective multiple use. This strategic objective constitutes the core part of this strategy since it focuses on the increase in RWH infrastructure both for rural and urban settings. This objective will finally lead to improve the capacity of collecting, storing and using rainwater both in quantity and in quality. This implies and is measured from the presence of structural facilities. Therefore particular tangible actions are needed to roll out rainwater harvesting infrastructures.

Strategic interventions

1. **Upscaling of equipping households and public buildings with basic RWH systems**

This strategy is intended to facilitate the households according to Ubudehe categories to acquire affordable RWH facilities. Category 1 consist of Rwandans without a residential house or are unable to rent one, and hardly get food and other primary necessities. This category consists of 376,192 families, comprising 481,161 citizens, i.e. 16% of total population. These will be provided with rainwater harvesting structures as they are assisted with all other necessities of life.

The second category includes those who own a residential house or can rent one but rarely get full time work and can afford eating at least twice a day. This category is made of 703,461 families, comprising 3,077,816 citizens which is equivalent to 29.8% of Rwandans. These will be assisted with a subsidy through a loan scheme whereby government contributes 40% and the beneficiary pays the 60% of the cost of the rainwater harvesting structure over a period of one year.

Categories 3 comprising 1,267,171 families made of 5,766,506 persons or 53.7% of total population and category 4 consisting of 11,664 families, comprising 58,069 persons or 0.5% of Rwanda's population will be mobilised to purchase rainwater harvesting structure through loans that are not subsidised but with soft terms whereby they can pay back within a period of one year..

As already 2.1% of the Rwandan population are using rain water tanks, this strategy has set a target of achieving 100% of all Rwandan households being equipped with rainwater harvesting structures by 2022. This would entail the following annual forecasts for each of the categories described above:

1. Category one; 75,240 households per year
2. Category two; 140,692 households per year
3. Category three; 253,434 households per year which means an average of 8447 HHs/District/year
4. Category four; 11,664 households which ought to be equipped by 2018.

For the issue of funding to achieve these ambitious targets, the participatory and cost-sharing mechanisms such as creation of special loan facilities, partial subsidies and revolving funds will be of paramount significance.

Equipping public buildings, commercial premises, institutional buildings and other big buildings will be guided by regulatory frameworks. It will incumbent upon government to issue directives that make it mandatory to include rainwater harvesting structures in all construction plans of such buildings. For the already existing buildings that have no such structures, government have to fix deadlines during which such buildings will have acquired rainwater harvesting structures. Thus within two years all buildings that were already existing will have installed these structures.

2. Harvesting run-off water from the road network

Currently, there is no integrated management of the runoff after it has left road impervious areas. As a consequence, the concentrated runoff is left to cause gully erosion. The main reason for failure to use this resource is the inadequate awareness among planners of both the common infrastructure as well as development, that water from the drainage system can be utilized in a much better way, instead of being allowed to cause soil erosion that is evident today. Integrating RWH with road drainage will reduce erosion caused by water drained from the road, as well as the cost of supplying water for different uses such as for domestic and crop production.

Ponds (120-500 m^3) and underground tanks (30-100 m^3) can be constructed along road networks to collect runoff for productive purposes. The technology will be tested and then through MININFRA (RTDA) it will be integrated in the road construction regulations and guidelines. Ten (10) asphalted national roads will be targeted and five water harvesting sites on each national road will be installed with at least 50 ponds each. Making a total of 250 ponds.

3. Construction of multipurpose dams and water ponds

This strategic intervention will focus on construction of multipurpose dams and water ponds augmenting those already in existence. Following the previsions of the Rwanda Water Resources Master Plan approved in 2015, it is planned to construct 17 dams with a total capacity of 55.38 million cubic metres and 2814 water ponds. Both dams and water ponds are expected to be in place by 2020 and will be constructed throughout the country. All these structures are anticipated to be additional to the already constructed dams and water ponds as presented in the status of RWH sub-sector.

4.8.3 Infiltration and groundwater recharge in urban and rural areas

Strategic objective

To promote infiltration and groundwater recharge in urban and rural areas for minimized surface run-off and reduced vulnerability to climate change. This strategic objective aims at increasing groundwater volume and preventing possible flooding due to rainwater causing erosions on arable land, flooding, and the destruction of the infrastructures like roads and buildings as well as environmental degradation.

Strategic interventions

1. **Revision of building regulations and standards**

The strategic intervention here is to ensure that building regulations will include clauses determining the proper discharge of excess rooftop. This should be mandatory and has to be taken into consideration when drawing housing plans. Any water that cannot be harvested from rooftops and open areas following substantial rainfall in urban places ought to be directed and controlled to enhance infiltration and groundwater recharge.

2. **Update cities master plans**

All cities' Master Plans must be updated to include systems of managing and controlling rainwater runoff to induce water seepage and infiltration subsequently leading to ground water recharge. Kigali City and Master Plans for Six Secondary cities of Muhanga, Rubavu, Nyagatare, Huye, Rusizi and Musanze, should be revised to comply with this strategy. Urban planning development will be successful and sustainable if it only takes into account rainwater harvesting as a serious hindrance to urban citizens sustainable livelihoods.

3. **Increase greening in urban areas and groundwater recharge**

Rainwater harvesting in parks and open spaces involving micro-watershed management methods that allow rainwater infiltration and percolation into the ground will be applied in the City of Kigali and the six secondary cities of Muhanga, Rubavu, Nyagatare, Huye, Rusizi and Musanze, There will be guidelines developed and demonstrated in a bid to promote the types of permeable pavements such as pervious concrete, porous asphalt, interlocking concrete pavers, and grid pavers, which allow rainwater and runoff to move and seep into underlying soil**.** These types of pavement systems are ideal for parking lots, driveways, alleys, sidewalks, and playgrounds.

Similarly, in order to increase ground water recharge by percolation and decrease the flooding of storm water drains, infiltration trenches could be built by the side of the drain all along the road, wherever possible. The infiltration trench can be 60 cm wide and 60 cm deep and filled with pebbles or aggregates with a top layer of coarse river sand. As the rainwater from the road flows into the infiltration trench, water percolates into the ground. During heavy rainfall, excess water spills over to the storm water drains. The infiltration trenches store water temporarily during rainfall and later for infiltration. These infiltration trenches may be exposed as walk ways or paved with inter-locking pavers, specially designed with gaps in between for water to flow into the infiltration trenches. Over this program period, 20 infiltration trenches will be constructed in selected sites especially in Kigali city.

4. **Development of soil erosion control structures**

In-situ rain water harvesting, also called soil and water conservation, will involve the use of methods that increase the amount of water stored in the soil profile by trapping or holding the rain where it falls. Terraces in form of embankments or ridges of earth constructed across the multitude of slopes to control runoff and minimize soil erosion will be constructed. Those terraces will reduce the length of the hill side slopes, thereby reducing sheet and rill erosion and prevents formation of gullies. Since the construction of radical bench terraces is simple and local people will be easily trained to build these by themselves; this reduces costs and encourages community participation. That way, in collaboration with running government programs specifically PSTAIII, 119,350 ha will be covered with bench terraces while 305,935 ha will be developed with progressive terraces.

When all these soil conservation infrastructure have been established they will cover 91% of all relevant land area.

5. **Agroforestry practices**

An agroforestry program will be developed in coordination with agricultural research, marketing and the provision of technical advisors for tree crops (including leguminous and fruit trees). Households will receive advice on agroforestry packages. The implementation of these activities will be coordinated with the IWM projects. There will also be an analysis of how the Crop Intensification Programme (CIP) and Land Use Consolidation (LUC) can be harmonized with the country's need to promote permanent soil-cover and agroforestry while taking advantage of harvested rain water. New agro-forestry species will be developed, and up to 90% of households will use agro-forestry by 2022.

6. **Constructing check dams and gabions**

This strategic intervention is meant to construct structures that will reduce tremendously the speed of the water runoff thus checking soil erosion and other destructive effects. Check dams and gabions are such effective structures in controlling water runoff speed .At least 1000 check dams and 1000 gabions will be constructed in river beds and waterways to reduce the speed of storm water especially in the hilly regions of the Northern and Western Provinces.

7. **Upscaling hillside, marshland and small scale irrigation**

This intervention will aim at scaling up the already existing irrigation infrastructure though strategic rain water harvesting and thus enhance greater areas under irrigation for hillside, marshland as well small scale irrigation. The harvested rainwater available in the multipurpose dams will be used collectively and well managed and distributed by the recently established Irrigation Water Users Associations (IWUAs). It is planned to develop irrigation on 5000 ha of marshland, 5000 ha of hillside and 1000 ha under Small Scale Irrigation by 2022.

4.8.4 Research, Innovation and Capacity building for rainwater harvesting

Strategic objective

The strategic objective of this strategic area is to promote innovation, research and capacity building for improved water harvesting and storage systems and technologies. This objective aims at building the research and documentation capacity of universities, high learning technological institutions and Research Centers in terms of RWH. Conducting local-specific research for the innovation of new and adoption of RWH technologies is needed.

Strategic interventions

1. **Initiating and strengthening research on RWH**

Research and documentation of RWH facilities will be undertaken and will be complemented by research with partners on how to improve local and imported technologies. There will also be an inventory on various RWH technologies and techniques covering different parts of the country taking into account technological options with respect to different bio-physical settings and socio-economic conditions.

2. **Conducting regular survey and develop MIS on RWH interventions**

It is imperative to carry out surveys regularly in order to obtain and disseminate relevant information on the availability and use of rain water harvesting technologies. This will facilitate further research and dissemination of newly obtained information on techniques and technologies.

3. Conducting technical and feasibility studies for RWH applications

Under this intervention technical studies will be conducted in order to match appropriate RWH technologies to suit demand requirements depending on application. Attention will be paid to the integration of RWH systems and the municipal supply system to ensure that there is no possibility for cross-contamination, where the harvested rainwater enters the pipe-borne supply. Technical institutes such as University of Rwanda , WFP, FAO, UNEP should be solicited to provide resources through either provision of personnel, financing, technical materials, or a combination. At least 4 Feasibility studies focusing on or fragmented into the following thematic areas (household level RWH from roof tops; Institutional RWH in urban as well as rural areas, RWH for multiple use, techniques for groundwater recharge) would be considered.

4. Awareness Raising

Although many households are equipped with back-up storage for potable water, the majority of households in Kigali city and in other towns do not practice water supply augmentation using rainwater. Some up-scale housing developments in Eastern and Southern Rwanda seem to be all outfitted with RWH systems largely due to the unreliability of the potable supply in those areas. The Program therefore focuses on crafting a new image for RWH on the premise of building resilience in an environment where there is increasing pressure on scarce water resources. The awareness raising campaigns will be conducted through the dissemination of technical material on RWH, the website dedicated to RWH, media productions and school competitions.

Dissemination of technical material

In addition to the media productions, a batch of technical materials will be made available to the general public for consultation where specific information on the design and construction of RWH systems including in-situ moisture conservation is being sought. A handbook and technical brochures will be developed under the RWH based projects which will furnish users appropriate information for all types of applications.

Creation of a RWH website and media productions

A national water resources website with resource material that should include RWH material (both structural and soil storage) will be developed. The, MINIRENA, RNRA, MINISANTE, MININFRA and REG/WASAC could be the primary institutional hosts. This site should be linked to SEARNET, IRHA, Global Water Partnership (GWP), and Climate Change based websites that features the RWH and storage techniques and applications.

Media productions

Public service announcements (PSAs), TV documentaries, features, radio/TV panel discussions and print articles in newspapers and magazines should be used to promote the message of RWH and storage. These should be designed to coincide with significant commemoration days (World Water Day, March 22nd, World Environment Day, June 5h, World Food Day October 16thand World Day to Combat Desertification, June 17th) and should be featured in advance of the annual dry season when the public is most aware of impending water scarcity.

School competitions

Competitive essay and art competitions to promote the message of water conservation to include RWH as a significant means of practicing water conservation should be organized. These programs can be tied into significant commemorative events such as World Water Day (March 22nd), World Environment Day (June 5th), World Food Day (October 16th) and World Day to Combat Desertification (June 17th).

5. Capacity building

There is need to develop capacity in operation of RWH systems especially in operation and maintenance of community RWH systems and for home owners in management of RWH systems. This Strategic plan also proposes to train a number of specialists in the area of design and planning of RWH systems within the private sector, drawn from the pool of private contractors, engineers and architects. Training will be necessary for public service professionals in the Ministry of Natural Resources, the Ministry of Infrastructure, the Ministry of Health and the Ministry of Agriculture to equip them with the necessary advisory and technical support tools for transfer to clients. Strengthening the capacity of the national, provincial and district level actors on the potential survey, planning, implementation and monitoring of RWH practices is required.

Training of communities in operation and management of community RWH systems

The management and operation of the communal RWH systems in schools, churches, prison centers, rural as well as urban setting is of serious concern. The strategy calls for awareness-building, developing capacity among the community so that members can play a collaborative role along with support agencies in management and maintenance of their rainwater harvesting facilities. Training workshops for targeted community members will be conducted in the areas of cistern and distribution network maintenance, water quality testing and treatment. It is proposed that this be carried out by MINIRENA/RNRA under technical supervision of the Ministry of Health with administrative and technical support from the Rwanda Bureau of Standards and MININFRA.

Training of professionals in rainwater harvesting development

Training professionals in application of RWH technologies for non-household uses will be organized, particularly in the commercial and agricultural sectors, with a clear focus on enhancing efficiencies in water utilization. Techniques to increase rainwater infiltration for groundwater recharge and soil moisture maintenance will also be part of the capacity development programme for professionals in RWH in public, private and civil society institutions.

Organizing technical exchange between local and public and private sector professionals

The Strategy calls for a series of technical exchanges between local public and private sector professionals with other professionals and consultants from the wider field. In and outside the region.

Preparation of RWH guideline and standard manuals

A national RWH implementation guideline is essential to effectively and appropriately promoting RWH. Furthermore, standard manuals on the various exiting or to be innovated technologies will be prepared, printed out and distributed to all potential users

5. IMPLEMENTATION FRAMEWORK AND INSTITUTIONAL ROLES

5.1 Institutional roles and responsibilities

The degree to which this plan gets translated into results will depend on the robustness of and functional coordination between the implementing institutions. Clarifying institutional roles is an essential first step in enhancing coordination. The development of this Strategy involved the lead Ministry, affiliated agencies and key stakeholders. This participative and inclusive approach will be maintained during the implementation, monitoring and evaluation phases, hence recommending the need to establish a joint RWH Forum to bring together Central and Local government institutions, development partners, the private sector and civil society engaged in RWH promotion and a specialized Unit dedicated to Rainwater Harvesting within the IWRMD. This section outlines the roles and responsibilities of the key institutions in the implementation of the RWHS.

5.1.1 Policy and Oversight Institutions

Ministry of Natural Resources (MINIRENA)

The MINIRENA has the general mandate to ensure that the WRM policy and strategy are passed by Cabinet and communicated to stakeholders; present and defend the WRM strategy budget and proposed institutional reforms to cabinet; lead/ actively participate in resource mobilization; provide policy oversight to Strategy implementation including enforcement of accountability and continued alignment to high level political interests. The roles specific to RWH include

- ✓ Ensure that RWH is promoted in Rwanda as per the IWRM principles
- ✓ Strategize the use of RWH for domestic, agriculture and environmental uses
- ✓ Resources mobilization for the promotion of RWH
- ✓ Scale up best practices in the country by consideration of piloting and facilitation of credit schemes
- ✓ Coordinate those sectoral institutions (MINAGRI; MININFRA; MINIRENA, etc) concerned with RWH.

Ministry of Local Government (MINALOC)

MINALOC is in charge of establishment, development and facilitation of the management of efficient and effective decentralized government systems capable of law enforcement and delivery of required services to the local communities as well as promoting the well-being of the population by good governance, community development and social affairs.

Roles and responsibilities related to RWH include

- ✓ Ensure that RWH is promoted in all districts and sectors
- ✓ Ensure that decentralized approach is used to the promotion of RWH

Ministry of Agriculture, Animal Resources (MINAGRI) and affiliated agencies

MINAGRI will integrate IWRM principles into agricultural policy priorities and budgets; participate actively in the WRM sector coordination platforms; report regularly on IWRM activities implemented in the agricultural, livestock and fisheries sectors. Roles and responsibilities specific to RWH include

- ✓ Ensure the integration of RWH according to the IWRM principles
- ✓ Ensure that all runoff harvesting for agricultural production (crop and livestock) is in favor of catchment protection

Ministry of Infrastructure (MININFRA)

MININFRA is in charge of the development of institutional and legal frameworks, national policies, strategies and master plans relating to water supply and sanitation, energy and transport subsectors. Roles and responsibilities related to RHS include

- ✓ Encourage and support the involvement of the private sector in the promotion of RWH
- ✓ Integrate rooftop RWH in construction policies (houses, roads, etc)
- ✓ Participate in stakeholders workshop for legislative and policy review

Ministry of Health (MINISANTE)

MINISANTE is in charge of Policy formulation and promotion of hygiene and public health and will integrate IWRM principles and activities in the sectoral strategies and budgets. Roles and responsibilities specific to RWH include

- ✓ Follow integration and promotion of hygiene in RWH facilities
- ✓ Ensure that in any RWH facilities hygiene and health risks are addressed.

Ministry of Family and Gender Promotion (MIGEPROF)

MIGEPROF ensures coordination of gender, promotion and mainstreaming and family planning activities. Roles and responsibilities specific to RWH include mainstreaming RWH in the ministry's family planning and gender promotion policy and strategies.

Ministry of Education (MINEDUC)

MINEDUC provides political advocacy and budget support to the training of WRM professionals; promotion of IWRM research and technological innovation, as well as basic education on water resources management through policy reform and curriculum reviews. Roles and responsibilities specific to RWH include

- ✓ Inclusion of RWH in school curricula
- ✓ Encourage use of RWH facilities in the urban and rural schools (both Primary and Secondary)
- ✓ Promotion of research on RWH and its impact on livelihoods
- ✓ Develop educational and training programmes in institutions of tertiary and secondary education to develop appropriate human resources to carry out effective promotion and dissemination of RWH practices.

Therefore reviewing the capacity of existing training institutions to provide for such needs is required. Preparing proposals and guidelines for any changes that may be required, particularly in curriculum development. Commissioning a Task Force on specific studies as it sees fit may be required.

Ministry of Commerce (MINICOM) and affiliated agencies

MINICOM is in charge of Policy formulation and promotion of investments by the private sector in water resources management/industries and manufacturing. Roles and responsibilities specific to RWH include

- ✓ Encourage investments that favor RWH
- ✓ Work on incentive modalities for the promotion of RWH.

Ministry of Disaster Management and Refugees Affairs (MIDIMAR)

The MIDMAR takes lead in formulation, coordination, control, direction of disasters management, refugee affairs policies, political guidance, and supervision of the humanitarian assistance in emergency situations and mobilization of appropriate resources accordingly in order to promote disaster awareness culture and handling timely of Rwandan and foreign refugee affairs. Roles and responsibilities specific to RWH include

- ✓ Integrate RWH in humanitarian assistance
- ✓ Collaborate with MINIRENA in environmental and climate change disaster management.

5.1.2 Financing Institutions

Ministry of Finance, Planning and Economic Development (MINECOFIN)

MINECOFIN leads in internal and external resource mobilization; advocates for IWRM prioritization within budgets of WRM-related sectors and provide adequate budget to WRM Strategy implementation and supports capacity building for financial management and accountability by implementing agencies including decentralized entities. Roles and responsibilities specific to RWH include

- ✓ Encourage investors, private firms to use RWH facilities
- ✓ Lead agency charged with the preparation of the Rwanda Investment Policy and Investment Act.
- ✓ Facilitate loans for the promotion of RWH
- ✓ Expand funding sources for promotion of RWH

Development partners

Development partners provide technical and financial resources for implementing the WRM strategy and related sectors; Assist in developing partnerships and linking the implementation outcomes to international commitments and targets. Roles and responsibilities specific to RWH include

- ✓ Technical and financial support for scaling up best practices in areas of RWH
- ✓ Support Rwanda in networking RWH across neighboring countries and beyond

5.1.3 Regulatory Institutions

Rwanda Environment Management Authority (REMA)

REMA has to develop regulations and ensure protection and conservation of the Environment and natural resources across the Country. Roles and responsibilities specific to RWH include

- ✓ Ensure that all RWH practices being promoted are environmentally friendly
- ✓ Refine environmental regulations in favor of catchment protection
- ✓ Include RWH in priority eligible projects for FONERWA funding

Rwanda Utilities Regulatory Agency (RURA)

RURA will integrate the IWRM targets for infrastructure and utilities within its regulatory framework and priorities. Will monitor enforcement of IWRM regulations and laws into water-related utilities' planning, financing and implementation to ensure compliance. Roles and responsibilities specific to RWH include

- ✓ Incorporate RWH related utilities and facilities in their regulatory framework
- ✓ Ensure the promotion of RWH is as per IWRM principles and laws
- ✓ RURA can play a paramount role in case we propose development of RWH for commercial purposes

Rwanda Bureau of Standards (RBS)

Provision of standards based solutions for Consumer Protection and Trade promotion for socio-economic growth in a safe and stable environment. Related to water RBS also makes provisions for setting quality standards. Roles and responsibilities specific to RWH include

- ✓ Ensure that water from RWH meets the necessary quality standard
- ✓ Follow that proper and quality RWH collection materials / accessories are used

Rwanda Natural Resources Authority (RNRA)

As the overall institution responsible for execution of the RWH Strategy (as part of the wider WRM mandate), RNRA will plan, budget and monitor and report on the strategy implementation, including coordination of other actors. Roles and responsibilities specific to RWH include

- ✓ Coordinate promotion of RWH in Rwanda
- ✓ Strategize phased dissemination and coverage of RWH in all the rural and urban areas
- ✓ Ensure that all regulatory, legislative and policy instruments are in place and operational for the promotion of RWH
- ✓ Researching on RWH technology options, development and policy advocacy in promoting RWH in rural/ urban areas.

5.1.4 Management/service Institutions

Water and Sanitation Corporation (WASAC)

WASAC will integrate the principles of IWRM in water supply, sanitation infrastructure; promote water use efficiency by promoting appropriate technologies and providing information, knowledge and appropriate incentives to clients and stakeholders; Plan for and mobilize resources for IWRM activities within WASAC planned activities, including sensitization of clients. Roles and responsibilities specific to RWH include

- ✓ Introduce appropriate and standardized RWH facilities
- ✓ Plan and work for the continuous supply and availability of RWH based facilities

Rwanda Development Board (RDB)

RDB supports enforcement of IWRM regulations and laws by incorporating them into Investment regulation and monitoring instruments including incentives and information packages; Facilitate registration and operation of investors in water services programs; to and support services to investors. Roles and responsibilities specific to RWH include

- ✓ Device incentive mechanisms for the promotion of RWH

User Communities

User communities deal with daily management of water resources in the course of their productive, consumptive and non-consumptive activities. Roles and responsibilities specific to RWH include

- ✓ Become conscious on the importance of Rainwater
- ✓ Participate in the management of local runoff and its productive use.

Local Government Authorities

Local Government Authorities Plan, mobilize resources, supervise and monitor the implementation of WRM projects and activities in line with the overall GoR policies, laws and strategies related to WRM; they report regularly on WRM activities implemented. Roles and responsibilities specific to RWH include

- ✓ Encourage the involvement of the private sector in the promotion of RWH
- ✓ Mobilize individual and community contribution for the promotion of RWH
- ✓ To institutionalize RWHS activities in Contract performance(Imihigo)

Private Sector

The Private Sector provides water-related services including design, construction, operation and maintenance of water supply infrastructure; operation and maintenance of efficiency and safety of water-related infrastructure; provides training and advisory services to water users, Government and non-state personnel; operates or provides other water-related services. Banking institutions such as banks and micro finances will play a key role in providing loans and other facilitation to households and institutions in a bid to access RHW facilities and systems. Roles and responsibilities specific to RWH include

- ✓ Involve in the study, design and construction of RWH services
- ✓ Involve in quality implementation of RWH services
- ✓ Specialize on various RWH technologies as suited for Rwanda
- ✓ Bulk importing of RWH promotion facilities e.g. weld mesh
- ✓ Establish loan schemes and other mechanisms to access RWH facilities

Non-Governmental Organizations (NGOs)

Non-Governmental Organizations (NGOs) supplement the public sector efforts in water resource management and development. Empower communities and Water user groups with skills, knowledge and information in IWRM; Enhance advocacy and accountability in water service delivery and watershed protection. Roles and responsibilities specific to RWH include

- ✓ Supporting piloting of RWH practices in rural areas
- ✓ Involve in the testing and demonstration of RWH practices
- ✓ Work on advocacy for the promotion of RWH and catchment protection, preparation of advocacy materials
- ✓ Promote RWH in a gender sensitive manner

RHA (Rwanda Housing Authority)

Ensuring that accommodation is accorded to Rwandans affordably. Roles and responsibilities specific to RWH include

- ✓ Integrate rooftop RWH in housing guidelines and standards
- ✓ Retro-fitting of RWH structures on existing buildings

RTDA (Rwanda Transport Development Agency)

RTDA is in charge of strengthening the institutional framework and capacity of transport institutions and stakeholders in the transport sector; as a backbone for sustainable economic development, transport enhances productivity and output, RTDA facilitates movement of people and goods, and improves access to social services like recreation, education, health services and others. Roles and responsibilities specific to RWH include support RWH structures from existing paved and unpaved Roads networks.

5.1.5 Research, Educational Institutions and Media

Research, technology and educational institutions have the mandate to conduct applied research, promote technology and educate people of all ages for sustainable development. They also buid capacity of professionals through short courses and trainings. The media disseminate information to the public and the community.

Research, technology and educational institutions such as the National Institute of Statistics of Rwanda (NISR), the University of Rwanda (UR) will play vital roles in promoting research, innovation and awareness in Rainwater harvesting.

Roles and responsibilities specific to RWH include

- ✓ The National Institute of Statistics of Rwanda (NISR) will integrate Rainwater harvesting issues into questions of national surveys, censuses and other data collection systems to provide technical support in the analysis and overview of rainwater harvesting activities.
- ✓ Research and technology institutions such as University of Rwanda (UR) will be mobilized and supported to identify and pursue research opportunities as well as innovative technologies to meet the challenges of Rainwater harvesting.
- ✓ Primary and Secondary schools as well as Universities and Higher learning institutions, have a key role in capacity building for Rainwater harvesting.

- ✓ They will be supported with a tailored curriculum to provide students with sufficient knowledge on Rainwater harvesting and management for water security, food security and environmental sustainability.

The Media

Roles and responsibilities specific to RWH include

- ✓ Raising public awareness by identifying and reporting importance of Rainwater harvesting activities.
- ✓ Being an effective agent of change, since the mass media (particularly radio) remains the main source of information for the majority of Rwandans.
- ✓ Collecting and disseminating information related to Rainwater harvesting.
- ✓ Press coverage of campaigns and special events organised on Rainwater harvesting

5.2 Institutional and policy set up for effective Rainwater harvesting coordination

There is a need to reinforce the Unit in charge of Water Resources Monitoring dealing with RWH. It already has two regular staff in charge of RWH. It is proposed to reinforce this Unit with three additional specialists in RWH. It is also recommended to have one specialist in RWH in charge of RWH monitoring and evaluation at the level of the Province in each Land Zone. This technical personnel would work under RNRA/IWRMD and would support Districts in the implementation of the RWH Strategy.

In the future and for the sustainability of RWH interventions, it should be envisaged to create a specific RWH Unit to coordinate all RWH activities. A specific RWH Policy is also urgently needed to clearly guide RWH interventions and install incentives through a policy document. It would define principles, policy statements to serve the basis of this strategy. This policy would also allow RWH to become a National Programme with a permanent national budget. Furthermore, RWH should be ranked to the level of a Sub-Sector or included in the cross-cutting issues in the next generation of EDPRS to start in 2018.

6. MONITORING AND EVALUATION FRAMEWORK

6.1. Establishment of a Joint RWH Forum (JRWHF)

For effective information sharing and exchange of experiences with regards to the promotion of RWH and networking establishment, a joint RWH forum will be set up and facilitate to function. This forum will be comprised of all active stakeholders involved in the promotion of RWH. Apart from information sharing through email and internet (developed website) quarterly, annual or biannual meeting sessions will be organized.

Procurement of necessary office facilities for the new staff and all the necessary office space and facilities (computers, photocopying, scanning, faxing machines, communication utilities, etc. will be procured). The recruitment of technical assistance where the Unit would be supported by periodic senior technical assistance will also be deemed necessary.

Regular monitoring and evaluation will be central to the effective implementation of this strategic plan. It will be a means of ensuring that implementation measures are on the right course to deliver the desired objectives. The strategic plan incorporates monitoring, evaluation and reporting frameworks that allow for appropriate intervention procedures and actions. A system for monitoring and evaluation will, therefore be operated on result, process and change levels, and separating monitoring from evaluation.

Monitoring and evaluation of this national RWH Strategic Plan is amongst the major tasks of the Unit which is mandated to supervise, coordinate and guide its implementation. This tool will bring about improvement in the effectiveness of implementation process, help to identify areas of support to enhance the capacity of implementing organizations, facilitate the collection and impact for decisions on future course of action, and assist in learning framework practices.

6.2 Operationalizing the M&E framework for the RWH Strategic Plan

The implementation of this WRH Strategic Plan entails the existence of a functional and comprehensive M&E System. To this end, an M&E Plan and M&E work Plan will be developed. The M&E Plan will define all aspects of what the M&E system will measure and how the M&E System will operate. It will be connected to the RNRA existing M&E System and will be updated on regular basis. It will also standardize and validate the mandates, authorities, and responsibilities for M&E stakeholders. This forthcoming M&E will assign specific responsibilities related to M&E functions to all stakeholders. It will also clarify all M&E activities, cost them out and indicate their timeliness

Following a consensus of key criteria and indicators that will form the core of the framework, metadata development to guide data generation and collection as well as analysis, RNRA/IWRMD will identify available baseline data and information as well as data gaps that must be filled prior to operationalising the M&E. This may require specific consultancies to support generation of the baseline data that is critical to RWH strategic plan implementation. It is recalled here that some indicators in the M&E framework do not have baseline data and annual targets, therefore, studies will be conducted in the first year of the Strategy implementation to set the baseline.

6.3. Monitoring and reporting

RNRA will develop system and build procedures for monitoring and for modifying strategies based on changes in the external environment or the organization. Progress towards goals and objectives and use of strategies is monitored regularly, with strategies revised and annual objectives developed yearly, based on the progress made, obstacles encountered, and changing environment. Annual objectives will be defined at start of each year. It is necessary to look back to see what progress has been made in critical success factors and the plan will be used as a compass, but not an inflexible blue print for action.

The coordinating body plays a critical role in reviewing progress and assuring that strategies are changed as appropriate. Staffs carry out the documentation required to generate ongoing data for this review, as well as carrying out periodic monitoring and making report to RNRA and stakeholders. RNRA/IWRMD through the Water Resources Monitoring Unit sets up planning and evaluation team, which would play an ongoing role in monitoring progress towards goals and objectives and analyzing reasons for shortfalls in accomplishments. An efficient information exchange system will be designed to track the developments. The followings are the major monitoring modalities applied.

- Periodic monitoring reports
- Review meetings
- On sites visits

Progress / periodic monitoring (quarterly, biannually and yearly) basis will be carried out using well-articulated planning and achievement reporting formats. For periodic monitoring and performance assessment of implemented RWH practices possibly a checklist presented in Annex 4 can be used.

6.4. Evaluation

The evaluation gives the actual deviation from plans, the reasons why and the lessons learnt. Evaluation questions are concerned with the effects and the impact of outputs and activities, assessing the actions or reactions of those affected by the programs at one points in time either during implementation (interim and final evaluation) or after the completion of activities (ex-post evaluation). Evaluation can be undertaken internally or externally, and it is possible self-evaluation can be complemented by independent/external evaluations. It is proposed that independent evaluations of the program be conducted periodically to assess success of the Project and contribute to recommendations in an adaptive learning process. A pre-program evaluation should establish the baseline (in conjunction with the assessment conducted under the intended RWH project) to be followed by a mid-term and post-program evaluation. The evaluation process should be done by an independent source.

7. COST ESTIMATES AND FINANCIAL MANAGEMENT

In the table in Annexe3, the budgeted expenditure for the next 5 years of implementation is given. The total estimated cost is 319,133,426,000 Frw. Of this estimated cost, 174,356,426,000 Frw are allocated to Outcome related to increased rainwater harvesting infrastructure for effective multiple use and 143,450,000,000 Frw are located to Soil and water conservation structures.

This investment will increase the water per capita par year from 670m^3 up to 830m^3 by 2022 with an average increase of 32m^3 per capita per year. The estimated quantity of rainwater to be stored is 1,683,680,360 m^3

8. ANNEXES

Annex1: Nine catchment level1 and their areas in Rwanda

1. Congo Kivu Catchment (**CKIV**) that covers the Districts of Rubavu, Nyabihu, Rutsiro, Karongi, Nyamasheke and Rusizi with some minute areas in Musanze, Ngororero and Nyamagabe Districts.

2. Congo Rusizi catchment (**CRUS**) that covers the District of Rusizi and some smaller areas in Nyamasheke and Nyaruguru Districts.

3. Nile Nyabarongo upper catchment (**NNYU**) that covers eight Districts of Ngororero, Rutsiro, Muhanga, Karongi, Nyamagabe, Ruhango, Nyanza, and Huye with some small areas in Nyamasheke and Nyaruguru Districts.

4. Nile Mukungwa catchment (**NMUK)** that covers five Districts of Burera,Musanze, Gakenke, Nyabihu and Ngororero with some ninute areas in Gicumdi District.

5. Nile Nyabarongo lower catchment(**NNYL)** covering ten Districts of Gakenke, Muhanga, Rulindo, Kamonyi,Gicumbi,Gasabo,Rwamagana and Kayonza with some minute areas in Kicukiro and Burera Districts.

6. Nile Akanyaru catchment (NAKN) covering seven Districts of Nyaruguru, Gisagara, Nyanza, Ruhango, Bugesera,Huye and Kamonyi with some minute areas in Nyamagabe and Muhanga Districts.

7. Nile Akagera upper catchment (NAKU) covering seven districts of Bugesera, Ngoma, Kirehe, Rwamagana, Kicukiro. Kayonza and Gasabo with smaller areas in Nyarugenge District.

8. Nile Akagera Lower catchment (NAKL) covering four Districts of Nyagatare, Gatsibo, Kayonza and Kirehe with a smaller part in Ngoma District.

9. Nile Muvumba catchment (NMUV) covering the Districts of Gicumbi and Nyagatare with smaller areas in Gatsibo and Burera Districts.

Annex2: Results based Monitoring and Evaluation for the RWH Strategic Plan

Key results	Key performance Indicators	Baseline by 2015/16	Targets by 2022	Means of verification	Critical assumptions
Overall objective: **To contribute to socio-economic development and environmental protection through sustainable water security**.					
	Contribution of RWH to water security(value)	670m3/capita/year	830m3/capita/year		Effective coordination with all stakeholders
Specific objective1: To strengthen policy, legal and institutional framework for improved rainwater harvesting coordination					
Outcome1					
Improved RWH governance and coordination	Percentage of public and private institutions having mainstreamed RWH in Policies, Plans and Programmes	TBD	80	MINIRENA Anuual report	RWH is accepted as an alternative for domestic water supply
	Number of Districts with RWH in annual contract performance/Imihigo	TBD	30	District Imihigo Evaluation report	
	Percentage of HHs aware of RWH best practices	TBD	80	RGB score card	
	Availability of functional M&E system on RWH progress	NA	1	Periodic M&E reports	
Output1 Policy, legal and institutional framework for improved rainwater harvesting is strengthened,	Availability of the New Water Law integrating Rain water Harvesting practices	NA	New water law gazetted	Official Gazette	
	Availability of harmonized incentive regimes to support RWH developed	NA	Ministerial order gazetted	Official Gazette	
Output 2. Required resources for rainwater harvesting across sectors for water storage and ground water recharge are mobilized,	Availability of feasibility study on Rainwater Harvesting Strategy implementation	NA	Approved study report	MINIRENA Report	
	Availability of resource mobilization strategy	NA	Resource mobilization strategy developed	Approved strategy document	

	% of required funds mobilized	TBD	90	Overall Development Assistance Report (MINECOFIN)	Cooperation with Development Partners will continue
Output 3: Rainwater Harvesting Stakeholders effectively coordinated	Percentage of Rainwater Harvesting stakeholders represented in existing institutions in charge of water domain	0	100	Periodic reports	
	% of Rain Water harvesting National Account Indicators reported	0	100%	RWH National Account periodic report	
Specific objective2:To increase rain water harvesting infrastructures for effective multiple use					
Outcome2					
Increased rainwater storage for effective multiple use.	Capacity of rainwater harvesting facilities installed (in m^3)	TBD	TBD	EICV biannual report by NISR	Increased acceptance of RWH among stakeholders
Output1					
Public, private, Collective and Individual HH rainwater harvesting systems constructed	Percentage of households with rainwater harvesting facilities.	17.4	100	EICV biannual report by NISR	Successful sensitization campaigns
	Percentage of public, private institutions, collective HHs equipped with RWH facilities.	2.4	100	Quarterly reports MINALOC MINIRENA	High costs
Output2					
Multipurpose dams, ponds and valley dams increased in the country	Number of dams, ponds and valley dams established	22 dams	39	Quarterly reports District & MINIRENA	Coordinated stakeholders in the country e.g MINAGRI, RAB,Districts and others
		735 water ponds	3,549		Availability of funds
		83 valley dams	98		
Specific objective 3:To promote infiltration and groundwater recharge in urban and rural areas					
Outcome 3					
Increased groundwater table in cities	Volume of groundwater recharge artificial	TBD	TBD	MINIRENA annual report	New building regulations and standards published

	infrastructures established in cities				
Output 1					
Regulations and standards document revised and published.	Availability of RWH standards in building laws and regulations	Existing Rwanda building code.	Implemented.	Updated check list for construction permit including RWH system.	Revision of building regulations and standards
Output 2					
Cities master plans revised and updated.	% of cities master plans integrating RWH	Existing master plans.	Revised and updated master plans	MININFRA/RHA reports	Availability of funds
Output 3					
Greening in urban areas increased	Number of Hectares (Ha) greened.	TBD	80	Reports	
Output 3					
Artificial groundwater recharge infrastructures developed	Number of studies for artificial groundwater recharge.	Zero	6 approved studies	Studies published. Reports .	
	Number of pilot projects for groundwater recharge implemented in cities.	Zero	6 pilot projects	Progress reports	
Output 4					
Soil erosion control structures (e.g progressive and radical terraces, contour bands, ridges, etc…) developed	Percentage of hectares (ha) developed with radical terraces and agroforestry	37.9	67.5	MINRENA &RAB Report	
	Percentage of hectares (ha) developed with progressive terrace and agroforestry.	80.2	93.6	MINRENA &RAB Report	
Output5					
Check dams, and gabion constructed	Availability of study on check dams and gabions localization	NA		Study report	

	Number of check dams and gabions constructed	1000	11000	MINERENA Report	
Output 6					
Hillside, marshland and small scale irrigation up scaled	Number of hectares (Ha) irrigated in marshland	30,753	35,753	RAB Report	
	Number of hectares (Ha) irrigated on hillside	4,807	9807	RAB Report	
	Number of hectares (Ha) irrigated under SSI	450	1450	RAB Report	
Specific objective4:To promote innovation and capacity building for improved water harvesting and storage systems and technologies					
Outcome 4					
Improved RWH technologies and increased innovation facilities	Number of new technologies in place e.g sand dam, retention basins, contour bunds etc.	TBD	3 -spate irrigation -retention basins -contour bunds	Annual reports MINIRENA	Cooperation with research institutions will continue
Output1					
Studies and applied research on Rain Water Harvest conducted and best practices documented	Number of studies conducted	1	4	Study reports/ MINIRENA	Availability of researchers
	Number of research topics	TBD	2		(Floodings,integration of RWH in public institutions)
	Number of best practices inventoried and documented	TBD	TBD		
Output2					
Skills and Knowledge in RWH acquired among stakeholders	Number of handbooks, guidelines, manuals and brochures on RWH prepared	TBD	TBD	Procurement plan and report	Availability of funds
	Percentage of staff trained in RWH in Ministries, Agencies, Districts and other stakeholders/ and community members	TBD	80%	Annual training report MINIRENA	Cooperation with specialized training centers in the country

Ouput3					
Increased awareness on RWH among stakeholders and beneficiaries	Percentage of the population reached by RHW technical material through meetings and media productions	TBD	70	RNRA report	
	Number of publications on the web link on RWH on RNRA website	TBD	Monthly	RNRA report	
	Number of artists participating in media campaigns	TBD	TBD	RNRA report	
	Number of schools participating in competitions on RWH	TBD	TBD	RNRA report	

Annex3: Time frame for the implementation of the RWH Strategic Plan 2017/2018-2021/22

Key Output(s)	Key Activities	Time frame					Responsible/ Lead Agency
		2017/18	2018/19	2019/20	2020/21	2021/22	
Outcome One: **Improved Rainwater harvesting governance and coordination**							
1.1 Policy, Legal and institutional framework for improved RWH strengthened	1.1.1 Review existing legal and policy instruments to propose an effective legal (regulatory) and policy framework for promotion of RWH	X	X				MINIRENA / RNRA
	1.1.2 Design appropriate regime to augment existing water conservation measures	X	X				MINIRENA / RNRA
	1.1.3 Enhancee the Unit in charge of RWH within RNRA/IWRMD	X	X				MINIRENA/ RNRA
	1.1.4 Create effective coordination /Joint Forum for RWH	x	x	x	x	x	MINRENA /RNRA
	1.1.5 Design RWH M&E system		x	x			MINIRENA/ RNRA
1.2 Adequate resources for RWH mobilized	1.2.1 Develop a feasibility study for RWH	X	X				RNRA
	1.2.2 Develop a resource mobilisation strategy for RWH		X				MINIRENA / RNRA
Outcome Two: Increased rainwater harvesting infrastructure for effective multiple use							
2.1 Public, private, collective and Individual HH rainwater harvesting systems constructed	2.1.1 Constructing water harvesting structures in 3000 public buildings like schools, health facilities, local administration)	X	X	X	X	X	MINIRENA, MININFRA, RNRA,RHA
	2.1.2 Equipping 2,358,488 households with rainwater harvesting facilities	X	X	X	X	X	MINIRENA, RNRA,Districts
	2.1.3 Constructing water harvesting structures in 3000 Private buildings like churches, financial institutions, commercial buildings)	X	X	X	X	X	Owners

2.2 Multipurpose dams, dykes, ponds and irrigation channels increased in the country	2.2.1 Constructing 17multipurpose dams	X	X	X	X	X	MINIRENA/ RNRA, MINAGRI
	2.2.2 Constructing 2814 water ponds	X	X	X	X	X	RNRA,RAB,Districts
	2.2.3 Cosntructing 15 valley dams						RNRA,RAB
	2.2.4 Constructing 250 irrigation ponds on roadside	X	X	X	X	X	RNRA,RTDA
Outcome Three: Increased infiltration and groundwater recharge in urban and rural areas							
3.1 Regulations and standards document revised and published.	3.1.1 Conduct the review of building regulations and standards		x				MININFRA, RHA
3.2 Cities master plans revised and updated.	3.2.1 Update 6 cities master plans		x	x			MININFRA, RHA
3.3 Artificial groundwater recharge infrastructures developed	3.3.1 Conduct 6 studies for artificial groundwater recharge infrastructures	x	x				RNRA, Districts
	3.3.2 Develop and implement 6 pilot projects for groundwater recharge in cities		x	x			RNRA, Districts
3.4 Soil erosion control structures developed	3.4.1 Develop 50000 ha of radical terraces	x	x	x	x	x	RNRA,RAB
	3.4.2 Develop100000 ha of progressive terraces	x	x	x	x	x	RNRA,RAB
3.5 Agroforestry practices developed	3.5.1 Plant 100000 ha with agroforestry species	x	x	x	x	x	RNRA,RAB
3.6 Check dams, and gabion constructed	3.6.1 Construct 10000 check dams and 1000 gabion	x	x	x	x	x	RNRA,RAB
3.7 Hillside, marshland and small scale irrigation up scaled	3.7.1 Develop irrigation on 5000ha of marshland,5000 of hillside and 1000 ha under SSI	x	x	x	x	x	RNRA,RAB
Outcome Four:Improved rainwater harvesting technologies and innovation facilities							

4.1 Studies and research on Rain Water Harvest conducted	4.1.1 Carry out impact assessment studies on implemented RWH practices (e.g dam-sheets) as well as their ecological viability and compatibility with other programs			x		x	MINIRENA / RNRA
	4.1.2 Investigate water quality and health aspects of RWH Structures		x	x			MINIRENA / RNRA
	4.1.3 Carry out research on factors enabling effective integration of different RWH techniques into existing or planned Public infrastructure			x	x		MINIRENA / RNRA
	4.1.4 Carry out research on RWH techniques that are suitable for floods management		x	x			MINIRENA / RNRA
	4.1.5 Feasibility study on appropriate RWH techniques suitable for handling road network runoff	x	x				MINIRENA / RNRA
4.2 Skills and Knowledge in RWH acquired among stake holders	4.2.1 Develop operation and maintenance manuals and guidelines for RWH users	x	x				MINIRENA / RNRA
	4.2.2Organise training for RWH technicians and users		x	x			MINIRENA / RNRA
	4.2.3 Organise technical exchanges of RWH professionals	x	x	x	x	x	MINIRENA / RNRA
4.3 Increased awareness on RWH among stakeholders and beneficiaries	4.3.1 Organise country-wide awareness seminars on RWH for public and policy makers	x	x	x	x		MINIRENA / RNRA
	4.3.2 Organise artist road shows with artists	x	x	x	x	x	MINIRENA / RNRA
	4.3.3 Produce a suite of media products	x	x	x			MINIRENA / RNRA
	4.3.4Develop a website on RWH	x					MINIRENA / RNRA
	4.3.5 Conduct school awareness programme through posters, essays, competitions on RWH		x	x			MINIRENA / RNRA

Annex4: Results based costing matrix

	Results based costing matrix									
Key Output(s)	**Key Activities**	**Unit**	**Unit cost**	**Quantity**	**Budget per year(Million Frw)**					**Total estimate for 5years**
					2017/18	**2018/19**	**2019/20**	**2020/21**	**2021/22**	
Outcome One: Improved Rainwater harvesting governance and coordination										
1.1 Policy, Legal and institutional framework for improved RWH strengthened	1.1.1 Review existing legal and policy instruments to propose an effective legal (regulatory) and policy framework for promotion of RWH	Study	10000000	2	10	10				20,000,000
	1.1.2 Design appropriate regime to augment existing rainwater harvesting and management measures	Study	10000000	1	10					10,000,000
	1.1.3 Enhancee the Unit in charge of RWH within RNRA/IWRMD	Staff	1000000	420	84	84	84	84	84	420,000,000
	1.1.4 Create effective coordination /Joint Forum for RWH	Meetings	1000000	10	2	2	2	2	2	10,000,000
	1.1.5 Design RWH M&E system	Study	50000000	1		50				50,000,000
1.2 Adequate resources for RWH mobilized	1.2.1 Develop a feasibility study for RWH strategy implementation	Study	50000000	1	50					50,000,000
	1.2.2 Develop a resource mobilization strategy	Study	10000000	1		10				10,000,000
Total Outcome1					156	156	86	86	**86**	**570,000,000**
Outcome Two: Increased rainwater harvesting infrastructure for effective multiple use										
2.1 Public, private, Collective and Individual HH rainwater harvesting systems constructed	2.1.1 Constructing water harvesting structures in 3000 public buildings like schools, health facilities, administration)	Public House	20000000	3000	12,000	12,000	12,000	12,000	12,000	60,000,000,000

	2.1.2 Equipping 2,358,488households with rainwater harvesting facilities	Category 1 HH	50000	376192	3,761	3,761	3,761	3,761	3,761	18,809,600,000
		Category 2 HH	50000	351730	3,517	3,517	3,517	3,517	3,517	17,586,500,000
		Category 2 HH	66000	351731	4,642	4,642	4,642	4,642	4,642	23,214,246,000
2.2 Multipurpose dams, dykes, ponds and irrigation channels increased in the country	2.2.1 Constructing 17 multipurpose dams of 55.38MCM	Multipurpose dam	856	55380000	9,481	9,481	9,481	9,481	9,481	47,405,280,000
	2.2.2Constructing 2814 water ponds	Pond(120$m^{3)}$	1000000	1000	200	200	200	200	200	1,000,000,000
		Pond(250m^3)	1500000	1500	450	450	450	450	450	2,250,000,000
		Pond((480m^3)	2200000	314	173	173	173	172	172	690,800,000
	2.2.3 Cosntructing 15 valley dams	Valley dam	160000000	15	4800	4800	4800	4800	4800	2,400,000,000
	2.2.4 Constructing 250 irrigation ponds on roadside	Irrigation pond/dam sheet	4000000	250	200	200	200	200	200	1,000,000,000
Total Outcome2					**39,224**	**39,224**	**39,224**	**39,223**	**39,223**	**174,356,426,000**
Outcome Three: Increased infiltration and groundwater recharge in urban and rural areas										
3.1 Regulations and standards document revised and published.	3.1.1 Conduct the review of building regulations and standards	Study	5000000	2		10				10,000,000
3.2 Cities master plans revised and updated.	3.2.1 Update 6 cities master plans	Study	30000000	6		90	90			180,000,000
3.3 Artificial groundwater recharge infrastructures developed	3.3.1 Conduct 6 studies for artificial groundwater recharge infrastructures	Study	10000000	6	30	30				60,000,000

	3.3.2 Develop and implement 6 pilot projects for groundwater recharge in cities	Project	10000000	6		30	30			60,000,000
3.4 Soil erosion control structures developed	3.4.1.Develop50000 ha of radical terraces	Ha	1000000	50000	10,000	10,000	10,000	10,000	10,000	50,000,000,000
	3.4.2 Develop 100000 ha of progressive terraces	Ha	100000	100000	2,000	2,000	2,000	2,000	2,000	10,000,000,000
3.5 Agroforestry practices developed	3.5.1. Plant 100000 ha with agroforestry species	Plant/ha	22500	100000	450	450	450	450	450	2,250,000,000
3.6 Check dams, and gabion constructed	3.6.1 Construct1000 check dams	Check dam	100000	1000	20	20	20	20	20	100,000,000
	3.6.2 Cosntruct 1000 gabion	Gabion	100000	1000	20	20	20	20	20	100,000,000
3.7 Hillside, marshland and small scale irrigation up scaled	3.7.1Irrigate 5000 ha of Hiilsides	Ha	10000000	5000	10,000	10,000	10,000	10,000	10,000	50,000,000,000
	3.7.2 Irrigate 5000 ha of marshland	Ha	6000000	5000	6,000	6,000	6,000	6,000	6,000	30,000,000,000
	3.7.3 Develop small scale irrigation on1000 ha.	Ha	1000000	1000	200	200	200	200	200	1,000,000,000
Total Outcome3					**28,720**	**28,850**	**28,810**	**28,690**	**28,690**	**143,760,000,000**
Outcome Four:Improved rainwater harvesting technologies and innovation facilities										
4.1 Studies and research on Rain Water Harvest conducted	4.1.1 Carry out impact assessment studies on implemented RWH practices (e.g dam-sheets) as well as their ecological viability and compatibility with other programs	Study	25000000	2			25		25	50,000,000
	4.1.2 Investigate water quality and health aspects of RWH Structures	Study	25000000	2		25	25			50,000,000

	4.1.3 Carry out research on factors enabling effective integration of different RWH techniques into existing or planned Public infrastructure	Study	15000000	2			15	15		30,000,000
	4.1.4 Carry out research on RWH techniques that are suitable for floods management	Study	40000000	2		40	40			80,000,000
	4.1.5 Feasibility study on appropriate RWH techniques suitable for handling road network runoff	Study	50000000	1	50					50,000,000
4.2 Skills and Knowledge in RWH acquired among stake holders	4.2.1 Develop operation and maintenance manuals and guidelines for RWH users	Manuals Guidelines	10000000	1	5	5				10,000,000
	4.2.2Organise training for RWH technicians and users	Training	2000000	10		10	10			20,000,000
	4.2.3 Organise technical exchanges of RWH professionals	Exchange visit	5000000	10	10	10	10	10	10	50,000,000
4.3 Increased awareness on RWH among stakeholders and beneficiaries	4.3.1 Organise country-wide awareness seminars on RWH for public and policy makers	Seminars	2000000	10	4	4	4	4		20,000,000
	4.3.2 Organise artist road shows	Artist shows	1000000	30	6	6	6	6	6	30,000,000
	4.3.3 Produce a suite of media products	Media product	25000000	1	5	10	10			25,000,000
	4.3.4 Develop a website on RWH	Website	2000000	1	2					2,000,000
	4.3.5 Conduct school awareness s on RWH	awarenes program	1000000	30		10	10	10		30,000,000
Total Outcome4				102	82	120	155	45	41	447,000,000
Grand total					**68,182**	**68,350**	**68,275**	**68,044**	**68,040**	**319,133,426,000**

Annex 5: Checklist for the performance assessment of implemented RWH practices

Performance Assessment on RWH Practices for Domestic Supply and Other Productive Uses of Rural and Urban Communities in Rwanda

Notes:

- *The various checklists for site visits are prepared for each type of RWH technology*
- *The fact that there is one type of technology at each scheme means that only one of the checklists will be used for each scheme*

Roof Catchments with Surface Tanks

- **General**

✓ Purposes for which the system is used/planned: domestic supply, livestock watering, crop production,
✓ domestic& livestock, all purposes
✓ Overall status of the roof RWH scheme: functional, not functional
✓ Overall handling of operation and maintenance: well managed, medium, poorly managed

- **Roof catchment conditions:**

✓ Roof RWH built on: institutional/communal building, individual HH
✓ Overall status of the roof catchment: functional, not functional
✓ Type of roof: corrugated iron sheet, other
✓ Total roof area: _____ m^2
✓ Area from which rainwater is harvested: _____ m^2
✓ Conditions of roof: good, medium, poor (Criteria: age, Imperviousness, Cleanness including debris &overhanging branches, etc)
✓ Lower roof edge slope: horizontal, irregular

- **Roof RWH conveyance systems (Gutters & downpipes/gutters)**

✓ Overall status of the conveyance system: functional, not functional
✓ Conveyance system capacity/size and placement in relation to lower roof edge to intercept and convey roof water: adequate, medium, inadequate
✓ Conveyance system slope: properly slopping, improperly sloping
✓ Conditions of Conveyance system: good, medium or poor (Criteria: age, whether clogged with debris, sagging, twisted, leaking, broken, etc.)
✓ Filter system conditions between gutter and tank: good, medium, not functional, no filter system
✓ First flash excluding mechanism: functional, not functional, no such mechanism

- **Surface tanks**

✓ Type of surface tank: stone masonry, concrete, ferro-cement, brick/block, metal, plastic, other
✓ Overall status of the surface tank: functional, not functional
✓ Siting/location of tanks: appropriate, medium, not appropriate (criteria minimizing conveyance requirement, not too far or close to wall of the house, away from water polluting facilities such as toilets, etc):
✓ Tank shape: rectangular, cylindrical or spherical
✓ Capacity estimate, _____m^3
✓ Water stored in the tank: nearly full, partially full, small quantity, no water in the tank
✓ Total cost estimate of construction: RwFr _____
✓ Water holding condition: water tight, minor seepage, major leakage, failed

- ✓ Tank top: covered, not covered
- ✓ Tank openings (inlet, overflow, etc): covered with screen, left open
- **Various surface tank system components**
- ✓ Water abstraction device/draw-off pipe: properly installed, causing leakage through the wall
- ✓ Water tap location: raised excessively high above the tank floor, placed at/below the tank floor
- ✓ Water tap conditions: properly functioning, out of order but not draining/leaking water, broken and draining/leaking water
- ✓ Washout pipe: properly installed, causing leakage, not plugged, no washout pipe
- ✓ Tank overflow facility: installed properly, placed excessively below the top of the tank, no tank overflow provision
- ✓ Tank manhole: tightly fitted, loosely fitted, no manhole
- ✓ Soak away pit: working, not working, no soak away pit
- ✓ Water ponding around tank/water abstraction facility: water ponding in small quantity, water ponding in large quantity, no water ponding
- ✓ Fencing: properly fenced, not properly fenced, no fence

Performance Assessment on RWH Practices for Domestic Supply and Other Productive Uses of Rural and Urban Communities in Rwanda

Ground Catchments with Sub-Surface Tanks

General:

- ✓ Type of RWH system: traditional, modern
- ✓ Purposes for which the system is used: domestic supply, livestock watering, crop production, domestic &livestock, all purposes
- ✓ Overall status of the RWH scheme: functional, not functional
- ✓ Overall handling of operation and maintenance: well managed, medium, poorly managed

Ground catchment conditions:

- ✓ Type of ground catchment: small/micro natural ground, rock catchment, , various purpose ground catchment (e.g. road, threshing floor), purpose built
- ✓ Catchment area in relation to tank size: too large, more or less matching, inadequate
- ✓ Catchment conditions: good, medium, poor (Criteria: level of contamination, debris, catchment treatment to prevent silt accumulation, etc)

Ground RWH conveyance systems:

- ✓ Overall status of the conveyance system: functional, not functional
- ✓ Conditions of conveyance system built: good, medium, poor, conveyed/drained naturally (Criteria: for good, medium & poor are slope, whether clogged with debris, leaking/seepage, broken/ruined, etc.)
- ✓ Silt trap Condition: good, medium, not functional, no silt trap
- ✓ Filter system conditions between conveyance and tank: good, medium, not functional, no filter system

Sub-surface tanks:

- ✓ Type of sub-surface tank: stone masonry, concrete, ferrocement, clay lined, brick/block, plastic, other
- ✓ Overall status of the sub-surface tank: functional, not functional

- ✓ Siting/location of tanks: appropriate, medium, not appropriate (criteria: close to point of use, etc):
- ✓ Tank shape: rectangular, cylindrical, spherical
- ✓ Capacity estimate: _____m^3
- ✓ Water stored in the tank: nearly full, partially full, small quantity, no water in the tank
- ✓ Total cost estimate of construction: Frw_____
- ✓ Water holding condition: water tight, minor seepage, major leakage, failed
- ✓ Tank top: covered, not covered
- ✓ Tank openings (inlet, overflow, etc): covered with screen cover, left open

Various sub-surface tank system components:

- ✓ Type of water abstraction device (originally planned & installed): gravity fed draw-off pipe, rope & bucket, pump, other
- ✓ Originally planned & installed pump/gravity fed draw-off pipe: still working, abandoned, not applicable
- ✓ Existing water abstraction device: properly functioning, not properly functioning
- ✓ Tank overflow facility: installed properly, placed excessively below the top of the tank, no tank overflow provision
- ✓ Tank manhole: tightly fitted, loosely fitted, no manhole
- ✓ Soak away pit: working, not working, no soak away pit
- ✓ Water ponding around tank/water abstraction facility: water ponding in small quantity, water ponding in large quantity, no water ponding
- ✓ Fencing: properly fenced, not properly fenced, no fence

Performance Assessment on RWH Practices for Domestic Supply and Other Productive Uses of Rural Communities in Rwanda

Ponds

General

- ✓ Type of RWH pond: traditional, modern
- ✓ Purposes for which the system is used: domestic supply, livestock watering, crop production, crop production& livestock, all purposes
- ✓ Overall status of the RWH scheme: functional, not functional
- ✓ Overall handling of operation and maintenance: well managed, medium, poorly managed

Ground catchment conditions:

- ✓ Type of ground catchment: large natural ground, rock catchment, small natural ground, various purpose
- ✓ ground catchment (e.g. road side drains), purpose built
- ✓ Catchment area in relation to pond size: too large, more or less matching, inadequate
- ✓ Catchment conditions: good, medium, poor (Criteria: level of contamination, debris, catchment treatment to prevent silt accumulation, etc)

RWH conveyance systems:

- ✓ Overall status of the conveyance system: functional, not functional
- ✓ Conditions of conveyance system built: good, medium, poor, conveyed/drained naturally (Criteria: slope, whether clogged with silt & debris, leaking/seepage, broken/ruined, etc.)

Storage facility/pond:

- ✓ Pond shape: rectangular, circular, trapezoidal, other
- ✓ Capacity estimate, _____m^3
- ✓ Total cost estimate of construction: RwF _____

- ✓ Siting/location of pond: appropriate, medium, not appropriate (criteria: built on gently sloping land, upslope of irrigated land, unproductive land, close to homestead, etc):
- ✓ Conditions of water inlet/entrance facility/structure: good, medium, poor
- ✓ Pond lining: lined with plastic sheet, lined with clay, no lining
- ✓ Embankment conditions: stable, damaged, failed
- ✓ Overflow conditions: good, medium, poor, no overflow facility
- ✓ Water stored in the pond: nearly full, partially full, small quantity, no water in the pond
- ✓ Level of water pollution/contamination: high, medium
- ✓ Water seepage loss: high, medium, low/negligible
- ✓ Various pond storage system components
- ✓ Silt trap conditions: good, medium, poor, no silt trap
- ✓ Type of water abstraction device/method (originally planned & installed): rope & bucket, pumping,
  HDW, gravity pipe, direct access by people/animals, other
- ✓ Originally planned & installed pump/HDW/gravity pipe: still working, abandoned, not applicable
- ✓ Existing water abstraction device/method: properly functioning, not properly functioning
- ✓ Fencing: properly fenced, not properly fenced, no fence

N.B: Additional checklists would be added as per the new technologies identified and implemented.

9. REFERENCES

1. ADB, Rainwater harvesting Handbook 2008.
2. FONERWA, Rainwater harvesting technical brief, Kigali,2015
3. MINECOFIN, Economic Development Poverty Reduction Strategy, 2013-2018, Kigali,2013
4. MINIRENA, Final revised Strategic Plan for the Environment and Natural Resources Sector 2015-2018, Kigali,2016
5. RNRA, Five years Plan for Water Resources Management 2103/14-2017/18, Kigali, 2013.
6. RNRA, Rwandan Water Resources Management sub-sector strategic plan (2011 – 2015), Kigali, 2011;
7. MINIRENA, National policy for Water Resources Management, Kigali, June 2011;
8. MININFRA, National Policy and Strategy for Water Supply and Sanitation Services, Kigali, 2010
9. MININFRA, Feasibility study of Rainwater collection systems on Public buildings in Kigali City and Other towns in Rwanda, Kigali, 2010
10. MINIRENA, National Water Resources Management Plan, Kigali, 2015.
11. Government of Rwanda, Seven years Government Program,2010-2017, Kigali,2010
12. MINAGRI, Irrigation, Land Husbandry and Management. Brief to the Economic Cluster, Kigali, 2015
13. MINAGRI, Land Husbandry, Water Harvesting and Hillside Irrigation (LWH) project under MINAGRI in Program1,Kigali,2016
14. MINAGRI, Small Scale Irrigation Strategy, Kigali, 2011.
15. MINAGRI, Rwanda Irrigation Mater Plan - the Government of Rwanda, Kigali, 2010.
16. MININFRA, Feasibility Study of Rainwater Collection Systems on Public Buildings in Kigali City and Other Towns in Rwanda; Kigali, 2010.
17. REMA, Rwanda Green Growth and Climate Resilience Strategy, Kigali,2011
18. MINAGRI, Strategic Plan for the Transformation of Agriculture (Phase III), Kigali,2013
19. MINECOFIN, Sustainable Development Goals(SDGs),Kigali,2016
20. MINECOFIN, Vision 2020, Kigali,2000
21. NISR, The Fourth Integrated Household Living Conditions Survey (EICV4); Main Indicators Report; Kigali, 2015.
22. NISR, The Fourth Integrated Household Living Conditions Survey /Enquête Intégrale sur les Conditions de Vie des Ménages 2013/2014- EICV4 Thematic report -Utilities and Amenities, Kigali,2016
23. National Rainwater Harvesting Programme for Grenada, March 2006;Prepared by The Caribbean Environmental Health Institute; P.O. Box 1111, The Morne, Castries, ST. LUCIA
24. RAB, Update of Small Scale Irrigation database in Rwanda,Kigali,2013
25. RNRA, The comprehensive assessment of water storage per capita in Rwanda,Kigali,2016
26. RNRA, Elaboration of a project document for up scaling rainwater harvesting technologies in Rwanda, Kigali,2012