



# Water Sector Working Paper

## Appendix B

June 2011



---

**Editor**

**Megan Cole**

*megan.cole@smithschool.ox.ac.uk*

**Authors**

**Dr Mathew Warnest**

*mathew.warnest@gmail.com*

**Ryan Hogarth (finance)**

*mathew.warnest@gmail.com*

**Government Counterparts**

**Vincent de Paul Kabalisa**

*nilerwa@yahoo.com*

**Francois Xavier Tetero**

*fteterov@yahoo.fr*

**Expert Advisors**

**Geoff Pearce**

**Dr Mark New**

Photography by Megan Cole



*This document is an output from a project funded by the UK Department for International Development (DFID) for the benefit of developing countries. However, the views expressed and information contained in it are not necessarily those of or endorsed by DFID or the members of the Climate and Development Knowledge Network\*, which can accept no responsibility or liability for such views, completeness or accuracy of the information or for any reliance placed on them.*

*\*The Climate and Development Knowledge Network ("CDKN") is funded by the Department for International Development and the Dutch Ministry of Foreign Affairs and is led and administered by PricewaterhouseCoopers LLP. PricewaterhouseCoopers LLP is assisted in the management of CDKN by an alliance of organisations comprising the Overseas Development Institute, Fundacion Futuro Latinoamericano, South-South-North, LEAD International, and INTRAC.*

Smith School of Enterprise and the Environment  
University of Oxford  
Hayes House  
75 George Street  
Oxford OX1 2BQ  
United Kingdom  
[www.smithschool.ox.ac.uk](http://www.smithschool.ox.ac.uk)

## Executive Summary



This paper is one of nine sector working papers written as part of the process of developing a National Strategy on Climate Change and Low Carbon Development for Rwanda. It follows on from the Baseline Report produced in February 2011 which provides the local context for each sector, including current programmes and development plans. This paper focuses on Land Use Management and Planning while the other working papers cover Energy, Water, Agriculture, Forestry, Transport, Built Environment, Mining and Finance. The paper should be read in conjunction with the ‘thinkpiece’ which proposes the Strategic Framework including a vision for 2050, objectives, guiding principles and enabling pillars. The aim of each paper is to identify the vulnerabilities and opportunities facing the sector, to review global best practice and relevant case studies, and to propose an action plan for addressing climate change and low carbon development in the short, medium and long term. This action plan is put forward to stakeholders in Rwanda for review and comment. As the title suggests, the working papers are aimed at prompting discussion with stakeholders, rather than being the final word. The sector working papers, thinkpiece and stakeholder input will be used to compose the final Strategy in July 2011.

Rwanda is endowed with substantial freshwater resources. To that extent, regular rainfall patterns and a low user base has, until now, not required water storage and water monitoring. There is a clear gap of observed data and a monitoring framework for Rwanda’s water and climate. The challenges of rapid population growth, increased urbanisation and

industry, environmental degradation and pollution are leading to accelerated depletion and degradation of the available water resources. Any significant increase in Rwanda’s water demand will impact downstream nations, primarily the beneficiaries of the Kagera basin and riparian states of the Nile.

Transforming the national reliance on rainfall, particularly rain-fed agriculture must be a priority reflected in sectoral development planning and public infrastructure spending. Rwanda is highly vulnerable to current climatic variances of flood and drought episodes. These episodes are dependent on the nature of the Intertropical Convergence Zone (ITCZ) as it moves from north to south across Sub-Saharan Africa and back again. Whether the belt reaches Ethiopia is very noticeable; what happens over a small centrally located country such as Rwanda is dependent on the fine movements of the rain belt as it passes overhead. Hitherto the rainfall that Rwanda has received has been sufficient to meet its modest demands from simple run-off-river systems. Now Rwanda’s hydrological system is being challenged to provide for the growing water needs of its recent development. A comprehensive programme to introduce flow control and storage will be needed.

How Rwanda’s energy, water supply and treatment infrastructure is planned now will dictate the success and resilience of future communities. Given these demands, preserving environmental flows and protecting biodiversity will become increasingly difficult. Establishing a robust IWRM framework that can better understand current and

future abstraction, and better plan for and respond to impacts of climate change, is crucial to the nation's water security.

A Vision of Water Resource Management in 2050 is proposed in box 1. The vision targets are provided as a guide to planners and administrators to consider where Rwanda is at now to where it may wish to be in 2050 when it surpasses middle income country status supporting a knowledge-based economy, market-based agriculture, and progressive green industry. The 2050 vision statements are principle ideals that will assist framing the climate change and low carbon development policies and guide the short, medium and long term action agenda.

The management of Rwanda's water and natural resources is complex and involves cross-cutting issues spanning all sectors, and demands the participation of national and regional stakeholders. The Water Law of 2008<sup>[1]</sup> prescribed the creation of a National Water Authority to lead a robust Integrated Water Resource Management (IWRM) approach. Integrated management of a nation's water resources is regarded as a prime method of climate change adaptation and building resilience to future water security vulnerabilities<sup>[2]</sup>. The National authority is yet to be formally established. Rwanda is now making important steps towards achieving the IWRM vision through the drafting of a National Policy for Water Resources Management (WRM) <sup>[3]</sup>

#### **Box 1. Establishing Rwanda's Water Resource Management Vision 2050**

- Water security for a 2050 Rwanda achieved across the country
- Riparian rights framework
- Supply charges and taxes contribute to watershed management, and infrastructure
- Energy derived from viable rivers at micro and pico scales.
- Secure catchments and water storage facilities
- Innovation in community water engineering and agriculture for integrated irrigation supporting climate and carbon smart agriculture.
- Efficient irrigation
- Minimum environmental flow, for conservation of wetlands and biodiversity
- Micro drip and spray technology introduced to high quality/high profit agriculture
- Potable water available everywhere
- Domestic harvesting rainwater
- Water treatment and recycling in industry and commerce
- Recycled waste water utilised for agriculture, recreation and public gardens
- Recycled water for consumption in cities
- Ground water treatment for safe use
- Integrated water distribution network eliminating physical or vehicle transport
- Rwanda a responsible user of water and contributor to regional basins, a leader in best WRM practice and innovation in water re-use technologies
- National water databases are authoritative, up to date, and available for use by all key stakeholders for WRM
- Advanced Weather Forecasting and Climate Observatory, provides decision support to guide sustainable water management nationally and regionally
- Flood Resilient Settlements and Infrastructure
- Innovation in water conservation, shared experiences from downstream partner States
- Improved management of water resources through better monitoring and integrated analysis of water use

and supporting Sub-Sector Strategic Plan (2011-2015)<sup>[4]</sup>.

In April 2011, Cabinet approved the establishment of the Rwanda Natural Resources Authority (RNRA) that will encompass the functions of the former Office of Geology and Mineral Resources (OGMR), the National Land Centre (NLC), the National Forestry Authority (NAFA), and notably a new National Water Authority (Directorate of Water Resource Management) supporting IWRM principles and set to bring together responsibilities, efforts, and regional focal points for water resources management.

There is need for a review of the national water management structures and cross sectoral consultation mechanisms – that will be required to support Rwanda's transboundary responsibilities to mitigate the future potential for difficulties in international water budgeting. Importantly, to ensure a robust and efficient national framework is realised, a suitable structure must be put in place that allows for decision making by an inter-Ministerial council, a supporting Directorate of Water Resource Management (as described in the National WRM Strategy) and rationalised structure within the bureaucracy to reduce overlap of responsibilities, and to optimise investment of effort, collection of hydrological data, and allocation of human resources. District and community based organs are part of a 'holistic' national framework in line with the national deconcentration strategies. Effective community and civil society consultation must also be built into the framework.

A key requirement for the Rwandan Water Sector is the establishment and development of water resources monitoring. This involves:- improved meteorological services, better understanding of agro-meteorological principles across agricultural areas, improved hydrological monitoring of both water quantity and water quality. Without sufficient information to understand how much water falls as rain in Rwanda, how much is typically retained by agriculture, forestry and natural vegetation, how much water is available for local

and national exploitation, and how much water is available for environmental conservation, the Rwandan authorities will face difficulties in managing their water resources and water resource plans. Similarly without information about the amount of water required by different industrial and municipal sectors (and the nature of return flows), they will not be able to manage water resources allocation. Both aspects are fundamental to government being able to manage their water sector, and the many different sectors that are dependent on it. Fluctuation in agricultural yields is hindering Rwanda's development and growth potential. However, these are just some of the challenges faced by Rwanda today. The growing population will draw and impact the national water resource. Business' demand for water will increase in line with an emerging economy. Equally, demands for hydro-power will also increase.

These considerations will become more important as development continues to take place, and when urban centres (along with associated industrial growth) require a larger percentage of water budgets. Furthermore, as climatic variability increases over the medium term, government authorities will be increasingly challenged to manage water resources as objectives of different sectors diverge (e.g. choosing between prioritising of water for agriculture and food and prioritising it for urban development).

For all these reasons, the installation of monitoring systems for water management is a key requirement in providing a basis for decision-making. IWRM provides many tools for such decision-making. Also needed is the development of local Rwandan capacity to understand climatology and climatic variability. The importance of this is to provide self-empowerment in understanding global climate change trends and enabling the Government of Rwanda (GoR) to develop its own conclusions and recommendations (e.g. about adaptation and mitigation) without being significantly dependent on advice provided by foreign agencies.

Finally, once the internal water management and national climate trends have been dealt with, there will remain the question of interaction with other countries in the region especially lower on the Nile system; and the need to establish satisfactory transboundary water management agreements.

## Contents



<b>Executive Summary</b>	<b>i</b>
<b>Acronyms and Abbreviations</b>	<b>vii</b>
<b>1. Introduction</b>	<b>1</b>
<b>2. Vulnerabilities</b>	<b>5</b>
2.1 Water Balance	6
2.2 Agriculture	7
2.3 Livestock	8
2.4 Industry	9
2.5 Mining and Mineral Processing	10
2.6 Infrastructure Development	10
2.7 Domestic water and sanitation	10
2.8 Industrial pollution	11
<b>3. Opportunities</b>	<b>13</b>
<b>4. Sectoral Overlaps</b>	<b>15</b>
<b>5. Focus Areas</b>	<b>19</b>
<b>6. Review of Best Practice</b>	<b>21</b>
6.1 International approaches to IWRM	21
6.2 Case study: Murray-Darling Basin	25
6.3 Green and Blue Waters	28
6.4 Case study: China	29
6.5 Groundwater management	30
<b>7. Analysis of Options</b>	<b>31</b>
7.1 IWRM Approach	31
7.2 Legal and Policy framework for WRM	32
7.3 Rwanda's National Draft Policy and Strategy for WRM	33
7.4 Rwanda Natural Resources Authority	34
7.5 Nationally Appropriate Plan of Action 2006	35
7.6 Rwanda's ENR Sector Strategic Plan	36

7.7 EDPRS Targets	36
<b>8. Action Plan</b>	<b>39</b>
8.1 Proposed actions	39
8.2 Options	40
8.3 Strategic Framework	41
8.4 Roadmap	42
<b>9. Climate Finance</b>	<b>43</b>
9.1 Bilateral and multilateral funding	43
9.2 Payments for ecosystems services	43
9.3 Carbon trading and water purification	44
<b>10. Summary</b>	<b>47</b>
<b>References</b>	<b>49</b>
<b>Appendices</b>	<b>51</b>

## Acronyms and Abbreviations



BTC	Belgian Technical Cooperation	KWAMP	Kirehe Community-Based Watershed Management
CGIAR	Consultative Group on International Agricultural Research	LAS	Land Administration System
CGIS-NUR	Centre for GIS and Remote Sensing of the National University of Rwanda	LIS	Land Information System
DFID	UK Department for International Development	LTR	Land Tenure Regularisation
DRC	Democratic Republic of Congo	LVBC	Lake Victoria Basin Commission
EIA	Environmental Impact Assessment	LWH	Land Husbandry, Water Harvesting and Hillside Irrigation Water Project of the World Bank
EWSA	Energy, Water and Sanitation Authority	MINAGRI	Ministry of Agriculture
FAO	Food and Agriculture Organisation	MINECOFIN	Ministry of Finance and Economic Planning
GEF	Global Environment Facility	MINICOM	Ministry of Commerce
GIS	Geographic Information System	MINIRENA	Ministry of Natural Resources
GIZ	German International Cooperation	NBI	Nile Basin Initiative
GoR	Government of Rwanda	NELSAP	Nile and Equatorial Lakes Subsidiary Action Plan
GPS	Global Positioning System	NISR	National Institute of Statistics of Rwanda
ICT	Information and Communication Technology	NLC	National Land Centre (now the Department of Lands and Mapping under RNRA)
IFAD	International Fund for Agricultural Development	NUR	National University of Rwanda
IFC	International Finance Corporation	PSTA II	Strategic Plan for the Transformation of Agriculture in Rwanda - Phase II
ISAR	Institut des Sciences Agronomiques du Rwanda	RADA	Rwanda Agricultural Development Agency
ISNAR	International Service for National Agriculture Research	RBS	Rwanda Bureau of Standards
IISD	International Institute for Sustainable Development	RDB	Rwanda Development Board
IWRM	Integrated Water Resource Management	REMA	Rwanda Environment Management Authority
Kagera-TAMP	Transboundary Agro-ecosystem Management Programme for the Kagera River Basin	RHODA	Rwanda Horticulture Development Authority
		RITA	Rwanda Information Technology Authority
		RNRA	Rwanda Natural Resources Authority

SDI	Spatial Data Infrastructure		Europe
SIDA	Swedish International Development Agency	UNEP	United Nations Environment Programme
UK	United Kingdom	US	United States
UNECA	United Nations Economic Commission for Africa	USAID	United States Agency for International Development
UN-ECE	United Nations Economic Commission for	WB	World Bank

## Introduction



Water is an abundant resource in Rwanda with vast potential for development. The water resources constitute 101 lakes, hundreds of rivers, marshlands and groundwater. Due to its relief and its location in the African Great Lakes region, Rwanda has a very dense hydrological network. This network is divided into two main drainage basins; the Nile Basin to the east covering 67% of the land area in Rwanda and delivering 90% of Rwanda's national water resource; and the Congo Basin to the west which covers 33% of the land area and contains the remaining 10% of national waters all of which drain into the Congo Basin system via Lake Kivu (figure 1). At present it is not clear what volume of water is pumped out of the rivers and exploited for various needs<sup>[5]</sup>.

The Kagera River Basin covers the territories of Burundi, Rwanda, Uganda and Tanzania and feeds into the Nile system. The total catchment area of the Kagera River basin is some 60,000km<sup>2</sup>. The Kagera is the largest of the 23 rivers that drain into Lake Victoria and it delivers 34% of the annual river inflow to the lake. The lower Kagera Basin is one of the most important areas in Africa for agrobiodiversity and food production. The natural resources of the Kagera River Basin support the livelihoods of some 16.5 million people in Rwanda and downstream. The majority of these people are rural and depend directly on farming, herding and fishing. However, the resource bases for water and ecosystems are facing increasing pressures as a result of rapid population growth, agricultural and livestock intensification. This is characterised by progressive reduction in farm sizes and unsustainable land use and management practices.

There are two rainfall seasons across the Kagera Basin, the longer southeasterly monsoon bringing rain between February and May, and the shorter north-easterly monsoon from September to November. The months of June, July, and August are generally dry.

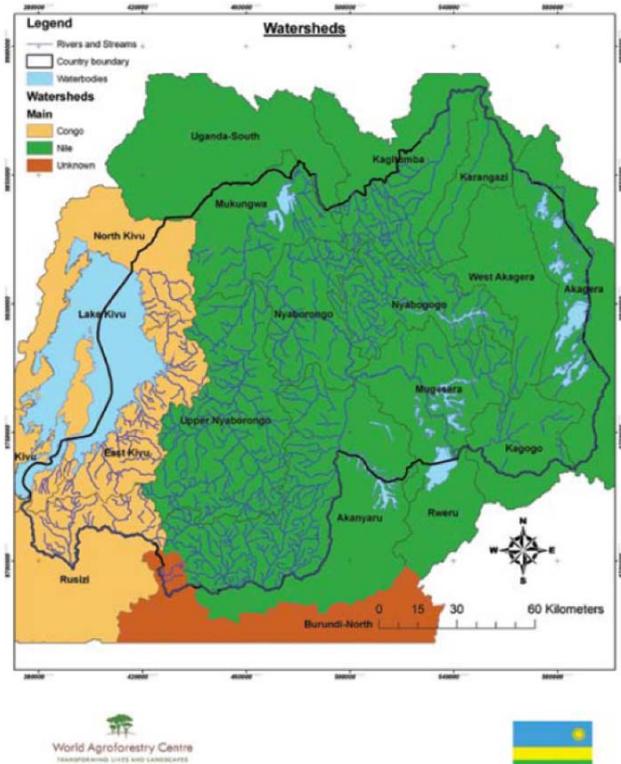


Figure 1: Water Basins of Rwanda (Congo Basin – Western Districts), (Kagera/Nile Basin – Central and Eastern Districts)<sup>[5]</sup>

Average rainfall over the basin amounts to some 1,000 to 1,200mm per year with highest average rainfall up to 1,800mm per year in the western mountain ranges in Rwanda and Burundi, with a descending gradient towards the east down to 800mm per year. The average annual temperatures are 15-18°C in the westernmost and north-western mountain range, and up to 22°C in the central area.

The Congo Basin of Central Africa, is the world's second largest river basin by discharge (average discharge of 42,000m<sup>3</sup>/s). Angola, Cameroon, the Central African Republic, the Republic of Congo and the Democratic Republic of Congo constitute 92% of the Congo Basin's total surface area of 3,691,000km<sup>2</sup>. In 2005, the total estimated basin population was over 77 million inhabitants. The Congo Basin is one of the world's richest in terms of water resources and biodiversity. About 33% of Rwanda's land area (about 8,140km<sup>2</sup>) is in the Congo River Basin, but this represents less than 0.002% of the basin's total area.

A clear opportunity exists to fully exploit the water resources of the far Western catchments that contribute to the Congo Basin. Whilst mindful of potential impacts to hydro-power on the Ruzizi River and microhydro installations through the Western districts, the substantial water resources in this region can be capitalised to build water security

in central and Eastern districts. Through appropriate engineering and irrigation systems, water can be transported to other districts. Natural environmental flows will need to be preserved. However, they can also be harnessed as natural water conduits for irrigation where flow allows. The key advantage is optimising the Western water resource that has little to no transboundary impact unlike that of the Kagera Basin catchments.

Nearly all (95%) of Rwanda's water resources originate from within the country and only about 5% from outside its territory, essentially Burundi. However, Rwanda has a net outflow mainly to the Nile via Akagera and to the Congo via Rusizi and Sebeya. As almost all of Rwanda's available fresh water resources are shared, internal utilisation has to consider downstream implications<sup>[4]</sup>.

Table 1, is drawn from the National WRM Strategy<sup>[4]</sup> and highlights Rwanda's responsibility to its downstream neighbours and the opportunity of substantial national water resource available.

The concept of shared waters has provided a natural way of fostering regional cooperation as common interests around a scarce resource and shared ecosystems have brought cross-border cooperation among peoples and governments. The Economic Community of the Great Lakes Countries (CEPGL), the Lake Victoria Basin Commission

Table 1: Water Availability and Use in the Nile Basin Countries

Country	Total Population ('000s)	Precipitation rate (mm <sup>3</sup> /yr)	Total Available water (km <sup>3</sup> /yr)	Incoming Waters (%)	Outgoing Waters (%)
Burundi	7068	1200	15	35	14
Egypt	73390	100	58	97	0
Eritrea	4297	400	6	56	35
Ethiopia	72420	800	122	0	80
Kenya	32420	700	30	33	30
Rwanda	8481	1200	5	0	81
Sudan	34333	400	65	77	30
Tanzania	37571	1100	91	10	14
Uganda	26699	1200	66	41	56

(LVBC) and the Nile Basin Initiative, demonstrate that there are political and socio-economic benefits beyond water. But trans-boundary water governance is a key issue for Rwanda because of the complexity of shared ecosystems, potential conflicts over shared waters, and climate change. Most critical ecosystems – afro-montane forests, wetlands, rangelands and other biodiversity hotspots - are shared and under severe degradation pressures<sup>[4]</sup>.

To be a good and responsible neighbor, Rwanda needs to put in place a robust national framework

to manage the national shared water resource and understand current and future water availability and abstraction. Extending programmes of water storage and harvesting, integrating water management programmes (i.e. combining irrigation infrastructure with water treatment engineering, domestic supply, waste water recycling and re-use), and promoting water conservation in agriculture, urban development and industry will contribute to achieving national water security.



## Vulnerabilities



The rationale for the National WRM Strategy (Draft 2011) lies in the fact that Rwanda lacks a clear framework for managing its water resources in the context of IWRM. A key priority is to reform the WRM institutions and make the ENR Sector Wide Group (SWAp) effective for IWRM. Lack of coordination is evident in the planning and utilisation of water resources. Managing the multiple interests in water resources and coordinating sectoral activities is a challenge. Cases of sectoral conflicts in water use have been reported at various levels, raising concern for a strong water governance framework. Poverty has pushed many Rwandans to settle on marginal lands (like steep hills and rangelands), to engage in sand and stone mining to survive and cultivate wetlands, resulting in severe degradation and pollution. Poor farming techniques have adversely impacted important catchments and critical watersheds. Both rural and urban poor lack basic sanitation, and are polluting water sources through poor sanitation and inappropriate settlements. The cost of availing water to poor people is high and maintenance of water infrastructure is low.

The possibility of more extreme climatic events such as prolonged drought have raised concerns for water access, even in areas hitherto known to be water secure. With reduced and increasingly unreliable rainfall, agriculture – the biggest water user – is expected to rely on irrigation. This will, undoubtedly increase the pressure on water resources. Floods and increase in heavy rain episodes will impact crops, roads, infrastructure, and dwellings. Occurrence of 1/100 year floods

may occur more frequently at up to 1/10 year occurrence, and the 1/100 flood may be far more extreme than experienced before. With warming sea temperatures in the Atlantic and Indian Oceans, weather such as extreme low pressure troughs may extend further inland than experienced before causing localised flooding. The future pattern of the African equatorial rain belt is not known.

From primary data, field research and interviews, a Baseline study was completed in January 2011. Findings from the study contributed to identifying the key vulnerabilities to water resource management in Rwanda. A summary of the key findings are listed in table 2.

### 2.1 Water Balance

Rwanda's water balance is impacted by the nation's high population density, and its reliance on subsistence farming practices. Intensification of agriculture and increasing urbanisation and industrialisation are placing further demands on the water resource. The water balance for 1993 and 2000 shows the estimates for available fresh water resources and the water consumption through domestic, industrial and agricultural uses. Table 1 suggests a large surplus of freshwater resources, and highlights the apparent potential for expansion and economic development of water consuming sectors.

Recent studies established projections for the 2020 water balance determined on the assumption that water consumption will vastly increase in line with infrastructure development and improved delivery to domestic, industrial and agricultural sectors. Based on the annual renewable water

Table 2: Vulnerabilities for Water Resource Management in Rwanda

Economic/ Finance	Water security, increasing water demands for population, agriculture, industry and urbanisation. Regional demand for water resource
Social/Capacity	Health and sanitation, food security, poverty alleviation, environmental change, extreme weather events drought and flood, high/low rainfall
Technology/ R&D	High sediment impact to dams and irrigation, unmanaged waste and sanitation. Poor understanding of current and future water balance
Political	Regional discord. Economic security of growth in industry and agricultural transformation, social safeguard, rural livelihoods and stability
Legal/ Institutional	Commitment to regional treaties on incomplete understanding of current and future water balance. Unsustainable exploitation of water resource
Environment/ Climate	Rainfall pattern change, climate variance, land degradation, biodiversity, minimum water flow for wetlands and regional basins
Communication/ Information	Silo based water use programming (i.e. infrastructure, industry, agriculture, forestry, housing), District WRM capacity, lack of spatially (GIS) based decision making, lack of community sensitisation of WRM and use practices

resource of 6,300 million m<sup>3</sup> per year, the vast water surplus may enable the system to be expanded by a factor of up to 40 when compared to the 2000 figures.

Groundwater in Rwanda is primarily within the vast alluvial aquifers adjacent to major rivers. Lesser amounts of groundwater can be found within the fractured bedrock of porous volcanic rock. It has been estimated that the total available groundwater resources of Rwanda have a renewable extraction rate of approximately 66m<sup>3</sup> per second.

## 2.2 Agriculture

### 2.2.1 Water demand

The agricultural sector is currently the largest consumer of water in the country, accounting for up to 70% of the water demand – expected to account for up to 80% of total water demand by 2020<sup>[6]</sup>. Rwanda's agriculture is predominantly rain-fed with some supplementary irrigation for rice from dams<sup>[4]</sup>. The use of groundwater in this sector is yet to be explored. With agricultural intensification and food security strategies in place, it is certain that withdrawal by the agriculture sector will increase.

Reliable information on how much water is used for agriculture is not readily available.

The agriculture sector is vital to Rwanda's economy contributing 36.7% in 2010. Not understanding current and future abstraction is a risk to both agricultural production and to the economy. Agricultural transformation is key to transitioning the economy from subsistence to market-based production systems. Sector growth, modernisation, mechanisation and industrialisation of agriculture will draw an exponential demand for water. Competition for the national water resource will increase with pressure from industry, energy generation, population and urbanisation. Understanding these competing demands and the available water is critical to Rwanda's growth. Improved observation and monitoring will inform Government on how to prioritise allocation. Improved monitoring of water quality, management of pollution and enforcement is required to meet the increased usage and impact to the water resource. Box 2 highlights the increasing demand from agricultural processing in the coffee sub-sector business.

**Box 2: Rwanda's Washed Coffee Station Industry: Water and Waste Management**

*Value-added coffee is emerging as a key driver of growth* and Rwanda has differentiated its coffee crop in the international market, thanks to the organic soils and coffee washing technology. Through public-private partnerships, the number of Coffee Washing Stations (CWS) has increased from 1 in 2002 and are expected to reach 240 by 2012. But according to OCIR Café (2009), Water management remains a serious constraint for CWS. It is estimated that a CWS with capacity to process 625 tons of coffee cherries operating at 4% capacity, would need 400m<sup>3</sup> of water per day if there was no water recirculation and 113m<sup>3</sup> if there was full recirculation (i.e. recirculation reduces water demand by 4 times). OCIR Café and OTF Group calculated that USD 2.6 million would need to be invested in water by 2012 to meet water needs.

*Coffee pulping often generates significant wastes that pollute surrounding soil and water sources and most CWS do not manage them effectively.* There are serious challenges of waste water management at most CWS, worsened by poor location near sensitive water sources or inefficient design.

Pulping uses a lot of fresh water which could be significantly reduced by the use of eco-pulpers. Eco-friendly processing techniques being encouraged include installing recirculation systems to decrease water use, sediment pond systems, and composting areas. Technoserve, an American company active in Rwanda's coffee sector, uses environmentally friendly Pedagos machines which use much less water and turn waste into compost rather than leave it to pollute the water. These measures should be encouraged in all stations, and operators trained to ensure that they are correctly applied. Public support will be required in areas where access to water is difficult or costly, and to promote environmentally sound practices.

*A strategy that encourages water and energy saving, and proper waste management, should be promoted in the coffee sector. The IWRM strategy should build incentives to encourage this.*

*"It cost us over RwF 15 million to catch a superficial spring and bring that water to our station; and since it's superficial, we can't even get water when it hasn't rained..." (CWS Operator)<sup>[7]</sup>.*

Source: Water Resources Management Sub-Sector Strategic Plan, Draft 2011<sup>[4]</sup>

**2.2.2 Vulnerabilities in Agricultural Water Use**

Identified in the National Water Resource Management Strategy in 2011, most pressures in agricultural water use will come from increased irrigation, but the impact on internal water resources and trans-boundary water flow will depend on how efficiently water is used. As rainfall becomes unreliable and extreme weather events intensify, Rwanda has shifted to expanding irrigated agriculture and harvesting rainwater. But there are still challenges in agricultural water management. The main issues of concern relate to:<sup>[4]</sup>

- Low levels of efficiency in agricultural water use: Rwanda's agricultural water use is inefficient. Both rain-fed and irrigation

systems are grossly inefficient. Rainwater evaporates very fast and most farmers do not practice improved soil water conservation (e.g. through mulching). As much as 4.3 km<sup>3</sup> of rain water is lost annually. The GoR has realised this challenge, and devised strategies to improve efficient in agricultural water management. For instance, under PSTA II and the Irrigation master plan, some 800,000 ha of irrigated agriculture is expected to depend on water harvesting and storage equivalent to 25 billion m<sup>3</sup> per year. Only 539,000 ha of the irrigation potential can be developed with available water resources. There are plans to invest

in efficient irrigation technologies that save water and are appropriate for smallholder farmers.

- Point source pollution: there has been unprecedented increase in use of chemical fertilisers and pesticides/fungicides [8]. While pesticides and fertilizers are boosting production, they are a major source of water pollution. This is exacerbated by limited knowledge among farmers; steep terrain which facilitates erosion and downstream runoff; and proximity to important water sources.
- Little advance in research and development to enhance water-efficient production systems. There is little advance in water-efficient cropping or livestock production systems. Flood-irrigated rice growing in extensive wetland systems is being expanded. Cultivation of water thirsty crops such as sugar cane, elephant grass and others, is increasing. The production of biodiesel crops is also under test. Biodiesel crops require extensive land and water, and given their economic potential, they could be adopted, resulting in increased water demand.

### 2.2.3 Irrigation for Agricultural Production

Rwanda has an estimated potential of 589,000ha of irrigated land, considering all production factors including water needs. According to the Ministry of Agriculture (MINAGRI), about 300,000ha will be irrigated. Presently, irrigation occurs in at least three forms – flood plain irrigation; sprinkler irrigation where water is transported to the crop area either by pumping or channels/ canals, and hillside irrigation. Over the next seven years, MINAGRI aims to increase the irrigated area from 18,000 ha in 2010 to 100,000ha in 2017, as shown in Figure 2. The six-fold increase in irrigated agriculture will increase the pressure on water resources. Considering that Rwanda's current water utilisation is less than 2% of available fresh water resources, increasing the irrigated area is a

positive development as it transforms resources into economic productivity and improved livelihoods[4].

The expansion of irrigation throughout Rwanda is detailed in the Irrigation Master Plan of 2010 that was prepared by MINAGRI with the support of the World Agroforestry Centre (ICRAF)[5]. A national irrigation policy and strategy is now required to support the preparation of the National Water Policy and National Water Resource Management Strategy. Irrigation efforts will need to adopt the principles of shared water resource management and the IWRM principles and structures detailed in the National Water Policy. Importantly, the irrigation plan will need to address climate resilience and adaptability to future climate change and improved monitoring of the water resource in relation to crop selection.

### 2.3 Livestock

According to the Agricultural Survey in 2008[8], Rwanda had 1,548,521 head of cattle. Most of these are located in the semi-arid rangelands of the eastern province where water is scarce. Hence, water development is a major challenge for livestock production. Inadequate access to clean water affects livestock productivity especially during the dry season. Pastoralists and farmers often force their way into areas where there is sufficient water, including illegally entering National Parks[9]. In response to the need to reduce land degradation, the GoR has enforced a policy of zero-movement grazing of livestock. Communal watering points are difficult to maintain and sharing water among

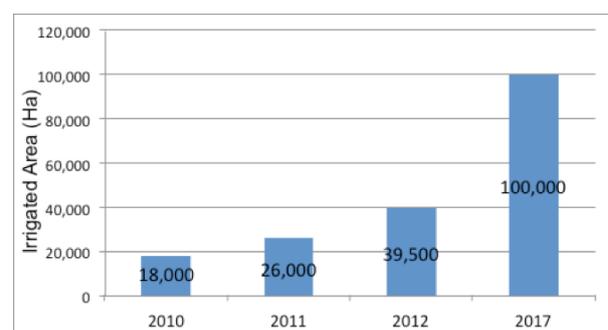


Figure 2: Planned expansion of irrigated agriculture (in hectares)

humans and livestock results in contamination (e.g. trampling and cow dung). Demand for water for livestock is also coming from another initiative which makes it a country-wide challenge – the highly commended and successful Girinka (One Cow per poor Family) programme, and the promotion of indoor livestock production. The needed expansion of this programme will further impact water demand for livestock and pressurise the national water resources.

The GoR has rolled out large scale infrastructure investments, notably construction of valley dams to increase water availability for livestock. These initiatives have been supported by International Fund for Agricultural Development (IFAD) and the African Development Bank, among others.

## 2.4 Industry

Industrial growth is a key driver of water demand both from industrial production perspective as well as the stimulation of service sectors and urbanisation which trigger domestic demand. Rwanda's industrial development has grown remarkably during the last five years, and is projected to grow significantly in the next ten years given the GoR emphasis on value addition to local production. Rwanda's fastest growing and arguably most successful industry – fully washed coffee production, is both an intense water user and polluter. As the number of coffee washing stations (CWS) is expected to increase from 46 in 2005 to 240 by 2012, it implies water use in coffee processing will increase as will likely the level of pollution in the absence of controls and enforcement<sup>[4]</sup>.

But what are the current and future abstraction demands and impacts of other industrial sub-sectors? Industrial activities that have implications for water demand include agro-processing (sugar production, milk and fruit processing), textile production, tea processing, bottled water production, leather tanning and clay products manufacturing. The establishment of a National Water Authority (vis Directorate of Water Resource Management) is a necessary step. Incorporated into

development planning and approval process, demands on the national water resource must be quantified and monitored across all sectors.

The National Water Strategy of 2011 highlights some of the key considerations for the industrial water demand:

- The nature and location of industrial activity influences water demand and waste management. About 90% of manufacturing industries in Rwanda are located in Kigali and Gisenyi, hence most industrial water demand is in the two cities. They are mostly primary industries for agro-processing.
- Secondly, the nature of the industry determines how water used and from where it's drawn. Most industrial activities are of small to medium scale. SMEs are known to be less efficient in water use, waste management and technological innovation, and they are difficult to regulate. Fully washed coffee is the fastest growing industry consuming more than 132,000 m<sup>3</sup> per year in 2010. Water is mostly drawn from springs and until recently, water recycling was not done.
- Water access, efficient use and waste management are identified as key priorities and there are demonstrable benefits. However, no investments are allocated to them in the Coffee Strategy budget (2009-2012) and scale-up may be difficult. There are improvements in some stations. The wastes from coffee processing are biodegradable and recent efforts in cleaner production have resulted in improved waste management at CWSs. Wastes are being converted into the much needed organic fertilisers and for energy production.

## 2.5 Mining and Mineral Processing

Rwanda's mineral industries are an important economic activity with high water demand and impact. Small-scale and artisanal mining activities, which dominate the mining sector in Rwanda, are inefficient water users. However, together with

sector growth and modernisation, the demand and pressures on the national water resource will increase. The current methods employed are known for their adverse environmental impacts. Stone and sand mining degrade river banks and river-beds, resulting in increase sediment loading and water pollution, declining stream flow and drying up of some streams. There are, however, initiatives to promote water-efficient and environmentally friendly mining activities. These include subjecting mining activities to environmental impact assessments; training artisanal mining operators in good practices; and incentivising mining operators to invest in modern appropriate technologies. Incorporation into a robust IWRM structure will assist transformation of the sector to become increasingly water efficient and less damaging as the sector expands.

## 2.6 Infrastructure

Construction of roads, bridges and buildings, expansion of housing in urban and peri-urban areas and construction of grouped settlements (Imidugudu), consume a lot of water. However, water consumption in infrastructure development is often not recorded. Large-scale water supply systems are being planned to support large-scale infrastructure projects – notably the Isaka-Kigali Railway and the New Bugesera International Airport, which could over-stretch existing water supply systems in the region<sup>[4]</sup>.

Urbanisation is expected to reach 30% of the population by 2020, and is a major factor in infrastructure expansion from two perspectives – increasing urban population is increasing demand for infrastructure, while the concentration of essential infrastructure like housing, sports, energy, health and education facilities, are contributing to rural-urban migration especially of young people in search of employment. This has a net increase in domestic water demand. In the context of IWRM, however, infrastructure development has increased impervious surfaces resulting in flash floods, pollution and accidents from storm water. Proper management of storm and roof-top water through

harvesting and storage reservoirs, maintaining a considerable size of urban green spaces, protecting urban wetlands, and promoting eco-friendly construction technologies are important to Rwanda's development planning. MINIRENA in collaboration with MININFRA and urban authorities have initiated campaigns and demonstration projects on rainwater harvesting in Kigali city and other urban areas.

## 2.7 Domestic Water and Sanitation

Domestic and municipal water use is taken to include clean water supply to households and institutions (schools, health facilities, prisons) for drinking, cooking, hygiene and other purposes.

The GoR recognises that access to adequate clean water and sanitation is a key strategy for reducing poverty. Water is particularly vital to the realisation of Rwanda's health sector goals given that more than 85% of health ailments are water-related<sup>[11]</sup>. Inadequate sanitation is one of the main causes of water pollution. Under the EDPRS, substantial investments have been made to raise access to clean water to 86% and basic sanitation to 80% by 2012. These efforts are already paying dividends. Access to clean water had reached 74% in 2008<sup>[11]</sup>. However, nearly half a million additional people will need to be connected to water every year until 2015. Providing a population of 10.42 million with at least 20 litres per person per day (standard minimum), implies that 73 million m<sup>3</sup> per year will be needed<sup>[11]</sup>. Domestic water demand projections will need to consider a reduction in mortality, population growth and movement, and a changing labour force. The current access rate for domestic water consumption is 6-8 litres per day. Rapid urbanisation and large scale housing developments coupled with increasing affluence, is likely to increase water use<sup>[4]</sup>.

Open defecation has practically been eradicated and most of Rwandan households have built on-site private sanitation facilities. Although only about half comply with the international standards for an improved sanitation facility. Very few Rwandan households have flush toilets. Currently, collective

(water-borne) sanitation systems for urban areas extends to only three small sewerage systems in Kigali for about 700 households. Major hotels, hospitals and some industries have installed their own treatment systems as part of commercial and industrial environmental management requirements. A conventional sewerage and treatment system for Kigali is in the planning process. Studies have estimated sanitation coverage at 45% (rural 44%, urban 54%) in 2008.

Most of the buildings in the urban areas are not connected to centralised waste water treatment systems or facilities, with the exceptions of high standing residential areas in Kigali namely Nyarutarama and the “Caisse Sociale” housing estates in Kacyiru and Kagugu. The rest of the buildings have individual sewage treatment systems that allow for the percolation of the treated effluent into the ground through leaching pits. This kind of localised handling of waste raises risk of groundwater contamination through malfunctioning and/or inefficient waste treatment systems. The main cause for this situation is the absence of

centralised or sewage treatment networks for urban and peri-urban settlements.

### 2.8 Industrial Pollution

Many of Rwanda's industries do not have efficient waste treatment facilities in place and the resulting poorly treated effluent ends up in streams and marshlands. Even with a small number of operational industries as compared to other cities in the region, this unchecked pollution has considerably contributed to the deterioration of water resources in the Gikondo, Nyabugogo and Nyabarongo marshlands in Kigali. Industries are a major contributor to water pollution mainly through the release of untreated effluent in streams, rivers and marshlands. Rwanda is addressing this issue through the regulatory role of the Rwanda Environment Management Authority (REMA), continued development of industrial and waste water standards by the Rwandan Bureau of Standards (RBS), and the recent establishment of land use and development laws and planning controls.



## Opportunities



The GoR has realised the urgent need to reverse the deteriorating situation of water resources, and hence has sought to put in place a framework to manage them sustainably. To this end, a new policy for WRM has been drafted, adopting the IWRM approach.

Transboundary WRM requires a governance framework that encourages cooperation, availability of adequate information about surface and ground water. Lack of adequate data at basin and sub-basin scales, inadequate institutional capacity, poverty and population growth, inadequate trans-boundary coordination, over-dependency on transboundary water and diverse hydro-political interests, are the main challenges in managing trans-boundary waters. Through cooperation in IWRM, there are opportunities to leverage resources for water development, poverty reduction and addressing complex extra-territorial challenges of climate change.

The key priorities for Rwanda in achieving water security and climate resilience are:

- National IWRM: Securing Water Resource for Domestic, Agriculture, Industry, Urban Infrastructure, Environment and trans-boundary basins
- Community Based Integrated Catchment Management as part of District planning under the National Land Use and Development framework

- Climate change mitigation and adaptation measures and low carbon development in water management:
  - Sustainable Land Management
  - Water Management in Agriculture
  - For Governments and Individuals
  - Energy
  - Monitoring, Observation
  - National and Regional Information Management
- Monitoring and Observation of Rainfall, Hydrological network, Current and Future Abstraction, Climate observatory (Meteo, Agriculture, Catchment Management, Watsan, Industry, Energy) “Collect Once – Use Many”
- Early Warning Systems (protect life, livelihood, infrastructure, and reduce crop losses): Real-time flow monitoring and rain gauge network, radar systems and dedicated hydrologists and meteorologists.
- Financing Water Management allocated through direct financing priority objectives and seek climate finance mechanisms as they apply to specific actions.

The opportunities are summarised in table 3.

Table 3: Opportunities for Water Resource Management in Rwanda

Economic/ Finance	Integrated Water Resource Management (IWRM) at National and community levels. National planning based on strong observational analysis and data.
Social/Capacity	Knowledge and education on good water use and protection, improved land and animal husbandry .
Technology/ R&D	Well planned water infrastructure. Efficient irrigation, municipal, rural and domestic water storage, dams, waste and sanitation, recycling, quality testing. Monitoring and observation.
Political	Regional stability, regional leadership in water use and management practice. Balanced national and community demand for water.
Legal/ Institutional	Regional treaties, Nile and Congo basin agreements, EAC, COMESA, organic law, environment law, land use and planning, codes of practice, enforcement of violators.
Environment/ Climate	Improved water resource management, efficient irrigation systems, sustainable land use management, land and animal husbandry, minimum environment flow.
Communication/ Information	National to District partnerships for delivery of services in WRM and planning. District peer to peer experience sharing. Extension and sensitisation to Districts, farmers, and communities.

### 3.1 Proposed strategies for water exploitation

Rwanda is blessed with large volumes of surface water. In order to facilitate its exploitation, it is necessary to make detailed studies of smaller rivers and drainage basins and to compare the hydrological characteristics. As this data is unavailable, it could not be used in this study. Watershed analysis using engineering principles and GIS was thus used to come up with estimates. Considering the evidence presented in the preceding figures and maps, the areas where demand for water is most acute are the eastern and southeastern parts of the country where the possibilities for exploitation of groundwater and lake water are favourable. In the central and western areas of the country, water supply could be based on exploitation of springs—keeping in mind that this water requires purification. In the northwestern part

of the country, water could be supplied from highly productive volcanic aquifers<sup>[5]</sup>.

Large areas of marshes store enormous volumes of water with potential value for irrigation, but these wetlands must be handled very carefully so as not to disrupt their capacity to store water and prevent violent and destructive floods. The most acute demand for water is in the eastern and southern part of the country. These are the areas where the possibilities for exploitation of groundwater and lake water are favourable. The best and easiest possibilities for groundwater utilisation exist in the northwestern part of the country where large amounts of groundwater occur in highly productive volcanic aquifers<sup>[5]</sup>.

## Sectoral Overlaps



The key sector and sub-sector areas of overlap in authority, powers and responsibility are identified in table 4 below. IWRM if implemented appropriately seeks to address these overlaps, providing national

leadership and inclusive district and local engagement into the framework.

Table 4: Sectoral Overlaps

Economic/ Finance	Economy, infrastructure, industry, energy, agriculture, built environment, transport.
Social/Capacity	Land reform, regularisation, governance, education, economy, education, infrastructure, industry, agriculture, built environment
Technology/ R&D	Planning, ICT, education and skills, disaster management, environment and climate.
Political	Governance, Planning, ICT, economy, finance, industry, agriculture, built environment.
Legal/ Institutional	Law, decrees, regulations, planning codes, enforcement.
Environment/ Climate	Development, urban and rural growth, agriculture, planning, Environmental monitoring and enforcement, energy, built environment, transport.
Communication/ Information	Communication across all land users: agriculture, industry, water, infrastructure, transport, forestry, environment tourism, housing.

### 4.1 Key stakeholders

The National WRM Strategy (Draft 2011) identifies the key responsible agencies for WRM, listed in table 5<sup>[4]</sup>.

The strategy also identifies the key stakeholder groups, listed in table 6<sup>[4]</sup>.

Table 5: Key Stakeholders identified in the National Water Strategy

Institution/ Agency	Core functions	Major Policy, legal & regulatory instruments
Ministry of Natural Resources (MINIRENA)	Overall policy development in WRM; ensure that watersheds & ecosystems are protected; Water allocation, regulation & monitoring of quantity & quality.	Water Policy, 2010; Water Act, 2008; Environment Law, 2005; ENR SWAp MoU an instrument for resource & stakeholder coordination.
REMA	Enforcement & monitoring of environmental standards	Environment Law, 2005 and attendant regulations on EIA;
Rwanda Utilities Regulatory Authority (RURA)	Licensing & regulation of water & water-based utilities development	Law establishing RURA.
Rwanda Bureau of Standards (RBS)	Water quality standards development & enforcement	Standards Law
Ministry of Infrastructure (MININFRA)	Water infrastructure – including marine transport; domestic water supply; hydro-power dams; methane gas; water installations in buildings; Meteorological services	Building Regulations; EIA Regulations, 2009;
Energy Water and Sanitation Authority (EWSA)	Domestic and industrial water supply to urban & peri-urban households	Service provision in water, sanitation and Hydro-power generation
Local Governments	Plan for and implement water services; Mobilise communities to protect watersheds & water infrastructure; implement CDD activities; coordinate & monitor CSOs activities in their districts.	Decentralisation Policy, 2000; Decentralisation Implementation Plan 2011-2015;

Table 6: Key Stakeholder Groups identified in the National Water Strategy

Category	Stakeholders	Institutions	Primary interests & Key Issues
Direct Water users	Domestic consumers	Urban and rural households	Managing communal facilities; user fees & charges; Access to water by urban poor; Private water flow; Rural Vs urban water supply systems
	Institutional Users	Educational institutions; Public health facilities; Government buildings & Installations;	Upstream-downstream farmers
	Farmers	Irrigated & non irrigation farmers; Livestock farmers & pastoralists	Commercial & subsistence farmers; Upstream-downstream user rights; payment of user fees
	Commercial users	Hoteliers; Industrialists; mining concessionaires;	User licences/fees;
	Water suppliers	EWSA; Private water suppliers; Bottled Water Companies; Vendors	Water use interests; rates & licences;
Non direct users	Energy generators/ power companies	EWSA	Water for hydro -and geothermal power generation; Safety, O&M of installations
	Marine transport operators	MININFRA; RDF & RNP	Marine safety and immigration issues; maritime boarder issues; pollution
	Fishers/Fish farmers & Aquariums	Water suppliers ; fishers; hotel/ recreation operators;	-licences & fishing rights; organisational capacities; illegal cross-border fishing;
	Recreation operators	Beaches, sports & swimming pools	User rights & licences; Efficiency, Pollution & waste management;
Government	Policy ministries & Agencies	-MINIRENA, MINAGRI, MININFRA, MINICOM, IPAR; Disaster Ministry; Districts	Policy, strategy & legal framework for WRM; water demand & supply issues; Safety & Disasters management issues
	Regulatory Agencies	REMA, RBS, RURA	Environment and Water quality standards monitoring & enforcement;
	Local Governments	District and lower structures	Implementing Government plans; mobilising communities & resources to implement local CDD actions and manage water facilities through Water User Committees(WUCs);
Service Providers	Private contractors	Drilling companies; Vendors,	Capacity; operational standards
	Trainers & Researchers	Universities; Research Institutions;	Knowledge generation & management; HR capacity development; advocacy
Development partners:	Donors/ Funding agencies,	SIDA, WB, AfDB, UNDP, GTZ, EU,	Providing technical & financial support to WRM public investments
	Trans-boundary Water Cooperation Agencies	NBI/NELSAP; LVBC, CEPGL	Trans-boundary conflict management; Riparian countries' capacity; Cooperation framework;
	CSOs	Nile Discourse Forum; International Water Partnership	Advocacy, networking and WUG capacity development
Riparian Countries	Riparian basin countries	NBI, LVBC & Congo Basin countries	Climate change & water quantity, quality & flow; Joint developments in WRM infrastructure; Water user rights & Cooperation framework



## Focus Areas



Building upon the baseline investigation and extensive in-country consultation, the following focus areas were established as being the foremost priorities for water for the Government of Rwanda to address in working towards a climate resilient and low carbon future. Options to address the focus areas are listed below in table 7 and are addressed in the following review of selected best practices.

Table 7: Focus Areas: Options to address Climate Change and Low Carbon Growth

Focus area	Option 1	Option 2	Option 3
Institutional / Legal Framework	Establish National Water Authority & Inter-Ministerial Council for WRM	Update relevant laws, special law for NWA	IWRM implemented at District level as part of planning process
Decentralisation of Public Administration	National & District WRM Partnerships	National Framework for IRWM from National to District levels	District and Community catchment management functions, water user associations
Information Management / ICT Infrastructure	Identify key hydro-related datasets, custodial & access arrangements	Delegate agencies to monitor water balance, climate observatory, model abstraction and future demand, extend infrastructure	WRM Technical Workgroup (National and District Managers)
Technology diffusion	NWA to support WRM Technical Working (User) Group meetings	National & District WRM Technology Partnerships, Foster technical WRM community, farmer extension services	District accreditation in NLUDMP, SLM, WRM technology and practice
Capacity	Formal courses at Universities in hydrology, WRM, meteorology, and climatology	Training programs, short courses and formal accreditation	Formal accreditation, continuing professional development



## Review of Best Practice



*“As the lack of funding of water management structures remain a gap in most donor funding policies, GWP-CAf is currently developing a water financing mechanism that aims at stimulating more internally generated funds as well as external funds to cover this gap. Ensuring the right policies are adopted, putting in place the right institutional structures, building capacities and applying integrated water resources management tools is the only guarantee to an effective development of the water sector in order to contribute to social and economic growth and improved welfare.”<sup>[12]</sup>*

### 6.1 International Approaches to Integrated Resource Management (IWRM)

There are many resources and tools available for IWRM. They offer a guide to governments and administrators to strike policy and implement strategies. However, as a ‘guide’ they must be tailored to the local and regional basin context of socio-economic constraints, nature of land and environment, geography of the basin, and national development priorities. Highlighted below are extracts from leading resources and discussion of relevance and potential for application in the Rwanda setting.

IWRM represents a paradigm shift from the traditional sectoral approach to water management that is still evident in Rwanda’s approach to WRM and distribution of responsibilities. IWRM aims to encompass the multiple cross-cutting goals and objectives, spatial focus on the entire river basin rather than single water course, and divergence from professional or political boundaries to an inclusive participatory approach to decision making [2].

### 6.1.2 IWRM Tool Kit “A Tool for Dealing with Climate Change”

The IWRM training manual was developed by the Global Water Partnership (GWP) as part of the Capacity Network (Cap-Net) initiative. The manual was developed to assist capacity builders in developing training and educational programmes on the use of IWRM tools and instruments for adaptation to climate change impacts. The material is intended to increase understanding of climate change impacts and what can be done to build resilience. Improving the way water resources are managed now to help communities adapt in the future.

Developed in partnership between Cap-Net, WMO/APFM, UNESCO-IHE, REDICA and Rhama, the format and contents of the manual are flexible enough to be adapted to different purposes and as such it could be used for short courses, educational programmes and awareness campaigns.

The Tool Kit is segmented into the modules of:

- Introduction to IWRM and Climate Change
- Drivers and impacts of Climate Change
- Strategy Development and Planning for Adaptation

- Dealing with Uncertainties
- Instruments and Measures for Adaptation
- Adaptation to Climate Change in Water Management

### 6.1.3 IWRM Strategic Policy Framework

A summary of the key reform and governance issues and lessons learnt in the IWRM Tool Kit is provided in box 3.

#### Box 3: GWP ToolBox – Reforming Institutions for Better Governance

- **Reforms should be done in a coherent and integrative way** and suit the broader social and political policies of the country.
- **Not all necessary reforms can be done at the same time** – it is important to decide on priorities and a sequence of actions to suit those priorities.
- **Avoid unrealistic reforms** that are not politically or socially acceptable
- **Raising awareness, sharing information and meaningful participatory debate** are key elements of any reform process.
- **Reform is a dynamic, iterative process** and the only certainty is change itself.
- **Vested interests and special interest groups should be included** in debates but decision-makers should avoid being ‘captured’ by special interest groups.
- **In any reform, regulation of service providers, both public and private,** is a key element and regulators must be independent and strong.
- **Reforms should avoid confusing the roles of resource management** (government responsibility) and service provision (public or privately operated utilities)
- **Governance for water must take account of all sectors** dependent on or key providers of water and not just on drinking water supply.

### 6.1.4 Principles of IWRM

The current models of IWRM are founded on the principles declared at the International Conference on Water and the Environment (ICWE) in Dublin, Ireland, in January 1992. The principles are shown in box 4.

An action agenda was elaborated at the International Conference on Water and the Environment (ICWE) in Dublin, Ireland, in January 1992, the agenda calls for:

- Alleviation of poverty and disease
- Protection against natural disasters
- Water conservation and reuse
- Sustainable urban development

- Agricultural production and rural water supply
- Protecting aquatic ecosystems
- Resolving water conflicts
- The enabling environment
- The knowledge base
- Capacity building

The three central governance principles for IWRM are provided in box 5.

**Box 4: Dublin Statements and Principles of Water Management*****Principle No. 1 - Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment***

Since water sustains life, effective management of water resources demands a holistic approach, linking social and economic development with protection of natural ecosystems. Effective management links land and water uses across the whole of a catchment area or groundwater aquifer.

***Principle No. 2 - Water development and management should be based on a participatory approach, involving users, planners and policy-makers at all levels***

The participatory approach involves raising awareness of the importance of water among policy-makers and the general public. It means that decisions are taken at the lowest appropriate level, with full public consultation and involvement of users in the planning and implementation of water projects.

***Principle No. 3 - Women play a central part in the provision, management and safeguarding of water***

This pivotal role of women as providers and users of water and guardians of the living environment has seldom been reflected in institutional arrangements for the development and management of water resources. Acceptance and implementation of this principle requires positive policies to address women's specific needs and to equip and empower women to participate at all levels in water resources programmes, including decision-making and implementation, in ways defined by them.

***Principle No. 4 - Water has an economic value in all its competing uses and should be recognised as an economic good***

Within this principle, it is vital to recognise first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognise the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use, and of encouraging conservation and protection of water resources.

Source: Cap-Net 2010<sup>[2]</sup>

**6.1.5 Why is It Important to Address Climate Change in Water Management?**

- The number of people in severely stressed river basins is projected to increase significantly
  - Semi-arid and arid areas are particularly exposed to the impact of climate change on freshwater
  - Higher water temperatures, increased precipitation intensity and longer periods of low flows lead to more pollution and impacts on ecosystems, human health and water system reliability and operating costs
  - Climate change affects the function and operation of existing water infrastructure and water management practices
  - Adaptation procedures and risk management practices for the water sector are being developed.
- In a situation of water stress:
- Water pricing
  - Seasonal water rationing during shortages
  - Adapt industrial and agricultural production to reduce water wastage
  - Increase capture and storage of surface run-off
  - Reuse or recycle waste water after treatment
  - Desalination of salty/brackish water (costly)
  - Better use of groundwater resources (risk: siltation)
  - Rainwater harvesting

**Box 5: Principles of Integrated Water Resource Management (IWRM)****The Enabling Environment**

1. Policies – setting goals for water use, protection and conservation.
2. Legislative framework – the rules to enforce to achieve policies and goals.
3. Financing and incentive structures – allocating financial resources to meet water needs.

**Institutional Roles**

4. Creating an organisational framework – forms and functions.
5. Institutional capacity building – developing human resources.

**Management Instruments**

6. Water resources assessment – understanding resources and needs.
7. Plans for IWRM – combining development options, resource use and human interaction.
8. Demand management – using water more efficiently.
9. Social change instruments – encouraging a water-oriented civil society.
10. Conflict resolution – managing disputes, ensuring sharing of water.
11. Regulatory instruments – allocation and water use limits.
12. Economic instruments – using value and prices for efficiency and equity.
13. Information management and exchange– improving knowledge for better water management.

Source: Cap-Net 2010<sup>[2]</sup>**6.1.6 Cap-Net Tool Box – Adaptation Measures**

The Cap-Net training manual was developed to assist capacity builders in developing training and educational programmes on the use of IWRM tools and instruments for adaptation to climate change impacts. The training modules highlight key strategies for how adaptation to climate change can be incorporated in water resources management at all levels. A summary of the key adaptation measures are listed in the table 8.

**6.2 Case Study: National WRM Governance – Murray Darling Basin Authority**

The Murray–Darling Basin incorporates Australia’s three longest rivers and is one of our most diverse regions, stretching from Queensland to South Australia. The Murray–Darling Basin is very important to Australia economically, socially and environmentally. Often called Australia’s food bowl,

the Murray–Darling Basin has a population of approximately 2 million people and supports much of Australia’s agriculture and agricultural exports<sup>[14]</sup>.

The Basin also contains more than 30,000 wetlands, including 16 internationally significant sites, many of which provide habitat for migratory birds. However, water use in the Basin has increased five-fold in the last century. The Basin is now under significant stress from the combined impacts of over allocation of water, severe drought, and the early impacts of climate change. There has been a marked decline in river health and it has become imperative to take action to return the system to a sustainable footing. The catchment area for the Murray and Darling rivers and their tributaries features<sup>[14]</sup>:

- Total of 23 river valleys
- Basin area over 1 million square kilometres
- 14% of total area of Australia

Table 8: Key Adaptation Measures for Water Resource Management<sup>[2]</sup>

Possible adaptation measures	IWRM function	Anticipated effect
Water pricing, cost recovery, investment	Economic/financial management	Reduced per capita consumption Improved efficiency
Seasonal water rationing, re-allocation, managing water use	Water allocation Pollution control	Availability and access improved Uninterrupted flow Purification function secured
Flood and drought risk mapping, infrastructure, scenario development	Basin planning	Reduced impact of extreme events
Increase capture and storage of surface runoff	Basin planning	Improved availability Reduced pollutants in the system
Reuse and recycle, better regulation, pressure for improved sanitation	Pollution control Water allocation Basin planning	Improved availability Reduced groundwater pollution
Groundwater usage	Water allocation Basin planning	Improved availability
Rainwater harvesting, warning systems	Water allocation Stakeholder participation	Improved availability Reduced drainage damage
Improving drainage systems and water treatment	Pollution control Basin planning	Reduced pollution Improved availability and recovery
Better monitoring	Information management Monitoring	Improved action responding to real needs

- Annual average rainfall 530,618 gigalitres
- 94% of rainfall evaporates; 2% drains into the ground; 4% ends up as runoff
- Basin generates 39% of the national income derived from agricultural production
- Produces 53% of Australian cereals grown for grain, 95% of oranges, and 54% of apples
- Supports 28% of the nation's cattle herd, 45% of sheep, and 62% of pigs.

Australia's Murray–Darling Basin Authority (MDBA) is the Commonwealth agency that manages the Murray–Darling Basin's water resources in the national interest. The Murray Darling spans Australia's four States of Queensland, New South Wales, Victoria and South Australia and services the Australian Capital Territory, the area of

the Basin in MDBA is responsible for preparing and overseeing a legally enforceable management plan – the Basin Plan<sup>[14]</sup>. The Basin Plan will:

- set and enforce environmentally sustainable limits on the quantities of water that may be taken from Basin water resources
- set Basin-wide environmental, water quality and salinity objectives
- develop efficient water trading regimes across the Basin
- set requirements for state water resource plans
- improve water security for all Basin water uses

Sustainable diversion limits (SDLs) are at the heart of the Basin Plan, a management plan covering water resources across the whole Murray–

Darling Basin. SDLs will be limits on the quantities of surface water and groundwater that can be taken from the Basin water resources. The need for SDLs has arisen because many of the Basin's rivers and groundwater systems are stressed and over-allocated. Lack of water and the absence of natural flooding are having a grave impact on many important environmental assets.

### 6.2.1 Australia's Water Act 2007 – National WRM and Sustainable Management

The Australian Government passed the Water Act in 2007 to help implement the National Water Initiative. The Water Act introduced new powers that help the Australian Government coordinate a national approach to water management and meet the challenges facing water management in the Murray–Darling Basin. Importantly, the Water Act established the Murray–Darling Basin Authority to prepare a Basin Plan for the sustainable

management of water across the whole of the Murray– Darling Basin.

### 6.2.2 Governance Structure

The governance structure of the Murray-Darling Basin is illustrated in figure 3. The key components of the institutional framework are:

- **Commonwealth Minister for Sustainability, Environment, Water, Population and Communities:** Elected Member of Parliament and Commonwealth Minister responsible Sustainability, Environment, Water, Population and Communities. Has responsibility under the Water Act 2007 and is the decision maker on the Basin Plan.
- **Ministerial Council:** The Council is responsible for the planning and management for the equitable, efficient and sustainable use of water, land and other environment resources. Membership of the

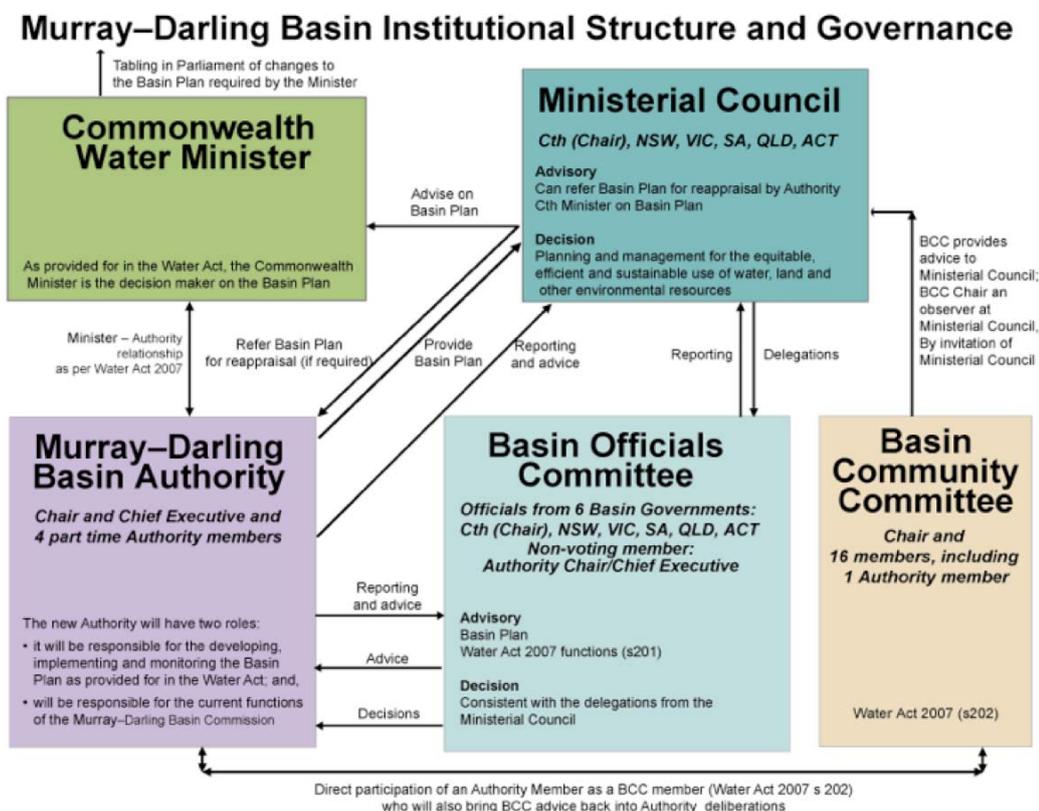


Figure 3: Governance Framework for IWRM in Australia's Murray-Darling Basin<sup>[14]</sup>

Ministerial Council comprises the Commonwealth Water Minister (chair), and one minister from each of the Basin states - Queensland, New South Wales, Victoria, South Australia, and the ACT. The Ministerial Council has an advisory role in the preparation of the Basin Plan by the Murray–Darling Basin Authority.

- **Murray-Darling Basin Authority (MDBA):** The Murray–Darling Basin Authority's principal aim is to manage the Basin's water resources in the national interest. The establishment of the MDBA in 2008 meant that, for the first time in Australia, a single agency is now responsible for planning integrated management of the water resources of the Murray–Darling Basin. Main roles and responsibilities of the Authority include:
  - preparing the Basin Plan for adoption by the Commonwealth Minister
  - implementing and enforcing the Basin Plan
  - advising the minister on the accreditation of state water resource plans
  - developing a water rights information service which facilitates water trading across the Murray–Darling Basin
  - measuring and monitoring water resources in the Basin
  - gathering information and undertaking research
  - educating and engaging the community in the management of the Basin's resources
- **Basin Officials Committee:** The committee facilitates cooperation and coordination between the Commonwealth, the Murray–Darling Basin Authority and the Basin states in funding works and managing the Basin water and other natural resources. Membership of the committee comprises

officials from the six Basin governments, and the committee is chaired by the Commonwealth committee member. The authority's Chair and Chief Executive are non-voting members of the committee. The committee is responsible for providing advice to the Ministerial Council and for implementing policy and decisions of the council on matters such as state water shares and the funding and delivery of natural resource management programs.

- **Basin Community Committee:** The Basin Community Committee (BCC) advises the Murray–Darling Basin Authority about the performance of its functions, including in relation to:
  - engaging the community in the preparation of each draft Basin Plan
  - community matters relating to the Basin water resources
  - matters referred to the committee by the authority.

The BCC comprises 16 members and one Authority member of the MDBA. BCC members are selected on the basis of their expertise or interest in community, water use, environmental water management, Indigenous or local government matters. The BCC must also establish irrigation and environmental water subcommittees, and an Indigenous water subcommittee to guide the consideration of Indigenous matters relevant to the Basin's water resources. The BCC may also establish other subcommittees.

- **Role of Australia's Bureau of Meteorology:** In addition to the governance arrangements, Australia's Bureau of Meteorology has the responsibility, through the Water Act 2007, for compiling and delivering consistent water information across all of Australia. The Bureau's functions include:

- conducting regular national water resources assessments
- publishing an annual National Water Account
- providing regular water availability forecasts

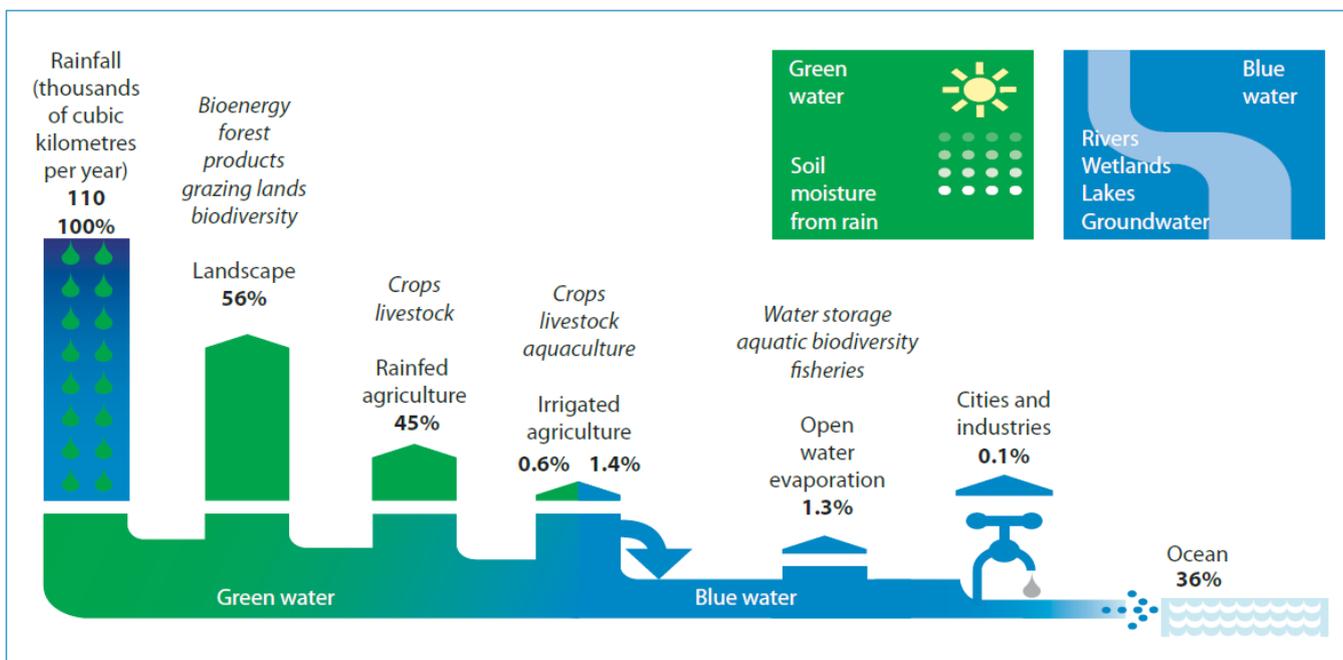
For Rwanda, the Murray-Darling Basin Governance Framework provides an appropriate and world class model for Rwanda to organise and coordinate the management of Green and Blue waters across the existing sectors of Water Resource Management and Water Supply and Sanitation. The key ‘take home’ messages are to establish an Inter-Ministerial Governance Committee to oversee competing demands, a national water authority linking a holistic national governance framework of responsible authorities, and lastly, district and community based structures to ensure comprehensive stakeholder group participation and

consultation in the decision-making processes of the Basin.

### 6.3 Green and Blue Waters: Understanding Water for Consumption and Non-Consumption

Access to the world’s water resources is heavily dependent upon the nature of the water cycle. While a massive amount of water reaches the earth’s land surface, much less, around 40%, makes its way into creeks, rivers, aquifers, wetlands, lakes and reservoirs, before cycling back into the atmosphere, refer figure 4 illustrating ‘Green’ and ‘Blue’ waters. Of the water that is extracted for human purposes, on average, approximately:

- 70% is used for agricultural purposes
- 20% is used by industry (including power generation)



**Figure 4:** Green Waters; rainwater stored in the soil or on vegetation, that cannot be diverted to different use, and Blue Waters; surface water and ground water that can be stored and diverted for a specific purpose. Source: UNEP (2011)<sup>[15]</sup> p121, Note: Figure 4 indicates global average water availability and use, and does not represent Rwanda’s water balance Source: UNEP (2011)<sup>[15]</sup> p121,

- 10% is used for direct human consumption.

Given that the vast majority of usable fresh water is channelled towards agriculture, any global consideration of water allocation must consider the factors that determine the efficiency of water use in the sector. Irrigated land produces around 40% of the world's food. One of the biggest challenges facing water managers is to find a way to significantly increase the productivity of irrigated agriculture so that water can be transferred to other sectors without adversely affecting the environment or food security. In developing countries, water management and investment is typically geared towards ways of reducing poverty and enabling economic development, while the priority for developed nations tends to be maintaining infrastructure and supplying access to water at reasonable cost<sup>[15]</sup>. In Rwanda, where nearly 90% of the population is involved in subsistence

agriculture, the abstraction for agriculture is much greater.

### 6.4 Case Study: Relative Costs of Supplying Water in China

In areas where the costs of enhancing water supplies from traditional sources are rising, the 2030 Water Working Group is recommending the preparation of formal costs curves similar to those shown in figure 5. These cost curves rank potential solutions to a problem in terms of the relative cost per unit of desired outcome achieved. The curve can be used to assess the likely costs and benefits of each solution. The benefit of this approach is that solutions can be found that both make water more available and at low cost. Relative costs of supplying water in China is used as an example. The China water-availability cost curve identified 21 opportunities to make more water available for use and to save money. Options included; increased paper recycling,

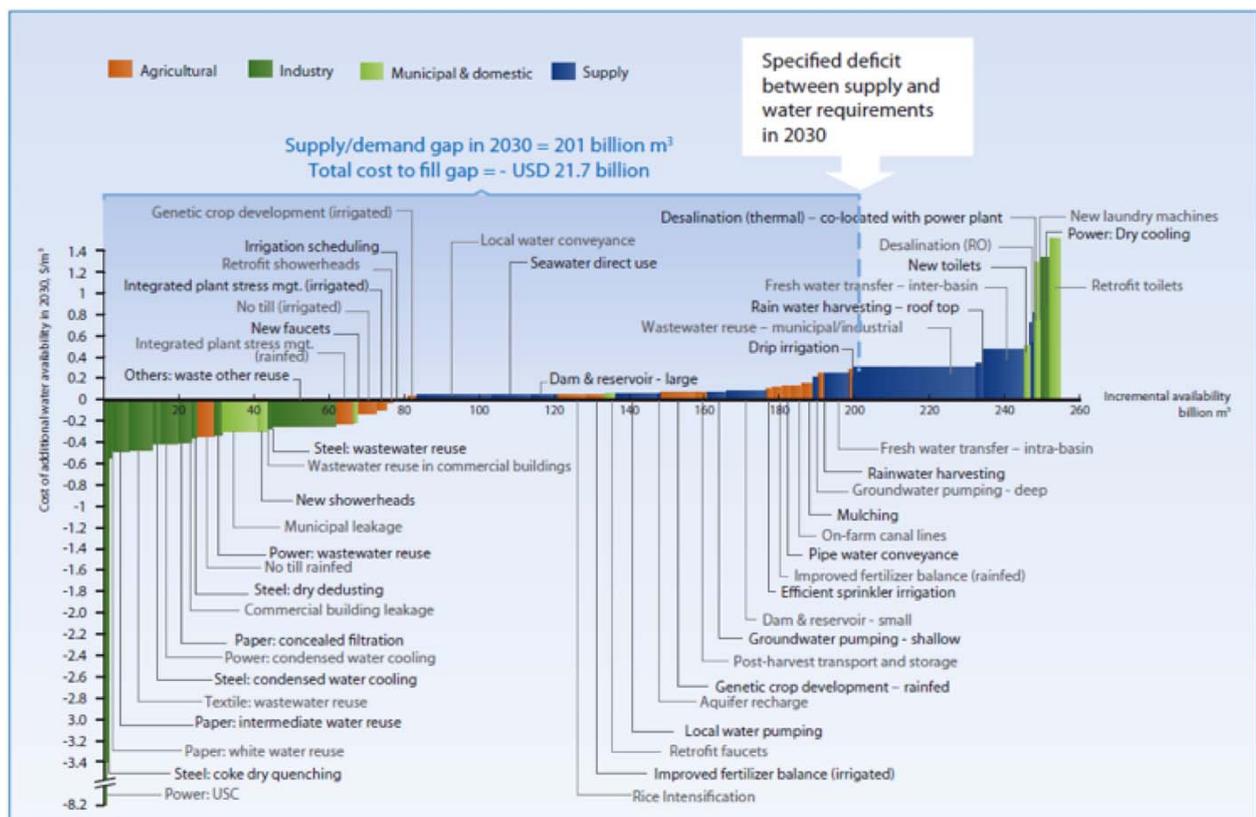


Figure 5: Relative Costs of Supplying Water in China  
Source: UNEP (2011)<sup>[15]</sup>, p136

investment in leakage reduction, wastewater reuse in power stations and commercial buildings and investment in water-efficient shower heads. All of these approaches are consistent with the development of a green economy, which seeks to minimise the impact of economic activity on the environment<sup>[15]</sup>. For Rwanda, such a detailed economic and quantitative assessment of water demand and water saving (of opportunities) will clearly assist the decision making process in progressing to a climate resilient and low carbon future. An economic analysis of Water Resource Management in terms of water availability and demand, climate resilience and low carbon development opportunities is highly recommended.

### 6.5 Ground Water Management

In many communities, groundwater is the main source of water for irrigation, domestic and industrial demands. Generally, there are two types of groundwater resources – renewable and non renewable. Renewable groundwater is directly tied to near-surface hydrologic processes; it is thus intricately tied to the overall hydrologic cycle and could be directly affected by climatic change. In

many places, because of increasing demands, the overdraft of renewable groundwater aquifers occurs because the rate of withdrawal exceeds the rate of recharge. Thus, climate changes could directly affect these recharge rates and the sustainability of renewable groundwater<sup>[2]</sup>.

It cannot be assumed that all ground water is naturally potable – ground water may be high in mineral elements, attributed to the nature of respective geologies, some with positive and other that may harm industrial equipment or domestic appliances, variation in acidity (pH), in some sources, hazardous compounds such as cyanide and arsenic are naturally occurring and must be adequately treated, overall, ground water must be continually monitored to a level commensurate with use.

There remains need for Rwanda to incorporate groundwater management into national and river-basin water resource planning. Assessments and sub-surface testing is currently being carried out in Rwanda to determine the extent of Rwanda's ground water resources with results expected in mid- to late 2011.

## Analysis of Options



### 7.1 Review of Current Initiatives as Part of IWRM Approach

Water and related resources management in both of the Kagera and Congo Basins' is being carried out through application of Integrated Water Resources Management (IWRM) principles. IWRM as defined by the Global Water Partnership is "a process which promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems". The pinnacle regional policy document is the 2008 Kagera Basin Monograph.

There are recent calls for strengthening IWRM with ecosystem services. There are 263 transboundary river and lake basins around the world, and about 300 transboundary aquifers. Transboundary lakes and river basins account for an estimated 60% of global freshwater flow and are home to 40% of the global population. The large majority of carbon emissions from land degradation and deforestation take place in transboundary basins, the same regions of highest biodiversity value and threats of biodiversity loss.

The Kagera river basin is managed and supported through the Nile Basin Initiative – Nile Equatorial Lakes Subsidiary Action Programme (NBI-NELSAP) which in addition to Kagera countries includes the DRC, Kenya, as well as downstream nations Egypt and Sudan. In addition to strategic linkages with key agencies such as MINAGRI, REMA, NMS and CGIS-NUR.

The East African Community (EAC) provides a framework for extensive political cooperation and integration, among Tanzania, Uganda and Kenya (which share Lake Victoria) as well as Burundi and Rwanda which have both recently joined. EAC has established the Lake Victoria Basin Commission (LVBC) to manage the entire basin area, including the Kagera. Important linkages are also found with the Environmental Programme and Action Plan of NEPAD (New Partnership for African Development) and NEPAD's Comprehensive Africa Agriculture Development Programme (CAADP) for integrating sustainable land management in agriculture and natural resource management.

A recent initiative which commenced in 2009/10, the FAO/GEF funded Kagera-TAMP project, supports the adoption of an integrated ecosystems approach for the management of land resources in the Kagera Basin which will generate local, national and global benefits including: restoration of degraded lands, carbon sequestration and climate change mitigation, agro-biodiversity conservation and sustainable use and improved agricultural production. Kagera-TAMP aims to help reinforce and make the respective NAPAs operational and contribute to effective harmonised implementation of UNCCD, CBD, UNFCCC and related conventions across the basin.

Rwanda is a signatory to the COMESA treaty for regional trade and Commerce, and for transboundary natural resource management and protection.

Countries sharing the Kagera Basin have all adopted various national strategies and action plans

that address sustainable management of natural resources, biodiversity conservation, agriculture, forests, desertification and climate change mitigation. Ratification of the Convention to Combat Desertification (UNCCD) in the late 1990s by the four countries, and subsequent development of National Adaptation Programmes of Action (NAPAs) for its implementation, has led to raised awareness at national to local levels of the close links between degradation and poverty.

The Rwanda Government has confirmed that reversing land degradation and biodiversity loss in the Kagera basin is a top priority in view of the serious impacts on resources and livelihoods. In addition to environmental conservation, Kagera TAMP actions should improve crop and livestock production and forestry and thereby improve income and food security.

The National Environmental Policy calls for the economic and social sectors: to use water without endangering the environment, to improve the conservation of wetlands, and to integrate environmental aspects into development policies, planning and all activities undertaken at local to national levels in a participatory manner.

The National Water and Sanitation Policy, in harmony with MDGs objectives and Vision 2020 targets, states that all of the population will have access to potable water and to sanitation services. The policy takes into account regional and international commitments related to IWRM and environment. The National Land Use and Development Policy addresses the use, conservation and management of marshlands.

## 7.2 Legal & Policy Framework for WRM

Rwanda's Water Law (Law No 62/2008 Putting in Place the Use, Conservation, Protection and Management of Water Resources Regulations) was designed within the framework of the 2004 Water Policy. The 2008 Water Law provides that water is a public good, and responsibility for its proper use and protection is the responsibility of the state, the private sector, civil society and the citizens. The water law recognises principles such as protecting

water resources from pollution, requiring water users and water polluters to pay, using water user associations, and providing for the public distribution of water. The priorities for water distribution are: (1) the population; (2) livestock; and (3) hydroelectric energy production. Notably, the 2008 Water Law sets out to establish IWRM framework and prescribes the establishment of a National Water Authority whose powers, functions and responsibilities are to be defined by special law. It establishes the principles of "user pays" and "polluter pays". The law calls for a National Policy for the Protection, Planning, Use and Management of the Water Resource and aquatic ecosystems including humid zones and swamps. It prioritises supply of water to populations and following, to animals and hydroelectric energy production.

The 2005 Organic Land Law provides that the country's lakes, rivers, and groundwater are in the public domain, and the use of water resources is shared by all.

Rwanda Natural Resources Authority (RNRA) (Law 53/2010 of 25/01/2011) Establishing Rwanda Natural Resources Authority (RNRA) and Determining its Mission, Organisation, and Functioning) was recently promulgated to bring together the functions of the National Land Centre (NLC), the Office of Geology and Mineral Resources (OGMR), the National Forestry Authority (NAFA), and notably functions of Water Resource Management under responsible Departments. A National Water Authority (Directorate of Water Resource Management as referred to in the National WRM Strategy) has not been established in statute and this Law refers to existing responsibilities for WRM under MINIRENA. Further amendment is likely at time a National Water Authority is implemented.

Draft National Policy for Water Resources Management (2011), has been prepared by the Ministry of Natural Resources (MINIRENA), Draft as of April 2011. Outlines an IWRM framework for managing the national water resource.

Draft Water Resources Management Sub-Sector Strategic Plan (2011), has been prepared by

MINIRENA, Draft as of April 2011. Details the strategic action agenda for IWRM and key priorities for Rwanda.

Sub-sector Policies, Strategies and National Plans for Energy, Sanitation, Land Use and Development, Irrigation, Forestry, Mineral Resources, Ground Water.

### 7.3 Rwanda's National Draft Policy and Strategy for WRM

The April 2011 Draft 'National Policy for Water Resources Management' and subsequent 'Water Resources Management Sub-Sector Strategic Plan (2011-2015)' are currently under GoR consideration.

The National Water Policy sets out to address the institutional gap that till now has not been realised since promulgation of the 2008 Water Law. The policy is a robust, modern statement of Government intention to manage the national Water Resources with an IWRM approach in consideration of the significant development challenges and future growth of Rwanda. However, further elaboration of the policy is required detailing the IWRM framework and allocation of responsibilities.

The vision of the Water Resources Management Policy is:

*A water resources sub-sector governed by a policy, legal and institutional framework that promotes sustainable use of water resources and which contributes meaningfully to the socio-economic development of Rwanda.*

The overall mission of the Water Resources Management Policy is:

*To contribute to, and enhance the achievement of, Rwanda's vision of transforming itself into a middle income economy by 2020.*

The policy outlines policy objectives for IWRM. The main objectives of the water resources management policy are to ensure that:

- a) the water resources of Rwanda are conserved, managed and developed in an integrated and sustainable manner;
- b) water of adequate quantity and quality is available for socio-economic and ecological needs of the present and future generations; and
- c) decisions affecting water resources management are made with the full participation of all stakeholders at local, national and trans-boundary levels.

Sub-objectives are detailed for each of these objectives. The first calls for the establishment of a comprehensive water resources management framework which incorporates the principle of IWRM.

Arising out of the policy objectives, policy statements and strategic actions are elaborated in order to achieve the objectives. Policy statement No.1 addresses the IWRM framework.

#### 7.3.1 Policy statement No. 1

Government will establish and operate a comprehensive water resources management institutional framework that incorporates the principle of integrated but decentralised management of water resources.

#### 7.3.2 Strategic Actions

For this purpose the Government will:

1. Rationalise the establishment of natural resources management institution with an overall mandate over the management of natural resources, including water resources.
2. Establish and operationalise a water inter-ministerial coordination committee to co-ordinate water resources management across all sectors of government;
3. Determine and delimit the local area institutions that will have water resources management committees (WRMC);

4. Decentralise water resources management functions to districts and other appropriate local level institutions;
5. Support and promote the establishment and operation of water resources users associations and other appropriate institutional frameworks for participation by user communities and stakeholders in water resources management.

Policy Action No.1 assigns responsibility for WRM to an umbrella Natural Resources Management Institution with overall mandate for natural resources including water resources. However, the structure and allocation of responsibilities is not detailed. Implementation and maintenance of the National Water Policy is the responsibility of MINIRENA as lead agency. The Natural Resources Institution is vested under MINIRENA.

Under Legal and Institutional Implications (chapter 3), the policy calls for institutional restructuring, including the establishment of a natural resources management institution, to discharge the functions of water resources management. The policy notes the Water Law of 2008 that envisaged powers would be discharged by a water resources management agency. The policy calls for amendment to the Water Law formalise this policy proposal. This is not required as the water law calls for a special law to define the powers of the national water authority. The policy correctly calls for a thorough review of the provisions of the Water Law to ensure the Water Law No 62/2008 and the Water Resources Management Policy are well aligned. It is important that the original intent of the Water Law is maintained in the policies and updated to national development priorities. The Water Law is adequate for IWRM. Revision is not a priority until the National Water Policy and WRM Strategy are activated and an agreed IWRM institutional framework is put in place. Drafting of a Law to establish the powers and functions of a National Water Authority in relation to the new RNRA Law 53/2010 is now priority.

#### 7.4 Rwanda Natural Resources Authority (RNRA) – Implications for IWRM

The Rwanda Natural Resources Authority (RNRA) (Law 53/2010 of 25/01/2011) Establishing Rwanda Natural Resources Authority (RNRA) and Determining its Mission, Organisation, and Functioning) was recently promulgated to bring together the functions of the National Land Centre (NLC), the Office of Geology and Mineral Resources (OGMR), the National Forestry Authority (NAFA), and notably functions of Water Resource Management. A National Water Authority (Directorate of Water Resource Management as referred to in the National WRM Strategy) has not been established in statute and this Law refers to existing responsibilities for WRM under MINIRENA. Further amendment is likely at time a National Water Authority is implemented. The Law does not elaborate on responsibilities for water supply, sanitation, energy, irrigation or riparian rights or relationship to other State organs such as EWSA, MININFRA, MINAGRI or MIDIMAR. It is important for Rwanda to establish a National Water Authority (Directorate of Water Resource Management) bringing together responsibilities for WRM supporting IWRM principles and bringing together responsibilities, efforts, and regional focal points for water resources management in a similar manner to which the National Land Centre was originally created to bring under one roof responsibilities for land.

There is need for a review of the National water resource management structures and cross sectoral consultation mechanisms – that will be required to support Rwanda’s transboundary responsibilities to mitigate the future potential for difficulties in international water budgeting. Importantly, to ensure a robust and efficient national framework is realised, a suitable structure must be put in place that allows for decision making by an inter-Ministerial council, a supporting Directorate of Water Resource Management (as described in the National WRM Strategy), and rationalised structure within the bureaucracy to ensure reduced overlap of responsibilities, duplication of effort, data and

human resources. District and community based organs are part of the national framework in line with the National deconcentration strategy. Effective community and civil society consultation must also be built into the framework.

### 7.5 Rwanda National Adaptation Programme of Action (NAPA) 2006

The Rwandan National Adaptation Programmes of Action (NAPA) to climate change was prepared in 2006 in conformity with the guidelines prepared by the Least Developed Countries Groups of Experts (LEG) – adopted by the November 2001 Assembly of the Conference of Parties to the United Nations Framework Convention on Climate Change (Decision 28/CP.7). Being a country with an economy essentially based on rain-fed agriculture, it is with no doubt vulnerable to negative effects of climate change. With a rate of 60% of the population below poverty line, its adaptive capacity to impacts related to extreme meteorological phenomena is very low.

This NAPA document is intended as a guide to decision makers and national planners on priorities in vulnerable economic sectors as well as strategies and priority actions of adaptation to climate change. The priorities were identified according to retained criteria during workshops and seminars of stakeholders organised for this purpose. From the ranking of priority actions, the project profiles were developed with an urgent character requiring funds to immediately respond to needs caused by the impacts of climate variability in Rwanda.

Of the Six Priority Adaptation Options identified, the first two are directly related to IWRM, being (numbered as presented):

1. An Integrated Water Resource Management (IWRM)
2. Setting up an Information System to early warning of hydro-agro meteorological systems and rapid intervention mechanisms

Of the Six Priority Options, Seven High Priority Projects were selected of which four address WRM efforts, they are (numbered as presented):

2. Establish the mastering hydro meteorological information and early warning systems to control extreme phenomena due to climate change: - Installation and rehabilitation of hydrological and meteorological stations;
3. Development of irrigated areas by gravity water systems from perennial streams and rivers in often vulnerable zones to prolonged droughts;
4. Support Districts of vulnerable regions to climate change in planning and implementing measures and techniques related to conservation and water harvesting and intensive agriculture, and promoting existing and new resistant varieties of crops adapted to different bioclimatic soil.
5. Increase adaptive capacity of grouped habitat "Imidugudu" located in vulnerable regions to climate change by the improvement of drinking water, sanitation and alternative energy services, and the promotion of non agricultural jobs.

Priorities and High Priority Projects were selected based on multi-criteria analysis. It is noted that the translation from priority option to actionable project, the opportunity to attune a project efforts towards realising IWRM was lost – despite being the highest adaptation option identified. Thus impacting the success of the applied high priority projects – as it is inferred, in the absence of an integrated approach to WRM and robust national framework, these projects will have limited capacity to address the multi-sectoral needs and impacts. The high priority projects identified are clearly needed for the development of Rwanda and to progress resilience to climate impacts. However, they do not address the systemic nature of natural resource management, planning and development, and the decision making of Government.

## 7.6 Rwanda ENR Sector Strategic Plan 2009-2013

IWRM and Water and Sanitation indicators feature strongly in MTEF Sector Targets and Budget Estimates in the ENR Sector Strategic Plan. There is much duplication and overlap in the priorities and objectives detailed in the ENR SSP and Draft National WRM Strategy. Further effort is required to rationalise these key targets and their relationship to EDPRS CPAF/MTEF targets in the ENR sector and related organs of Government responsible for water resource management.

### 7.6.1 Integrated Water Resources Management (IWRM) Programme

Under the EDPRS, water will be an important resource in the economic growth agenda (hydropower production, irrigated agriculture, transport, industry, recreation and tourism), as well as social development (e.g. hygiene) and ecological functioning. To realise the EDPRS targets for integrated water resources management, this SSP has included the projects and activities, under the following sub-programmes:<sup>[16]</sup>

1. **Institutional & legal framework** for integrated water resources management (IWRM). This is of particular priority from three perspectives:
  - a) increasing interests in water for economic growth under the EDPRS (water for irrigation, power generation, recreation, industry);
  - b) trans-boundary interests especially in the Congo, Nile, Lake Victoria and Kagera Basins in which Rwanda is a key upstream country;
  - c) addressing emerging challenges related to ecosystem functioning and sustainability including desertification and other climate change concerns;

The water law reform and regulatory setting will include, among others, setting user fees for commercial water abstraction; regulatory water quality standards to promote efficiency by

encouraging commercial farmers, industrialists, hotels and other large scale water users to adopt such measures as water recycling and efficient technologies in irrigation, cleaning, etc.

2. **Assessment and monitoring of water resources** (quality & quantity monitoring): Infrastructure and human resource capacities will be developed to enable regular and continuous monitoring of the country's ground and surface water resources, and ensure that this information is fed into the decision making process.
3. **Assessment of water balance** and regulating water use by different economic and social sectors;
4. **Watershed & water catchment protection/conservation** targeting densely populated, intensively cultivated and upstream areas;

The recent Rwandan WRM Strategy addresses climate change in the 'Logical Framework: Outcome for Climate, Mitigation and Adaptation'. An extract of the logical framework is provided in table 9. Key to the strategy is disaster management, water security planning, and mainstreaming climate change.

### 7.7 Review of EDPRS CPAF/MTEF Targets

It would be the responsibility of a future National Water Authority to ensure consistency of EDPRS targets across sub-sectors. The next revision cycle of EDPRS III presents this opportunity to enrich performance indicators. Existing targets require alignment with contemporary policy and priorities. Furthermore, assessment of the ability of targets to represent performance in achieving water security and climate resilience is required. It is important that targets and indicators are quantifiable and meaningful, and are associated with a level of confidence in accuracy of reporting instruments. The use of GIS to determine spatially (geographic area) based targets is a useful way of accurately monitoring performance and should be incorporated into the CPAF/MTEF process, i.e. targets are often associated with 'number of households (HH)' although this is a very difficult

number to quantify and doesn't relate to all land and water users or formal tenure; similarly, without employing GIS the 'length of river' system indicators may not reflect change within sub-basins areas and is limited to the scale (level of detail between points) used to measure the river.

Table 9: Logical Framework of the Rwandan WRM Strategy

Outcomes	Key Outputs	Key Performance Indicators and Targets	Key Activities	Responsible Agencies
An effective framework for Water-related disaster management and Climate change mitigation and adaptation in place and implemented.	Climate change resilience and vulnerability status established, regularly updated and used to inform policy and planning;	<ul style="list-style-type: none"> <li>- Sector-based cc vulnerability and resilience maps and reports;</li> <li>- CC Mainstreaming reports;</li> <li>- Early warning systems for extreme weather;</li> <li>- National sensitisation programme for CC awareness, adaptation and mitigation</li> </ul>	Studies on climate change resilience and vulnerability status and trends	REMA
			Support for integrating cc information into sector planning processes	REMA, MINIRENA
			Catchment-based national sensitisation programme	ISRA, RADA, MINAGRI
			Develop and promote drought-resistant crop and pasture varieties	MINAGRI
	National Water balance and water security plan	<ul style="list-style-type: none"> <li>- Water Security plan;</li> <li>- Reliable information on national water balance</li> </ul>	Establish a national water security plan, and establish a water reserve;	MINIRENA
			Train farmers and communities on water storage and security;	MINAGRI
	Operational safety plans for Water ways and Water infrastructure installations;	<ul style="list-style-type: none"> <li>- Flood information system</li> <li>- Status reports on disaster incidences;</li> <li>- Incidences of dangerous attacks or losses from water-based wildlife (e.g. crocodiles)</li> </ul>	Safety monitoring strategy for water infrastructure, integrate into national infrastructure development and Disaster Management Plans	MININFRA
			Review Infrastructure design policies, include construction of storm water collection channels and reservoirs for major infrastructures	MIDIMAR; MINIRENA
	Effective National Disaster Management plan that prioritises water-related disasters;	<ul style="list-style-type: none"> <li>- National Disaster management plan includes water-related issues</li> </ul>	Map potential risks and develop prevention of water-based wildlife attacks (hippos, crocodiles)	REMA/RDB/ National Parks
			Assess the level of national disaster preparedness, develop a National Disaster Management Plan	MIDIMAR
		Strengthen capacity of national and decentralised institutions for disaster prediction and response	MIDIMAR	



## Action Plan



The proposed Policies for Climate Change and Low Carbon Development drawn from the discussion and focus areas are listed in box 6.

### 8.1 Proposed Actions

1. Reduced duplication of effort and divergent/competing policies for water resource management (i.e. opportunities lost, inappropriate use, redirection or water supply, land degradation, loss of biodiversity and ecosystem, unsustainable land use).
2. Optimal use of water flow for renewable energy production at micro and pico scales.
3. Optimal allocation of water resource management and infrastructure finances – programme coverage beyond pilot area to national roll out. Successful pilot programmes must establish national scale-up strategies.
4. Land use and development planning process protects watershed catchments and water bodies for domestic supply.
5. Land use and development planning process prescribes and enforces sustainable land management, prevention of soil erosion, restriction of sediment and chemical (pesticides, mineral fertilizers) run-off into aquatic ecosystems.
6. Water conservation and efficiency promoted at individual, domestic, industrial, and agricultural users (sensitisation, planning, regulation, and enforcement).
7. Promotion of carbon sequestration through, improved infiltration and hillside irrigation, prevent soil loss, maintain soil fertility for improved cropping, intercropping with legumes, deep rooted trees in marginal lands and high slope areas.
8. Small to medium scale solar-PV water treatment (CDM opportunity)

#### Box 6: Priority policies for achieving Climate Change Resilience and Low Carbon Development

1. Integrated Water Resource Management (IWRM) approach to managing the National water resource
2. District and Community based catchment management based on IWRM principles
3. Understanding the Water Balance: Monitoring, Observation, Analysis, Information Management
4. Efficient Irrigation, Storage, Transport
5. Capacity and Professional Development

9. Ground water testing and monitoring (naturally occurring heavy metals, industrial or agricultural chemicals), and treatment and filtration systems at communal supply points, potential for solar-PV treatment of ground water supply.
  10. Domestic and community water harvesting and storage, save pumping and water carting, improve livelihoods, improve sanitation and health.
  11. Improved management of water bodies and still waters, reduce vector-borne disease, improve monitoring and management of disease to population, animals and livestock, natural vegetation and crops.
  12. Improved monitoring of pest and invasive species and diseases, transport by water, animal vectors, movement of humans and agricultural vehicles (nationally between districts and agricultural zones, and regionally at border crossings)
  13. Robust institutional linkage to agricultural production to manage inputs and water use for production to manage agricultural transformation in cropping, storage, processing, manufacturing, dairy and livestock.
4. Land use and development planning process protects watershed catchments and water bodies for domestic supply.
  5. Land use and development planning process prescribes and enforces sustainable land management, prevention of soil erosion, restriction of sediment and chemical (pesticides, mineral fertilizers) run-off into aquatic ecosystems.
  6. Water conservation and efficiency promoted at individual, domestic, industrial, and agricultural users (sensitisation, planning, regulation, and enforcement).
  7. Promotion of carbon sequestration through, improved infiltration and hillside irrigation, prevent soil loss, maintain soil fertility for improved cropping, intercropping with legumes, deep rooted trees in marginal lands and high slope areas.
  8. Small to medium scale solar-PV water treatment (CDM opportunity)
  9. Ground water testing and monitoring (naturally occurring heavy metals, industrial or agricultural chemicals), and treatment and filtration systems at communal supply points, potential for solar-PV treatment of ground water supply.

## 8.2 Options for Low Carbon Development and Climate Resilience

1. Reduced duplication of effort and divergent/competing policies for water resource management (i.e. opportunities lost, inappropriate use, redirection or water supply, land degradation, loss of biodiversity and ecosystem, unsustainable land use).
  2. Optimal use of water flow for renewable energy production at micro and pico scales.
  3. Optimal allocation of water resource management and infrastructure finances – programme coverage beyond pilot area to national roll out. Successful pilot programmes must establish national scale-up strategies.
10. Domestic and community water harvesting and storage, save pumping and water carting, improve livelihoods, improve sanitation and health.
  11. Improved management of water bodies and still waters, reduce vector-borne disease, improve monitoring and management of disease to population, animals and livestock, natural vegetation and crops.
  12. Improved monitoring of pest and invasive species and diseases, transport by water, animal vectors, movement of humans and agricultural vehicles (nationally between districts and agricultural zones, and regionally at border crossings)

13. Robust institutional linkage to agricultural production to manage inputs and water use for production to manage agricultural transformation in cropping, storage, processing, manufacturing, dairy and livestock.

### 8.3 Action Plan

To guide decision-makers, the policies are brought together into the action plan in table 10 based on the focus areas, indicating policies and actions, responsible stakeholders, suggested timing, preliminary indicators and finance source.

Table 10: Policy action plan

Focus area WHY	Policies and Actions WHAT	Stakeholders WHO	Timescale WHEN	Measurables HOW	Sources of Finance
National IWRM	Integrated Water Resource Management (IWRM) approach to managing the National Water Resource - Establish National Water Authority (NWA) - Establish Inter-Ministerial Council for WRM - National Framework for IRWM from National to District levels	Ministerial Council for Water Resource Management, Department of Water Resource Management, RNRA, MINIRENA, MININFRA, EWSA, RMS, MINAGRI, MINALOC, Districts	Short Term	- Adopt National WRM Policy & Strategy - Ministerial Council and NWA Established - Pass special law for NWA - Districts 'accredited' for Integrated WRM - National land use planning incorporates IWRM principles	Central
District & Local Catchment Management	District and Community based catchment management based on IWRM principles - National & District WRM Partnerships - Establish Water Users Associations	RNRA, All Ministries - Custodians of Key National Datasets	Short – Medium Term	- Strategy adopted - Policies adopted	Central
Spatial Information: Hydrology Ground Water Monitoring & Observation	Understanding the Water Balance: Monitoring, Observation, Analysis, Information Management - Identify key hydro datasets - Custodial arrangements for each theme - Information sharing and access policy - Monitor water balance - Model abstraction and future demand	RNRA, MINIRENA, MININFRA, EWSA, RMS, MINAGRI, MINALOC, RNRA, Department of Lands and Districts, CGIS-NUR, KIST, Trans-boundary Agencies	Short – Medium Term	- GIS Units in Ministries and Districts - National SDI for climate observation and management - WRM Technical Workgroup	Central, climate finance
Water Security, Efficiency and Conservation	Efficient Irrigation, Storage, Transport - Extend Water Storage and Harvesting - Promote water conservation and efficiency - Irrigation infrastructure nationally - Water security for communities, industry, agriculture	RNRA, MINIRENA, MININFRA, EWSA, MINAGRI, Districts	Medium Term	- No. Communities water secure - Access to potable water - Districts water secure - Agricultural zones water secure - Areas irrigated - Hillside areas irrigated - National drought resilience strategy	Central, climate finance
Professional & Technical Capacity	Capacity Development - CGIS-NUR, KIST etc to provide additional training courses - Extend formal courses in GIS and twinning	RNRA, MINIRENA, MININFRA, EWSA, RMS, MINAGRI, MINALOC, Districts	Medium Term	- No. Certified Professionals - No. Courses - No. Students enrolled /graduated	Central

The policies offered are geared to overcome the most pressing challenges in achieving sustainable land use management and optimal use of Rwanda's limited land resource. Priorities are listed in order of priority and have a natural timing involved. All can be commence immediately. However, a roadmap of

set actions and tasks will also be provided with short term geared to the EDPRS III revision for 2013-2017, medium term from 2017 onwards and select long term outcomes to be achieved by 2050. The timescales are mapped out in table11 below.

Table 11. Timeline for Policies and Actions										
Focus Area	Policies and Actions	2011		2012		2013	2014	2015	2016	2017
		Q3	Q4	H1	H2					
Integrated IWRM	Institutional Review of IWRM Governance Framework	█		█						
	Appoint Inter-Ministerial WRM Committee			█						
	Establish National Directorate for WRM			█						
	National Water Security Plan including Disaster Mitigation, Flood, Dam Levels, Evacuation Plans			█						
District and Local Catchment Mgt based on IWRM	Community Water Security Strategies			█						
	Riparian Rights Framework linked to Tenure			█						
	Water User Associations to activate National Strategy			█						
	District WRM Extension & Workshops	█	█	█	█	█	█	█	█	█
	Wetland Protection Strategies			█						
Understanding the Water Balance	Establish Water Accounting System inc Agriculture, Industry, Urban Demands for Water	█		█						
	Dynamic Rain and Flow Gauge Network, Early Warning Systems	█		█						
	Monitoring Unit for Water Quality, Ground Water, Flood, Hazard, Dam and River Level	█		█						
	Hydro, Flood Hazard Mapping Unit	█		█						
Efficient Irrigation, Storage, Supply	National Plan for Water Conservation, Storage, Harvesting & Irrigation	█		█						
	Assess Minimum Environmental Flows			█						
	Drought Alert System & Water Restriction Scale			█						
	District WRM Capacity Programme	█	█	█	█	█	█	█	█	█
	Financial & Technical Assessment Water Use & Efficient Technology			█						
	Water Saving Programme for Domestic, Agriculture & Industry			█						
Capacity Building / Professional Development	Higher Education & Short Courses	█		█						
	Professional Accreditation Competency Framework			█						
	Climate & IWRM Education			█						

## Climate Finance



### 9.1 Bilateral and Multilateral Funding

Integrated water resource management featured prominently in Rwanda's National Adaptation Plan of Action (NAPA). As such, there should be significant opportunities to receive grants from multilateral climate funds. Below is a list of the funds that offer support for NAPA implementation:

- Adaptation Fund
- Least Developed Country Fund
- Global Environmental Facility
- Global Facility for Disaster Reduction and Recovery
- Global Climate Change Alliance

Other multilateral funds that support water management activities specifically include the following:

- International Climate Initiative
- Special Climate Change Fund
- UNDP/Spain MDG Achievement Fund
- International Development Association
- ClimDev-Africa Special Fund
- Nordic Climate Facility
- Public-Private Infrastructure Advisory Facility

Each fund has its own mandate, institutional requirements, and application and monitoring procedures which are outlined on the website [www.climatefinanceoptions.org](http://www.climatefinanceoptions.org). Public funds could also come from Rwanda's future environmental fund, FONERWA, which will in turn be capitalised by

bilateral development partners and environmental fiscal sources.

### 9.2 Payments for Ecosystem Services

An innovative source of financing for Rwanda's water resource management activities could involve payments for ecosystem services (PES). PES is based on the principle that a primary cause of ecosystem degradation is 'missing markets' for the vital public services that ecosystems provide. Many ecosystem services are directly related to water resources management. For example, watersheds will catch and provision water used by agriculture, residential areas, industries and utilities.

Forests and marshlands will regulate water levels preventing droughts, flooding, erosion and excessive sedimentation, and act as natural filtration system by taking up nitrogen, etc.

While the costs of maintaining these services fall solely on the landowners of the ecosystem, the benefits are enjoyed on a much wider-scale. The services are non-marketable because they are non-excludable. For example, it would be impossible for a landowner to deny beneficiaries access to the water purified by their forest. The failure to provide payments for these ecosystem services leads to perverse incentives and suboptimal use of the land. To illustrate, from the perspective of the landowner, the net benefit from logging and developing a forest will outweigh the net benefit from preserving it. In contrast, from society's point of view, preservation is often optimal.

The results of these perverse incentives can be observed in Rwandan examples of ecosystem

degradation. For example, the clearing of the Gishwati Forest for subsistence farming in the 1990s was a direct cause of the Nyabihu flooding in 2006. The economic costs of the flood were estimated to be between USD4.1 and 21 million. Furthermore, the clearing of the Gishwati Forest caused increased erosion and sedimentation, which damaged the Gihira Hydro Power Plant to the point where the entire system needed to be replaced. Likewise, the degradation Rugezi Marshland resulted in a shortage of hydroelectric power, and had significant knock-on effects on people's livelihoods and the entire Rwandan economy. Subsequent restoration of the Rugezi marshland increased RECO's capacity to generate power (Musanze PES Workshop Report 2010).

PES strategies aim to directly compensate landowners for public services that their land provides. For PES to function properly, two requirements must be fulfilled: payments to the landowner must exceed the opportunity costs of developing the land, and property rights must be well defined and enforced.

There are numerous variations of PES, but three models are applicable. Private PES deals involve payments from the beneficiaries of the ecosystem service to private landowners of the ecosystem. Often, downstream businesses reliant on the water supply, such as the utility EWSA, would be willing to pay upstream landowners for a well-regulated and quality water supply. A commonly cited example is that of the bottled water company, Perrier, paying French landowners to maintain the forests surrounding their water sources (Jenkins 2009). The government can actively engage beneficiaries and landowners to facilitate bargains, but once the market is established, it can be relatively hands off (Mourato 2010). Alternatively, a 'direct payment' model could be established, in which the government would act the middleman between the beneficiaries of an ecosystem service and the private landowner. The GoR could collect payments from the beneficiaries through environmental taxes, and recycle them as direct payments to landowners that conserve the ecosystem. These payments

could be made from a central fund, such as FONERWA. Finally, in cases where ecosystems lie within publicly owned lands, the GoR could pay for their preservation and maintenance through environmental levies on the beneficiaries. Note that if the taxes were levied on the utility EWSA, they would be passed on to its consumers in the form of higher prices for electricity and water services.

The Rwanda Environmental Management Authority (REMA) held a workshop on PES in December 2010. The workshop resulted in the establishment of a PES Task Force. The core team is made up representatives from REMA, RDB, PSF, WCS, and RECO/RWASCO and has the following mandate:

1. Commission research to understand potential PES transactions
2. Review current legislation and identify entry points for PES
3. Identify key stakeholders to be included in the working group
4. Leverage interest in the private sector
5. Review case studies and draw specific recommendations for PES in Rwanda
6. Establish a TOR, Modus operandi, and Timeframe for PES implementation

### 9.3 Carbon Trading and Water Purification

To treat drinking water in Rwanda, the prevailing practice is to boil it by burning biomass (Thomas & Spannagle 2010). This practice is carbon intensive, and numerous water purification technologies exist that could negate this thermal energy need. By displacing the greenhouse gas emissions associated with boiling water, such technologies could qualify for carbon finance.

A number of carbon markets have been created for trading certificates – called carbon credits – that denote a reduction in greenhouse gas emissions against a baseline of projected emissions. One carbon credit represents a reduction of one tonne of CO<sub>2</sub>e.

Each carbon market has different rules and prices. They can be divided into two broad categories: mandatory cap-and-trade markets, and voluntary markets. The difference between the two lay in whether those purchasing carbon credits have legally binding emissions reduction commitments. Of particular interest is the Clean Development Mechanism (CDM), which was established as a mandatory cap-and-trade scheme between countries party to the Kyoto Protocol. It has two aims: assist Annex 1 (predominantly 'industrialised') countries achieve compliance with their quantified emission reduction commitments by purchasing carbon credits from offset projects in non-Annex 1 countries; and promote sustainable development in non-Annex 1 countries. Voluntary markets generally have less strict requirements than the CDM in regards to monitoring, verification, etc, however the value of carbon credits is reduced. The price of CDM credits has been volatile, but an appropriate benchmark is USD15 per tonne of CO<sub>2</sub>e reduced.

Recently two CDM methodologies have been approved for CDM water treatment projects (AM0086 – "Installation of zero energy water purifier for safe drinking water application" and AMS.III.AV – "Low greenhouse gas emitting water purification systems"). Both methodologies are for point-of use (POU) treatment system or point-of-entry treatment systems, which treat the water from a single tap or all the water entering a single home, business, school, or facility respectively. To measure the carbon offset per system, one must first calculate the baseline – i.e. the amount of greenhouse gas

emissions that would have been produced during the purification of an equivalent volume of water using the prevailing practice.

The only water purification CDM project in existence has been implemented by a company called Hindustan Unilever Limited in India. Using methodology AM0086, the project's stipulated carbon offset per water purification system is 0.05413 tCO<sub>2</sub>e/year. Valued at USD15, this offset is worth only USD0.81 per system. However, with large sales, the revenues add up, and Hindustan Unilever projects it will be selling over one million water purification systems and offsetting over 250 thousand tCO<sub>2</sub>e by 2013.

The opportunities for scale are not as large in Rwanda, and ideally, the Government of Rwanda would be able to secure carbon finance for centralised water purification systems. One Rwandan example is that of that of Manna Energy, which attempted to use the CDM to finance the implementation of water purification systems in four water pipelines that serve approximately 7,750 people. Each system was to use a solar panel powered ultraviolet (UV) irradiation system, and, as necessary, gravel flocculators and rapid sand filters. The Project Design Document claimed a yearly offset of 7.5 tCO<sub>2</sub>e per person and was initially denied due to errors in calculation (Manna Energy, 2009). However, it could provide a useful model for the Government of Rwanda in its efforts to finance the extension of water treatment services.



## Summary



Realising a robust national framework for IWRM is the first step for Rwanda charting a course towards water security and climate resilient development. The strong legal and policy framework currently being drafted, is a good basis on which to support IWRM. The challenge is to ensure the national water resource is managed in a balanced manner across priorities of supply, infrastructure, energy generation, industrial and agricultural demand, sanitation, and protection of the natural resource and dependent ecosystems. Attention to improvement of monitoring and observation of Rwanda's hydrology will support improved decision making and adaptability to change throughout the course of Rwanda's development. Water storage and harvesting is key to achieving water security with irrigation planning

essential to minimising agricultural seasonal production loss and ensuring food security and export supply. Promotion of water efficiency and conservation in usage in development planning and domestic and farming behaviour will avail water for other purposes required for growth. As a water conscious nation and responsible water user, Rwanda will be a better neighbour in contributing to the regional transboundary catchments.

A draft set of priority policies and actions is provided that will be taken to consultation with Government administrators and key water stakeholders. A road map of short, medium and long term actions is outlined as a suggested course for achieving water security and climate resilient growth to 2050.



## References



- [1] No 62/2008 of 10/09/2008, Law putting in place the Use, Conservation, Protection and Management of Water Resources Regulations.
- [2] Cap-Net (2009) IWRM as a Tool for Adaptation to Climate Change: Training Manual and Facilitator's Guide, International Network for Capacity Building in Integrated Water Resources Management, Pretoria, pp.129
- [3] GoR (2011) National Policy for Water Resources Management, Ministry of Environment and Lands (MINIRENA), Draft, April, pp.26
- [4] GoR (2011) Water Resources Management Sub-Sector Strategic Plan, Ministry of Environment and Lands (MINIRENA), Draft, April, pp.84
- [5] MINAGRI (2010) Rwanda Irrigation Master Plan, Ministry of Agriculture and Animal Resources (MINAGRI), Government of Rwanda, Kigali, pp.229
- [6] UNEP (2009). Rwanda: From Post-Conflict to Environmentally Sustainable Development. Post-Conflict and Disaster Management Branch.
- [7] OCIR Cafe, 2009. Coffee Development Strategy Update 2009 - 2012
- [8] National Institute of Statistics of Rwanda (2008): National Agricultural Survey, Government of Rwanda.
- [9] RARDA (2011) Source: <http://www.rarda.gov.rw/spip.php?article32>
- [10] Population projection based on 2002 Census (Haguma et al 2008).
- [11] MININFRA (2010) Government of Rwanda, Kigali.
- [12] GWP (2011) Available, <http://www.gwp.org/en/gwp-in-action/Central-Africa/>
- [13] WMO (2011) The Dublin Statement on Water and Sustainable Development, Available <http://www.wmo.int/pages/prog/hwrrp/documents/english/icwedece.html> 09 April 2011.
- [14] MDBA (2011) Murray-Darling Basin Authority (MDBA), Australian Government, Available <http://www.mdba.gov.au/> 09 May 2011.
- [15] UNEP (2011) Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication, Advanced Copy Online Release, United Nations Environment Programme, pp626.
- [16] GoR (2009) Five-Year Strategic Plan for the Environment and Natural Resources Sector (2009 – 2013), Ministry of Environment and Lands (MINIRENA), Government of Rwanda, pp.97
- Climate Finance:**
- Hindustan Unilever Limited (2008) Installation of Zero Energy Water Purifier in India. CDM Executive Board Project Design Document Form. Accessed online 3 May 2011 at <http://cdm.unfccc.int/methodologies/DB/9VTXPHAU3QSG26CDIU0EWX81JSYKKO>
- Jenkins, M. (2009) Michael Jenkins on Ecosystem Payments. International Foundation Caucus Foundation. Uploaded July 27, 2009. Accessed online 15 March 2010 at <http://www.youtube.com/watch?v=m9gyXuKlvUQ&feature=channel>
- Manna Energy (2009) Rwanda Natural Energy Project: Water Treatment Systems for Rural Rwanda

08/10/2009. CDM Executive Board Project Design Document Form. Accessed online 3 May 2011 at [http://cdm.unfccc.int/filestorage/S/L/J/SLJM7RHFDQX28ACKBE0OWUPYGN596T/Shyira%20Fawe%20PDD.pdf?t=R2x8MTMwNDQ5MjUzMS4xNg==|V7\\_vEVcKZM0HQGd5vz4iSaHsUJg=](http://cdm.unfccc.int/filestorage/S/L/J/SLJM7RHFDQX28ACKBE0OWUPYGN596T/Shyira%20Fawe%20PDD.pdf?t=R2x8MTMwNDQ5MjUzMS4xNg==|V7_vEVcKZM0HQGd5vz4iSaHsUJg=)

Mourato, S. (2010) Lecture Notes 5. Biodiversity, Ecosystem Services and Economic Appraisal. GY455 Economic Aspects of Project Appraisal. London School of Economics.

GoR (2010) REMA PES Workshop, Report, Musanze 17th-18th Dec 2010.

Thomas, E., and Spannagle, M. (2010) CDM Recommendation Form for Small Scale Methodologies: Establishing the baseline thermal energy needs in AMS-I.E using literature data. United Nations Framework Convention on Climate Change. Accessed 25 April 2011 at <http://cdm.unfccc.int/filestorage/V/R/6/VR6UD98ZP2XO74ECAT1SNMQFWYJ015/Final%20response.pdf?t=UEI8MTMwNDQzNTMxMS41Mw==|GOTEIfpTejKVyLitHgsvgWJkrbY=>

## Appendices



Additional National IWRM Plans available Online:

### IWRM Tool Kit Source:

[http://www.gwptoolbox.org/index.php?option=com\\_tool&id=28](http://www.gwptoolbox.org/index.php?option=com_tool&id=28)

Key References:

- Water framework directive 2000/60/EC (EU WISE, 2000)
- Status Report on IWRM and Water Efficiency Plans (UN-Water, 2008)
- Evaluation of partnership for Africa's water development program (GWP, 2008)
- Planning Process: Guidance Document # 11 (EC, 2000)
- Unlocking door to social development and economic growth (GWP, 2004)
- Catalyzing Change: A handbook for developing IWRM and water efficiency strategies (GWP, 2004)
- IWRM and water efficiency plans by 2005 (GWP, 2004)
- IWRM Plans Training Manual (Cap-Net/ GWP/UNDP, 2005)
- Planning for a water secure future; lessons from Africa (GWP, 2008)
- IWRM guidelines at river basin level (UNESCO, 2009)
- IWRM in Action (UNESCO/UNWWAP/ UNEP-DHI, 2009)
- Lessons from IWRM in Practice (GWP, 2009)
- Improving Africa Water Security (GWP, 2009)

- Better water resources management – Greater resilience today, more effective adaptation tomorrow (GWP, 2009)
- Development Lessons from Water Management (GWP, 2010)
- Water security for development: Insights from African partnerships in action (GWP, 2010)
- Setting the stage for change (GWP, 2006)

Related Cases:

- USA: Application of watershed models for integrated water quality and coastal resources restoration in Chesapeake Bay (#123)
- Zambia: Integrated Water Resources Management and Water Efficiency (IWRM/ WE) planning process (#332)
- Burkina Faso: Action Plan for IWRM (#338)
- Senegal: IWRM Planning Process in Senegal (#334)
- Mali: Capitalizing on the process of elaboration of the Action Plan for IWRM (#345)
- Kazakhstan: Institutional reform in water sector to implement IWRM plan (#342)
- Eritrea: Vital aspects of the Eritrean IWRM planning process (#366)
- Kenya: Roles and Responsibilities in IWRM Planning Process (#373)
- Malawi: Ensuring sustainability in IWRM processes (#374)

- Cameroon: Planning for sustainable water resources development and management (#375)
- Benin: Getting started: the experiences of IWRM planning process (#381)
- Uganda: Progress towards IWRM (#382)







Smith School of Enterprise and the Environment  
University of Oxford  
Hayes House  
75 George Street  
Oxford  
OX1 2BQ  
United Kingdom  
[www.smithschool.ox.ac.uk](http://www.smithschool.ox.ac.uk)