SURVEY AND EVALUATION REPORT ON BEST PRACTICES ON CLIMATE CHANGE ADAPTATION AND MITIGATION INITIATIVES IN RWANDA

May 2010
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Acronyms
MINAGRI : Ministry of Agriculture and Animal Resources
MINECOFIN : Ministry of Finance and Economic Planning
MINALOC : Ministry of Local Government
REMA : Rwanda Environment Management Authority
RADA : Rwanda Agriculture Development Authority
RALGA : Rwandese Association of Local Government Authorities
MININFRA : Ministry of Infrastructure
GDP : Gross Domestic Rate
NBDF : Nile Basin Discourse Forum
UNDP : United Nations Development Programme
UNEP : United Nations Environment Programme
IPCC : Intergovernmental Panel on Climate Change
NAPA-Rwanda : National Adaptation Programme of Action for Climate Change in Rwanda
SSA : Sub Saharan Africa
NAFA : National Forestry Authority
PSTAI &II : Plan Stratégique pour la Transformation de l’Agriculture au Rwanda
UNFCCC : United Nations Framework Convention on Climate Change
EDPRS: Economic Development and Poverty Reduction Strategy
RDB: Rwanda Development Board
ISAR: Institut des Sciences Agronomiques du Rwanda
RHODA : Rwanda Horticulture Development Authority
RARDA : Rwanda Animal Resources Development Authority
NLC : National Land Centre
WHO : World Health Organisation
KP : Kyoto Protocol
VUP : Vision 2020 Umurenge Programme
HIMO : Haute Intensité de Main d’œuvre
# Table of Contents

Acronyms ........................................................................................................................................ 2

1.0 Introduction ..................................................................................................................................... 5
  1.1 General Objective of the study ............................................................................................................. 6
  1.2 Specific Objectives of the study ............................................................................................................. 6
  1.3 The Rationale for carrying out the study and anticipated Benefits ................................................. 6
  1.4 Study Methodology and Approach ...................................................................................................... 7

2.0 Climate Change, causes, effects and mitigation ....................................................................................... 8
  2.1 Definition ............................................................................................................................................ 8
  2.2 Causes of climate change ..................................................................................................................... 8
  2.3 General Effects of climate change ......................................................................................................... 10
  2.4 International effort to mitigate effects of Climate Change. ................................................................. 11

3.0 Climate change in Rwanda ..................................................................................................................... 12
  3.1 Current Situation ................................................................................................................................. 12
  3.2 Effects of Climate Change in Rwanda. ................................................................................................. 13

4.0 Climate Change Adaptation and Mitigation Initiatives .......................................................................... 16
  4.1 Policy, legal and institutional Best Practices ......................................................................................... 17
    4.1.1 Legal Best Practices ....................................................................................................................... 17
    4.1.2 Policy and Strategy Best Practices ................................................................................................. 19
    4.1.3 Institutional Best Practices ............................................................................................................. 22
  4.2 Field level Best Practices for Adaptation to climate change ................................................................. 22
    4.2.1 Agriculture Best Practices .............................................................................................................. 23
    4.2.1.1 Agriculture and Livestock Intensification .................................................................................... 23
      Photo Credit: Bugesera District .............................................................................................................. 27
    4.2.2 Human Resettlement ....................................................................................................................... 27
    4.2.3 Infrastructure .................................................................................................................................. 29
    4.2.4 Natural Resource management ....................................................................................................... 32
    4.2.5 Income Generation Activities ........................................................................................................... 37

5.0 Conclusion ........................................................................................................................................... 38

BIBLIOGRAPHY ....................................................................................................................................... 40
List of Figures.

Figure 1: Temperature variations from 1971-2005. ...................................................13
Figure 2: The flooding and creation of Lake Nyarikigugu in Nyabihu...........................14
Figure 3: The effects of forest destruction leading to erosion, flooding and destruction of crops in Gishwati area. .................................................................14
Figure 4: Destroyed Bridge and Properties in western province due to heavy rains.....15
Figure 5: Radical terraces under irish potatoes in Gicumbi District.........................24
Figure 6: Zero grazing and organic manure production in Gicumbi District. ...............25
Figure 7: Rice Production in Marshland in Kirehe District .......................................26
Figure 8: Climbing beans in Nyabihu .................................................................26
Figure 9: Drought resistant Cassava growing in Bugesera........................................27
Figure 10: Roof water harvesting and hillside micro dams ......................................28
Figure 11: Solar Energy generation on Rusumo High school in Kirehe District. ..........29
Figure 12: Efficient Energy Cooking Stoves being made by women ......................30
Figure 13: Biogas unit in Mukamira sector, Nyabihu District. .................................30
Figure 14: Micro hydro power unit in Butaro Sector, Burera District.......................31
Figure 15: Rehabilitated Rugezi wetland ...............................................................32
Figure 16: Afforestation efforts in Bugesera District..............................................33
Figure 17: Conserved Nyangwe forest in Karongi District...................................33
Figure 18: Agro forestry efforts in Bugesera ................................................................34
Figure 19: Land use consolidation, Kirehe District, Eastern Province .................35
Figure 20: Consolidation and pasture development, Nyabihu District, Western Province 36
Figure 21: Highly Intensive Public Works in Cyumba Sector, Gicumbi District. ....37
1.0 Introduction

In its Vision 2020 strategy, Rwanda set an ambitious goal for its development. Between 2000 and 2020, the country would like its per capita GDP to grow from $250 to $900 (Rwanda Vision 2020, 2000).

Attaining the above goal requires among other things that Rwanda adopts strategies that utilis es her natural resources on a sustainable basis and this calls for the development of a vast environmental protection programme.

According to Rwanda’s vision 2020 the major problem in the field of environmental protection in Rwanda is the imbalance between the population and the natural resources (land, water, flora and fauna and non renewable resources, which have been degrading for decades). This degradation is observed through massive deforestation, the depletion of bio-diversity, erosion and landslides, pollution of waterways and the degradation of fragile ecosystems, such as swamps and wetlands (Rwanda Vision 2020, 2000).

The undesirable environmental effects described above resulted from a greater population growth estimated at 3% per annum during the 80's to 90's compared to an agricultural growth of only 2.2%. This has led to the occupation of more and more marginal areas and to the rapid and continuous soil degradation of the fragile ecosystems of the country. These environmental problems are exacerbated by the poor location of industries and the direct evacuation of their waste, without any treatment, into waterways and lakes (Rwanda Vision 2020, 2000).

In order to ensure sustainable development, Rwanda has among other things developed programmes/measures to implement adequate land, water and environmental management techniques, sustainable forestry development together with a sound biodiversity policy.

The Nile Basin Initiative-NBI is one such programme that aims at ensuring that Rwanda and Nile Basin countries attain sustainable development. The implementation of this initiative requires the involvement of civil society in the planning and development processes. The Nile Basin Discourse Forum in Rwanda was thus formed to assist the constructive engagement of civil society in the NBI through development of knowledge, greater capacity, better networking and stronger linkages at all levels of civil society and the government.

It is against this background that in August 2009, the Nile Basin Discourse Forum in Rwanda received funding from a joint UNEP-UNDP CC DARE project of the Danish Foreign Ministry on climate change development to implement a project called Building
capacity and raising awareness for a sensitive community on climate change adaptation in Rwanda. Part of these funds was allocated to carry a study whose objective appears in 1.1 below.

1.1 General Objective of the study

The general objective of this study is to carry out a survey and document best practices on climate change adaptation and mitigation in Rwanda

1.2 Specific Objectives of the study

The study will help in achieving the following specific objectives:

1. To equip civil society organizations with different skills and knowledge on climate change
2. To enhance NGO Managers skills and efforts in managing their organizations in a changing climate;
3. To provide the basis for an effective dialogue between all stakeholders in facing the climate change challenge
4. To gather, document, disseminate and share information for combating climate change with all stakeholders in Rwanda.

It is in the attempt to attain the above objectives that the Nile Basin Discourse Forum in Rwanda contracted a national consultant to undertake the following tasks:

1. Solicit and source data currently existing on best practices on climate change adaptation and mitigation in Rwanda in the area of infrastructure, human resettlements, agriculture, and natural resource management in Rwanda
2. Document and report all best practices for combating impacts of climate change basing on the collected data,
3. Present a draft report to a stakeholders workshop and members of NBDF Rwanda
4. Make a final report including comments and additional inputs from the above workshop.

1.3 The Rationale for carrying out the study and anticipated Benefits

The proposed study is to survey and document best practices on climate change adaptation and mitigation in Rwanda.
The study is expected to avail to Nile Basin Discourse Forum in Rwanda a report that will enable them understand clearly the meaning of climate change, adaptation and mitigation as well as existing best practices on combating climate change impacts in the sectors under review.

In addition, this report will be used as a funding tool by stakeholders to scale up the highlighted best practices.

NBDF members will be availed with a document containing knowledge on impacts and opportunities of climate change and the sharing of this vital information among ordinary Rwandese will strengthen their capacity to adapt to climate change in Rwanda.

Additionally, the study will equip NBDF with skills and knowledge on best practices to climate change adaptation and mitigation with respect to daily human activities.

Finally the document report will be shared within the NBDF Rwanda information resource center located at the offices of NBDF Rwanda.

1.4 Study Methodology and Approach

The study was based on four main research tools.

Firstly, literature review of relevant background data and information provided by the client, REMA/NAFA, RDB as well as from internet and other sources accessible to the consultants has benefited this study.

Secondly, very brief and short field interviews of key players both with REMA, NAFA, NBDF, as well as District officials and residents of Bugesera, Nyagatare, Gicumbi, Burera, Nyabihu, Karongi, Rutsiro, and Ngororero were used. The interview instrument used open-ended questions, purposefully to extract individual opinions on overall objective of the best practices on climate change in Rwanda but with to respect to their institutions.

Field visits to the study area were made to physically examine the existing evidence on climate change challenges and adaptation in area of infrastructure, human resettlements, agriculture and natural resource management.
2.0 Climate Change, causes, effects and mitigation

2.1 Definition

There are several definitions of climate change. The definitions differ mainly on the cause of climate change.

Climate change is defined as a change in the statistical distribution of weather over periods of time that range from decades to millions of years. It can be a change in the average weather or a change in the distribution of weather events around an average (for example, greater or fewer extreme weather events). Climate change may be limited to a specific region, or may occur across the whole Earth (http://en.wikipedia.org).

The United Nations Framework Convention on Climate Change defines climate change as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. In this case climate change is synonymous with global warming (http://en.wikipedia.org).

The most general definition of climate change is a change in the statistical properties of the climate system when considered over periods of decades or longer, regardless of cause. This means that fluctuations on periods shorter than a few decades, such as El Niño episode, do not represent climate change (http://en.wikipedia.org).

2.2 Causes of climate change

Climate can be shaped or changed by factors known as climate forcings. These forcings include such processes as

- Plate tectonics
- Solar Output
- Orbital Variations
- Volcanism
- Ocean Variability
- Human Influences (anthropogenic)

The initial forcing can be amplified or diminished by a variety of climate change feedbacks. Some parts of the climate system, for example the oceans and ice caps, take longer to respond to these climate forcings because of their large mass. Thus, the climate system can take centuries or longer to fully respond to new external forcings.
Plate tectonics

The movement of tectonic plates over the course of millions of years has and continues to reconfigure global land and ocean areas generating topography. This can affect both global and local patterns of climate and atmosphere-ocean circulation.

Solar output

The sun is the principal source of energy input to the Earth. Both long- and short-term variations in the amount solar energy are known to affect global climate.

Orbital variations

Any slight variations in Earth’s orbit lead to changes in the seasonal distribution of sunlight reaching the Earth's surface and how it is distributed across the globe. There is very little change to the area-average annual sunshine; but there can be strong changes in the geographical and seasonal distribution.

Volcanism

Volcanism is a process of conveying material from the Earth’s crust to its surface. These volcanic eruptions are known to release gases and/or particulates into the atmosphere hence affecting the global climate.

Ocean variability

Changes to ocean processes such as thermohaline circulation over longer durations are known to play a key role in redistributing heat by carrying out a very slow and extremely deep movement of water, and the long-term redistribution of heat in the world's ocean influencing climate.

However, short-term fluctuations (years to a few decades) such as the El Niño represent climate variability rather than climate change.

Human influences (anthropogenic)

Human activities change the environment. In some cases the human influence on the climate is direct and unambiguous while in others instances it is less clear. There has been various hypotheses for human-induced climate change for many years but the general consensus is that human activity is very likely the cause for the rapid increase in global average temperatures over the past several decades and there is need to find ways of reducing further human impact (mitigation) as well as adaptation mechanisms.
The biggest concern of all these human factors is the increase in CO$_2$ concentration due to emissions from fossil fuel combustion, followed by aerosols (particulate matter in the atmosphere) and cement manufacture. However other factors, such as land use, ozone depletion, animal production, agriculture and deforestation also pose serious threat to climate either individually or in combination with other factors.

Human influence is the most fundamental of all the clauses of climate changes, as it can be controlled and the current efforts to adapt and mitigate effects of climate change are directed towards human activities.

2.3 General Effects of climate change

Existing evidence indicates that global temperatures are rising and the effects of the resultant climate change such as drought, floods, are serious challenges to the world (IPPC, 2007).

The cruel irony of climate change is that the countries least responsible for it will be worst affected. Greater variations of rainfall, combined with rising sea levels, will lead to more extreme weather, particularly in parts of Asia, sub-Saharan Africa and Latin America (Douglas Alexander, July 2007).

Similarly, the world's less industrialised regions are particularly vulnerable to the effects of climate change. In rural areas, specifically, environmental change has immediate and direct effects on the health and well-being of millions of households that depend on natural resources for their basic livelihoods (Izabella Koziell and Jacqueline Saunders, 2001).

Rural households rely heavily on climate-sensitive resources such as local water supplies, agricultural land and forestry resource for plant, animal, forestry products and services such as cereals, pulses, meat, milk, fuel wood, wild herbs, carbon sequestration etc (Shackelton and Shackelton, 2004). Climate change can reduce the availability of these local natural resources and this limits the survival options for rural households that depend on natural resources for consumption or trade. Land may become less fertile; fewer forestry products may be available for handcrafts; and there may be less local fuel wood for cooking.

Rural women and youths are most vulnerable to effects of climate change because they have limited access to resources and are not involved in decision-making processes. As they are the ones responsible for household water supply and energy for cooking and heating, as well as for food security, effects of climate change such as drought, uncertain rainfall and deforestation hit them most.
Climate change is expected to a large extent reduce agricultural production and increase food insecurity. This is because it affects rainfall, temperature and water availability. The effects of climate change to agriculture are expected to be felt most in Sub-Saharan Africa (SSA), Latin America and South Asia where the adaptation capacity is low. However, there are some regions especially cold areas where climate change may bring warmer conditions hence increasing agricultural production.

A recent IPCC report suggests that farmers in warmer and drier conditions in the Sahelian region of Africa have already curtailed their cropping seasons. Yields from rain-fed agriculture are expected to fall as much as 50 percent in some poor African countries (WHO and UNEP IPCC, 2007).

Where weather changes reduce families’ livelihood options, these changes can force people to leave resource-dependent rural areas and create new migration patterns (Shackelton and Shackelton, 2004). For instance declining agricultural productivity due to climate change may force rural residents to migrate in search of work and food.

The relationship between migration and climatic factors, such as temperature and rainfall, has been documented in several rural regions of developing countries. In Burkina Faso, for example, residents of dry, rural areas are likely to migrate to rural regions with greater rainfall (Sabine Henry et al 2004). In this way, migration may be a long-term response to the threat of recurrent droughts. Rwanda has had cases of farmers migrating because of a failed crop due to either drought or floods/heavy rainfall damages.

Migration is also one of many survival strategies used by Ethiopian households in times of environmental stress. Other survival strategies include using food reserves, seeking local nonfarm employment, selling livestock, borrowing food, or selling household and farm equipment. However, once these livelihood options are exhausted, people often migrate to a new area (Elisabeth Meze-Hausken, 2004).

### 2.4 International effort to mitigate effects of Climate Change.

Mitigation is a process of curbing greenhouse gas emissions from human activities, for example, emissions from fossil fuels as well as deforestation, with a view to stabilizing greenhouse gas concentration at a safe level. The first serious international attempt to develop a mitigation strategy came in 1987; when international community met in the Montreal Protocol and came up with an international agreement to protect the stratospheric ozone layer. This resulted from member countries having recognized that human activities related to the burning of fossil fuels and biomass, and deforestation, etc. have largely contributed to the increased emissions of carbon (C) and other greenhouse gases (GHGs) in the atmosphere and that the changes in the concentration of various GHG in the atmosphere, including carbon, are expected to alter the
atmospheric balance and lead to a rise in the global temperature with serious impacts on human health, sea level rise, agriculture production, forest fires, etc.

However, it was until December 1997 that binding targets for reducing GHG emissions were formally adopted by the Third Conference of Parties (COP3) in Kyoto, Japan. The protocol, known as the "Kyoto Protocol (KP)"", came up with mechanisms and guidelines for the control of GHG emissions. The KP also included six other GHGs not previously covered by the conventions on climate change. The KP sets limits for the reduction of GHG emissions for the industrialised countries at 5.2% between 2008 and 2012 with 8% for the USA, 6% for the Japan and Canada, and 7% for the Europe below the base year 1990 level.

The Kyoto Protocol adopted the Clean Development Mechanism adapted as an important mitigation strategy to climate change. It recognizes the role of land use change, forestry and agriculture soils for the reduction of GHG emissions by source, and removals by sinks.

Recent studies have shown that improved agriculture practices can significantly help in reducing the emissions of the carbon dioxide by increasing carbon sequestration (Lal et al., 1998).

Improved agriculture practices that enhance carbon sequestration include conservation tillage, crop rotations, management of fallow lands, soil conservation and rehabilitation of degraded lands.

3.Climate change in Rwanda

3.1 Current Situation

Rwanda has experienced climatic changes related to general circulation of airstreams and variations of temperatures in the Central Africa region where it is located (Initial Communication under UNCCC, 2005). This publication indicates that Rwanda has over the past 30 years undergone climate changes with respect to frequency, intensity and persistence of extremes like heavy rainfall, waves of heat, drought, and El Nino and Nina phenomena. In this period, frequencies of rainfall deficient and excesses have considerably increased, with occurrences of rainfall deficit reaching 16% and of course this has had an impact of the environment, economy and human lives.

Already temperature observations of a warmer climate are being noticed in Rwanda. Figure 1 overleaf indicates the temperature variations from 1971 to 2005 with a marked increase as observed at Kigali Metrological Station. Historical changes can only be explained by including additional greenhouse gas emissions (IPCC, SPM, 2007). Available evidence indicates that emission of green house gases notably carbon dioxide,
methane, dinitrogen monoxide are on the rise as a result of the use of petroleum products, agriculture and forestry activities and industrial processes mainly cement and lime production (Initial National Communication under UNFCCC, 2005).

**Figure 1: Temperature variations from 1971-2005.**

Consultant’s graph using MININFRA data.

There are reported cases of weather variability and extreme events such as drought, floods and severe rains. Floods, and landslides have become common in the mountainous areas of the country particularly Northern and Western parts. Droughts and desertification, food insecurity have been reported in the Eastern Province and Southeastern parts of the Southern Province (NAPA-Rwanda, 2006).

**3.2 Effects of Climate Change in Rwanda.**

Rwanda has had an increased number of rainfall deficits and excesses over the past 30 years. These climate change extreme events have had a considerable impact on all sectors of Rwandan economy. The following are known effects on infrastructure, human resettlement, agriculture, and natural resource management.

Human resettlements have been adversely affected by heavy rains that result from climate change. These heavy rains have in many cases resulted into landslides and floods destroying human houses in the highland areas notably Western and Northern provinces. The effects of heavy rains are pronounced in hilly areas with no forest cover and unplanned settlements. The destruction of houses in 2001-2002 in Northwest of the country around Gishwati was facilitated by the deforestation of Gishwati forest.
Heavy rains have also resulted into floods destroying human settlements in valleys. The photographs below indicate the flooding and destruction of houses in Nyabihu district in April 2010.

**Figure 2: The flooding and creation of Lake Nyarakigugu in Nyabihu**

![Image of flooded area in Nyabihu with photo credit: NBDF-Rwanda]

Heavy rain in areas with no vegetation cover results into serious soil erosion on the hill sides as well as flooding of valley bottoms. The former leads to adverse land degradation reducing agricultural productivity while the later destroys farmers’s crops. Both cases are known to cause food insecurity.

**Figure 3: The effects of forest destruction leading to erosion, flooding and destruction of crops in Gishwati area.**
Most hillsides without anti-erosion infrastructure in the districts of Burera, Gicumbi, Nyabihu, Ngororero, Karongi and Rutsiro are reported to be degraded and are food insecure due to soil erosion caused by heavy rains.

As valley bottoms are flooded, diseases such as malaria and diarrhoea emerge causing serious disruption to the general welfare of the population.

The urban dwellers are equally affected by heavy rains. Lack of a proper drainage system that results in heavy runoffs have often washed away people’s houses in Kigali city and other towns. This has particularly affected houses in slum areas.

Heavy rains due to climate change have also affected infrastructure adversely. Floods and heavy runoffs are reported to have destroyed roads and bridges. The following is a collapsed bridge in the Western Province as a result of heavy rains.

Figure 4: Destroyed Bridge and Properties in western province due to heavy rains.
Rwanda’s power generation capacity was significantly disrupted due to decrease in water levels of Burera and Ruhondo Lakes in 2003 and 2004 as result of disruption of Rugezi marshlands due to climate change. This forced the government to import diesel generators to supplement the hydropower and this affected the social-economic fabric of the country.

Prolonged droughts are a common occurrence in Rwanda’s Eastern and South Eastern and Central plateau. Such droughts have significantly affected agriculture production resulting into crop failure and livestock deaths. The above caused food insecurity, famine and migration of people to areas with sufficient rainfall. In 2005, Bugesera region experienced the above situation; crops failed, cows died and people were forced to migrate to other parts of the country in search of food. In this year, statistics indicate that rainfall had reduced to 300 mm per year from 700-800 mm per year experienced before 90’s. This made cereal and legume production almost impossible. Due to these conditions, pests such as caterpillars that destroy sweet potatoes and beans became a frequent phenomenon in the region.

Flooding is known to cause crop destruction hence decrease food production and increase in food insecurity in marshland areas. Flooding is believed to have reduced beans and maize production by a margin of 20-30% in marshlands of Nyabugogo and Akanyaru watershed (Brian Harding, 2009).

4.0 Climate Change Adaptation and Mitigation Initiatives
Adaptation to climate change is a response to actual or expected climatic conditions or their effects that have a negative impact on human development (UNDP Human Development Report, 2006). These measures can be used to describe a variety of ways to reduce vulnerability and can be implemented by both public and private sectors. Adaptation to the negative impacts of climate change can either be anticipatory (before impacts) or reactive (after initial impacts).

Mitigation on the other hand refers to all human interventions that reduce the sources of or enhance the sinks for the greenhouse gases (IPPC Third Assessment Report). It means reducing the extent of (pace, rate, magnitude, probability, scope) human induced global climate change. Public and Private efforts related to policies, legal instruments as well as field level activities that reduce the release of green house gases into the air such as afforestation, reforestation, use of non combustible energy etc come under mitigation.

Adaptation and Mitigation initiatives can be either at policy, legal and institutional or at field level. The following are some of the adaptation and mitigation best practices to climate change in Rwanda.

### 4.1 Policy, legal and institutional Best Practices

The Government of Rwanda has developed key policy, legal and strategy documents that give the country the orientation towards its development. These documents contain provisions on best practices on adaptation and mitigation to climate change. The following are best practices in the sectors of infrastructure, human resettlement, and agriculture and natural resource management.

#### 4.1.1 Legal Best Practices

The constitution of Rwanda in its article 49 stipulates that the Government shall protect the environment and that every citizen is entitled to a healthy and satisfying environment; every person has the duty to protect, safeguard and promote the environment. This is a very strong commitment that when implemented adequately will definitely enable Rwandan population to mitigate and adapt to effects of climate change.
The organic law on environment (№4/2005) aims at its protection, conservation and sustainable management for welfare of the population. To achieve the above aims, the law obliges the central and local governments, local and international organizations and citizens to conserve, protect and sustainably manage the environment (art 8). It also sets up punishments to whoever destroys the environment as well as offers incentives (art 71, 72 & 73) to people who carry out activities that protect the environment. Incentives include grant support from National Environmental Fund, and a reduction in taxes for such activities (Official Gazette of Republic of Rwanda, 1st May 2005).

The Land Law (№ 08/2005) set guidelines that ensure that land is sustainably utilized. It facilitates the development of land markets; conditions land owners to plant trees and control soil erosion on their land in order to obtain land titles. It also discourages land fragmentation by prohibiting families to subdivide into smaller pieces of land (Official Gazette of Republic of Rwanda, 15th September 2005). This law in a way directly and indirectly both encourages and obliges people to carry out activities related to Clean Development Mechanisms adopted under Kyoto Protocol.

The Law on forestry protection (№ 47/1988) calls for protection, and conservation of forests. It offers punishments for anybody found destroying the forests. It sets out areas that are strictly nature reserves and this enhances the provision of forest ecological services and functions including carbon sequestration (Official Gazette of Republic of Rwanda, 5th December, 1988).

The law establishing Rwanda Bureau of Standards aims at producing and consumption of safe and quality products. The various agricultural standards so far developed by RBS all have elements on environmental and sustainable management.

The Investment code requires investors to carry out an environment impact assessment for any investment to be acceptable. This requirement forces an investor to put in place mechanisms to protect environment during her/his investment implementation.

In addition to having enacted the above laws, the government has also passed many by-laws and regulations that promote adaptation and mitigation to effects of climate change. Notable among these include the banning of use of plastic bags, use of refrigerators that emit CFs, and making it illegal to burn crop residues and savanna.

Rwanda is committed to environment management under international treaties. The Government collaborates with international community to protect the environment and it is in regard that it has signed and ratified the International Convention on Biological Diversity and its Habitat, the United Nations Framework Convention on Climate Change, the KYOTO Protocol to the Framework Convention on Climate change, Convention on persistent organic pollutants, International Convention on the establishment of international procedures agreed by states on commercial transactions of agricultural
pesticides and other poisonous products, Convention on the Control of Transboundary Movements of Hazardous wastes and their disposal, International Convention on Substances that Deplete the Ozone Layer, Biosafety to the Convention of Biological Biodiversity, International Convention on Wetlands of International importance, especially as water flow habitats and Convention on International Trade in endangered species. Rwanda is also involved in regional environmental protection and management initiatives such as Nile Basin Initiatives and Lake Victoria Biodiversity Programme.

4.1.2 Policy and Strategy Best Practices

Sustainable development, environment protection and proper natural resource management, poverty reduction and investment promotion are highlighted as priority programmes in Rwanda’s vision 2020, Economic Development Poverty Reduction Strategy (EDPRS) as well as in the agriculture, infrastructure, human resettlements, and natural resource sector strategies (Vision 2020, 2000, EDPRS, 2008, PSTA I, 2004 & PSTA II, 2008). These provide a considerable basis for addressing impacts of climate change.

Vision 2020 groups land use management, urban development, transport, communication and ICT, energy, water and waste management under infrastructure development.

It highlights that Land use management is a fundamental tool in development and its use must be planned for effective utilization. It indicates that an inefficient and unsustainable utilization of Rwanda’s land resources limits the profitability of land and infrastructure and aggravates the national capacity to retain rainwater.

It proposes to institute a modern land law providing security of tenure and freedom of exchange as a measure to address these anomalies. It also proposes the development of a policy of grouped settlements based on economic activity that will be transformed into active development centres equipped with basic infrastructure and services. This system of settlements will serve as an entry point into the development of non-agricultural income generating activities while land will be reorganized and consolidated for modern and viable farming.

It also suggests that the rural and urban areas should have sufficient sewerage and disposal systems and the population should have clean drinking water by increasing the access rate to potable water by 2.5 percentage points, annually from the current rate of 52%, by tapping water from rain, lakes, streams and watercourses and high altitude water.

In addition vision 2020 indicates that wood is the source of energy for 99% of the population and this leads to massive deforestation and soil destruction. It is in this
respect that the use of wood energy will reduce from 99%-50% by switching to the use of methane gas, hyrodropower and renewable energy such as solar. This is expected to increase rural electrification to 30% and raise electricity access from 6% to 35%

These targets above are expected to be achieved through regional cooperation in hydropower generation and interstate connectivity, increase national power generation capacity including min hydropower, and solar energy as well as energy saving schemes.

Natural resources and environment are discussed as cross cutting issues in vision 2020. It highlights that the major problem in the field of environmental protection in Rwanda is the imbalance between the population and the natural resources (land, water, flora and fauna and non renewable resources, which have been degrading for decades). This degradation is observed through massive deforestation, the depletion of bio-diversity, erosion and landslides, pollution of waterways and the degradation of fragile ecosystems, such as swamps and wetlands.

The average population growth of 3% per annum during the 80's to 90's period was faster than that of agricultural production, estimated at 2.2%. This has led to the occupation of more and more marginal areas and to the rapid and continuous soil degradation of the fragile ecosystems of the country. These environmental problems are exacerbated by the poor location of industries and the direct evacuation of their waste, without any treatment, into waterways and lakes. In order to address these problems and ensure sustainable development, vision 2020 proposes the implementation of adequate land and water management techniques with a sound biodiversity policy.

In the agriculture sector, vision 2020 advocates for agricultural intensification in order to increase productivity and achieve growth rates of 4.5 % to 5% per year. Intensification of agriculture and animal production is expected to be done through the use of farm inputs, improved seeds, and livestock breeds, livestock stalling system, soil conservation techniques and use of organic manure, and use of appropriate technologies. These will maximize production and adapt to and mitigate effects of climate change.

Basing on the above highlights of vision 2020, the Economic Development and Poverty Reduction strategy as well as the agriculture, infrastructure, human resettlements and natural resource sectors developed detailed policy and strategy actions for implementation. The following are key activities that aim at addressing climate change in the above sectors.

The agricultural Policy and the strategic plan for transformation of agriculture two propose actions that promote soil conservation and restoration of soil fertility, environmental protection, diversification, use of improved seeds and irrigation (MINAGRI, 2000, PSTA II, 2008). These actions offer both adaptation and mitigation
measures to climate change. The activities that increase food such as use of improved seeds, irrigation etc are aimed at helping farmers to adapt to effects of climate change. However, good agricultural practices that reduce the release of green houses into the atmosphere are mitigation in nature. For example the following strategies are intended to reduce the emission of nitrogen dioxide and methane gases (two common green house gases produced by agricultural activities) into the air.

- Improve effective use of nitrogen within artificial nitrogenous fertilizers to ensure that nitrogen is released as $N_2$ instead of $N_2O$ by liming of acid soils to reduce nitrogen emission into the air.
- Reduce methane emissions into air through educating and encouraging farmers to respect carrying capacity of pasture lands, improve productivity and feed content, use digesters and reduce fermentable matter and prohibit the burning of savannah and burning of farm residues.
- Increase carbon sequestration on farmlands through better management of residues and rehabilitation of degraded hillside soils as well as practicing agro forestry.

The national Forestry Policy and strategy aims at preserving enough forest cover areas in order to protect biodiversity conserve critical ecosystems and maintain the functioning of forests and trees in the environment particularly in water catchment areas (NAFA, 2009)

The National Environmental Policy and Strategy aims at protection and rational use of environment and natural resource management for poverty and sustainable development. It specifically calls for integration of environment in national policies, conservation, protection and restoration of ecosystems, for its optimum utilization, awareness raising and ensuring population’s participation in environmental activities, all for the improvement of well being of the people now and in the future.

The policy also sets out policy orientation and strategic actions for environmentally friendly management practices for land, natural resource, water, transport, agriculture, wetlands, biodiversity, forests and protected areas.

The National strategy and Action Plan for Biodiversity Conservation has important elements when implemented would mitigate effects of climate change. It proposes conservation and sustainable use of biodiversity, promotion of modern farming methods, use of energy saving technologies, use of environmentally friendly technologies for mining, cutting of trees, fishing, and agriculture. The strategy also calls for policies and laws that favour conservation and sustainable use of biodiversity and equitable sharing of benefits from use of biological resources.

Reducing the use of wood energy and alternative energy sources such as solar, biogas, methane gas extraction, improving energy efficiency using improved cooking stoves,
extension of national electricity through use of micro power plants are key activities proposed in Energy Policy and strategy that are likely to mitigate effects of climate change.

The policy on risk and disaster management opts for an institutional framework to deal with risks and disaster including climate change related events.

4.1.3 Institutional Best Practices

There exists a strong institutional framework for formulating policies and laws aimed at protecting and rational use of resources in the areas of infrastructure, human resettlements, agriculture and natural resource management. The four ministries of agricultural and Animal Resources, Forestry and Mines, Environment and lands, Infrastructure, Disaster Preparedness and agencies under these ministries (NLC,NAFA, REMA ,RADA,RARDA, RHODA,ISAR) ensure that there is smooth coordination of all stakeholders for proper policy and law formulation and implementation.

The decentralized approach to environmental and sustainable management is a strong institutional best practice. It is because of this institutional commitment that Rwandese Local Government Association, RALGA made a declaration on climate change highlighted in Box 1.

4.2 Field level Best Practices for Adaptation to climate change.

A 4 day field survey was carried out in the districts of Gicumbi and Burera (Northern Province), Nyabihu, Karongi, Rutsiro and Ngororero (Western Province) and Bugesera
and Nyagatare of Eastern Province to assess best practices for adaptation and mitigation to climate change. These provinces are situated in different ecological zones and therefore have different adaptation and mitigation measures to climate change. The western and Northern provinces are affected by heavy rains that cause landslides, erosion, and flooding while prolonged drought and desertification are the major events in the Eastern Province. The following are examples of the best practices for adaptation and mitigation to climate change in the sectors of agriculture, human resettlement, infrastructure and natural resources. The existing best practices in the surveyed districts were actually found to be in line with NAPA, Rwanda priorities as revealed in Box 2.

4.2.1 Agriculture Best Practices

4.2.1.1 Agriculture and Livestock Intensification.

A set of activities under this programme are believed to enable farmers adapt to effects of climate change by increasing productivity of their farming systems hence allowing farmers to access sufficient food even in cases of extreme events such as drought and heavy rains. The intensive practices vary depending on vulnerability impacts. For example in Northern and Western Provinces, farmers adapt to heavy rains that cause soil erosion reducing productivity, floods destroying crops and houses in valley bottoms etc by carrying out soil conservation practices such as radical, and progressive terraces. In the Eastern Province, farmers adapt to prolonged drought that lead to drying of crops, loss of pasture land etc by carrying out irrigation, use of hey and silage etc. Examples of best practices found under this broad activity include the following:

a) Radical terraces and other soil conservation practices

These are extensively carried out in Gicumbi, Burera, Karongi, Rutsiro, and Ngororero. Where such practices have been properly done, soils have stabilised, landslides and floods reduced, houses and road destruction reduced and restored proper functioning of the ecosystem. This has overall increased agricultural productivity and farmes’s live hood. Farmers in Gicumbi have reported increased production of Irish potatoes, climbing beans and wheat because of the soil conservation practices.
Rugezi wetland is also reported to have regained its water reservoir functioning due to soil conservation efforts carried out both in Burera and Gicumbi districts. This has in turn increased water levels in Ruhondo and Burera lakes hence restoring their hydropower generation capacity.

b) **Zero grazing and intensive livestock feeding.**

Farm animals are being fed within permanent structures that do not allow them to roam around. Such farming practices have been entrenched in all the districts surveyed. However, small animals such as rabbits and pigs are common in Northern and Western Provinces compared to the Eastern Province. Zero grazing and other intensive livestock
feeding methods have improved efficient feed utilization and proper land use management hence increasing their capacity to survive effects of climate change. They have also reduced accelerating climate change by decreasing the emission of methane gas into the air.

In addition, agriculture productivity has increased by providing manure to crop fields. The zero grazing facility below belongs to a beneficiary of Girinka programme in Gicumbi District.

**Figure 6: Zero grazing and organic manure production in Gicumbi District.**

![Zero grazing and organic manure production](photo.png)

Photo Credit: NBDF-Rwanda

c) Irrigation and proper use of marshlands.

The dependence on rain fed agriculture is a serious challenge as far as ensuring food security is concerned especially in areas prone to drought. One of the adaptation mechanisms to address this challenge is the development and sustainable use of marshlands by growing paddy rice.

This arrangement first of all collects and stores water in a big reservoir and it is then used to irrigate rice beneath the dam. This increases both production and productivity as it increases the cropping intensity, reduces crop failure and increases yields per unit area.
Marshland development in Rwanda goes hand in hand with hillside protection through agro forestry practices to reduce silting of the dam as well as increasing fertility of hillsides. Below is rice growing in Kirehe district, Eastern Province.

Figure 7: Rice Production in Marshland in Kirehe District

![Rice Production in Marshland in Kirehe District](image)

Photo Credit: NBDF- Rwanda

d) Use of Improved and High yielding plant and animal varieties

The use of improved and high yield crop and animal varieties has been adapted throughout these districts as an adaptation strategy to deal with effects of declining agricultural productivity.

The growing of climbing beans and rearing of exotic cows were evidently practiced in Gicumbi, Burera, Ngororero, Rutsiro, Karungi and Nyabihu.

Interviewed farmers revealed to the survey team that the above has enabled them to
produce enough food for their home consumption as well as surplus to take to the market for sale.

Photo Credit: ISAR

e) Use of drought crop resistant varieties

In the Eastern Province prone to prolonged drought, adaptation measures centred mainly at the use of drought resistant crop varieties, water harvesting for both irrigation and domestic, making and storing of hey for animal consumption use during dry season. The crops commonly adapted include cassava, pineapples, short season growing maize and paddy rice.

Figure 9: Drought resistant Cassava growing in Bugesera

Photo Credit: Bugesera District

4.2.2 Human Resettlement

The adaptation measures found in all the districts visited under human resettlement include mainly planned settlements and water harvesting on both peoples and public houses. According to residents, both grouped resettlements and water harvesting have benefited them beyond expectations. People are no more travelling long distances to find social amenities such as schools, health centres and water.
a) Modern grouped settlement.

These grouped resettlements have solved different problems in different locations. In highland areas with heavy rain falls, the resettlement of people has helped to reduce destruction of houses and human death as a result of landslides. It has also helped to restore and rehabilitated ecosystem as for the case of Gishwati. In the Eastern Province prone to prolonged drought, the resettlements have enabled people to easily find clear water through various water harvesting techniques. The harvested water is used mainly for home consumption. Although water harvesting has not solved the water problem 100%, it has enabled families to access water for some months without difficulties.

b) Water harvesting

Various water harvesting techniques were found in the surveyed districts. In the highland areas with heavy rainfall, water is being harvested through hill side micro dams. These micro dams serve as both soil and water conservation tools. In such areas, water is used for irrigation mainly of vegetables. In medium altitude an area, water is harvested using micro dams as well as roofs and the harvested water is used for house hold consumption, irrigation and for cows’ use.

Figure 10: Roof water harvesting and hillside micro dams

Photos Credit: NBDF-Rwanda
4.2.3 Infrastructure

a) Use of alternative energy sources and efficient use of wood energy.

The use of the above helps to reduce the rate of forest overexploitation and degradation. The use of solar energy, biogas, improved cooking stoves and micro hydropower generation has and will continue to help Rwandese especially those in rural areas to cook and light without destroying our forest any further. This will in turn reduce release of green house gases into the air hence mitigating effects of climate change. The following are solar panels on Rusumo high school in Kirehe District.

Figure 11: Solar Energy generation on Rusumo High school in Kirehe District.
b) Efficient Cooking Stoves

The use of efficient cooking stoves is believed to have reduced the burden on forests, reduce farmers time spent on looking for fuel wood, reduced expenditure of wood energy and enhanced girl child education. This is because less wood energy is used to cook the same food as compared to ordinary stoves.

Figure 12: Efficient Energy Cooking Stoves being made by women

Photo Credit: NBDF-Rwanda


c) Use of Biogas

Biogas energy is becoming increasingly important to rural farmers. Its use has revolutionized rural life. Rural people using biogas have reported improved school performance of their children as it provides light for reading. Incomes have increased due to increased agricultural productivity due to its manure, and women have found spare time to other income generating activities.

Figure 13: Biogas unit in Mukamira sector, Nyabihu District.
The use of micro hydro power to generate electricity has and will continue to reduce dependence on wood energy relieving pressure on our forests. It has also helped and will continue to facilitate the development of small and medium enterprises. Production of sufficient electricity will reduce the use of combustible energy reducing the emission of green house gases into the air hence mitigating effects of climate change.

Figure 14: Micro hydro power unit in Butaro Sector, Burera District.
The site is fed with water from Rugezi wetland which was once destroyed and led to decreased levels of Ruhondo and Burera lakes hence disrupting hydro power generation in 2003-2004. To date the wetland is able to supply enough water to existing the hydro power infrastructure as well as surplus for other sites. Thanks to the rehabilitation efforts by the government.

e) Water supply under ubudehe programme

There are numerous activities under Ubudehe programe that help people in rural areas to adapt to effects of climate change. One such activity is the provision and supply of water to rural communities.

4.2.4 Natural Resource management

a) Ecosystem rehabilitation

The rehabilitation of Rugezi has restored its water reservoir functioning, increased the water levels of Burera and Ruhondo lakes and restored their hydro power generation capacity.

Figure 15: Rehabilitated Rugezi wetland

Photo Credit: NBDF-Rwanda

b) afforestation and reforestaion

The government in partnership with people has increased afforestation and reforestation programmes in all the surveyed districts. Forests are very important to the livelihood of many rural people and their development and restoration has improved their capacity to survive effects of climate change.
Forest are being used for honey collection, fuel wood energy, soil erosion control, and influencing microclimate. The above have improved the well being of the people. In Bugesera for example, it is believed that the restored forest have modified climate and the region to date received regular rainfall.

**Figure 16: Afforestation efforts in Bugesera District**

![Afforestation efforts in Bugesera District](Photo Credit: NBDF-Rwanda)

c) Forest and Biodiversity Conservation

The government has strengthened efforts to conserve existing natural forests and other ecosystems in attempt to allow them continue providing their ecological functions. There are efforts to conserve Nyungwe Natural forest in Karongi, Mukura in Rutsiro and Gishwati in Nyabihu. Efforts to conserve and protect wetlands were noticed in Bugesera (Nyabarongo), Gicumbi and Burera (Rugezi) districts.

**Figure 17: Conserved Nyangwe forest in Karongi District**
d) Agro forestry

Agro forestry is one of the good practices for management the land resource. Agro forestry is believed to restore soil fertility and increase agricultural productivity, increase honey production, provide fuel wood and poles, influence micro climate, and provide fodder to livestock. These agro forestry benefits are believed to help farmers adapt to effects of climate change. However, agro forestry practices also provide mitigation to effects of climate change by carbon sequestration. Agro forestry as both an adaptation and mitigation are prominent in all the districts surveyed.

Figure 18: Agro forestry efforts in Bugesera

Photo credit: MINAGRI

Photo credit: NBDF-Rwanda
e) Agasozí Ndatwa Programme.

This is a development where government helps the population living in the same village to transform it into a best practice zone in terms of agriculture, livestock development and environment protection.

Main activities carried in model villages visited during the field work include:

- Construction and development of bench terraces;
- Practising modern farming using fertilizers (mineral and organic fertilizers, crop regionalization, use of veterinary products);
- Practising intensive modern livestock
- Practising irrigation
- Practising Crop rotation and crop regionalization
- Practicing Land use and crop consolidation
- Grouping the population into associations
- Planting of at least 10 fruit trees per every household
- Every household hold has a garden for vegetable or mushroom farming
- Every household has a water tank or a pool to harvest rain water
- Every household has two compost pits
- Every model village has a tree nursery;
- People living in a reference village are characterized by body cleanliness, hygiene within their houses and have to follow the Government programmes and policies;

All the above activities in one way or another are related to climate change mitigation and adaptation.

The following pictures show land use consolidation for maize plantations and modernising livestock farm.

Figure 19: Land use consolidation, Kirehe District, Eastern Province
Land use consolidation has helped the farmers to practise crop regionalization and specialization to increase the production and maximize their incomes. With consolidated plantations, it is easier to protect land, to use fertilizers and to ensure watersheds management by the community. Products are easily transported and marketed as the population save their interests and households get increased income.

The modernization of livestock farms in Gishwati, Nyabihu district has also improved farmers’ incomes, improved land management and reduced soil erosion. Figure 21 below shows the current situation.

**Figure 20: Consolidation and pasture development, Nyabihu District, Western Province**
4.2.5 Income Generation Activities

a) Highly Intensive Public Works.

In an effort to help the vulnerable groups to earn a living including the adaptation to effects of climate change, the government initiated a number of income generation initiatives. One such initiative found in the districts visited by the survey team includes the High Labour Intensive Public Works (HIMO) on road construction as well as making radical terraces. The people found working on radical terraces in Cyumba sector; Gicumbi district informed the survey team that HIMO activities have enabled them to earn money for daily consumption as well as surplus for saving for future investments.

Figure 21: Highly Intensive Public Works in Cyumba Sector, Gicumbi District.
They also reported that in the event of crop failure, they do not get serious food shortage as they used the saved money to buy food from elsewhere.

**b) Vision 2020 Umurenge Programme.**

This programme intends to fast track development in the poorest sector in each district. All the districts surveyed have a number of income generation activities under this programe including High Labour Public Works.

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**5.0 Conclusion.**
Climate change in Rwanda is real. All the districts surveyed have already felt effects of climate change. The effects to climate change vary from province to province.

Floods and landslides caused by heavy rains that are common in the highland areas of the Western and Northern Provinces. The floods and landslides have also led to soil erosion reducing agricultural productivity as well as destroying houses and crops in the valley bottoms.

In the Eastern Province, the effects are related to prolonged drought and desertification and include famine, food insecurity and migrations.

The adaptation and mitigation measures equally vary from province to province. In the Northern and Western Province with high rains, the adaptation measures include the use of soil conservation techniques such as radical and progressive terraces, use of high yielding crop and animal varieties, and hill side irrigation.

In the Eastern Province, the adaptation measures include the use of marshland irrigation, roof water harvesting, and the use of drought resistant crop varieties.

Agricultural and intensification such as use of high yielding varieties and zero grazing, income generation activities such as High Labour Public Works, Ubudehe and VUP, agro forestry and forestry programmes and planed settlements are common to all the districts surveyed. Similarly the use of alternative and clean sources of energy as well as efficient cooking stoves are common to all districts visited. It was also found that Agasozir Ndatwa approach is being implemented in all visited Districts.
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