Republic of Rwanda

BASELINE CLIMATE CHANGE VULNERABILITY INDEX FOR RWANDA

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Executive Summary

This report provides a first assessment of climate change vulnerability at the national level in Rwanda, and lays out a framework to enable Rwanda to answer the question: "*How well have prior national investments succeeded in making Rwanda less vulnerable to the impact of climate change?*" It is anticipated that this assessment will also provide knowledge or guidance about where to make new investments by providing key inputs for the targeting, formulating and evaluating of adaptation policies and will provide information that can be used in the design of new programs for adaptation and resilience, and to acquire additional resources for adaptation.

There are two outputs of the study that include: (a) a set of national vulnerability indicators which constitutes the basis for a national vulnerability index, and (b) a household-based climate change Vulnerability Index. Both of these outputs are an attempt to identify and characterize the sensitivity of human and natural systems to climate change using 'composite indices' together with a baseline of information that provide a framework for the ongoing monitoring of Rwanda's progress on addressing climate change adaptation requirements. They also provide a system to track data in key areas of national development that are particularly climate sensitive.

The methodology used by the study was carried out along two tracks that combine to provide a comprehensive picture. *Track One* involved the development of a set of *national-level vulnerability indicators*, selected through the use of specific criteria. The indicators – of exposure, sensitivity and adaptive capacity – are relevant in light of national policy, are coherent with international institutions and funding sources, and allow for the collection of associated baseline data from Rwanda sources, mainly from NISR and other Government of Rwanda agencies. *Track Two* involved conducting a *national survey on household vulnerability to climate change* wherein quantitative and qualitative field data was collected and analyzed. This data was used to prepare an index of household climate change vulnerability.

The study sought national stakeholder responses to the set of proposed indicators and to the baseline data collected and provided. It was planned that both qualitative and quantitative data would be acquired. The survey information for the household climate change vulnerability index was based primarily on perceptions from respondents, or qualitative data; however the size of the sample establishes suitable quantitative or fact-based data. In contrast, the national vulnerability indicators and related baseline data are largely based on factual evidence derived mainly from statistical sources, yet elements of the baseline data are based on qualitative assessments.

Specifically, the study presents a national-level 'Framework of Climate Change Vulnerability Indicators' that is cross cutting, and includes baseline data on meteorological and disaster risks reduction indicators, plus indicators and baseline data in the sectors of agriculture, food and nutrition, health, water, territorial biodiversity, energy, transportation and infrastructure, with 10 indicators across the sectors for exposure, 10 indicators for sensitivity, 17 indicators for adaptive capacity. The vulnerability indicators are provided together with information on the sources of the indicators. There are nine (9) international sources for the indicators – each one is matched with Rwandan baseline data. Two indicators are derived from Rwandan sources. Of the 37 indicators used in this framework for Rwanda, 23 were adopted directly or modified from ND-GAIN, an internationally-recognized statistical comparison of vulnerability and adaptation across all UN member countries using a 36-indicator assessment system.

The second output of the study is a household climate change vulnerability index derived from a 2015 household survey, together with an analysis of survey results. The household survey explored the experience and perceptions of the 1500 respondents in the areas of:

- *Exposure*: involving change in temperature, rainfall amount and start date of the rainy season, drought episodes, flooding and wind storm events, heat waves and thunderstorms with lightening;

- *Sensitivity*: involving change in soil erosion and landslides, soil fertility, changes in the natural environment, household size, extent of irrigation used, water catchments, the extent of reliance

on income from farming and non-farming sources, and change in income levels;

- *Adaptive Capacity*: involving a composite indicator on awareness of climate variability and climate change, respondents' access to hazard alerts and weather information, respondent's change in surplus production, agricultural practices, and household practices following extreme weather events.

Twenty four (24) indicators were used to compile the household climate change vulnerability index, including eight (8) indicators for exposure, eight (8) indicators for sensitivity and five (5) indicators for adaptive capacity with one of those indicators being a composite of four additional indicators of climate change awareness. The resulting statistical 'Index' is provided that conveys household vulnerability in terms of numbers and graphs. An analysis of other data about the respondents collected during the survey is also provided.

Overall, the study provides a picture of the situation of the country through the data associated with the selected indices (indicators) - a unique composite set - at both national and household level. As an index it is not a comprehensive study of adaptation, but a sufficient study to indicate sector-specific areas and in cross-cutting areas where the country is vulnerable, and where policies and programs can be put in place to reduce vulnerability by increasing adaptive capacity and improving living conditions.

At a high level of strategic analysis, the report points to the requirement for actions that will decrease Rwanda's vulnerability, as the country's sensitivity to climate change is high, and its adaptive capacity is low. The report indicates that the Government of Rwanda should keep on developing tools and approaches to mainstream climate change adaptation into all climate-sensitive policies and programs, and update national strategies in order to improve how climate change vulnerabilities and adaptation requirements are addressed – with both efforts influencing financial flows to support climate change adaptation at the local level.

The national household vulnerability index shows us that vulnerability is located in all part of the country, though the overall level of exposure to climate change impacts are greatest in Eastern Province, due to change in the temperature and heat episodes, shift in rainfall start dates and change in the amount of rainfall.

Overall levels of sensitivity to climate change impact is highest in Southern Province due to lower family income levels, less diversity in household incomes, higher levels of dependency within the household, less use of water catchment, less irrigation of fields dependent on rain fed agriculture, lower soil fertility and greater changes in the natural environment.

Combining both exposure and sensitivity, Southern Province appears to have the greatest potential vulnerability, followed by Eastern Province, then Western Province.

In terms of adaptive capacity, respondents in Eastern Province are more aware of climate change, rely more on radio for weather and farming information that respondents in other provinces, have somewhat great amount of agricultural surplus to sell and have made more changes in their mix of farm crops that the respondents in other provinces; however respondents in Northern and Western province made more changes in their behavior following extreme weather events, mainly to do with securing their homesteads following intensive rains, storms and landslides.

In combination, considering exposure, sensitivity and adaptive capacity, the vulnerability of Eastern Province is the highest.

Using the national vulnerability indicators, it is evident that there are many areas for more intensive or aggressive action to reduce vulnerability. Rwanda needs not be a victim of climate change impacts; rather, decisions can be made to address vulnerabilities. Key sectors are urged to respond, especially by mainstreaming climate risk reduction within climate sensitive programs. A list of twenty-nine (29) recommendations is provided – based only on an interpretations of the baseline data, including decisions to (1) improve the availability of climate information; (2) undertake more comprehensive

adaptation planning; and (3) undertake action by sector, including action in the sectors of agriculture, water resources, health, biodiversity, energy, and transportation, plus action to strengthen or 'climate proof' infrastructure across all sectors.

A key recommendation is that Rwanda should proceed on an urgent basis to develop a comprehensive National Adaptation Plan (NAP), consistent with UNFCCC guidelines for LDCs.

Considering the investment by the Government of Rwanda in the preparation of this vulnerability index and the need for a national measurement tool on vulnerability, it is incumbent on authorities to facilitate and ensure the sustainability of the national and household vulnerability index, to ensure that the data collected in this 2015 study is subject to more research, and ensure that the vulnerability index is updated on a timely basis. The recommendation is that the vulnerability index should be updated in 2017 using new NISR and other data that will become available between 2015 and 2017, and carry out the update in time to feed into the preparation of EDPRS 3. Thereafter, the vulnerability index should be updated every 5 years, consistent with the renewal period of EDPRS.

Further, the Government of Rwanda should undertake genuine stakeholder engagement and outreach outside of government agencies – to enable information sharing about – and action to reduce – vulnerability, including engagement with NGOs/CSOs and the private sector. Efforts to increase adaptation efforts should be consistent with efforts to influence financial flows to support climate change adaptation at the local or community level.

Foreword

Rwanda has seen significant economic development in recent years and yet is we are also experiencing the effects of climate change in all parts of the country. We need to adapt – and keep adapting – so that Rwandans can build climate resilience and be assured that they can manage the risks and thrive under changing climate conditions.

In the bid to build a green economy, Rwanda adopted Vision 2020, the Economic Development and Poverty Reduction Strategy (EDPRS) and the Green Growth and Climate Resilience Strategy (GGCRS). These are excellent strategies which set a clear and ambitious target for Rwanda to become a middle income country – a developed climate-resilient, low-carbon economy – by 2050. In the context of these strategies, a climate change vulnerability index will enable us to monitor our progress, specifically the results of our efforts to reduce our vulnerability to the direct and indirect impacts of climate change.

This study developed a baseline framework for the ongoing monitoring of Rwanda's progress over time on addressing adaptation needs by developing a system to track data in key areas of national development, especially those that are particularly climate sensitive.

This report provides us with a set of indicators to monitor and assess the vulnerability of livelihoods at the local level and to measure progress at the national level – to know how well we are doing.

Climate change is not going away, and a baseline vulnerability assessment as provided in this report is crucial for future assessment of how successful we have been at reducing our vulnerabilities. We are highly exposed to climate change factors in Rwanda and the conditions in all parts of the country are very sensitive – highly affected – by climate change: our vulnerability is therefore very high. In this context we need to know how the investments made so far have been effective and where we need to make new investment to reduce our vulnerability - to build our capacity to adapt. Above all, we need to inform people on the ground about what to do to support and enhance adaptation and reduce vulnerability to the impact of climate change.

We need to take information on our climate change vulnerability to the highest level - so decision makers are aware of key requirements to reduce climate risk, to support adaptation and build the capacity to adapt in everyone and across the country. Our leaders need to integrate this information into our national priorities within our current strategies. As we manage our natural resources we need to know, today and in the future, how climate change will affect what we have and therefore how best to use our resources today – to effectively reduce climate change impacts expected tomorrow.

The challenges ahead are large indeed, but with the commitment to carry on a national system of monitoring our adaptation and build a strong climate change adaptation approach and system, Rwanda is in the position to achieve its goals. I take pleasure in introducing you to the Report of the Baseline Climate Change Vulnerability Index study and invite you to work with us to ensure we use this system effectively in the years ahead.

Dr. Rose Mukankomeje
Director General
Rwanda Environment Management Authority

Production and Editorial Teams

Contents

List of Figures

List of Tables

Acronyms

AC	Adaptive Capacity
ARCC	Africa and Latin America Resilience to Climate Change (project of USAID)
ACPC	Africa Climate Policy Centre
ADR	Age Dependency Ratio
AF	Adaptation Fund
AfDB	African Development Bank
AR5	Fifth Assessment Report of the IPCC (2014)
CBD	Convention on Biodiversity
CCIO	Department of Climate Change and International Obligations, REMA
CIF	Climate Investment Funds
DFID	Department for International Development (UK)
DHS	Demographic and Health Survey
E	Exposure
EDPRS 2	Second Economic Development and Poverty Reduction Strategy
EICV	Integrated Household Living Conditions Survey
FAO	Food and Agricultural Organization of the United Nations
FONERWA	Rwanda's Fund for Environment and Climate Change
GEF	Global Environment Facility
GGCRS	Green Growth and Climate Resilience Strategy
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit - Germany's official development agency, formerly (GTZ)
HFA	Hyogo Framework for Action
HH	Household
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
LDCs	Least Developed Countries
LDCF	Least Developed Country Fund
LPI	Logistics Performance index
MDG	Millennium Development Goals
MIDIMAR	Ministry of Disaster Management and Refugee Affairs
MINAGRI	Ministry of Agriculture and Animal Resources
MINALOC	Ministry of Local Government
MINECOFIN	Ministry of Finance and Economic Planning
MINICOM	Ministry of Trade and Industry
MININFRA	Ministry of Infrastructure
MINIRENA	Ministry of Natural Resources
MINISANTE	Ministry of Health
MT	Metric tons

ND-GAIN	Notre Dame Global Adaptation Index
NISR	National Institute of Statistic of Rwanda
ODI	Overseas Development Institute, UK
PPCR	Pilot Program in Climate Resilience
PSU	Primary Sampling Unit
RBC	Rwanda Biomedical Centre
RCAA	Rwanda Civil Aviation Authority
RDB	Rwanda Development Board
REG	Rwanda Energy Group
REMA	Rwanda Environment Management Authority
RENGOF	Rwanda Environmental NGO's Forum
RGB	Rwanda Governance Board
RNRA	Rwanda Natural Resources Authority
RTDA	Rwanda Transportation Development Agency
S	Sensitivity
SESMEC	Social Economic Studies, Surveys, Monitoring and Evaluation Consult
SMS	Short Message System (text message)
SPAT	Strategic Program for Agricultural Transformation
UNECA	United National Economic Commission for Africa
UNFCCC	United National Framework Convention on Climate Change
USAID	United States Agency for International Development

Glossary

Adaptation In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate (IPCC).

Vulnerability The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (Parry et al, 2007) (GIZ).

The propensity or predisposition to be adversely affected (IPCC), formulated as follows:

$$Vulnerability = f(Exposure, Sensitivity, AdaptiveCapacity)$$

Exposure Exposure is the character, magnitude, and rate of change and variation in the climate. Typical exposure factors include temperature, precipitation, evapotranspiration and climatic water balance, as well as extreme events such as heavy rain and meteorological drought. Changes in these parameters can exert major additional stress on systems (e.g. heavy rain events, increase in temperature, or shifts in the period of peak rain) (GIZ).

The presence of people, livelihoods, environmental services and resources, infrastructure, or economic, social, or cultural assets in , places that could be adversely affected (IPCC, 2012).

Sensitivity Sensitivity determines the degree to which a system is adversely or beneficially affected by a given climate change exposure. Sensitivity is typically shaped by natural and/or physical attributes of the system including topography, the capacity of different soil types to resist erosion, land cover type. But it also refers to human activities which affect the physical constitution of a system, such as tillage systems, water management, resource depletion and population pressure. As most systems have been adapted to the current climate (e.g. construction of dams and dikes, irrigation systems), sensitivity already includes historic and recent adaptation. Societal factors such as population density should only be regarded as sensitivities if they contribute directly to a specific climate (change) impact (GIZ).

Potential Impact Exposure and sensitivity in combination determine the potential impact of climate change. For instance, heavy rain events (exposure) in combination with steep slopes and soils with high susceptibility to erosion (sensitivity) will result in erosion (potential impact). Climate change impacts can form a chain from more direct impact (e.g. erosion) to indirect impact (e.g. reduction in yield, loss of income) which stretches from the biophysical sphere to the societal sphere. In many developing countries, direct dependency on natural resources means that the link between biophysical impacts of climate change and human activities and well-being is particularly strong (GIZ).

Adaptive Capacity Adaptive capacity is 'the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences' (Parry et al, 2007). Adaptive capacity is a set of factors which determine the capacity of a system to generate and implement adaptation measures. These factors relate largely to available resources of human systems and their socio-economic, structural, institutional and technological characteristics and capacities (GIZ).

The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities (IPCC).

Climate scenario A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use

in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models. Climate projections often serve as the raw material for constructing climate scenarios, but climate scenarios usually require additional information such as about the observed current climate (IPCC).

Climate projection A projection of the response of the climate system to emissions or concentration scenarios of greenhouse gases and aerosols, or radiative forcing scenarios, often based upon simulations by climate models. Climate projections are distinguished from climate predictions in order to emphasize that climate projections depend upon the emission/ concentration/radiative-forcing scenario used, which are based on assumptions concerning, e.g., future socioeconomic and technological developments that may or may not be realized and are therefore subject to substantial uncertainty (IPCC).

Indicator An indicator is a sign, or estimate of the state of something and often of the future state of something. Most importantly they are used to identify vulnerable people, communities and regions. And to elucidate information on the nature of vulnerability and to better identify adaptation options. Also they are used to measuring and tracking the process of implementing adaptive actions. Indicators are used in Monitoring and evaluation systems but are hard to use in measuring outcomes. Adaption outcomes take time to become identifiable and are often subject to evolving conditions and objectives (Adapted from IPCC; WGII AR5 Chapter 14 – Adaptation Needs and Options).

Climate Change Vulnerability Index A statistical number, a measure developed for comparison purposes, developed by aggregating multiple individual indicators of a complex, multi-dimensional, and meaningful societal issue (e.g., climate change vulnerability). Individual indicators and indicator sets can be selected, arranged, and combined to produce sub-indices representing the main components or dimensions of the system under investigation. The individual indicators are measures of a component of the system and can indicate a baseline or a trend over time. The measures are compiled systematically using a theoretical formula to provide the statistical number (USAID, adapted).

Figure 1: A village in Nyabihu District, Western Province

1 Introduction

1.1 General context

This is a report on the first assessment of climate change vulnerability at the national level in Rwanda.

Global changes in temperature and precipitation and the regional distribution of those changes are the primary drivers affecting climate-related natural hazards such as floods, landslides and droughts that struck Rwanda in recent years with a devastating effect on the population. From the livelihoods of rural populations to food security in urban areas, core gateway transportation, communication, energy, health, water control, and institutional systems upon which populations depended failed in some cases.

The capacity and scale of adaptation to climate change depends on the vulnerability of people and natural systems to the impacts, whereas vulnerability is shaped by exposure, sensitivity and adaptive capacity or resilience. In relation to climate change, vulnerability relates to direct effects such as increased storm intensity, floods, hot weather and heat waves, lower or higher rainfall and change in the timing of the rains that lead to indirect effects such as lower productivity from changing ecosystems or disruption to economic systems. With the poor being more directly dependent on ecosystem services and products for their livelihoods, the vulnerability of natural systems has profound implications.

Rwanda's current policy approach to climate change, vulnerability and adaptation are contained within several policy documents that have been embraced by the government and are driving many initiatives. Those documents include:

- *Vision 2020.* Rwanda's current policy and institutional framework is focused on the outcomes envisage in Vision 2020 updated in 2012;

- *Second Economic Development and Poverty Reduction Strategy (EDPRS 2)*;

- *Green Growth and Climate Resilience - National Strategy for Climate Change and Low Carbon Development (GGCR).* More specifically the GGCR addresses the challenges and provides a pathway forward to address climate change and low carbon development. It aims to make a significant impact on adaptation, mitigation and economic development. With a focus on agroforestry, climate knowledge, irrigation and roads infrastructure as its main tenants for adaptation, it provides a strategy focusing on green, low carbon development, but does not explicitly provide mechanisms to deal with vulnerabilities, associated with climate change, and it could have a stronger focus on adaptation, as is now being recommended by the UNFCCC, among others. This is particularly urgent as the assessment of greenhouse gas emissions reductions globally is not encouraging and the stresses on East Africa as a region from larger temperature rises than earlier expected are extremely challenging. An effective vulnerability monitoring mechanism linked to the currently well-integrated economic and low carbon growth strategies would benefit Rwanda and enable policies and programs to specifically address adaptation needs and build adaptive capacity, capitalizing on Rwanda's readiness to change.

In the future, a long term adaptation strategy or pathway will emerge (i.e from the NAP process), but the monitoring of climate vulnerability should start now, with indicators at both the national level and at the household level.

At a national level, vulnerability assessments will contribute to setting development priorities and monitoring progress. The identification and characterization of the manner in which human and natural systems are sensitive to climate become key inputs for targeting, formulating and evaluating adaptation policies. On the other hand, the identification and the mapping of climate related hazard risks will provide definite information on the nature and characteristics of potential disasters and inform disaster management policy and planning.

This study, then, develops a baseline framework for the ongoing monitoring of Rwanda's progress over time on addressing adaptation needs by developing a system to track data in key areas of national development, especially those that are particularly climate sensitive. The use of this framework and data tracking system is intended for policy maker and program designers with a reading on how well prior investments have succeeded in making Rwanda less vulnerable to the impact of climate change, and information that can be used in the design of new programs, the acquisition of additional resources for adaptation, and knowledge about where to make the new investments.

1.2   Measuring and Monitoring Vulnerability

The impacts of climate change present a new set of challenges in efforts to reduce poverty and promote social justice. Climate change has created a 'new normal' that is full of uncertainties. As such climate change requires new monitoring and new responses through the complex systems of economic development, governance, livelihoods and social relationships. Changing temperatures, erratic rainfall, floods, landslides and droughts all have significant consequences for the livelihoods, health, food security; educational opportunities and the survival of people living in poverty, and recent first-hand evidence of the effects of a changing climate are evident. There is a need therefore, to understand how climate change affects a country and communities, to understand who is vulnerable to the potential impact of climate change, and why. Rwanda needs to apply this information in order to design programs that will reduce people's vulnerabilities to climate risks and uncertainties.

In its bid to build resilience and ensure that the country is pursuing a green economy, the Government of Rwanda established a National Environment and Climate Change Fund (FONERWA) to bridge the gap in resource mobilization and fund various initiatives aimed at reducing vulnerability of the Rwandan people. It is therefore important that Rwanda know if these investments as well as the policies and programs of other government Ministries and departments are helping the country to address its development priorities in the context of a changing climate. For that, a systematic approach is needed to monitor the progress being made at the national level, at the outcome level. There is a need to have evidence of the results of investments – and evidence of the gaps that need to be addressed.

A set of key understandings surrounded the study. These concepts had to do with the relationship among Exposure and Sensitivity to climate change, Adaptive Capacity and Vulnerability. Figure 2 illustrates those relationships as they were used in this study.
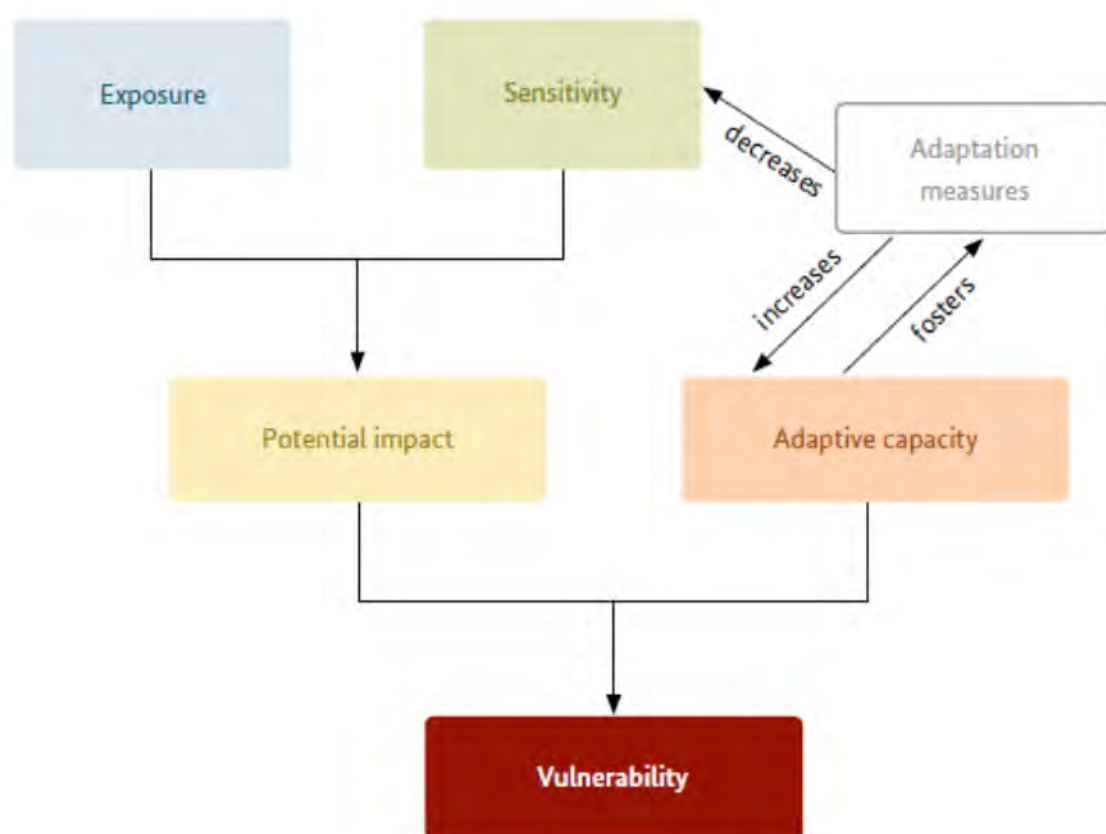
Source: adelphi/EURAC 2014.

Figure 2: Components of Vulnerability (GIZ, 2014)

Climate change exposure and a system's sensitivity to it determine the potential impact. However vulnerability to that impact also depends on the system's adaptive capacity.

Adaptation interventions are activities that aim to reduce climate (change) vulnerability at different levels – sectoral, national or local. They are based on the assumption of inherent adaptive capacity which can be used to lower its sensitivity to climate exposure. Such measures include efficient irrigation systems to overcome water scarcity and improvements to tillage systems for combatting soil erosion. Adaptation measures can also target the increase of adaptive capacity itself. Examples include training programmes for integrated water management and improved marketing strategies for small farm holders (GIZ, 2014).

1.3   Purpose and Approach

This report is intended to provide the results of a study on Rwanda's vulnerability to climate change. It also intends to provide an approach and some tools to monitor progress on adaptation to the impact of climate change to key stakeholders. Among the key stakeholders are the Rwanda Environment Management Authority- REMA and the African Climate Policy Centre-ACPC of the UN Economic Commission for Africa-UNECA - the two sponsors, plus various ministries and agencies of the Government of Rwanda, a full range of development actors including multi-lateral and bilateral agencies, international and national private and non-government organizations, academics, researchers, and others – all of which are working in Rwanda with the Government of Rwanda and with communities across the country to strengthen climate-related resilience in this country.

The UNECA, acting through the ACPC, in 2013 entered into a Project Agreement with the Ministry of

Environment and Natural Resources, including REMA, RNRA and Meteo-Rwanda, entitled "Technical Support Program to the Republic of Rwanda on Climate and Hydrology." The project aimed to improve Rwanda's climate information system and enhance the analytical capacity of relevant institutions on assessment of risk, vulnerability and impacts resulting from climate variability and climate change. Under this project REMA specifically was charged with coordinating the risk and vulnerability assessment component of the project and UNECA-ACPC provided technical support to the risk and vulnerability assessment.

UNECA-ACPC contracted the services of an international consultant to carry out the first national level climate change vulnerability assessment in the Republic of Rwanda. It included efforts to build capacity and transfer knowledge to REMA staff responsible for the assessment's sustainability. The specific terms of reference focused on the development of a climate change vulnerability assessment and the preparation of a baseline climate change '*vulnerability index*' that would be used for the investigation of specific areas of vulnerability, indicating where special attention would be needed to achieve resilience. This vulnerability assessment was to focus on real and potential climate change risks at the national level with special attention to hydro-meteorological aspects. The program was to engage agencies that have a stake in reducing climate risks, implementing adaptation or risk and vulnerability reduction measures, and learning about climate information as it affects their sector or area. Above all, it was to provide a national level mechanism that would provide a periodic picture of how well Rwanda is implementing resilience measures.

ACPC's resources as well as resources from the Rwanda Environment Management Authority-REMA were combined to facilitate the specific work that resulted in this report.

1.4   Methodology

This section will introduce the methodologies that were used to prepare vulnerability indicators and a Vulnerability Index.

1.4.1   Approaches to Vulnerability Assessment

TRACK ONE is the development of a framework or directory of national indicators along with baseline data related to those indicators. These are national indicators and are high-level and 'outcome' oriented. These indicators are to be used in periodic assessments of the impact of all the changes in policies and programs, including special initiatives, pilot studies, etc. undertaken over time to develop Rwanda while also aiming to increase resilience and increase adaptation to the impact of climate change as it affects many sectors. This report provided the set of selected indicators as well as the related baseline data for those indicators.

This study is the first national level climate change vulnerability assessment in the Republic of Rwanda. As such it sets a baseline of data, but also a basis or future assessments using or building on the approaches and methods employed in this study.

TRACK TWO is the development of a national survey on household vulnerability to climate change designed to enable an analysis of how climate change is having an impact at the household level across all provinces and districts of Rwanda. In this track the study designed and carried out a national household survey which enabled the collection of data that in turn as has enabled this analysis. Included within this track was the collection of data to be used in the preparation of an index of household vulnerability. This report provides the results of that survey and the household climate change vulnerability index.

Other pilot assessments have been done in the context of other projects. One previous study worthy of mention was undertaken by REMA .The project was called "*Reducing Vulnerability to Climate Change by Establishing Early Warning and Disaster Preparedness Systems and Support for Integrated Watershed Management in Flood Prone Areas.*" It was implemented in 2011-2014 and funded by the

Least Developed Countries Fund (LDCF) under the United National Framework Convention on Climate Change (UNFCCC). References to this study/project are made throughout this report. This LDCF project was complemented by another study entitled: "Supporting Integrated and Comprehensive Approaches to Climate Change Adaptation in Africa - Building a Comprehensive National Approach in Rwanda" funded by the Africa Adaptation Program (AAP) supported by the Government of Japan through the UNDP. These projects were first laid out in Rwanda's National Adaptation Plan of Action (NAPA) of 2006.

1.4.2 Resources for Framework of National Indicators and Household Vulnerability Index

A few key sources need to be mentioned here as basic background material consulted during the study. They include:

1. The "*Design and use of composite indices in assessments of climate change vulnerability and resilience*" (USAID, 2014). This document had excellent advice for the development of the framework of national vulnerability indicators. It clearly articulates that "*a composite index aggregates multiple individual indicators to provide a synthetic measure (providing a summary statistic) of a complex, multidimensional, and meaningful societal issue.*" It understands composite indices as being designed "*to capture complex social-ecological systems at multiple spatial scales, ranging from national to local levels, and to support comparative analysis of unit of exposure to climate change within particular geographic areas and socioeconomic sectors*" and is clear that "*composite indices can help assess and track vulnerability and resilience to climate variability and change at national and subnational scales.*" It is precisely this task that this study aims to accomplish.

   The guidance from this paper is very direct and cautionary. It writes about the advantages, disadvantages and limitations of composite indices, in an excellent review of the literature on the topic and various approaches to national vulnerability indicators that have been well documented. Specifically it states that "*composite indices have the potential to misguide policy and practice if used in an indiscriminating manner or if results are misinterpreted, misrepresented, or overstated*" and that "*care and vigilance should be exercised to avoid such risks.*" It advises that "***transparency*** *throughout the process of composite index design, use, and refinement is essential.*" It recommends strongly that "*composite indices should be based on trusted, reputable, reliable, and accessible data sources.*" It also advises that "*construction of a composite index should not be viewed as an end goal, but rather as* **an analytical tool to facilitate the evaluation and interpretation of information, support decision making, promote discussion, and attract public attention to an important multidimensional subject**.*" (Italics and bold added for emphasis by the author of this paper.)

2. "*Compendium of lessons learned from ARCC climate change vulnerability assessments*", prepared in 2012 also by USAID. This document draws on the experience gained by USAID through preparing vulnerability assessments in the Dominican Republic, Honduras, Malawi, Senegal, and Uganda. The Ugandan vulnerability assessment report is highly relevant to Rwanda. The report argues that "*a climate change vulnerability assessment does not end with the presentation of findings. It needs to have an* ***afterlife***, *during which it is used to make decisions about policy or programming relevant to adaptation to the potential effects of climate change.*" And that "*...the degree to which this* '***uptake***' *occurs is influenced by three factors:* ***credibility***, *the perceived technical quality and adequacy of the findings;* ***salience***, *the perceived relevance of the information provided; and* ***legitimacy***.*"

   It is the hope of REMA that this paper on vulnerabilities will enable an assessment of vulnerabilities, the development of an adaptation strategy and that use will be made of the measuring tool laid out in this report to develop Rwanda's capacity to address adaptation needs and the deal effectively with the impacts of climate change.

3. *"The Vulnerability Sourcebook"* prepared in 2014 by GIZ. It was most helpful in the processing of the data gathered through the national survey to prepare a household climate change vulnerability index - discussed in Section 1.4.4 on the following page. It contained methodologies that were used in this study, and explanations that enabled those involved in this study to acquire a good understanding of what was involved in the preparation of a *Vulnerability Index.*

Three other documents from highly credible institutions were also very helpful in helping to frame this study and its analysis:

1. "*Guidance on Assessing Vulnerability, Impacts and Adaptation to Climate Change*", prepared in 2013 by UNEP's Global Programme of Research on Climate Change Vulnerability, Impacts and Adaptation (PROVIA).

2. "*Review and quantitative analysis of indices of climate change exposure, adaptive capacity, sensitivity, and impacts*" prepared in 2009 by Hans-Martin Füssel of Potsdam Institute for Climate Impact Research, Germany

3. "*Chapter 14 - Adaptation Needs and Options*" prepared by Working Group Two (WGII), part of the Fifth Assessment Report (AR5) by the Intergovernmental Panel on Climate Change (IPCC) which focuses on adaptation, released in 2014.

1.4.3   Track One – Framework of National Vulnerability Indicators and Baseline

This study undertook to develop a set of vulnerability indicators and the associated baseline data was collected, accessing data largely from The National Institute for Statistics of Rwanda (NISR). Combining the vulnerability indicators and baseline data supports the creation a framework for assessing climate change vulnerability that can be used to monitor future climate change adaptation and to some extent drive adaptation policy and in some cases, specific adaptation initiatives.

The framework for the climate change vulnerability indicators will allow Rwanda to measure progress every five years on the effectiveness of efforts to reduce vulnerabilities to the impacts of climate change, build up adaptive capacity, manage the readiness of its institutions to be supportive of adaptation initiatives and through those efforts establish confidence in Rwanda's adaptation approach and its effectiveness, measured by progress on adaptation on the ground.

To undertake the study, the following steps[1] were envisioned:

1. Identify and define a key issue or problem related to climate change impacts and associated risks and sensitivity to these impacts, with input from key stakeholders,

2. Identify what information is required to monitor and evaluate the impacts, and current actions taken to address the issues, and key achievements, with input from key stakeholders,

3. Identify existing indicators that could potentially capture this information in a measurable form,

4. Evaluate these indicators according to their a) relevance to policy, program and project initiatives, b) appropriateness in terms of climate sensitivity, exposure and adaptive capacity, c) place and role as key performance indicators (KPIs) in the M& E frameworks of relevant ministries and agencies from where the data is acquired, d) coherence with the funding frameworks of international bodies supporting countries like Rwanda to undertake adaptation measures, and other relevant characteristics,

5. Choose the most useful indicators for the circumstances. Collect the available data being collected by national agencies including the NISR,

6. Get national stakeholder response to the proposed set of Indicators and adjust as necessary, ensuring the indicators and baseline data have to confidence key stakeholders,

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[1]Adapted from the Hyogo Framework for Disaster Risk Reduction handbook (United Nations, 2008a)

7. Implement vulnerability monitoring approach which includes periodic data updates and dissemination of results,

8. Use the framework of selected indicators to evaluate and develop policy and program at the national and provincial levels, even the district level,

9. Facilitate the use of the vulnerability index and indicators by stakeholders involved in data collection, including NISR, and stakeholders involved in relevant programs and projects being implemented,

10. Monitor the utility of the index and the indicators' for the purposes that are driving its existence – namely addressing Rwanda's adaptation needs and response (measures) related to reducing its vulnerability to climate change impacts.

The vision of this study extends beyond the time frame of preparing the documentation, into the future to when a new study or a review is done. See 'Recommendations' in Section 4.1, (Page 46) and also Section 6 (Page 51) on 'Sustainability' of the Vulnerability Index.

1.4.4   Track Two - National Survey on Household Vulnerability

The objective of the survey was to collect and produce quantitative, qualitative field data required for the national climate change vulnerability assessment in Rwanda.

The survey questionnaire was designed to provide:

1. Information about household vulnerability in rural areas to the impacts of climate change and climate variability, specifically related to experience of household members, including exposure, sensitivity and adaptive capacity,
2. Baseline quantitative data on the vulnerability of households so that a 'household livelihood vulnerability index' could be calculated by province and for the country as a whole (Sensitivity, Exposure, Adaptive Capacity),
3. Socio-economic data on the respondents and data related to specific adaptation responses, so that correlations can be made across the sample and to the 'household livelihood vulnerability index', and
4. Sufficient data from each district such that results were statistically valid/significant at the provincial level: gathering data from 300 households (HH) per province on average, or around 50 households per district - from a total of 1500 households; data collection was designed so that the data would be statistically valid/significant for the country as a whole when aggregated at the national level. The data was tagged in order to be stratified or disaggregated by district.

The Survey Sample Size

The sample universe to undertake national baseline climate change vulnerability index in Rwanda consisted of the whole country. The sample size was determined by three factors: (i) the estimated prevalence of the variable of interest, (ii) the desired level of confidence, and (iii) the acceptable margin of error.

The survey design was based on a simple random and stratified sample; the sample size was calculated using the following formula:

$$n = \frac{t^2 \times p(1-p)}{m^2}$$

n = required sample size;

t = confidence level at 95% (standard value of 1.96);

p = estimated proportion of the population exhibiting the characteristic of interest in the study. When this ratio is ignored, a preliminary study can be made or if $p = 0.5$ will be retained;

m = margin of error at 5% (standard value of 0.05).

The sample size was selected according to the confidence level desired.

Maximum margin allowable error	Level desired confidence	80%	90%	95%
	1%	4100	6715	9594
	3%	455	746	1066
More or less	5%	164	269	382
	10%	41	67	96
	15%	18	30	43
	20%	10	17	24

Table 1: Confidence level of the sample size

At the national level, the sample size of '1,066' was selected, which can be compounded to 1500 households who were partitioned in the 5 provinces proportional to the number of districts. The Primary Sampling Unit (PSU) was the village (*Umudugudu*) and comprised 25 households. Selected district had an equal distribution of 2 PSUs. A table with the distribution of households surveyed and villages sampled (PSUs) as well as the questionnaire used are available on request.

On the basis of this methodology and provision of the draft questionnaire in Kinyarwanda, among other things, NISR approved the request for survey to proceed.

The survey was carried out in all 30 districts of Rwanda in February 2015.

1.4.5 Links Between the National Vulnerability Indicators and the Household Vulnerability Index

The two tracks pursued in this study represent two sides of the same coin. One is a view of climate change from the national perspective where national institutions with sector-specific mandates implement national development programs. The other is the view of climate change from the level of the household where individuals make daily decisions about managing risk and , where there is an integration of all areas of life where livelihood decisions are made and where the test of the societal systems takes place. If households are coping with the effects of climate change – in addition to other factors that households deal with, like sickness, making a living, etc., – it may mean that national agencies are doing their work well. If there are crises related to rural livelihoods, agricultural production, accessing water, health, transportation and energy, and where those crises are increased or exacerbated by climate variability and climate uncertainty, the national institutions may need to take into account things that need improvement. What is helpful to everyone in this context is information and prediction.

The efforts of this study to find key indicators of climate sensitive areas of the national life and national economy – and to understand the impact of climate change on key areas – are mirrored by the study's parallel efforts to understand the effects of climate change at the household level. Two side of the same coin; two ways of measuring vulnerability - two measures that are both required for a complete picture, both required to clarify what action may be required to increase resilience and adaptation. The two tracks link in specific ways. For example, both include measures of how the climate is changing, both include measures of how homesteads are affected by more intensive storms, both measure capture how climate information is conveyed to people who need it, both ask whether families are growing enough food and are using the best methods to grow it. In effect the two tracks of this study undertake two scales of assessment: the national and the local. Information about what is happening on both scales is required for good policy responses.

The two tracks link in terms of methodology as well. While the information for the household climate change vulnerability index is based on perceptions, the size of the sample establishes factual realities. While the National indicators and related baseline data appear to be based largely on factual evidence, many elements of the baseline data are qualitative assessments. The convergence of the two levels of

assessment is found in the mix of qualitative and quantitative data and in the indicator approach that both tracks employ.

2 Rwanda National Vulnerability Indicators and Baselines

This Section introduces a set of national indicators of climate change vulnerability.

2.1 Objectives of the National Vulnerability Indicators

Introduced earlier as TRACK ONE, the objective of this part of the study was to provide at the national level a set of indicators and baseline data that would enable a periodical assessment designed to answer these key questions:

> After policies have been changed to take account of climate change and after programs to deal with climate change have been implemented, when we look at the outcomes or results,
>
> 1. Are we making progress?
> 2. Are we more or less vulnerable to the impacts of climate change?
> 3. Where should we be investing our resources to increase our ability as a nation to adapt, to increase our resilience?

The study was therefore undertaken to assemble indicators that would suit a periodic 'outcome' assessment of the effectiveness of policies and programs on the reduction of vulnerability. Specifically, the study sought to provide a set of high level indicators that could be used over time to track the progress being made by Rwanda in reducing its vulnerability to the impacts of climate change and supporting effective adaptation across specific sectors.

The selection of indicators was linked in part to the availability of reliable data from national sources. These national sources maintain data bases and in particular collect the required data on a regular, ongoing basis for their own purposes, and likely will continue to do so. This way baseline information could be obtained in Rwanda now, and would be updated periodically in the future within the country. Other indicator selection criteria are discussed below.

At a national level, vulnerability assessments contribute to setting development priorities and monitoring progress. The identification and characterization of the manner in which human and natural systems are sensitive to climate become key inputs for targeting, formulating and evaluating adaptation policies.

Significant guidance was obtained for the development of this Framework of indicators and baseline data from the Global Adaptation Index (GAIN) project housed at the University of Notre Dame in South Bend, Indiana, USA, and called "ND-GAIN[2]" . ND-GAIN brings together 45 indicators of vulnerability and readiness to adapt to measure the 178 UN countries from 1995 to the present.

ND GAIN released in latest country assessment in November 2014. In doing so, it also released documentation on the methodology used for its assessment. That methodology has been scrutinized in detail by the consultant preparing this study. ND GAIN profiled Rwanda in its most recent assessment saying that Rwanda had made significant strides in its ability to adapt by improving its readiness to adapt (economic readiness, governance readiness and social readiness), specifically by increasing its ability to accept adaptation investment to address the urgent need for action. In its release ND-GAIN portrayed Rwanda as one of only 5 countries that while highly vulnerable (ranked 131 out of 178 countries).are relatively well equipped to deal with the vulnerability. ND-GAIN's 2014 assessment was profiled at the UNFCCC COP20 in Lima, Peru, in November 2014.

The ND GAIN Methodology was a key reference for the preparation of this framework for Vulnerability Indicators and Baseline Data.

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[2]The full details of ND-GAIN are available at `www.GAIN.org`

2.2 Exposure, Sensitivity and Adaptive Capacity at National Level

The approach taken in this study was to adopt the ND-GAIN indicators as much as primarily for purposes of trying to replicate it using data available in Rwanda. Adopting it posed many challenges. Many of its indicators required the use of projects of what the situation in Rwanda will be like in the future, viewed through the 'lens' of anticipated climate change impacts. Also several of the data used by ND-GAIN for their assessment were not available in Rwanda but had been developed in research institutions around the world using global data sets and not those provided by countries themselves. So it was impossible to compare the data used by ND-GAIN with data available in Rwanda. Attempts were made to adapt the ND-GAIN indicators to the context of Rwanda. This was done for several of the indicators this study has used. The ND-GAIN set of indicators includes a total of 36 indicators. Several of the ND-GAIN indicators did to not apply to Rwanda, for example those having to do with sea level rise. In the end 32 of ND-GAIN's 36 indicators were deemed relevant.

Twenty of the ND-GAIN indicators are used in the list of indicators presented in this paper, most of them in an adapted form.

The ND-GAIN Indicators, like all sets of indicators of vulnerability are based on the definition of vulnerability, which includes the ideas of exposure, sensitivity and adaptive capacity as well as the concept of 'readiness to adapt'. Their system balanced an equal number of indicators for each – or 12 indicators for each of Exposure, Sensitivity and Adaptive Capacity.

2.3 Critical Issues in the Development of Vulnerability Indicators

In the preparation of this report, efforts were made to find indicators that would meet certain criteria. In the review of possible indicators, the following criteria were considered and used to assist in selecting the indicators now being recommended in this report.

- **Transparency** to users, both in Rwanda at various level, and outside of the country;

- **Reliability** in different analytical situations, involving different groups of stakeholders;

- **Consistency** in updates over time - forward & back in time;

- **Significance** in the Rwanda context of its experience with climate variability and climate change impacts;

- **Relevance** to Rwanda's Economic Development and Poverty Reduction Strategy (EDPRS 2), and other key policies & strategies;

- **Measureable** by NISR and other government agency with data collecting capabilities;

- **Resonance** resonates with key audience(s), government stakeholders, and also with community-based organizations (CBOs), civil society organizations (CSOs) and other non-government organizations, (NGOs);

- **Salience** relevant to intended users in government and outside of gov't to help them drive policy responses, including new initiatives and investments;

- **Credible** compare favourably with vulnerability indicators used elsewhere including in the East African Regions, development partners and among global climate funding agencies, at the broader international level and among research agencies;

- **Availability and accessibility** of data – this is a real concern in making an indicator choice.

2.3.1 Advice From the Literature and the Experience of Others

The literature on preparing composite indices was introduced in Section 1.4.2 (on Page 5). In addition to those sources, the study accessed and review studies and processes carried out in Africa concerning the preparation of national indicators of climate change vulnerability.

The main preoccupation in the literature was on the selection on indicators. In this regard there is some consensus on the use of climate information as a growing area for knowledge management. There is some consensus on the need for indicators that have relevance both nationally and internationally. There is consensus that indicators need also to be relevant in communities and at local level where responses to local conditions is most direct. There is also consensus on the likelihood that as climate change funds for adaptation become increasingly available following expected decisions on global climate funds expected in late 2015, systematic measurement will be required for comparisons among or between countries as priorities are assigned for the use of what may well be scarce funds.

In this context the study was able to make good use of indicators from a range of credible international sources that will lend credibility to Rwanda's efforts. At the same time those indicators need to be mirrored in the national development work going on in the country. The effort then focused on sufficient indicators, indicators meeting touching many aspects of live and many cross cutting indicators. With these observations in mind the study proceeded with the task finding the balance between ideal indicators and those that are available and relevant.

2.3.2 Relevance of International and Domestic Indicators

This study researched other indicators being used elsewhere that might be applicable in a Rwanda's framework. While these sources were consulted for possible indicators, they did not undertake assessments of each country or of Rwanda, and as such they are unlike the ND-GAIN source this study has relied on.

This study examined the indicators used internationally by these organizations and selected some for inclusion in the recommended set of indicators. Several indicators were adopted from international sources (see Section 2.5, on Page 15).

The study also looked at indicators being used in Rwanda by NISR, Rwanda Governance Board and various Ministries. The study adopted Key Performance Indicators used by various Ministries and accessed data they collect – including indicators and data from:

- Ministry of Health - MINISANTE;
- Ministry of Agriculture and Animal Resources - MINAGRI;
- Ministry for Disaster Management and Refugee Affairs - MIDIMAR;
- Rwanda Energy Group - REG Ltd.;
- Rwanda Transportation Development Agency - RTDA; and
- Ministry of Natural Resources (MINIRENA). Including in RNRA/IWRM, RNRA/Forestry, Rwanda Meterological Agency (also known as Meteo Rwanda), as well as REMA.

In the case of REMA, the study spoke with focal points for international environmental agreements - for climate change and biodiversity. REMA also compiled the assessment of Rwanda's work in the implementation of the Multi-lateral Environmental Agreements under all Rio Conventions (including the UNFCCC).

The review of indicators undertaken by this study was quite thorough, as was the process to select indicators for adoption into the vulnerability framework.

2.4 Selection of Indicators for Rwanda

Indicators have been selected through the efforts of this study and thirty-seven (37) indicators were recommended, including 23 that have been taken directly from ND-GAIN or modified based on ND-GAIN indicators. This study has categorized them into seven areas, which are as follows:

1. Cross cutting;
2. Meteorological/disaster risks reduction;
3. Agriculture, food and nutrition;
4. Health;
5. Water;
6. Territorial Biodiversity; and
7. Energy, Transportation and Infrastructure.

The selected indicators cover the vulnerability areas of exposure, sensitivity and adaptive capacity. During the study, 10 indicators were selected for exposure, 10 indicators for sensitivity and 17 indicators for adaptive capacity.

Below is a chart containing the indicators that were proposed for inclusion within the framework on Vulnerability in Rwanda. It is a composite set of indices that together captures data from many sources to create a large picture of the areas where vulnerabilities can bother be discerned or where vulnerabilities can have an impact. It is important to see these indicators with the baseline information and over time to see the trends across all the indicators. And then to have assess the whole picture, the whole situation for overall improvements.

In the chart below, E stands for Exposure, S for Sensitivity and AC for Adaptive Capacity.

The full chart of indicators with the baseline data and other relevant information is presented on the next page.

Figure 3: Landslide in the District of Nyamagabe, Southern Province

1	**Cross-cutting - 6 vulnerability indicators**	
1.1	Projected change in population growth to 2032	E
1.2	Age dependency ratio (ADR)	S
1.3	Total urbanized population	S
1.4	Effectiveness of Rwanda's social safety net/social protection system	S
1.5	Level of education attained by women	AC
1.6	Strength of government capacity and coordination to mainstream climate change	AC
1.7	Engagement by Rwanda in international environmental conventions	AC
2	**Meteorological and Disaster Risk Reduction (DRR) - 6 vulnerability indicators**	
2.1	Annual frequency of continuous warm days (above 30°C)	E
2.2	Current annual mean temperature and annual change (variation) in temperature	E
2.4	Number of people with access to improved climate-related early warning information or systems for extreme weather events	AC
2.5	Percentage of the area of the country covered by the Meteo Rwanda	AC
2.6	Extent of use of climate information products & services in decision-making in climate sensitive sectors	AC
3	**Agriculture, food and nutrition - 4 vulnerability indicators**	
3.1	Change in agricultural production	E
3.2	Rural population as % of total population	S
3.3	Extent of fertilizer use in agricultural production	AC
3.4	Level of severe child malnutrition	AC
4	**Water - 6 vulnerability indicators**	
4.1	Annual precipitation runoff rate	E
4.2	Annual groundwater recharge rate (GWR)	E
4.3	Fresh water withdrawal rate	S
4.4	Change in future water demand	AC
4.5	Capacity of dams and lakes to store water	AC
4.6	Access to reliable drinking water	AC
5	**Health - 6 vulnerability indicators**	
5.1	Change in number of deaths from diarrhea diseases and malnutrition (stunting and wasting)	E
5.2	Change of malaria hazard	E
5.3	Dependency on external resource for health services	S
5.4	Proportion of urban population living in slum areas	S
5.5	Change is access to health care facilities	AC
5.6	Access to improved sanitation facilities	AC
6	**Protection of terrestrial biodiversity - 4 vulnerability indicators**	
6.1	Change in % of national forest cover	E
6.2	Change in size (ha or km^2) of natural habitats or critical ecosystems	S
6.3	Proportion (%) and extent (ha) of land area protected to maintain biodiversity and natural ecosystem	AC
6.4	Engagement by Rwanda in international environmental conventions	AC
7	**Energy, transportation and infrastructure - 5 vulnerability indicators**	
7.1	Change of hydropower generation capacity	E
7.2	Level of dependency on imported fuel	S
7.3	Quality of trade and transportation infrastructure	AC
7.4	Length of paved national roads	AC
7.5	Proportion of population with access to electricity for lighting	AC

Table 2: **Proposed National Climate Change Vulnerability Indicators**

2.5 Presentation of the National-level Climate Change Vulnerability Indicators and Baselines

The following chart (Table 3) builds on the list of indicators on the preceding page by adding in baseline information derived from Rwandan sources. The chart also indicates the source of the indicators and the source of the baseline data.

The indicators were derived from nine (9) international sources and matched with Rwandan sources. In two cases Rwandan only sources were used. Of the 37 indicators, 23 were adopted directly or modified from DN-GAIN.

One column is used to show if the ND-GAIN data for its Rwanda assessment were derived from information about Rwanda that can be traced back to a source in Rwanda or not.

Some ND-GAIN indicators used data on countries that were developed by specialized research institutes that generated electronically, often from models based on such sources as satellite imagery. Such sources do not use national data as the basis for their assessment.

Internationally, the indicators were derived from the following sources:

1. **ND-GAIN** - Notre Dame University (USA) - Global Adaptation Index (2014);
2. **PPCR** - Pilot Program in Climate Resilience of the Climate Investment Funds (CIF) being managed by the Multilateral Development Banks (World Bank, African Development Bank, International Finance Corporation);
3. **LDCF-GEF** - Least Developed Country Fund under the Global Environment Facility;
4. **ODI** - Overseas Development Institute (UK);
5. **AF** - Adaptation Fund;
6. **CBD** - Convention on Biodiversity;
7. **GIZ** - German official development agency;
8. **Hyogo Framework for Action (HFA)** - Global Disaster Risk Reduction (DRR) planning and reporting framework;
9. **USAID** – Official development agency of the United States.

Figure 4: Steep terraced hill in Nyabihu District, Western Province

Table 3: The National Climate Change Indicators and Baseline Data for Rwanda (2015)

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
1	-	***Cross-cutting and multi-sector vulnerability***	-	-	-
1.1	E	**Projected change in population growth to 2032** *Baseline data*: Population growth forecast by 2032: there will be 15.4m people (low estimate), 16.3m (medium estimate), 16.9m (high estimate); The 2013 growth rate is 2.37%; the projected growth rate in 2032 is 2.18% (high scenario). The 2012 Rwandan National Census shows the population as 10,515,973 persons. At the 2013 growth rate of 2.37%, the population will exceed twelve million people in 2018. [World Bank data puts the population at 11,776,522 for 2013. Based on this figure, with growth at 2.37%, Rwanda will exceed thirteen million people in 2018.]	ND-GAIN modified	NISR 2014 Statistical Yearbook; Thematic Report, Pop. Projections, January 2014	Yes
1.2	S	**Age dependency ratio (ADR)** An EICV indicator; NISR defines ADR as the proportion (%) of people in Rwanda under 16 and over 64 years (dependent, not of working age), to those 16-64 years (economically productive ages). *Baseline data*: NISR DevInfo shows the ADR for Rwanda as 93.2% in 2012. [Internationally, ADR means the ratio of persons in dependent ages (under 15 and over 60 years) to economically productive ages (15-59 years).] [World Bank data shows Rwanda's ADR decreasing slightly each year in the last 5 years.]	ND-GAIN modified	NISR 2012 Census data	Yes
1.3	S	**Total urbanized population** An EICV indicator; this is the proportion (%) of urban population over the total country population (an EICV indicator), or urban concentration. *Baseline data*: NISR 2012 census data says urban rate is 16.5% - approximately half in Kigali and half outside of Kigali. Past rates from NISR show urban concentration as: 10.4% in 2000/01; 16.6% in 2005/06; 14.8% in 2010/11.	ND-GAIN modified	NISR 2014 Statistical handbook; NISR 2012 census data	Yes

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
1.4	S	**The effectiveness of Rwanda's social safety net/social protection system** An EICV indicator; the proportion (%) of the population with climate sensitive livelihoods (highly dependent on natural resources) who are able to access the social safety net (social protection) system - a measure of rural coping capacity. A proxy for this in Rwanda is "coverage by a health insurance plan" (e.g., Mutuelle de Santé/MUSA). ***Baseline data***: The 2014 Statistical Yearbook indicates the prevalence of health insurance at 68.8% of Rwandans in 2010/11 - with enrollment rate in Mutuelle de Santé - community based health insurance - at 92% of the target population (those eligible for Mutuelle de Santé enrollment - informal sector workers, people in poverty - a majority of the population.) Ministry of Health data shows this enrollment rated dropped to 90.2% in 2011/12, from a high of 91% in 2010; decreasing in 2012/13 to 80.7%; and decreasing again in 2013/14 to 73%.	DFID-ODI	NISR, MINISANTE	N/A
1.5	AC	**Level of education attained by women** This is a rural capacity and gender equality indicator. ***Baseline data***: 2012 Census from NISR shows the level of education for women in 2012 as follows: 21.9% with no education, 62.2% with primary education, and 11.7% with secondary education. For rural women only, Census data shows: 27.7% with no education, 61.8% with primary education, and 8.3% with secondary education. This data will be updated by NISR in June 2015. The 2012 National Census showed that 51.8% of the population is female.	USAID Mali	NISR	N/A

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
1.6	AC	**Strength of government capacity and coordination to mainstream climate change** The 2014 Rwanda Governance Board (RGB) scorecard contains new sub-indicators for environmental protection, using five variables including: % of area covered by radical terraces; % of areas covered by forests; area of land protected to maintain biodiversity. We will use the RGB scorecard on environmental protection for now. *Baseline data*: RGB 2014 score for environmental protection is 95%. However, RGB does not monitor performance on mainstreaming climate resilience. It must be encouraged to go further and regularly assess the capacity in this area using these criteria: (i) existence of climate change plan or strategy with targets embedded at national, sector, ministry levels; (ii) assigned responsibility to coordinate climate change planning and actions; (iii) specific measures to address climate change adaptation and/or mitigation; (iv) existence of a formal system of 'climate safeguards' integrating, where required, climate risk screening, assessment and reduction measures.	PPCR	RGB	N/A
1.7	AC	**Engagement in international environmental conventions** Measure of Rwanda's participation in international environmental forums, indicating the country's capacity to reach agreement on appropriate actions internally and thereby engage in multilateral negotiations on environmental issues. *Baseline data*: Rwanda scores 87.5% on the implementation of six multilateral environmental agreements. This indicator currently assesses Rwanda's performance on the "Rio Conventions" (climate change, biodiversity and desertification) considering (i) signing the convention, (ii) ratification of convention participation and denunciation of treaty agreements, (iii) setting of national rules and policies, (iv) existence of a national strategy/implementation plan, including reporting. The multilateral environmental agreements included in the scope of this assessment can be expanded in the future.	ND-GAIN modified	REMA qualitative report	Yes
2	-	*Meteorological and Disaster Risk Reduction (DRR)*	-	-	-

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
2.1	E	**Annual frequency of continuous warm days (above 30°C)** Measures heat wave hazard, i.e., periods of excessive warmth. For reference, we aim to count annual frequency when daily near surface temperature exceeded the 90th percent threshold for 6 consecutive days or longer in the base period 1961-1990. Data for the last 10 years provided by Meteo Rwanda gives us recent temperature observations. *Baseline data*: We are expecting an analysis of climate data for the last 10 years, based on data received from Meteo Rwanda. Meteo Rwanda reports that the highest temperature recorded in 1971-80 at Kigali airport was 31.2°C; the highest temp in 1981-90 was 32.7°C; for 1991-2000 it was 32.8°C; and for 2001-2010 it was 35.4°C. The chart in Annex A.5 shows changes in annual warm days from 1971 to 2013.	GTZ modified	Meteo Rwanda	N/A
2.2	E	**Current annual mean temperature and annual change (variation) in temperature** *Baseline data*: Meteo Rwanda reports show an increase year-over-year of the mean annual temperature from 20.33°C in 2001 to 21.49°C in 2010 - an increase of the mean temperature of 1.06°C - an average annual increase of .06%. The aim is to include temperature projections to 2030 and beyond from a credible East African regional climate model. Raw weather data has been received; it needs to be analyzed and data included here.	ND-GAIN	Meteo Rwanda	N/A
2.3	S	**Annual loss due to damage caused by multi-hazards, particularly weather-related hazards** MIDIMAR data provides some information. *Baseline data*: 2012 data shows there were deaths (72), injuries (122), crops damaged (2,580 ha) and houses damaged or destroyed (3,176) due to landslides, floods, fire, heavy rains, heavy rains and winds, thunderstorms and lightning. The aim is to include temperature projections to 2030 and beyond from a credible East African regional climate model. Raw weather data has been received; it needs to be analyzed and data included here.	Hyogo FA	MIDIMAR	N/A

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
2.4	AC	**Number of people with access to improved climate-related early warning information or systems for extreme weather events** Information supporting risk management and adaptive capacity of communities and individuals. *Baseline data*: Currently, in 2014, MIDIMAR has a pilot project running in 4 Districts; it involves a system to send SMS 'early warning' messages to 2000 people, including Heads of villages and cells, District officials, Red Cross first respondents, Police and RDF, with more people to be added. This pilot is to be rolled out to whole of country within 3 years.	GEF-LDCF	MIDIMAR	N/A
2.5	AC	**Percentage of the area of the country covered by the Meteo Rwanda** By location of weather stations and by production of localized weather reports. *Baseline data*: Forty-one (41) automatic weather stations across the country current stream data to Meteo Rwanda. 100 automatic rain stations are also in operation. The number of weather stations reporting has fluctuated considerably in the last five years, although the number is considerably higher since 2009 than during the previous 15 year period. All manual weather stations were closed in early 2015. The spatial density of weather stations in Rwanda may be the highest in East Africa. Meteo Rwanda's website provides: 24 hour/daily forecasts for 13 locations in all five provinces; 5-day forecasts for the same locations; and seasonal forecasts. RMA's time series data is available on line through a joint arrangement with the ENACT program of the International Research Institute for Climate and Society of Columbia University (USA).	REMA	Meteo Rwanda	N/A

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
2.6	AC	**Extent of use of climate information products and services in decision-making in climate sensitive sectors.** This indicator is qualitative in nature and requires a scorecard approach to capturing where climate information is used in determining decisions. *Baseline data*: Currently, Meteo Rwanda has links to some sectoral agencies, including a memorandum of understanding with Rwanda Biomedical Centre's Malaria Unit (health); with MINAGRI's irrigation program (water); with REMA (environment). However, no RMA agreements exist with NISR, none with Rwanda Development Board (tourism), none with NRNA-Forestry (which has its own weather stations) and none with NRNA's-Integrated Water Resources Management unit. There is evidence of inconsistent delivery of dekad bulletins issued jointly with Ministry of Agriculture. Meteo Rwanda has targets under EDPRS 2 including feeding information into MIDIMAR's Multi-Hazard Early Warning System.	PPCR	REMA and MINILOC in the future	N/A
3	-	*Food, agriculture and nutrition*	-	-	-
3.1	E	**Change in agricultural production** For the country's 7 key food crops - bananas, wheat, maize, rice, Irish potato, cassava, soya beans, & beans. Data is accessed from MINAGRI Sector Plan for Agricultural Transformation-3 (SPAT-3) (2014). *Baseline data*: In 2007 production of wheat was 24,633 MT, and in 2011 it reached 114,075 MT; maize production was 573,038 MT (2012); cassava production was 2,716,421 MT in 2012.	GTZ	MINAGRI	N/A
3.2	S	**Rural population as % of total population** A high proportion of rural population is indicative of a strong dependency on subsistence, or near subsistence and rain fed agriculture - i.e., farming with few buffers against climate shocks. *Baseline data*: NISR 2012 Census data indicates a rural population of 83.5%.	ND-GAIN	NISR	Yes

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
3.3	AC	**Extent of fertilizer use** This indicator will measure agricultural production capacity, particularly future capacity in a changing climate. It is similar to an EICV indicator that measures the % of crops produced by Households purchasing fertilizer. *Baseline data*: Inorganic fertilizer application rate in crop improvement areas was on average 29 kg/ha/year in 2011-2012 compared to a national average of 4.2 kg/ha/year from 1998-2005. The target is 45 kg/ha/yr for fertilizer application by 2017. Percentage of coverage and effectiveness of soil conservation infrastructure - 73% (1,095,914 ha) in 2012. MINAGRI measurement of Rwanda's agricultural capacity is contained in the Sectoral Plan for Agricultural Transformation-3 (SPAT-3) (2013). MINAGRI has strategies for crop intensification to increase production to meet the targets, linked to land consolidation initiatives. These strategies include: soil and land conservation including land use consolidation, water management and irrigation, mechanization, soil fertility management, livestock development, seed development and improved inputs, as well as value chain enhancement.	ND-GAIN modified	MINAGRI	Yes
3.4	AC	**Level of severe child malnutrition** Prevalence of wasting - viewed internationally as an indicator of a country's current capacity to deliver basic nutritional needs to the most sensitive group in society. *Baseline data*: DHS indicators show 2.8% of children suffered from extreme malnutrition (wasting) in 2010; NISR's DevInfo for 2010 indicates 2%. Earlier figures show 4% in 1992, 7% in 2000, and 4% in 2005/06.	ND-GAIN	NISR	Yes
4	-	*Water sector: vulnerability of fresh water supplies to climate change*	-	-	-

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
4.1	E	**Annual precipitation runoff rate** Runoff is defined as precipitation minus evapotranspiration and change in soil moisture storage. Currently we have precipitation rates. ***Baseline data***: RNRA-IWRM master plan has current/recent data. The current calculation of rainfall in Rwanda at 27.505 BCM*/annum. No change in that rate has been projected and then modified by the expected impact of climate change. Surface water resources are considered susceptible to climate change because of the impact of temperature and precipitation variability on rainfall, evaporation, etc. [Eventually this indicator will include future / projected runoff rates in the context of future climate impact scenarios.] **BCM=billion cubic meter*	ND-GAIN modified	RNRA/IWRM	No
4.2	E	**Annual groundwater recharge rate (GWR)** An indicator to measure climate change impacts on fresh water supply. Soil moisture is the only source considered to affect GWR in the models. ***Baseline data***: RNRA-IWRM data indicates that the GWR rate is 4.554 BCM*/annum. [Eventually this indicator will include GWR rate in the context of future climate impact scenarios]. Groundwater storage is estimated at 6.175 BCM in the Water Resources Master Plan. **BCM=billion cubic meter*	ND-GAIN modified	RNRA/IWRM	No

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
4.3	S	**Fresh water withdrawal rate** % of total actual renewable water resources withdrawn as freshwater. Annual freshwater withdrawal out of the total renewable water resources is a proxy for a countries' water stress, approximating the pressure on the renewable water resources. *Baseline data*: RNRA-IWRM data indicates the total renewable water resources are 6.826 BCM*/annum, with current water availability per capita at 670 m3/annum. Rwanda is classified as a water scarce country according to the 'Falkenmark indicator' or 'water stress index'*. Four water basins are experiencing absolute water scarcity: Nyabarongo lower catchment, Akanyaru catchment, Akagera upper catchment, and Muvumba catchment - all in the great Nile River basin. Water use stands at 2.23% of available water resources - with irrigation as the main user at 1.57% followed by domestic and industrial water supply. The current Water Resources Master Plan says that Rwanda loses almost all of its water resources through evaporation or runoff to downstream countries. **Below 1,700 cubic meters per person per year, a country is experiencing water stress; below 1,000 cubic meters it is experiencing water scarcity; and below 500 cubic meters, absolute water scarcity.*	ND-GAIN	RNRA - IWRM	Yes
4.4	AC	**Change in future water demand** Aggregate demand of top 6 utilizing sectors by 2040. Water demand is expected to change rapidly in the coming years due to the on-going plans related to irrigation development, development of industries, expansion of domestic water supply, urbanization, population growth, etc. *Baseline data*: The projected (2040) demand is 3.356 BCM* /annum of the total renewable water resources of 6.826 BCM*/annum projected as available. Projections to 2040 indicate that some catchment areas are already expected to experience a deficit in water availability: Muvumba, Akagera Upper and Akanyaru catchments. **BCM=billion cubic meter*	ND-GAIN modified	RNRA - IWRM	No

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
4.5	AC	**Capacity of dams and lakes to store water** Total storage capacities of all dams and lakes (within the territorial control of the country, i.e., not including trans boundary lakes) per capita - this is a measure of the capacity to cope with changes brought about by climate change regarding temporal and geographic distribution of water resources - storage capacity vs distribution and use. *Baseline data*: It is anticipated that RNRA-IWRM unit will be able to compile a figure from the Water Resources Master Plan data. (Baseline data is still being acquired for this indicator.)	ND-GAIN	RNRA - IWRM, MI-NAGRI	No
4.6	AC	**Access to reliable drinking water** Extent of population with access to drinking water is a strong vulnerability indicator. An EICV indicator. It measures the % of population with access to improved water source, e.g., household connection, public stand pipe, borehole, protected well or spring and rainwater collection. *Baseline data*: NISR data (2010) indicates72.3% of the population have access to improved drinking water. NISR data (2011) indicates 74.2%. In MINAGRI strategic plan, the proportion of the population using an improved source of drinking water rose from 64% in 2006 to 73.6% in 2011/12, partly driven by rural development programs. (To be updated in June 2015.)	ND-GAIN	NISR, RNRA - IWRM	Yes
5	-	*Health - vulnerability of public health to climate change through the spread of communicable diseases and change in the provision of health services*	-	-	-

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
5.1	E	**Change of number of deaths from diarrhea diseases and malnutrition (stunting and wasting only)** These are climate change induced diseases. ***Baseline data***: Diarrhea is the 3rd cause of morbidity in children under 5, at 26% of all - morbidity cases (130,189 case in 2013). Our aim is to have data on the ***costs*** of treating diarrheal diseases and malnutrition (stunting and wasting only) using (1) the current numbers of cases, and (2) current treatment costs. We want to measure of the projected relative risks of these diseases in 2030 - under a relevant climate scenario and then the future cost of treatment).	ND-GAIN modified	MINISANTE	No
5.2	E	**Change of malaria hazard** The malaria vector is climate sensitive. We want to measure the % rate of change rate of death from malaria. ***Baseline data***: Rwanda National Malaria Control program indicates a 66% decline in incidence of malaria from 2001 to 2010. However Malaria remains the top cause of morbidity in children under 5 yrs. (U5) reported by Health Centres in Rwanda - at 36% of all cases. The RBC Malaria Unit reports that the 'U5 proportional malaria morbidity has declined from 22.76% in 2009 to 3.45% in 2013. [Eventually the indicator should be a measure of the projected relative risks of malaria deaths in 2030 and the future cost of treatment.]	ND-GAIN modified	NISR and RBC	No
5.3	S	**Dependency on external resource for health services** Proportion of total expenditures on health or related services that are provided by entities external to the country, specifically with reference to primary health services, if possible. ***Baseline data***: (Baseline data is still being acquired for this indicator.) [Eventually the indicator should be a measure of the projected relative risks of malaria deaths in 2030 and the future cost of treatment.]	ND-GAIN	MINISANTE or MINECOFIN	Yes

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
5.4	S	**Proportion of urban population living in slum areas** An EICV indicator, and an MDG goal and indicator. The proportion (%) urban pop living in slums is an indication of climate sensitive urban vulnerability - i.e., the proportion of urban dwellers living in slum households (defined as a group of individuals living under the same roof lacking one or more life supporting facilities including sanitation, water access, etc.) *Baseline data*: NISR data (2012 Census) indicates 14% (nationally) of the population lives in slum conditions, while the rate is 65.7% in Kigali.	ND-GAIN, MDG	NISR	Yes
5.5	AC	**Change is access to health care facilities** The annual change in % of population able to access to health care facilities. Current we have data on the average time a person takes to reach a health center (in minutes) - this is an EICV indicator and will be updated in June 2015. *Baseline data*: in 2005/06 it took 95.1 minutes and in 2010/11 it took 59.9 minutes. (NISR, 2014 Statistical Year book)	GTZ	MINISANTE	N/A
5.6	AC	**Access to improved sanitation facilities** An EICV indicator; the proportion (%) of the population with access to pit latrine, ideally with access to hand washing system - *kandagira and ukarabe* (i.e., disposal facilities that can effectively prevent human, animal, and insect contact with excreta and related bacteria.) *Baseline data*: NISR (2012) census data indicates % of population using an improved sanitation facility is 95.6% including flush toilets (.8%), private pit latrine (82.4%) and shared pit latrine (12.4%).	ND-GAIN, GIZ	NISR	Yes
6	-	*Terrestrial Biodiversity*	-	-	-

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
6.1	E	**Change in % of national forest cover** The current target of RNRA-Forestry is to have 30% of the country covered by forests by 2020. A government of Rwanda study (2010) shows natural forest areas declined by 65% during the period from 1960 to 2007. ***Baseline data***: In 2008, 28.28% of Rwanda dry land area was forest cover, including shrub land, or 17.34% excluding shrub land. (U of Rwanda-CGIS). MINIRENA-RNRA detailed data for 2012 indicates 4.8% is natural forest cover, 10.9% is plantation forest cover, 2.9% is wetlands and 9.9% is savanna shrub, for a total of 28.5%. [Eventually we want to measure change of terrestrial biodiversity/biome distribution - i.e., the proportion of land area within Rwanda that would become a different biome type under future climate scenario, or the Natural Capital Index, i.e., the percentage of the remaining area of natural ecosystems and the quality of the remaining habitat - measured on the basis of the abundance of a group of selected species relative to a known baseline level.]	AES-REMA	RNRA - Forestry	N/A
6.2	S	**Change in size (ha or km^2) of natural habitats or critical ecosystems** Including wetlands that are protected plus non-protected areas that are rehabilitated and managed. ***Baseline data***: Rwanda in 2010 had 278,536 ha of wetland areas in 860 areas; of these 56,120 ha are full protected, 206,732 ha can be used under certain conditions, and 15, 689 ha can be used if an environmental impact assessment is provided. (From report of World Bank project entitle "Integrated Management of Critical Ecosystems"(Rwanda), 2010. Rwanda has made an international commitment that by 2020, at least 50 percent of natural ecosystems are safeguarded, their degradation and fragmentation significantly reduced, in order to reduce anthropogenic pressures on biodiversity resources and promote their sustainable use.	AF	RNRA - Forestry, REMA	N/A

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
6.3	AC	**Proportion of land area protected to maintain biodiversity and natural ecosystem** Taking into account the landscape approach to conservation. This is a measure of the extent to which national targets established for biodiversity conservation have been met. ***Baseline data***: Currently 10.714% of the total dry land area is protected, and 246,181 ha of natural forest land is to be protected (published in the Official Gazette of the Republic of Rwanda) including the 3 national parks. The current target is to have 10.3% of Rwanda's land area protected by 2020 to maintain biological diversity.	CBD	RNRA - Forestry, REMA	N/A
6.4	AC	**Engagement in international environmental conventions** Work is still being done to confirm one more indicators related to terrestrial biodiversity that meets the criteria for indicator selection. ***Baseline data***: Measure of Rwanda's participation in international environmental forums, indicating the country's capacity to reach agreement on appropriate actions internally and thereby engage in multilateral negotiations on environmental issues. This indicator currently assesses Rwanda's performance on the "Rio Conventions" (climate change, biodiversity and desertification) considering (i) signing the convention, (ii) ratification of convention participation and denunciation of treaty agreements, (iii) setting of national rules and policies, (iv) existence of a national strategy/implementation plan, including reporting. The multilateral environmental agreements included in the scope of this assessment can be expanded in the future.	ND-GAIN modified	REMA (qualitative report)	Yes
7	-	***Energy and transportation sector, including infrastructure***	-	-	-

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
7.1	E	**Change of hydropower generation capacity** This indicator shows the proportion (%) of power generating capacity that comes from hydropower generation. Water availability for hydropower is climate sensitive, water has competing demands. We want to show the projected risk of hydropower generation capacity weighted by the importance of hydropower to the country. ***Baseline***: The installed hydropower generation capacity in Rwanda in 2005 was 41.75 MW or 65% of generation capacity; in 2010 was 42.25 MW or 53% of generation capacity; and in 2014 was 95.93 MW or 57% of generation capacity. It is projected by 2018 to be 141.97 MW or 25% of the total generation capacity in Rwanda. [Eventually we want to measure the projected change as the % decrease of the hydropower generation capacity from the historical baseline (2005) to the future projection (2030 or 2050), using future climate scenario.]	ND-GAIN	REG	No
7.2	S	**Level of dependency on imported fuel** The proportion of energy use from imported fuel. A higher proportion of imported energy implies higher sensitivity to price increases or supply crises. Being heavily dependent on imported energy is considered as energy vulnerable in the present context and, presumably, under climate change. Rwanda's energy mix is dominated by biomass that accounts for about 85% of primary energy use while petroleum accounts for 11% and electricity for the remaining 4%. (AfDB 2013 with data for 2012). 100% of Rwanda's petroleum-based fuel is imported. One use of imported petroleum is to generate electricity. ***Baseline***: In 2005 13.158 million liters of imported oil were used to generate electricity; 37.83 million liters were used in 2010 and 64.288 million liters were used in 2013; the estimate for 2014 is 71.046 million liters used. [Eventually we aim to measure proportion of total energy requirements from domestically produced renewable energy sources or % change in energy from biomass, i.e. renewable natural resources.]	ND-GAIN	REG	No

		Proposed national level climate change vulnerability indicators for Rwanda	International Indicator Source	Source of Rwanda National Baseline Data	ND-GAIN - comparative data available from their sources?
7.3	AC	**Quality of trade and transport infrastructure** Logistic Performance Index (LPI), an overall score (between 1 to 5) with higher scores representing better performance in a country's trade and transport infrastructure, including quality of trade and transport-related infrastructure, ease of arranging competitively priced shipments, etc.; it reflects the perception of logistics professionals; a World Bank indicator. *Baseline*: An indicator being used in Rwanda that corresponds to this World Bank indicator – and meets the criteria for indicator choice – has not yet been identified.	ND-GAIN	No data established	Yes
7.4	AC	**Length of paved roads** The length of paved roads in Rwanda and more specifically the annual change in the length of paved roads. *Baseline*: In 2011-12 there were 1,171 km of national roads paved; in 2012-13 there were 1,210 km of pave roads; in 2013-14 there were 1,216 km; and in 2014-15 there were 1,242 km of national roads paved. We can also add the km of national roads in good condition We aim to have the length of paved roads as a proportion (%) of all the country's roads, measured in length (km).	ND-GAIN	REG	No
7.5	AC	**Proportion of population with access to electricity for lighting** The annual change in the % of population with access to electricity for lighting, an EICV indicator, will be updated in June 2015. *Baseline*: NISR (2012 - 4th Population and Housing Census) shows that 16.8% of Rwandan households use electricity as the primary source of energy for lighting. ECVI report by NISR show that in 2010/11 only 10.8% of the population had access to electricity for lighting; the figure in 2005/06 was 4.03%. NISR's 2014 Statistical yearbook shows showed there was an increase of 19% in electricity customers since 2011. We can also add the km of national roads in good condition We aim to have the length of paved roads as a proportion (%) of all the country's roads, measured in length (km).	ND-GAIN, GTZ	NISR	Yes

2.6   Uses and Meaning of the Selected Indicators

The basic purpose of the above composite set of indicators is to bring together actors from many backgrounds for an assessment of Rwanda's vulnerabilities. A wide conversation on vulnerability is a good outcome. This conversation should be institutional in nature and it is the institutions that need to learn about their role in monitoring vulnerability, working together to assess vulnerability and working together to devise policy responses. There is a clear role for REMA in that process and possibly a role for decision makers at the political level, at least for the purpose of giving the discussion about vulnerability and adaptation a strong profile and legitimacy.

This set of indicators must also drive the collection of relevant data in the future and it is hoped that data collectors, such as NISR, will increasingly undertake to collect the necessary data more centrally to enable updates on this set of vulnerability indicators as required.

It is also anticipated that the relevance of the indicators will be debated and understandings gained about how to measure vulnerability. The indicators need to evolve to take account the predictions and also the impacts of a future climate on those predictions. So there is work to be done on each indicator to enable it to evolve to be more climate sensitive and more useful at the level of indicating policy and program options that are well beyond 'business as usual.' It has been said that we live in a 'post normal' society where the climate science interface with normal decision making systems requires wholly new options and new thinking - in large measure a response to increasing uncertainty.

2.7   Issues Related to the Baseline Data

This composite set of vulnerability indicators is a work in progress; and the baseline information will change as indicators change. It assumed that these indicators and the baseline data will be periodically updated. A continual effort is needed to upgrade these indicators and therefore amend the associated baseline data. This will happen as the Government of Rwanda undertakes more work related to climate change, especially work focused on adaptation, which may happen as more global resources are available for adaptation measures by highly affected countries.

There are other tasks that will need to be done to keep the indicators valid. Opportunities to evolve the framework and bring more relevant data into the analysis are described in a later part of this report. It focuses mainly on the development of capacity to produce climate scenarios and the data processing capacity to view sector projections through 'a climate lens.' This means that future sector projections (such as agricultural productivity, health care costs or water availability) need to be viewed in the context of a changing climate, as the changing climate is likely to have an impact on those projections.

The preparation this national framework of vulnerability indicators and associated baselines intended to promote discussion, learning and action. The real benefit will be the policy discussion that needs to take place to move forward more initiatives that will increase adaptive capacity and reduce Rwanda's susceptibility or vulnerability to the impacts of climate change.. Chapter 4 of this report provides an initial set of policy recommendations that can highlight the kind of changes – the initiatives – that might be considered and undertaken.

The baseline data collected related to the indicators will also be subjected to statistical methods in the future to create a national vulnerability index – a number between zero and one, a statistical measure of vulnerability. Eventually this national vulnerability index can be compared to the new index (number) emerging from the next update of the baseline data - to see the extent and direction of change in the numbers, and hence the change in vulnerability.

2.8 Increasing Detail or Resolution

Most of the data sources in the baseline data provided are national level indicator but they are frequently aggregates of data that is collected at the District level. A more sophisticated and possible a more helpful approach is to collect all the data at both the national and district levels. This will enable a direct comparison to the data emerging from the Household Survey as discussed in the next section. Abut also, it will allow Rwandan policy makers to identify those Districts where the program interventions need to have real effect to bring up the level of resilience.

2.9 Observations and Conclusions

Part of the research for this study was to go to the data sources for each of the indicators used by ND GAIN in their assessment of vulnerability in Rwanda. Once discovery was that a good amount of the information on Rwanda came from Rwanda sources by way or international agencies such as the World Bank, the FAO, etc. However it also came to light that several of the data sets that were used to assess Rwanda by ND-GAIN use global data sets that are not ground truth or not based on national data. This is a problem with many 'global systems researchers' who do not get national data for their analysis. This study has been fairly successful as getting local data to use in the baseline. The problem however is that few pieces of the baseline data are a projection into the future and few if any have been viewed through a climate change lens. This means that the set of national indicators does not provide a glimpse of the future. Or a glimpse of the future impact of climate change on the counties systems. This is a factor to be very well understood when using this set of the indicators to assist Rwanda in making decisions to manage risk, support adaptation and increase resilience.

3   Household Climate Change Vulnerability Index

This section introduces an Index – a set of measurements – of household vulnerability to the potential impacts of climate change. The index is derived from a national household survey and is provided in terms of numbers, with graphs and maps, as well as some analysis of additional information of household-level capacities and responses to changing climate based on additional data collected by the national survey.

3.1   Origins and Objectives of measuring vulnerability at the household level

The national household survey on climate change vulnerability was introduced into this study in order to capture a picture of how households are coping with climate change. The intension also was to have baseline data, to complement the national baseline data, including data suitable for the creation of a Household Vulnerability Index.

As explained in the methodology for this study [Section 1.4, Page 4] the process involved collecting responses to questionnaire data, - i.e., collecting data from 1500 households across all 30 Districts of Rwanda. The national baseline data needs to be 'ground truthed' with this household data.

In the household there are no sectors or projects or monitoring and evaluation systems. Everything is integrated. Daily decisions are made on managing resources or assets, and on managing risk. Rural households are very sensitive to the exposure they have to natural systems – farming relies on rain fed agriculture; water depends directly on supply from well, springs and standpipes linked to them; cooking depends on the availability of firewood; agricultural productivity depends on soil moisture, soil cover, organic matter in the soils, etc. Rural families are coping with climate change already, as precipitation patters have become highly uncertain. But a comprehensive picture of rural perceptions, experience and knowledge was not available.

REMA had previously undertaken two household surveys in a total of 14 Districts[3] under two projects. One project was known as the 'LDCF Project', though formally entitled "Reducing Vulnerability to Climate Change by Establishing Early Warning and Disaster Preparedness Systems and Support for Integrated Watershed Management in Flood Prone Areas"; the second project was funded through the Africa Adaptation Program (AAP) and was entitled: "Supporting Integrated and Comprehensive Approaches to Climate Change Adaptation in Africa – Building a comprehensive national approach in Rwanda." In order to build on those initiatives, this study used the second survey that had been developed as a basis for the design of a survey questionnaire suitable for this study. Extensive changes were made, mainly by adding questions to strengthen the sectoral and climate hazard coverage, as this study had significantly different requirements.

3.1.1   Household Survey Data Analysis

Two important sets of results emerged from the data collected using this survey. The first is the preparation of a *Household Climate Change Vulnerability Index*. This index utilized data on household perceptions collected using the survey. Question focused on the respondent's perceptions of issues related to exposure, sensitivity and adaptive capacity including *awareness*. The range of questions used for the preparation of the vulnerability index cover:

1. The respondent's perceptions of change in **exposure** to a range of climate factors: change in temperature, rainfall amount and start date of the rainy season, drought episodes, flooding and wind storm events, heat waves and thunderstorms with lightening,

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[3]The first survey (2010) was carried out in these 10 districts: Nyabihu, Rubavu, Ngororero, Rutsiro under the 'LDCF project', and Bugesera, Kirehe, Kayonza, Nyamagabe, Gatsibo, Rulindo under the 'AAP project'. The second survey (2014) under the LDCF project was carried out in 4 districts included in the 2010 survey (Nyabihu, Rubavu, Ngororero, Rutsiro) plus 4 additional districts (Burera, Musanze, Rusizi, Bugesera) not previously surveyed.

2. The respondent's perceptions of change in **sensitivity** to a range natural and man-made contexts: change in soil erosion and landslides, soil fertility, changes in the natural environment, household size, extent of irrigation used, reliance in their income on farming and non-farming sources, water catchment, and change in income levels

3. The respondent's perceptions of change in **adaptive capacity** including: awareness of climate variability and climate change; access to alerts and weather information; surplus production; change in agricultural practices; and change in household practices following extreme weather events.

In total, twenty four (24) indicators were used to compile the index: Eight (8) indicators for exposure, eight (8) indicators for sensitivity and five (5) indicators for adaptive capacity though one of those indicators is a composite of responses to 4 separate indicators of awareness, that are combined into one. The Vulnerability Index was tabulated in MS Excel and entered into a highly suitable spreadsheet specifically designed for the formulation of an index by GIZ, and found within its Vulnerability Sourcebook[4]. This tool (specifically the spreadsheets) provided a most robust (automated) approach than that which used by the mentioned LDCF project.

The spread sheets for the household vulnerability index calculated vulnerability as sensitivity plus exposure plus adaptive capacity where sensitivity plus exposure combine to create the potential impact (PI), which is then modified by adaptive capacity. All figures in the index are between 0 and 1. Exposure (E), sensitivity (S) and adaptive capacity (AC) are all calculated as an index between 0 and 1. To achieve an index for Vulnerability, the two indices of exposure and sensitivity are added together and divided by 2. The index for Adaptive Capacity is then added and that total is again divided by two. The resulting number is an index between 0 and 1. The formula was provided in the GIZ Vulnerability Sourcebook and is provided below:

$$V = \frac{\left(\frac{(E+S)}{2}\right) + AC}{2}$$

Note that the greater the number, the greater the level or degree of Exposure, Sensitivity, Adaptive Capacity or Vulnerability.

Note also that the values in the spreadsheets are illustrated in colour with, for example, red indicating an index value of between .76 and 1.00 (high) and green indicating a value between 0 and .25 (very low), plus two other categories: between .26 and.49 (low) shown in light brown, and between .50 and .75 (medium) shown in pink.

Below, in Section 3.2, are graphs that illustrate the levels of Exposure, Sensitivity and Adaptive Capacity and the overall Vulnerability of each province, showing the indicators that have been used to make the assessment. The numbers shown are based on the set of 6 spreadsheets. The spread sheets are provided in the Annex. The following the graphs is a *summary table* covering both the provinces (indicators of household vulnerability by province) and the national picture (an aggregation of the household vulnerability index at the national level).

The second set of results emerging from the data collected by this survey is located in Annex A.2 (from Page 63). The data collection generated a great deal of information about the respondents. An early analysis of this data provides useful results that help to relate the sample to the larger population as well as point to explanations behind the household vulnerability index. It is hoped that the data will be used by others to mine it for more observations and reports on vulnerability following the publication of this report.

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[4]See: `https://gc21.giz.de/ibt/var/app/wp342deP/1443/index.php/knowledge/vulnerability-assessment/vulnerability-sourcebook/`

3.2 Presentation of the Household Climate Change Vulnerability Index for Rwanda

The presentation of information on the following pages uses data collected in the Household Climate Vulnerability Survey conducted across 1500 households in all 30 districts of Rwanda in February 2015. The survey was commissioned by Rwanda Environment Management Authority-REMA. In addition to calculating the Vulnerability Index on spreadsheets (contained in Annex A.1), the analysis is presented in graphs and in maps. The data is presented at the Provincial level where it has statistical validity. The map and the list of the villages across the 30 districts are provided in Annex A.4 (on Page 74).

The Household Climate Change Vulnerability Index summary chart follows on the next page - based on a set of 6 spreadsheets covering both the provinces (provincial indices of household vulnerability); and the national level (the national index on household vulnerability). This chart shows values for Exposure and Sensitivity for each Province. All values are given the same weight of one . These values are then added to show a computed value for Potential Impact. The Potential Impact is then moderated by the value for Adaptive Capacity. Again, all values are given the same weight of one[5]. The computed value of the impact of these values combined creates the "impact to vulnerability" value, or the vulnerability index.

The spreadsheets are used to calculate the index – a statistical number that 'measures' vulnerability' for comparative purposes. They also provide data that is presented in graphic form. The charts that follow the summary sheet on the next page show the data in bar charts with corresponding data, and finally, the data is aggregated or combined and is shown at the national level.

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[5]For purposes of this study, the weights are 'neutral' at 'one'. By choosing the value of one (1) for all indicators, all indicators were given the same value. Had the study been provided with more time for discussions with stakeholders, different weights might have been applied. The weighting of factors needs input from community representatives and more technical specialists. If the weights are changed, the number (index) in the index would changes

Figure 5: **Exposure to Climate Variability and Change by Province**

	Change in temperature	Change in rainfall amount	Shift in rainfall start date	Drought episodes	Flooding events	Wind events	Heat episodes	Thunder storms
Eastern Province	0.7	0.8	0.8	0.6	0.1	0.5	0.7	0.4
Northern Province	0.4	0.7	0.7	0.1	0.2	0.4	0.1	0.6
Western Province	0.4	0.6	0.6	0.3	0.3	0.5	0.3	0.6
Southern Province	0.6	0.7	0.7	0.6	0.2	0.5	0.5	0.5
Kigali City	0.5	0.6	0.6	0.3	0.1	0.5	0.3	0.3
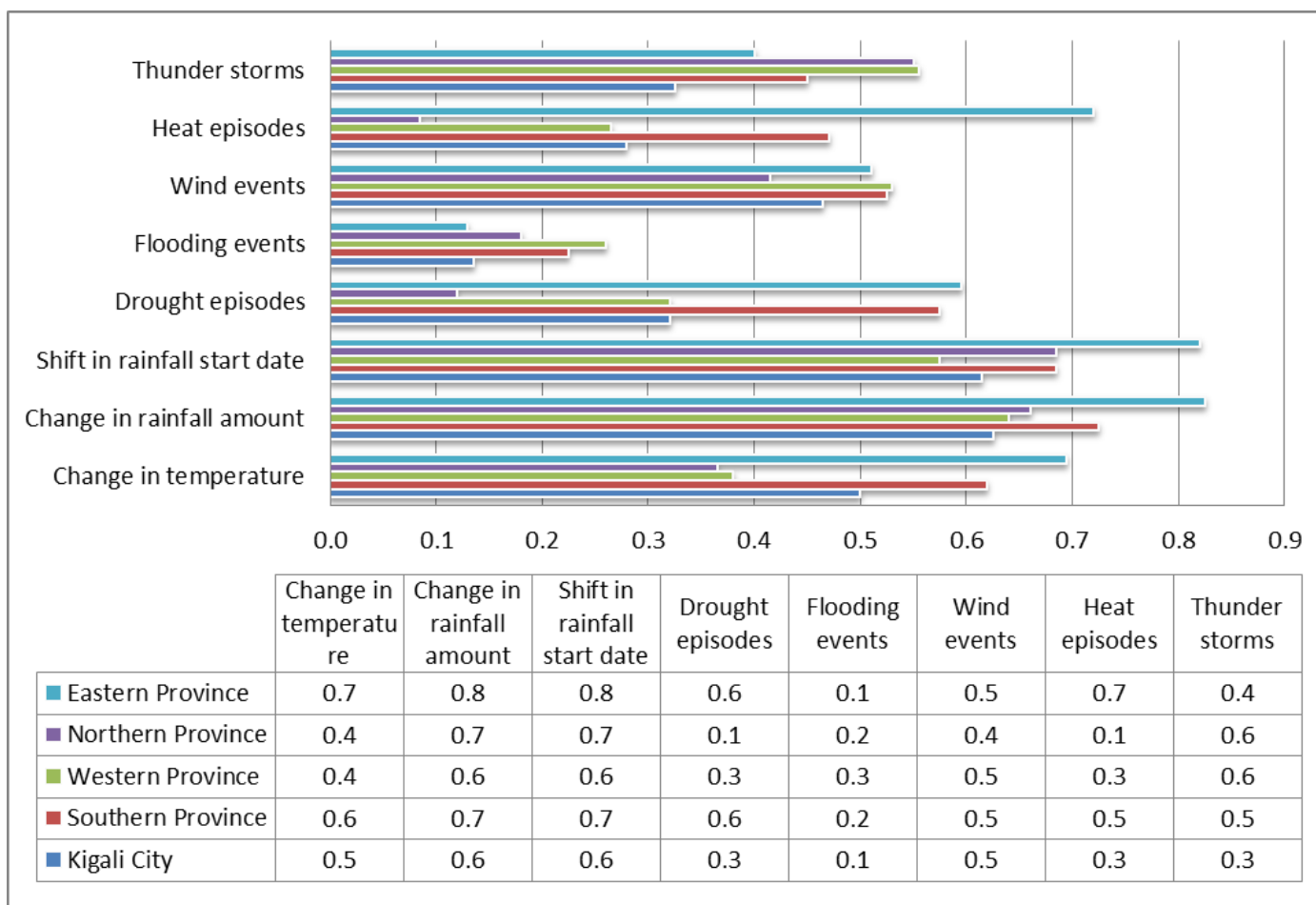
This chart shows the values for **Exposure** for each province using eight (8) indicators that are listed on the left side of the chart. It show Eastern Province as more exposed to the effects of changes in **temperature** (heat waves or episode) and **rainfall** (shifts in amount of rain and when the rainfall starts). The first geographical map on Page 43 shows the combined levels of exposure by Province - by colour codes – darkest colour indicates the highest level of exposure.

Figure 6: **Sensitivity to Climate Vulnerability and Change by Province**

	Soil erosion and landslides	Soil fertility	Change in natural environment	Dependency level	Irrigation of fields	Livelihood sources	Use of water catchment	Family income
EASTERN PROVINCE	0.12	0.495	0.455	0.52	0.875	0.315	0.4	0.66
NORTHERN PROVINCE	0.49	0.595	0.375	0.44	0.9	0.24	0.49	0.585
WESTERN PROVINCE	0.5	0.555	0.435	0.45	0.855	0.305	0.515	0.63
SOUTHERN PROVINCE	0.36	0.665	0.51	0.48	0.9	0.395	0.625	0.705
KIGALI CITY	0.235	0.355	0.235	0.47	0.75	0.235	0.45	0.59

This chart shows the values for **Sensitivity** for each province using eight (8) indicators that are listed on the left side of the chart. It shows the provinces as having similar levels of sensitivity to climate factors. The chart indicates the highest level of sensitivity in the area of irrigation of fields. Southern Province shows the greatest sensitivity especially in terms of income and soil fertility. The second geographical map on Page 43 shows the combined levels of sensitivity by Province - by colour codes – darkest colour indicates the highest level of sensitivity.

Figure 7: **Adaptive Capacity to respond to Climate Vulnerability and Change by Province**

	Awareness of climate change	Received weather information	Surplus production available	Changes in agicultural practices	Change behavior following extreme events
■ EASTERN PROVINCE	0.505	0.355	0.365	0.42	0.4
■ NORTHERN PROVINCE	0.375	0.225	0.265	0.4	0.485
■ WESTERN PROVINCE	0.415	0.325	0.34	0.33	0.485
■ SOUTHERN PROVINCE	0.365	0.225	0.24	0.3	0.38
■ KIGALI	0.395	0.28	0.27	0.26	0.29
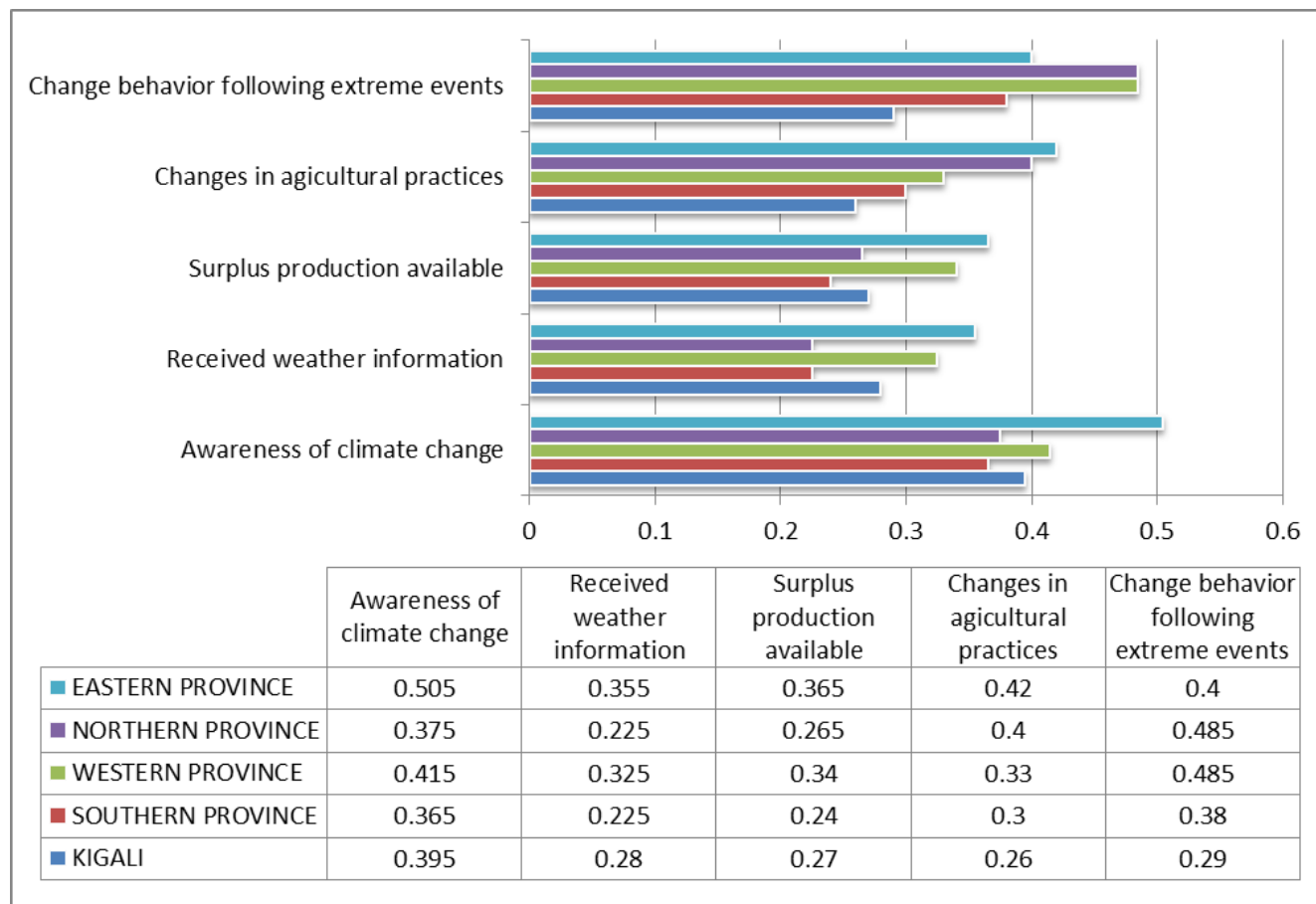
This chart shows the values for **Adaptive Capacity** for each province using five (5) indicators that are listed on the left side of the chart. It shows the provinces as having different levels of adaptive capacity. The chart indicates the highest level of adaptive capacity in Eastern Province in the area of awareness, the lowest levels of adaptive capacity in South Province in the areas of income and surplus production. The map on the next page shows the levels of adaptive capacity by Province - by colour codes – darkest colour indicates the highest level of adaptive capacity, which moderates the potential impact of climate change.

Figure 8: **Potential Impact (Sensitivity, Exposure) Adaptive Capacity and Impact to vulnerability by Province**
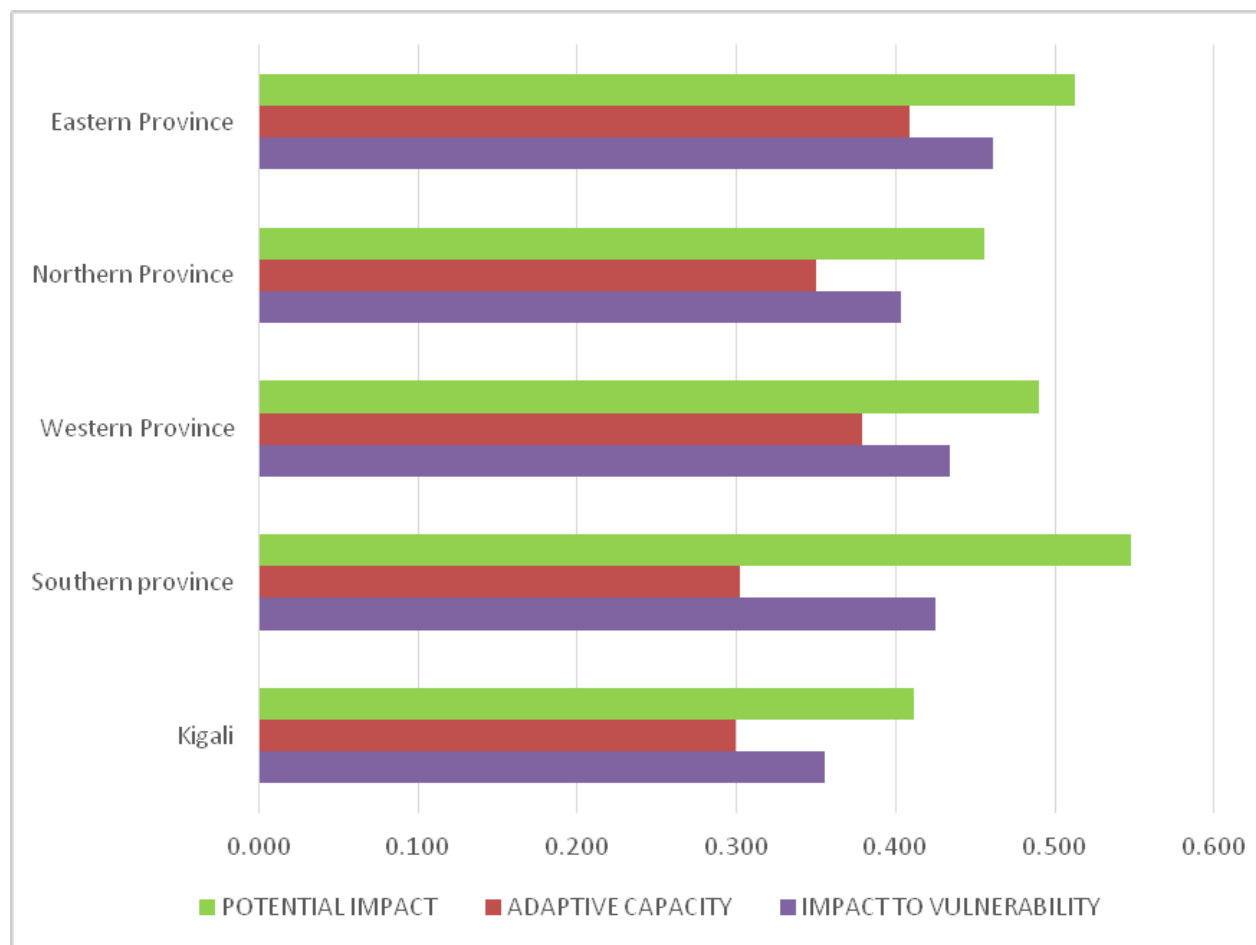
This chart shows the three values – Potential Impact (Exposure plus Sensitivity), Adaptive Capacity, and Impact to Vulnerability by Province, with Eastern Province having the highest level of vulnerability followed by Eastern Province and Southern Province, in that order.

Table 5: **Climate change vulnerability index – National baseline survey of climate change vulnerability at household level (2015)**

Factor	Factor value	Potential impact	Weighting factor for potential impact	Adaptive capacity	Weighting factor for adaptive capacity	IMPACT TO VULNERABILITY
CLIMATE CHANGE VULNERABILITY INDEX FOR KIGALI CITY						
Exposure	0.408	0.412	1	0.299	1	0.355
Sensitivity	0.415					
CLIMATE CHANGE VULNERABILITY INDEX FOR SOUTHERN PROVINCE						
Exposure	0.534	0.548	1	0.302	1	0.425
Sensitivity	0.561					
CLIMATE CHANGE VULNERABILITY INDEX FOR WESTERN PROVINCE						
Exposure	0.441	0.490	1	0.379	1	0.434
Sensitivity	0.539					
CLIMATE CHANGE VULNERABILITY INDEX FOR NORTHERN PROVINCE						
Exposure	0.383	0.456	1	0.350	1	0.403
Sensitivity	0.529					
CLIMATE CHANGE VULNERABILITY INDEX FOR EASTERN PROVINCE						
Exposure	0.587	0.513	1	0.409	1	0.461
Sensitivity	0.438					
CLIMATE CHANGE VULNERABILITY INDEX FOR RWANDA (NATIONAL)						
Exposure	0.488	0.498	1	0.357	1	0.428
Sensitivity	0.509					

This chart shows all values – or tabulated measurements of vulnerability – falling on the 'low' category, between .25 and .49: the higher the value the greater the vulnerability. The chart indicates that Eastern Province has the greatest vulnerability followed by Western Province. This summary sheet, however, loses some interesting detail since the results for core indicators are not shown. The spreadsheets which include the detail are provided in Annex A.1 (from Page 57).
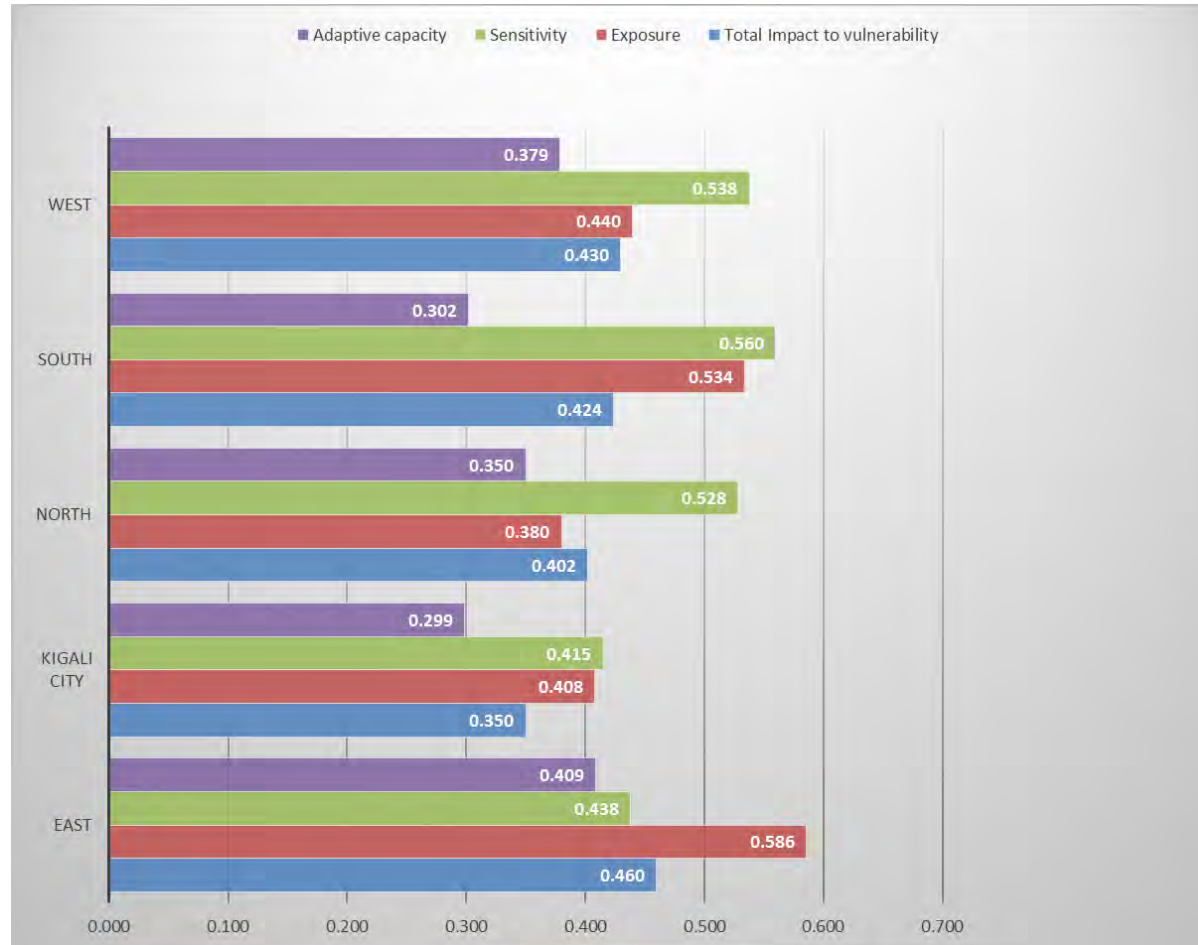
Figure 9: **Climate Change Household Vulnerability Index: Provincial Distribution - 2015, Rwanda**
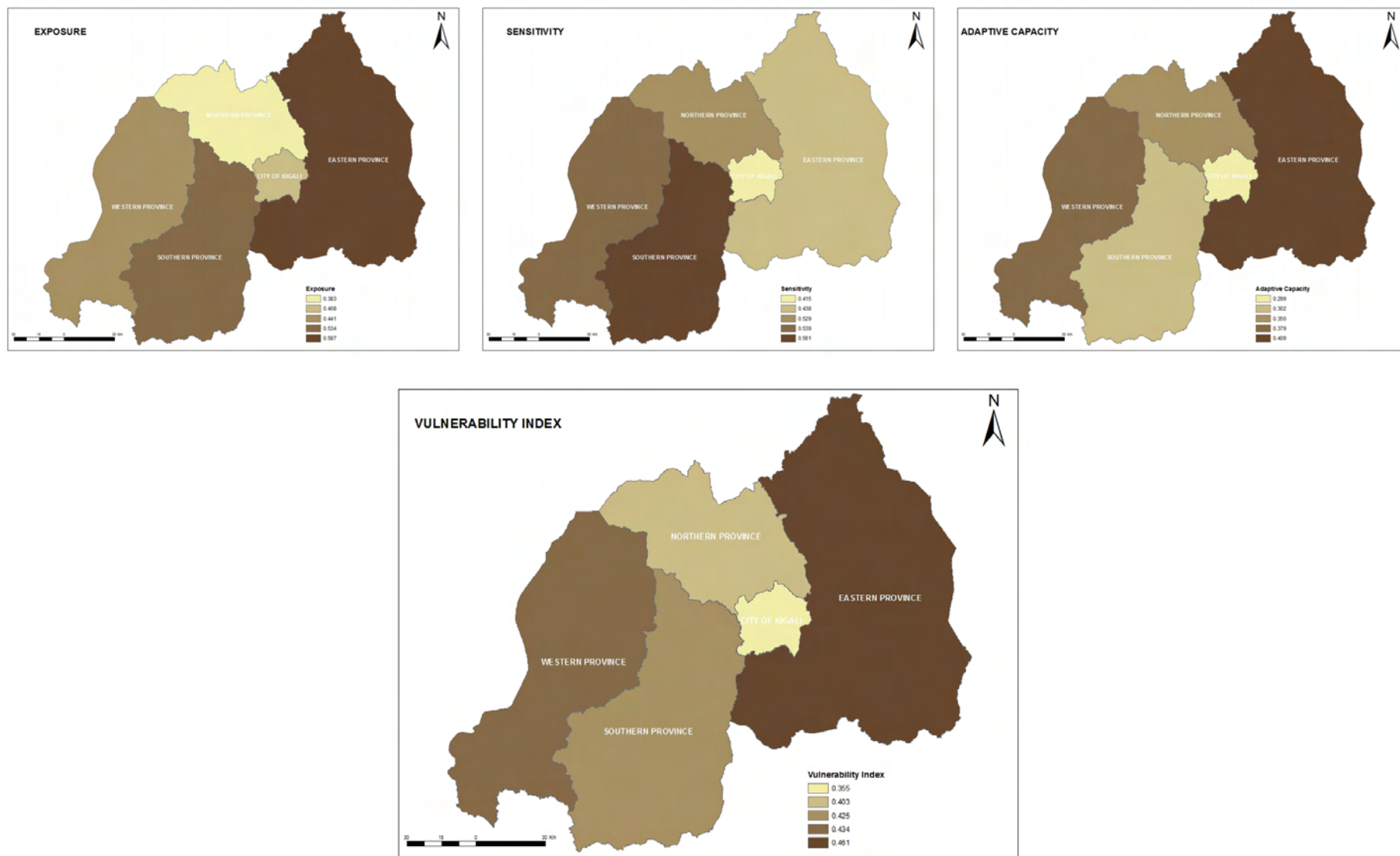
Figure 10: Geographical maps showing provincial distributions of exposure, sensitivity, adaptive capacity and overall impact to vulnerability to climate variability and change in Rwanda based on the survey results on Household Climate Change Vulnerability with lighter as lower and darker is higher.

All the data shown in the previous charts by province is aggregated or combined in this chart to show the index at the national level. The detail is lost when this level of aggregation is done. In the future, however, if there is a change in this index number, it will indicate a shift in Rwanda's vulnerability – an improvement, or deterioration.
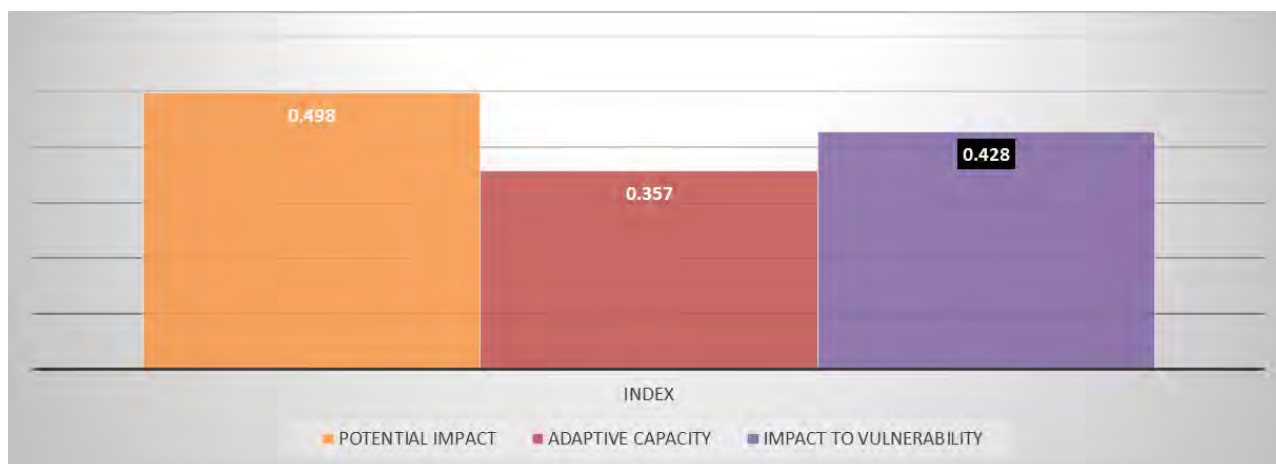
Figure 11: **Climate Change Vulnerability Index at National Level for Rwanda in 2015**

3.3   Follow-up Options - Using the Wealth of Data

There are opportunities for follow-up now that the household vulnerability index has been calculated, and data from the households has been made available and analyzed. More work can be done to show cross tabulations and break downs by province, breakdowns by gender, etc. REMA may invite – or welcome requests from researchers or students to continue to mine the data for results, to add to the analysis started above, to develop additional knowledge about vulnerability. Critiques of the data and the analysis are also welcomed so that the methodology can be improved over time. It objective of collecting the data is to learn and to contribute to the discussion about appropriate policy and program responses that can be taken in Rwanda to increase adaptive capacity, to reduce sensitivity, and overall to reduce vulnerability.

3.4   Stakeholder Participation in Data Analysis

The process undertaken to develop the Household Survey would have been strengthened by more extensive stakeholder participation, with a wide range of stakeholders both within and from outside of government. Processes that are more participatory take more time. However, the results of the HH survey can still be scrutinized by stakeholders. For the survey results to be understood and accepted, t is recommended that this stakeholder scrutiny should be pursued. The scrutiny may also result in improved interpretation of results and meaningful contributions to the development of adaptation strategies and action plans.

3.5   Community-based Adaptation

The use of community-based adaptation (CBA) approaches to improve household resilience and adaptive capacity is highly recommended. CBA is a participatory, community-led and environmentally sustainable approach to adaptation that aims to strengthen the resilience of poor and vulnerable communities. It requires a credible methodology that is participatory and involves work at the district,

sector and cell levels. Good models and experience for planning and implementing community based adaptation exists in East Africa.[6] Key to CBA is the provision of climate information - the introduction and integration of climate information into CBA, for which there are also good models in East Africa as well as good experience. It is recommended that these models are pursued, are seriously considered and that budgets are found to facilitate CBA using these available proven models and approaches.

3.6 Observations and Conclusions

The first Household Climate Change Vulnerability Index for Rwanda has been developed using rigorous and statistically valid methods. In addition, information on households has been collected that provide insight into coping strategies, access to information, assets, etc., within a livelihood context. It is hoped that discussions will follow in many quarters to gain value from this effort and to determine policy and program responses. The particular benefit of this effort is that it has been done at the national level and includes all 30 Districts. It provides a level of comprehensiveness and overview that is often lacking within individual projects. However the individual projects that might evolve may go towards addressing the sensitivity and adaptive capacity needs in the Districts and enable households to have more resilience, more security, more capacity overall. As the climate changes even more and the impacts change and the variability of the climate gets more extreme, these changes are imperative.

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[6]See `www.careclimatechange.org` and `http://www.careclimatechange.org/files/LearningRoute_Blog.pdf`

4 Interpretation of the Study Results and Recommendations

The outputs of this study provide the Government of Rwanda with a series of robust observations about the wide range of impacts that climate change is having and will have in Rwanda, and the wide scope of responsibility for action on adaptation, risk reduction, and building adaptive capacity and climate resilience. Across thirty-seven indicators of vulnerability at the national level and across twenty-four indicators of vulnerability at the household level – a total of sixty-one indicators - underlie the observations of this study. This study provides a comprehensive review of climate risk and vulnerability in Rwanda.

On the surface, the material presented in the report provides a set of areas where action can be taken. However, care needs to be taken that the responses should not be to invest in narrow areas that are in the sights of the indicators. Rather people in each sector need to understand how climate change is having impacts in their sector and take action guided by that understanding. A comprehensive approach needs to be taken across all climate sensitive policies and programs.

As a way to start the conversation about what this study means and what thinking, planning and actions it can promote, a series of proposals were put to a set of government representatives at the Validation Workshop. There were a lot of responses and this resulted in a strengthening of the proposals and in particular, the isolation of s few strategic actions that were brought forward to be highlighted. The resulting considerations are set out below.

A key discussion was that the data related to the national Vulnerability indicators needs to be updated in 2017, taking into account new information that will be available from NISR and other key data sources. By having the indicator-lined data updated then, the data can feed into the next round of planning for the next EDPRS. The updated data will allow the indicators to be used to measure change and be used as a comprehensive index measuring change. This is the purpose for which it was intended.

Further, Rwanda needs to acquire the capability to prepare future climate scenarios and apply these to critical sectors such as agricultural production, water resources management, health planning, energy, transportation and infrastructure. As Rwanda aims to get its climate resilience strategy right, it needs to know more about the future through the lens of the changing climate. All strategies, programs, plans and projects operate in a changing climate context and that context is – and will – affect the plans being rolled out and have an impact on what can be expected. Until that impact is understood, those plans are not complete. As well, until the impact of climate risk is understood, all investments are at risk.

Twenty-eight recommendations follow. They are worthy of rigorous debate and where action is taken, there is a likelihood that climate change impacts in Rwanda will be reduced significantly.

4.1 Recommendations

The Baseline Climate Change Vulnerability Index is a measure of Rwanda's vulnerability to climate change across sectors and across urban and rural population affecting overall economic performance.

It has been reviewed by stakeholders during its preparation and during the validation of this report. During these processes, various recommendations arose; now with the preliminary assessment of vulnerabilities using the indicators and baseline data collected in the preparation of the Baseline Climate Change Vulnerability Index, this study is able to provide a fuller set of recommendations.

4.1.1 Strategic Cross-Sector Action

1. Develop tools and approaches to mainstreaming climate change adaptation into all climate sensitive policies and programs of the Government of Rwanda, and update national strategies to improve how climate change vulnerabilities and adaptation are addressed – with both efforts influencing financial flows to support climate change adaptation at the local level; and report again in 2017 on the Vulnerability Index at the national and household levels. Fully implement national commitments under all multilateral environmental agreements and ensure concrete targets and timetables are met.

2. Enforce existing check lists for policy monitoring related to the GGCR Strategy.

4.1.2 Climate Change Adaptation Planning

3. Develop a national adaptation plan through a multi-sector, multi-stakeholder process involving both government and non-government sector that integrates participatory community-based adaptation approaches supporting community engagement and learning, that is broadly owned by participating stakeholders.

4. Develop and disseminate appropriate tools that integrate participatory community-based adaptation approaches to continually improve responses to emerging climate risks and threats.

5. Develop a clear and concrete approach that facilitates policy makers to lead and guide the implementation of a national adaptation plan.

4.1.3 Climate Information Services

6. Develop clear and concrete policy to effectively manage robust data and climate projections to address uncertainties associated with climate change.

7. Provide appropriate climate information services to all Ministries, Departments and Agencies with climate sensitive policies and programs, and to the NGOs and private sector involved in development.

8. Mainstream climate change vulnerability information into government decision-making with climate safeguard measures and climate risk screening requirements and tools in place.

9. Develop capacity to prepare climate change projections and the capacity to apply them to various climate sensitive socio-economic sectors policies and programs.

10. Implement an effective early warning systems nation-wide for disaster risk reduction related to climate hazards.

11. Require accurate monitoring of the cost of damages caused by - and attributed to – weather-related hazards and multi-source hazards directly involving weather variability.

4.1.4 Agricultural Production

12. Increase agricultural production and capacity through a national strategy that fully integrates environmentally sustainable production systems, including climate smart agricultural methods such as increased use of organic fertilizers and highly efficient irrigation.

13. Develop agricultural production targets including multi-year projections that integrate climate change impact scenarios, and ensure that current and future climate impacts in agriculture sector are well understood by senior decision-makers in the agriculture sector and national leaders.

4.1.5 Water Resources Management

14. Fully implement the national water resources management strategy integrating aggressive water conservation methods in water deficit watersheds, combined with intensive programs to increase water storage such as water harvesting; water catchment, etc.

15. Increase access to reliable clean drinking water where it is not available using intensive targets and timetables.

4.1.6 Health

16. Strengthen the social safety net/social protection for full inclusion of vulnerable people, including much greater health insurance coverage.

17. Reduce extreme malnutrition especially among children under 5 years old through specific targeted interventions.

18. Reduce the prevalence of the causes and incidents of illness and death from diarrhea and malaria especially among children under 5 years old; and specifically address causes of the recent upturn in malaria incidents while increasing understanding of the reasons for this recent upturn.

19. Increase the proportion of national health costs covered by domestic resources relative to costs covered by external resources.

20. Provided reliable effective community-based public health services to urban slum dwellers.

21. Increase the number of nurses and doctors per unit of population.

22. Increase the rate of access to improved sanitation – with hand washing system – *kandagira ukarabe*.

4.1.7 Biodivesity

23. Define concrete targets and timetables for protection of biodiversity, including natural habitat and critical ecosystems measured on the abundance of groups of selected species relative to established baselines, linking to RDB Tourism to engage tourism partners to help reach specific targets.

4.1.8 Transportation and Energy Infrastructure

24. Increase access to electricity, for uses such as lighting, for a large portion of the population – a key step to increased resilience – using intense targets and timetables.

25. Increase the amount of electricity produced from renewable energy sources including renewable natural resources and using decentralized distribution systems.

26. Increase the number of kilometers of paved roads in the road network including national roads and district roads outside of Kigali – a key step to achieve increased resilience; and assess the road network for climate change vulnerability in order to set priorities for climate proofing the road infrastructure.

27. Increase the availability of – and access to – public transportation for people in all cities and in rural areas

28. Assess the climate change vulnerability of multi-purpose dams including hydro-electric production facilities, including both future production and future climate projections - in the context of protecting the watersheds.

These recommendations are addressed to various audiences – decision-makers and leaders as well as institutions and agencies with sector responsibilities. Action taken in response to these recommendations will help Rwanda to reduce its vulnerability to climate change at the national scale. As a package of recommendations, it is anticipated that the Prime Minister's Office and the Cabinet will have ultimate responsibility. In particular:

- Recommendations 1, 4, 7 and 9 are for action at a high level as they implicate the whole of government - across all Ministries, Departments and Agencies.

- Recommendations 2 and 3 are to draw attention to those agencies with current commitment, reinforcing the critical nature of action in their purview that facilitates and supports adaptation.

- Recommendations 5 and 6 are specifically to those agencies involved in the preparation of a national adaptation plan, such as REMA, though other agencies may be implicated.

- Recommendations 8 and 10 implicates MINIREMA but when done provides information to a wide range of Ministries, Departments and Agencies which, if they use the climate information, will be strengthening decisions and action taken under Recommendations 1.

- Recommendations 11 and 12 directly implicate MIDIMAR and those agencies to which MIDIMAR relates in implementing and maintaining disaster risk reduction (DRR) activities.

- Recommendations 13 to 23 refer respectively to Agriculture, Water Resources (IWRM) and Health. Recommendation 24 refers to REMA.

- Recommendations 25 to 29 refer to Rwanda Energy Group (REG) and Road Transportation Development Agency (RTDA) and the Ministry of Infrastructure.

5 Towards a National Adaptation Strategy and Plan of Action

Rwanda has strong policy frameworks in place for green growth and climate resilience. However the needs for intervention to support adaptation require more planning and more precision. They also require more investment. Rural household realities tell the story about where there are gaps and where there is room for improvement – in other words, where adaptation must be supported.

Under the UNFCCC, least developed countries are currently developing National Adaptation Plans (NAPs) through a standardized NAP process. Some countries in Africa have already developed these strategies and are implementing them now. Rwanda is well placed with its policy frameworks in place to augment them with more details about where adaptation efforts must be focused. For example, for rural families to feed themselves, they need irrigation to offset the uncertainties and the gaps in rainfall. However plans to develop irrigation come up against water shortages and deficits in some catchments areas. How can farmers be supported with irrigation in the context of water deficits? This is one of the challenges that must be addressed. There are many. Adaptation is a multi-sector multidimensional challenge. It takes perspective over time and perspective across areas of life or sectors. It requires participation from all those involved. It requires change and learning. It requires monitoring and evaluation and re-learning or redesigning. Above all, with the climate changing and becoming more difficult to cope with as temperatures rise, the imperative for adaptation grows.

This study will spur on efforts to develop a national adaptation strategy. From that strategy a plan of action would emerge. That plan would include policy and program interventions or change. Overall those changes must have outcomes for people, the economy and for the environment and natural resources of the country. Those outcomes should be measurable and the next use of the tools set out in this study should show a change in the vulnerability of Rwanda's most vulnerable population. The adaptation strategy should include the next use of these tools to make those measurements.

In the meantime this study points to areas where action can be taken by appropriate institutions. It would be the concern, no doubt, of REMA, if not other authorities, that the responses to this assessment of vulnerability are coherent and that responses or measures are supportive of effective adaptation and not supportive of measures that support mal-adaptation. This is where learning is important.

One key idea for going forward is the early establishment of a multi-ministry technical coordinating committee including non-governmental or civic organizations with credibility in the area of concern. This technical committee could be the same one that may be emerging in Rwanda linked to the Green Growth and Climate Resilient strategy. If the effort is made to steer the adaptation strategy forward and to ensure it is integrated with other initiatives or strategies, then this committee may be the best way to do that, as it is not separate from the Green Growth and Climate Resilience framework.

An adaptation strategy for Rwanda will take the country forward by establishing a framework for changing institutional knowledge and behavior related to the handling the growing impacts of climate change.

6 Sustainability of the Climate Change Vulnerability Index in Rwanda

This section suggests how Rwanda can proceed to manage the Vulnerability Index going forward, strengthen the efforts to track or collect useful data on the indicators; develop the household vulnerable index further including the analysis of relevant data and oversee the step of developing the national indicators into an index, parallel to the household vulnerability index. These actions are all part of the sustainability of the climate change vulnerability index for Rwanda.

The responsibility for preparing this study has rested with REMA. When a period of no more five years has lapsed, it is recommended that REMA conduct a new study of national and household vulnerability. It will be linked to national progress on adaptation. It to determine if Rwanda is on a track that sees reductions in vulnerability and increases in adaptation.

REMA carried out a significant amount of work to prepare and implement the household survey and to collect the baseline data for the national indicators. The modalities are now well known. REMA is well placed to update the survey and the baseline data when the next monitoring exercise is required.

At the household level, the survey of 2015 will form the base of that new review, though that inquiry will not be limited to the use of this survey or a revised survey. The baseline data acquired though this 2015 survey will be used in that new review process to provide a comparison with data acquired in the new review.

REMA has had the support of NISR and other agencies of the GOR in accomplishing this work. It would be normal for those relationships to be in place for the next survey in five years. As the household survey, the household vulnerability index and the development of National Vulnerability Indicators and baselines are part of a national exercise, it is anticipated that the stakeholders will make a larger contribution to the process. Stakeholders will not only be informed of the next review or monitoring process, including a renewed household survey, they will also be encouraged to make a contribution to it. It is assumed that the process of updating the baseline data for the National Vulnerability Indicators also will provide opportunity for those stakeholders to be involved.

Between 2015 and 2017 when the Vulnerability Index at the national and household levels will be updated, all agencies are encouraged also to learn - on an ongoing basis - about REMA's work in monitoring climate change risk and vulnerability, its work in adaptation planning. They are encouraged to be involved also in the formulation of plans and projects to reduce climate risk in the many vulnerable communities across Rwanda.

6.1 Improving Vulnerability Monitoring and Data Collection

Data collection for vulnerability monitoring is essential. It is part of the framework of monitoring and evaluating adaptation efforts at the national level – down to the local levels. The data collection must become institutionalized, regular, credible and integrated.

6.2 Roles and Responsibilities of Government Agencies and other Stakeholders

The National Institute of Statistics of Rwanda and the Rwanda Governance Board are two places where significant efforts in data collection and data analysis are possible. The opportunity to incorporate relevant data collection and data oversight needs to be explored seriously to that these functions can be assured and certain. These agencies have national level responsibilities and technical capacities to perform this function. Increasingly they can be part of the cross cutting effort to support multi-sector, multi- ministry/agency responsibilities. Already NISR has been approached to assist with the efforts of this study and was very cooperative. There is a basis for going further. RGB this year included

environmental protection in its scorecard. This is a good basis for expanding efforts to include monitoring the mainstreaming of climate change.

Efforts also need to be made to undertaken some specific data collection at the level of individual ministries, agencies, departments, units and authorities. As can be understood from the chart laying out the national indicators and baselines, at Section 3 (from Page 16), there are areas where data must be collected that is closer to what is most useful for vulnerability monitoring. One specific capability is for projections in some areas (such as water availability, agricultural production) to be viewed through or modified as a result of applying a climate lens, a method that would examine those projections in the context of a changing climate, more particularly, in the context of the most recent, most robust and highest resolution projections for climate change in the East Africa Community.

The capacity to undertake this analysis needs to be institutionalized in Rwanda or a permanent capacity to do them needs to be arranged within the East Africa Community. This will take cooperation of specific ministries and some inter-ministry cooperation. The importance of this capacity needs to be well understood within each ministry or agency as well. This earning will do a long way toward increasing the overall capacity in the country to be more effective at monitoring the dynamic effect of climate change and the various kinds of vulnerability to climate change impacts.

7   Conclusion

This report provides a comprehensive approach to understanding and monitoring vulnerabilities to climate change in Rwanda. It provides the first Vulnerability Index for the country to be used to better understand climate change impacts and to help drive responses in terms of policy and programs. It provides a methodology and it provides initial results. It focuses on outcomes of efforts to increase resilience getting away from the monitoring of outputs of specific initiative and projects.

Its key objectives were to enable important answers to such questions as these:

- Is Rwanda making progress in terms of increasing its capacity to adapt and its rate of adaption?
- Is Rwanda becoming more - or less - vulnerable to the impacts of climate change?
- What will be the increasing effects of climate change on the efforts Rwanda is making to achieve economic development and poverty reduction?
- Where should Rwanda be investing its resources to increase its ability as a nation to adapt, to increase resilience?

What the report says is that there are specific ways to monitoring vulnerability and that the baselines established in this report not only provide a comparison to the next use of this index but also some indication of where early investment or the next round of investments might best go in terms of adaptation, risk management, growing the adaptive capacity might go.

Stakeholders will expand the menu of what constitutes appropriate responses to this Vulnerability document. And that is good as it will be a measure of stakeholder use of this report and also generate ideas for changes - all in all improve the buy in to this model or undertaking adaptation analysis.

Rwanda must institutionalize its monitoring of adaptation and increase the capacity to make projections using climate information at national level and at household or community level.

Rwanda must make investments to resolve contradictions or conflicts in its development pathway – difficulties that come up when certain initiatives are reviewed from a climate change vulnerability perspective. For example the need to grow more food in a context where there is a water deficit.

There are other areas for action arising from this study that will facilitate its impact, its sustainability, and the understanding of climate change vulnerability among significant stakeholders and within the local level of government, at District Sector and cell levels. Most important among them is to have a process for stakeholder engagement and outreach. Further, key ministries need to be engaged to undertake reviews of programs from a climate change perspective and incorporate the mainstreaming of climate change into their systems.

Rwanda must support the efforts of REMA to develop a climate change adaptation strategy with reference to obligations under the UNFCCC but also with reference to its moral and political obligations to understand adaptation requirements across the county in a more detailed way to be able to incorporate more adaptation goals and measures into its current economic development strategies.

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A Annexes

A.1 Technical Spreadsheets calculating the Household Vulnerability Index

Table 6: Climate change vulnerability index for **Rwanda** - Results of the national baseline survey of climate change vulnerability at household level (2015)

		Description of factor	Indicator	Assessment scale Lowest value	Assessment scale Highest value	Observed value	Normali-zed value	Weighting factor for each indicator	Total	POTENTIAL IMPACT (PI)	Weighting factor (PI)	ADAPTIVE CAPACITY (AC)	Weighting factor (AC)	IMPACT TO VULNERABILITY
Exposure														
	1	Change in temperature	Change in temperature	0	2	1.06	0.5	1						
	2	Change in rainfall amount	Change in rainfall amount	0	2	1.42	0.7	1						
	3	Shift in rainfall start date	Shift in rainfall start date	0	2	1.37	0.7	1						
	4	Drought episodes	Drought episodes	0	2	0.84	0.4	1	0.488					
	5	Flooding events	Flooding events	0	2	0.39	0.2	1						
	6	Wind events	Wind events	0	2	1.00	0.5	1						
	7	Heat episodes	Long period of very hot days	0	2	0.79	0.4	1						
	8	Thunder storms	Thunder storms	0	2	0.94	0.5	1						
Sensitivity														
	1	Soil erosion and landslides	Soil erosion and landslides	0	2	0.69	0.345	1						
	2	Soil fertility	Soil fertility	0	2	1.12	0.56	1		0.498	1	0.357	1	0.428
	3	Change in natural environment	Change in natural environment	0	2	0.86	0.43	1						
	4	Dependency level	Household size	0	2	0.95	0.475	1	0.509					
	5	Irrigation of fields	Irrigation of fields	0	2	1.75	0.875	1						
	6	Livelihood sources	Livelihood sources	0	2	0.63	0.315	1						
	7	Use of water catchment	Use of water catchment	0	2	1.02	0.51	1						
	8	Family income	Family income	0	2	1.29	0.645	1						
Adaptive Capacity														
	1	Awareness of climate change	Awareness of climate change	0	2	0.86	0.43	1						
	2	Received weather information	Received weather information	0	2	0.57	0.285	1						
	3	Surplus production available	Surplus production available	0	2	0.60	0.3	1						
	4	Changes in agricultural practices	Changes in agricultural practices	0	2	0.70	0.35	1						
	5	Change in behavior following extreme weather	Change in behavior following extreme weather	0	2	0.84	0.42	1						

All indicators of the vulnerability components and the composite indicators for the potential impact and vulnerability are measured on a scale from 0-1.

Table 7: Climate change vulnerability index for **Kigali City** - Results of the national baseline survey of climate change vulnerability at household level (2015)

		Description of factor	Indicator	Assessment scale Lowest value	Highest value	Observed value	Normalized value	Weighting factor for each indicator	Total	POTENTIAL IMPACT (PI)	Weighting factor (PI)	ADAPTIVE CAPACITY (AC)	Weighting factor (AC)	IMPACT TO VULNERABILITY
Exposure														
	1	Change in temperature	Change in temperature	0	2	1	0.5	1						
	2	Change in rainfall amount	Change in rainfall amount	0	2	1.25	0.6	1						
	3	Shift in rainfall start date	Shift in rainfall start date	0	2	1.23	0.6	1						
	4	Drought episodes	Drought episodes	0	2	0.64	0.3	1	0.408					
	5	Flooding events	Flooding events	0	2	0.27	0.1	1						
	6	Wind events	Wind events	0	2	0.93	0.5	1						
	7	Heat episodes	Long period of very hot days	0	2	0.56	0.3	1						
	8	Thunder storms	Thunder storms	0	2	0.65	0.3	1						
Sensitivity														
	1	Soil erosion and landslides	Soil erosion and landslides	0	2	0.47	0.235	1						
	2	Soil fertility	Soil fertility	0	2	0.71	0.355	1		0.412	1	0.299	1	0.355
	3	Change in natural environment	Change in natural environment	0	2	0.47	0.235	1						
	4	Dependency level	Household size	0	2	0.94	0.47	1	0.415					
	5	Irrigation of fields	Irrigation of fields	0	2	1.50	0.75	1						
	6	Livelihood sources	Livelihood sources	0	2	0.47	0.235	1						
	7	Use of water catchment	Use of water catchment	0	2	0.90	0.45	1						
	8	Family income	Family income	0	2	1.18	0.59	1						
Adaptive Capacity														
	1	Awareness of climate change	Awareness of climate change	0	2	0.79	0.395	1						
	2	Received weather information	Received weather information	0	2	0.56	0.28	1						
	3	Surplus production available	Surplus production available	0	2	0.54	0.27	1						
	4	Changes in agricultural practices	Changes in agricultural practices	0	2	0.52	0.26	1						
	5	Change in behavior following extreme weather	Change in behavior following extreme weather	0	2	0.58	0.29	1						

All indicators of the vulnerability components and the composite indicators for the potential impact and vulnerability are measured on a scale from 0-1.

Table 8: Climate change vulnerability index for **Southern Province** - National baseline survey of climate change vulnerability at household level (2015)

		Description of factor	Indicator	Assessment scale		Observed value	Normali-zed value	Weighting factor for each indicator	Total	POTENTIAL IMPACT (PI)	Weighting factor (PI)	ADAPTIVE CAPACITY (AC)	Weighting factor (AC)	IMPACT TO VULNERABILITY
				Lowest value	Highest value									
Exposure														
	1	Change in temperature	Change in temperature	0	2	1.24	0.6	1						
	2	Change in rainfall amount	Change in rainfall amount	0	2	1.45	0.7	1						
	3	Shift in rainfall start date	Shift in rainfall start date	0	2	1.37	0.7	1						
	4	Drought episodes	Drought episodes	0	2	1.15	0.6	1	0.534					
	5	Flooding events	Flooding events	0	2	0.45	0.2	1						
	6	Wind events	Wind events	0	2	1.05	0.5	1						
	7	Heat episodes	Long period of very hot days	0	2	0.94	0.5	1						
	8	Thunder storms	Thunder storms	0	2	0.90	0.5	1						
Sensitivity														
	1	Soil erosion and landslides	Soil erosion and landslides	0	2	0.72	0.36	1						
	2	Soil fertility	Soil fertility	0	2	0.33	0.665	1		0.548	1	0.302	1	0.425
	3	Change in natural environment	Change in natural environment	0	2	0.02	0.51	1						
	4	Dependency level	Household size	0	2	0.96	0.48	1	0.561					
	5	Irrigation of fields	Irrigation of fields	0	2	1.80	0.9	1						
	6	Livelihood sources	Livelihood sources	0	2	0.79	0.395	1						
	7	Use of water catchment	Use of water catchment	0	2	1.25	0.625	1						
	8	Family income	Family income	0	2	1.41	0.705	1						
Adaptive Capacity														
	1	Awareness of climate change	Awareness of climate change	0	2	0.73	0.365	1						
	2	Received weather information	Received weather information	0	2	0.45	0.225	1						
	3	Surplus production available	Surplus production available	0	2	0.48	0.24	1						
	4	Changes in agricultural practices	Changes in agricultural practices	0	2	0.60	0.3	1						
	5	Change in behavior following extreme weather	Change in behavior following extreme weather	0	2	0.76	0.38	1						

All indicators of the vulnerability components and the composite indicators for the potential impact and vulnerability are measured on a scale from 0-1.

Table 9: Climate change vulnerability index for **Western Province** - National baseline survey of climate change vulnerability at household level (2015)

	Description of factor	Indicator	Assessment scale		Observed value	Normali-zed value	Weighting factor for each indicator	Total	POTENTIAL IMPACT (PI)	Weighting factor (PI)	ADAPTIVE CAPACITY (AC)	Weighting factor (AC)	IMPACT TO VULNERABILITY
			Lowest value	Highest value									
Exposure													
1	Change in temperature	Change in temperature	0	2	0.76	0.4	1						
2	Change in rainfall amount	Change in rainfall amount	0	2	1.28	0.6	1						
3	Shift in rainfall start date	Shift in rainfall start date	0	2	1.15	0.6	1						
4	Drought episodes	Drought episodes	0	2	0.64	0.3	1	0.441					
5	Flooding events	Flooding events	0	2	0.52	0.3	1						
6	Wind events	Wind events	0	2	1.06	0.5	1						
7	Heat episodes	Long period of very hot days	0	2	0.53	0.3	1						
8	Thunder storms	Thunder storms	0	2	1.11	0.6	1						
Sensitivity													
1	Soil erosion and landslides	Soil erosion and landslides	0	2	1.00	0.5	1		0.490	1	0.379	1	0.434
2	Soil fertility	Soil fertility	0	2	1.11	0.555	1						
3	Change in natural environment	Change in natural environment	0	2	0.87	0.435	1						
4	Dependency level	Household size	0	2	0.90	0.45	1	0.539					
5	Irrigation of fields	Irrigation of fields	0	2	1.71	0.855	1						
6	Livelihood sources	Livelihood sources	0	2	0.61	0.305	1						
7	Use of water catchment	Use of water catchment	0	2	1.03	0.515	1						
8	Family income	Family income	0	2	1.26	0.63	1						
Adaptive Capacity													
1	Awareness of climate change	Awareness of climate change	0	2	0.83	0.415	1						
2	Received weather information	Received weather information	0	2	0.65	0.325	1						
3	Surplus production available	Surplus production available	0	2	0.68	0.34	1						
4	Changes in agricultural practices	Changes in agricultural practices	0	2	0.66	0.33	1						
5	Change in behavior following extreme weather	Change in behavior following extreme weather	0	2	0.97	0.485	1						

All indicators of the vulnerability components and the composite indicators for the potential impact and vulnerability are measured on a scale from 0-1.

Table 10: Climate change vulnerability index for **Northern Province** - National baseline survey of climate change vulnerability at household level (2015)

		Description of factor	Indicator	Assessment scale Lowest value	Highest value	Observed value	Normalized value	Weighting factor for each indicator	Total	POTENTIAL IMPACT (PI)	Weighting factor (PI)	ADAPTIVE CAPACITY (AC)	Weighting factor (AC)	IMPACT TO VULNERABILITY
Exposure														
	1	Change in temperature	Change in temperature	0	2	0.73	0.4	1						
	2	Change in rainfall amount	Change in rainfall amount	0	2	1.32	0.7	1						
	3	Shift in rainfall start date	Shift in rainfall start date	0	2	1.37	0.7	1						
	4	Drought episodes	Drought episodes	0	2	0.24	0.1	1	0.383					
	5	Flooding events	Flooding events	0	2	0.36	0.2	1						
	6	Wind events	Wind events	0	2	0.83	0.4	1						
	7	Heat episodes	Long period of very hot days	0	2	0.17	0.1	1						
	8	Thunder storms	Thunder storms	0	2	1.10	0.6	1						
Sensitivity														
	1	Soil erosion and landslides	Soil erosion and landslides	0	2	0.98	0.49	1						
	2	Soil fertility	Soil fertility	0	2	1.19	0.595	1		0.456	1	0.350	1	0.403
	3	Change in natural environment	Change in natural environment	0	2	0.75	0.375	1						
	4	Dependency level	Household size	0	2	0.88	0.44	1	0.529					
	5	Irrigation of fields	Irrigation of fields	0	2	1.80	0.9	1						
	6	Livelihood sources	Livelihood sources	0	2	0.48	0.24	1						
	7	Use of water catchment	Use of water catchment	0	2	0.98	0.49	1						
	8	Family income	Family income	0	2	1.17	0.585	1						
Adaptive Capacity														
	1	Awareness of climate change	Awareness of climate change	0	2	0.75	0.375	1						
	2	Received weather information	Received weather information	0	2	0.45	0.225	1						
	3	Surplus production available	Surplus production available	0	2	0.53	0.265	1						
	4	Changes in agricultural practices	Changes in agricultural practices	0	2	0.80	0.4	1						
	5	Change in behavior following extreme weather	Change in behavior following extreme weather	0	2	0.97	0.485	1						

All indicators of the vulnerability components and the composite indicators for the potential impact and vulnerability are measured on a scale from 0-1.

Table 11: Climate change vulnerability index for **Eastern Province** - National baseline survey of climate change vulnerability at household level (2015)

| | | Description of factor | Indicator | Assessment scale | | Observed value | Normalized value | Weighting factor for each indicator | Total | POTENTIAL IMPACT (PI) | Weighting factor (PI) | ADAPTIVE CAPACITY (AC) | Weighting factor (AC) | IMPACT TO VULNERABILITY |
				Lowest value	Highest value									
Exposure														
	1	Change in temperature	Change in temperature	0	2	1.39	0.7	1						
	2	Change in rainfall amount	Change in rainfall amount	0	2	1.65	0.8	1						
	3	Shift in rainfall start date	Shift in rainfall start date	0	2	1.64	0.8	1						
	4	Drought episodes	Drought episodes	0	2	1.19	0.6	1	0.587					
	5	Flooding events	Flooding events	0	2	0.26	0.1	1						
	6	Wind events	Wind events	0	2	1.02	0.5	1						
	7	Heat episodes	Long period of very hot days	0	2	1.44	0.7	1						
	8	Thunder storms	Thunder storms	0	2	0.80	0.4	1						
Sensitivity										0.513	1	0.409	1	0.461
	1	Soil erosion and landslides	Soil erosion and landslides	0	2	0.24	0.12	1						
	2	Soil fertility	Soil fertility	0	2	0.99	0.495	1						
	3	Change in natural environment	Change in natural environment	0	2	0.91	0.455	1						
	4	Dependency level	Household size	0	2	1.04	0.52	1	0.438					
	5	Irrigation of fields	Irrigation of fields	0	2	1.75	0.875	1						
	6	Livelihood sources	Livelihood sources	0	2	0.63	0.315	1						
	7	Use of water catchment	Use of water catchment	0	2	0.80	0.4	1						
	8	Family income	Family income	0	2	1.32	0.66	1						
Adaptive Capacity														
	1	Awareness of climate change	Awareness of climate change	0	2	1.01	0.505	1						
	2	Received weather information	Received weather information	0	2	0.71	0.355	1						
	3	Surplus production available	Surplus production available	0	2	0.73	0.365	1						
	4	Changes in agricultural practices	Changes in agricultural practices	0	2	0.84	0.42	1						
	5	Change in behavior following extreme weather	Change in behavior following extreme weather	0	2	0.80	0.4	1						

All indicators of the vulnerability components and the composite indicators for the potential impact and vulnerability are measured on a scale from 0-1.

A.2 National Climate Change Household Vulnerability Survey – Results of Early Analysis

The following pages provide an analysis of data collected in the household survey. The data was collected over and above the date used to calculate the Vulnerability Index as described or the previous pages. This analysis gives us more insight into the particular situation of those people who were surveyed.

The survey collected data from 1500 people in 30 districts across Rwanda. The random choice of 2 villages per district, and interviews with representatives of 25 households per village was approved by National Institute of Statistics of Rwanda (NISR) as being statistically significant (valid) where data was aggregated at the provincial level. Results are therefore presented at the provincial level or aggregated at the national level. Provincially, the number of households where data was collected is provided below:

Province	# of households (frequency)	% of total households per province (percent)
Kigali	150	10.0
South	400	26.7
West	350	23.3
North	250	16.7
East	350	23.3
Total	1500	100.0

Table 12: Distribution of household surveys across the five provinces showing the % of questionnaires administered in each province.

The survey collected data from household respondents on these parameters:

1. Details on household members – including: gender, age, level of education completed;
2. Details on number of household members with disabilities or chronic illness;
3. Sources of Household income, including what are the top two sources of income;
4. Whether land is owned by the household with title;
5. Access to electricity and sources of energy used for cooking and lighting;
6. Whether households are covered by health insurance and have a bank account;
7. The training received on agricultural techniques in the last two years and what training has been put into practice;
8. What radio stations provide the households with farming and market information and whether weekly weather information from any source, to help them make decisions related to farming;
9. A series of short questions:
   (a) What changes farmers have made in the mix of crops their grow;
   (b) Whether they use organic manure or inorganic fertilizer;
   (c) Whether they have had to repair their houses due to storm or landslide damage;
   (d) Whether the roads in their village or cell have improved;
   (e) Whether the respondents are satisfied with the level of service of agricultural coops and clinics;
   (f) Whether they have to cross a river on a bridge to get to market, or to get to school or a clinic;
   (g) How long it takes to get to market with their farm produce.

A.3 Basic Information About the Survey Respondents

1. Of the survey respondents forty-three percent (43%) were male and fifty-seven percent (57%) were female. This is a slightly higher level than normal female response rate, likely explained by the fact that interviews were administered throughout the day by the surveyors and the likelihood decreases of male household heads being at home during the day.

	# of respondents (frequency)	% by gender (percent)
Male	647	43.1
Female	853	56.9
Total	1500	100

Table 13: Number of the survey respondents by gender or sex (male, female)

2. The Age Dependency Ratio (ADR) among household family members among the respondents to the survey is 92.8% which is calculated according to NISR's methods. This calculation is the ratio of the total number of individuals who are 15 years of age and younger plus individuals who are 65 years of age and older and who are dependent be definition - to the total number of individuals who are 16-64 years of age, who are the producers or providers in households by definition. A lower age dependency ratio increases the potential for household resilience and improved adaptive capacity, in other words few dependents, fewer mouths to feed.

Age Dependency Ratio (ADR)		
Age group	% of respondents (percent)	
under 16 (dependent)	44.8	
over 64 (dependent)	3.1	
sub-total of dependent age groups	48.0	
16-64 (productive age)	51.7	
Ratio of dependent age groups to productive age group	48:51.7	= 92.81 %
Total number of household members = 7029		

Table 14: The ratio of dependent family members to supporting family members – the age dependency ratio (ADR)

Note: NISR calculated the ADR for Rwanda as 93.2% in 2012 (2012 Census Data). The World Bank indicates that Rwanda's ADR has been falling slightly each year in the last 5 years.

3. The level of education attained among family members in this survey of 1500 households is shown below. Increasing the level of education is one way that households increase their resilience and adaptive capacity - enabling household members to make better decisions informed by information received through extension training or other services. Seventy percent (70%) have not attained more than primary level schooling or remain illiterate. Sixteen percent (16%) are not yet of school age. Nearly thirteen percent (13%) have achieved education above the primary school level. It is likely that the three Districts comprising Kigali City will have a higher proportion of those with higher levels of education.

Level of education attained among household family members	# of respondents (frequency)	% of respondents (percent)
Note yet in school	1117	15.9
Illiterate	714	10.2
Literate but below primary	2027	28.8
Primary	2179	31.0
Vocational training	71	1.0
Secondary	510	7.3
Higher Secondary	227	3.2
Graduate or higher	93	1.3
Catch up	24	.3
Other	62	.9
Total number of household members	7024	99.9%

Table 15: Levels of education achieved among household members surveyed

4. The number of households surveyed that reported a member is disabled is twenty-two percent (22%). Families normally support disabled family members. This increases the number of people who are dependent on the household income - and household food production where the main income is from cultivation. An increase in dependency generally makes a household less resilient. The reality of households having disabled and chronically ill members needs to be taken into account in adaptation planning, when making assumptions about household capabilities.

   (a) Respondents indicated the range of disabilities in their households. Out of 1500 households (twenty-two percent (22% out of 1500) reported a person with a disability. Not all those indicating a disability in the household responded with details about the disability of the family members. However,

	Response	# of respondents (frequency)
Yes	329	21.9
No	1171	78.1
Total	1500	100.0

Table 16: % of households surveyed reporting disabilities among family members

seventeen percent of the surveyed household (17% out of 1500) did provide information on the disability in their household. These respondents indicated that nearly thirty percent (30%) of them have orthopedic disabilities, more than fourteen percent (14%) of them a member who is mentally challenged, thirteen percent (13%) of them have a member who is deaf, and eleven percent (11%) of them have member who is blind. The figures are provided below.

Disability	# of respondents (frequency)	% of respondents (percent)
Blind	28	10.8
Deaf	34	13.1
Mute	11	4.2
Orthopedic	76	29.3
Mentally challenged	37	14.3
Other	73	28.2
Total	259	100.0

Table 17: Disabilities within households reporting disabled members

(b) Survey respondents indicated the range of chronic illnesses in their households. Chronic illness within a household increases the dependency on those members within that household who are earning income and producing food. An increase in dependency generally makes a household less resilient. Among specific chronic illnesses reported in the survey, the most frequent was HIV/AIDS at twenty three percent (23%) and hypertension at fourteen percent (14%). However forty seven percent (47%) of those who reported chronic illness in their household did not provide the specific illness.

Chronic Illness	# of respondents (frequency)	% of respondents (percent)
Cancer	4	2.6
HIV/AIDs	35	23.2
TB	3	2.0
Leprosy	6	4.0
Silicosis (pneumonia)	5	3.3
Diabetic	6	4.0
Hypertension	13.9	13.9
Other	71	47.0
Total	151	100

Table 18: Type and frequency of chronic illness among households reporting chronic illness

5. The survey asked respondents to indicate if land was owned with title among household members and a large percent did indicate land ownership. Eighty four percent (84%) of households reported land ownership with title. Owning land with title is considered as a positive factor in rural resilience, as it provides an indicator of the ability of household members to access land for farming and other activities without being removed from their land. Sometimes in enables households to get financial credit.

Response	Frequency	%
Yes	1253	83.5
No	247	16.5
Total	1500	100.0

Table 19: Percent (%) of households owning land with title

6. The survey asked respondents to indicate the sources of household income, assuming there might be more than one source of income per household. The chart below shows the frequency and percent of households reporting income by source. The vast majority had income from cultivation, from casual wage employment in agricultural, from selling livestock or animals and from selling grain and vegetables. Diversified income sources at the household level are considered a good adaptation measure, enabling households to manage risk related to climate-related impacts on income, especially agricultural income. The percent of people who have non-agriculture income remains low.

Response	Income from cultivation		Income from livestock or other animals		Income from selling grain or vegetable		Income from casual wage employment (agricultural)	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Yes	1103	73.5	321	21.4	321	21.4	531	35.4
No	397	26.5	1179	78.6	1179	78.6	969	64.6
Total	1500	100.0	1500	100.0	1500	100.0	1500	100.0

Response	Income from casual wage employment (non-agricultural)		Income from salaried employment		Income from own non-agricultural enterprises or services		Income from logging, cutting and selling of logs/wood/timber /charcoal	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Yes	232	15.5	115	7.7	130	8.7	36	2.4
No	1268	84.5	1385	92.3	1370	91.3	1464	97.6
Total	1500	100.0	1500	100.0	1500	100.0	1500	100.0

Table 20: Sources of income among respondents - with percent of respondent acquiring income from each source.

Distribution of combined sources of household income	
Source of income	Percent
Cultivation	42.50%
Fishing	1.10%
Forest gatherer/natural produce collection/non timber	0.40%
Logging, cutting and selling of logs/wood/ timber/charcoal	0.70%
Livestock/other animal enterprise (agriculture)	8.20%
Selling of grain and/or vegetable crops	11.40%
Casual wage employment (agricultural)	17.30%
Casual wage employment (non-agricultural)	6.40%
Salaried employment	4.30%
Own non-agricultural enterprises or services	3.20%
Interest and rental income	1.20%
Pension	0.10%
Remittances/Transfers from friends or family (cash or kind)	1.10%
Begging/charity	0.70%
Mining	1.00%
Other	0.30%
Total	100.00%

Table 21: The two main sources of income combined

7. Access to clean water and electricity by households is a strong indicator of potential vulnerability or similarly supports adaptive capacity at the household level. Rwanda has a national policy to increase access to electricity. Our survey indicated that twenty-two percent (22%) had access to electricity in their home. This compares closely to NISR's 2012 Census Data showing 17.5% of Rwandans have electricity in their home and NISR's 2014 Statistical Yearbook which indicated there as a 19% increase in the number of electricity consumers in 2013 over the previous year.

While we asked in the survey about access to WASAC water in the home, there is other data available in Rwanda on access to 'improved' sources of clean water, which includes stand pipes outside of the

home, borehole water, protected spring water and collected or harvested rainwater. Our results show only slightly more than six percent (6%) of households have access to WASAC water in their homes. National data from NISR and MININFRA indicates that in 2013/14 that more than 75% of the households have reliable access to a clean water source.

Response	Do you have access to clean water (WASAC water) in your house?		Do you have access to electricity in your house?	
	Frequency	%	Frequency	%
Yes	96	6.4	336	22.4
No	1404	93.6	1164	77.6
Total	1500	100.0	1500	100.0

Table 22: Percent of households surveyed with access to WASAC water and access to electricity – both in their homes

8. The survey asked respondent to provide information on the sources of energy they use for cooking. Nearly ninety-two percent indicated they primarily use wood as their source of energy for cooking. Ten percent indicated charcoal as their primary sources, which likely applies more to people living in three Districts of Kigali City.

	Energy source for cooking					
	Wood		Electricity		Charcoal	
Response	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	1379	91.9	12	.8	161	10.7
No	121	8.1	1488	99.2	1339	89.3
Total	1500	100.0	1500	100.0	1500	100.0

Table 23: Indicating the sources of energy used for cooking at the household level and percent of respondents using each source

9. The survey asked respondent to provide information on the sources of energy they use for lighting. It was assumed that households use multiple sources of energy for lighting. The top four energy sources are reported below. Electricity from EWSA (electrical utility) and from batteries and cells are the main source of energy for lighting. Forty-seven percent (47%) of households surveyed use batteries and cells as their source of energy for lighting. And just over twenty-three percent (23%) use electricity from power lines as their source of energy for lighting. Solar and biogas as energy sources are reported by an extremely few number of households. However, twenty-three percent (23%) of households use kerosene and ten percent (10%) of households use candle as their source of energy for lighting.

	Energy source for lighting							
	Battery/cells		Electricity		Kerosene		Candle	
Response	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Yes	706	47.1	348	23.2	344	22.9	161	10.7
No	794	52.9	1152	76.8	1156	77.1	1339	89.3
Total	1500	100.0	1500	100.0	1500	100.0	1500	100.0

Table 24: Indicating the sources of energy used for lighting at the household level and percent of respondents using each source

10. The survey wanted to get an indication of the access of households to the countries social safety net or social protection systems. Rural livelihoods are more resilient if they are lived in the context of s strong, comprehensive, appropriate and well implemented social protection system.

The survey asked respondents to tell us if household members are registered in Mutuelle de Santé or in in RAMA/RSSB, MMI, CORAR, MEDIPLAN, etc. They indicated that seventy-eight percent (78%) are registered with Mutuelle de Santé and over six percent are enrolled in RSSB or another insurance scheme outside of Mutuelle, for a combined total of eighty-five percent (85%).

NISR's 2014 Statistical Yearbook says that the prevalence of health insurance among Rwanda's is at 68.8% in 2010/11, which is an enrollment rate of ninety two percent of the target population of *Mutuelle*

de Santé. We know also from the Ministry of Health that the number of people enrolled in *Mutuelle de Santé* is dropping every year.

The survey results seem somewhat high compared to NISR's reported prevalence level of enrollment in health insurance and need to be examined more closely. But our results may be close to NISR's reported Mutuelle de Santé enrollment rate taking recent declines in enrollment into account. Two charts with survey data following below.

Response	Frequency	Percent
Yes	1177	78.5
No	323	21.5
Total	1500	100.0

Table 25: Percent of enrollment in *Mutuelle de Santé* among those surveyed

Response	Frequency	Percent
Yes	96	6.4
No	1404	93.6
Total	1500	100.0

Table 26: Percent of enrollment in other health insurances (RAMA/ RSSB/MMI, CORAR, MEDIPLAN, etc.) among those surveyed

11. An additional indicator of rural adaptive capacity if the extent to which households have access to bank account for purposes of having saving and making loans. Our survey showed that among respondents, thirty-nine percent (39%) of households had at least one member with a bank account.

Response	Frequency	Percent
Yes	585	39.0
No	915	61.0
Total	1500	100.0

Table 27: Percent of households where at least one member has a bank account

12. The survey asked about the rural extension training that household members have received in the last five years. For all areas of training that we inquired about, no more than ten percent (10%) had received training in any one of the areas. Rates of rural extension training received ranged from seven point five percent (7.5%) on inter cropping techniques in agriculture to nine point five percent (9.5%) on seed preservation. Training on small scale irrigation and rainwater harvesting and collection appeared on the low side of the range of responses. Rural capacities in these areas are considered by many to be essential to enable rural communities to cope with climate variability and change. Rwanda has a master plan for irrigation, for example. We did not examine its implementation.

The survey went further and asked respondents to indicate where training of a household member had been put to use or put into practice. Of those indicating they received training in the area of organic manure/fertilizer use (only) five percent (5%) say they have put the training into practice. The data from our survey show that just over four and a quarter percent (4.25%) of those receiving training in seed preservation have used that training; just three percent (3%) of those receiving training in rain water harvesting have used that training; and fewer than three percent (3%) of those receiving training in mulching (*gusasira*) have used that training.

In light of the high level of potential vulnerability to climate variability, and exposure to climate change because of the predominance of rain-fed agriculture, rates of training and use of training are important measures. And the future use of this vulnerability index should monitor change in these rates.

Table 28: Percent of households where at least one member has received rural extension training - in the last five years - in a variety of areas recognized as relevant for climate change adaptation/household adaptive capacity

Training Received from Extension Services							
Response	Small scale irrigation		Rainwater collecting/ harvesting		Grain storage		Seed preservation	
Yes	121	8.1	119	7.9	117	7.8	142	9.5
No	1379	91.9	1381	92.1	1383	92.2	1358	90.5
Total	1500	100.0	1500	100.0	1500	100.0	1500	100.0

Response	Food processing		Mulching (gusasira)		Inter cropping		Tree Planting	
Yes	121	8.1	127	8.5	113	7.5	129	8.6
No	1379	91.9	1373	91.5	1387	92.5	1371	91.4
Total	1500	100.0	1500	100.0	1500	100.0	1500	100.0

Response	Pest and Weed Control		Organic manure/ fertilizer use		Terracing and slope maintenance		Agro forestry	
Yes	117	7.8	197	13.1	197	13.1	114	7.6
No	1383	92.2	1303	86.9	1303	86.9	1386	92.4
Total	1500	100.0	1500	100.0	1500	100.0	1500	100.0

And the uses made of the training:

Area of training put into practice	First area of training put into practice		Second area of training put into practice		Combined
	Frequency	Percent	Frequency	Percent	Percent
No training & no use of training	1282	85.5	1320	88.0	
Small scale irrigation	39	2.6	2	.1	2.73
Rainwater collecting/harvesting	19	1.3	26	1.7	3.00
Grain storage	22	1.5	7	.5	1.93
Seed preservation	33	2.2	31	2.1	4.27
Food processing	14	.9	21	1.4	2.33
Mulching (*gusasira*)	21	1.4	19	1.3	2.67
Inter cropping	6	.4	10	.7	1.07
Tree planting	7	.5	15	1.0	1.47
Pest and weed control	5	.3	5	.3	0.67
Organic manure/fertilizer use	45	3.0	32	2.1	5.13
Terracing and slope maintenance	3	.2	7	.5	0.67
Agro forestry	4	.3	5	.3	0.60
Total	1500	100.0	1500	100.0	

Table 29: Percent of households indicating areas where they have made use of – put into practice – the training they received

13. The survey inquired of respondents if they listen to radio broadcasts to get farm news and information about farming from those radio programs. The response showed that over fifty-five percent (55%) have indicated positively that they do. Many respondents also indicated up to five radio stations they prefer to listen to. This information offers a possibility for innovative initiatives to be undertaken to strengthen information broadcasting for farmers, especially participatory radio approaches that engage farmers actively, which are quickly developing in other parts of East Africa.

Response	Frequency	Percent
Yes	834	55.6
No	666	44.4
Total	1500	100.0

Table 30: Percent of respondents who listen to the radio for farm news and farming information

14. The survey also inquired about whether the respondents get weather information from any source that helps them make decisions about their farming activities for the day or the week – for a short-term period. Slightly over forty two percent (42%) indicated they did. This information offers a possibility for initiatives to strengthen climate information services, which are quickly developing in other parts of East Africa.

Response	Frequency	Percent
Yes	635	42.3
No	865	57.7
Total	1500	100.0

Table 31: Percent of respondents who get daily or weekly weather information that helps them make decisions about their daily or weekly farming activities

15. The survey asked the respondents what crops they were growing and whether the mix of crops they were growing had changed in the last five years[7]. The percent of respondents growing up to thirteen (13) different crops is provided below. For example, nearly eighty percent (80%) of the households are growing beans; sixty three percent (63%) of the households are growing maize; more than fifty-eight percent (58%) of the households are growing plantain; fifty-five percent (55%) are growing cassava; nearly fifty percent (50%) are growing sweet potato and nearly thirty percent (30%) of respondents grow sorghum. While there appear to have been great strides in Rwanda to increase wheat and rice production, only five percent (5%) of respondents grow wheat and just fewer than six percent (6%) of respondents grow rice.

    Farmers are shifting their mix of crops to take advantage of prices, or to address their needs. These shifts are made slowly. The date we collected shows that among respondents, there are shifts but in no cases did more than five percent (5%) our survey respondents add a particular crop to their mix of crops grown. For example, around four and a half percent of respondents indicated they had added maize to their mix of crops; three and a half percent (3.5%) have added plantain. We were looking to see if farmers were adding drought tolerant crops to their mix of crops - knowing this would be likely, if at all, in Eastern or Southern Provinces. A look at Provincial level data is needed and we have not yet done that analysis. However only one and a half percent of households added cassava and less than one percent (1%) added sorghum - both drought tolerant crops.

16. The survey inquired whether household were using organic manure and almost seventy eight percent (78%) indicated there were using manure. This is a fairly high rate of manure use and can be the basis for programs that can be promote the most effective and efficient use of manure to increase crop productivity and soil health.

Response	Frequency	Percent
Yes, I use manure	1166	77.7
No manure used	239	15.9
Don't know	95	6.3
Total	1500	100.0

Table 33: Percent of respondent using of manure or organic fertilizer

    (a) The survey also inquired about the change households have made in the use of organic manure this year compared to last year among those using it. Some thirty percent (30%) are using more, while

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[7]See full results in Table 32, on the next page

	Change in types of crops being grown			
	Growing this crop now		As a new crop added in the last 5 years	
Crop	Frequency	Percent	Frequency	Percent
Bananas	593	39.5	29	1.9
Plantain	876	58.4	53	3.5
Cassava	828	55.2	21	1.4
Beans	1192	79.5	24	1.6
Maize	943	62.9	69	4.6
Sweet Potato	740	49.3	9	.6
Wheat	77	5.1	1	.1
Rice	87	5.8	13	.9
Irish Potato	357	23.8	10	.7
Tea	35	2.3	2	.1
Coffee	111	7.4	4	.3
Pyrethrum	52	3.5	2	.1
Sorghum	438	29.2	9	.6

Table 32: Percent of survey respondents growing up to thirteen crops; and percent who have added a new crop to their mix of crops grown

forty one percent (41%) are using less. This might be further analyzed at the provincial level to see the distribution of this change.

Response	Frequency	Percent
More	439	29.3
Less	615	41.0
Same amount	100	6.7
Don't know	12	.8
Total	1166	77.7

Table 34: Percent of those using manure or organic fertilizer and whether they have used or less of it this year compared to last year

17. The survey inquired whether household were using inorganic fertilizer and almost forty one percent (41%) indicated there were using inorganic fertilizer. This level may be consistent with MINAGRI's promotion of fertilizer use. This fertilizer type does help with increased production in most cases at least in the near term, though it is not part of climate smart agriculture being promoted by the FAO and IFAD.

Response	Frequency	Percent
Yes, I use inorganic fertilizer	614	40.9
No inorganic fertilizer used	877	58.5
Don't know	9	.6
Total	1500	100.0

Table 35: Percent of respondent using of inorganic or chemical fertilizer

(a) The survey also asked respondents whether more or less inorganic fertilizer was being used by their household members this year compared to last year. Of those using inorganic fertilizer ten percent (10%) are using more and twenty three percent (23%) are using less.

Response	Frequency	Percent
More	150	10.0
Less	344	22.9
Same amount	113	7.5
Don't know	5	.3
Total	612	40.8

Table 36: Percent of those using inorganic or chemical fertilizer and whether they have used or less of it this year compared to last year

18. The survey asked out respondents two questions about access to markets. It asked whether they had to cross a bridge or a river - knowing that some rivers can flood and that bridges can be vulnerable under condition of flooding – especially in flash flood conditions.

Response	Frequency	Percent
Yes	614	40.9
No	886	59.1
Total	1500	100.0

Table 37: Percent of respondents who have to cross a bridge or a river when they go to the market to sell crops

(a) The survey asked respondents how long it takes them to get your farm produce to market. Distance from the market is a of vulnerability factor for rural food producers. Our data showed that seventy six percent (76%) of respondents get to market in less than three hours. Ten percent (10%) take between three and six hours to get to market and a similar amount of people require a whole day to get their good to their market. In combination twenty percent (20%) take more than three hours – up to a full day – to get their produce to their market. It will be useful to see the breakdown of this data by Province.

Response	Frequency	Percent
Less than 3 hours	1154	76.9
Between 3-6 hours	154	10.3
One full day	142	9.5
N/A	50	3.3
Total	1500	100.0

Table 38: Amount of time respondents require to get their produce to their market

19. The survey wanted to gage the level of use and the level of satisfaction of people to their local institutions. It then asked respondent how happy they were with the level of services at the agricultural cooperative in your sector. We found that a high percent of respondents did not use the service of the agricultural cooperative. Of those that did, ten percent (10%) were' more happy' with its services and nearly twenty one percent (21%) were less happy or not happy with its services.

Response	Frequency	Percent
More happy	163	10.9
Less Happy	288	19.2
Not happy	22	1.5
I don't use the agricultural cooperative	1027	68.5
Total	1500	100.0

Table 39: Percent of respondents indicating their level of use, and then satisfaction with the services of the agricultural cooperative in their sector

20. The survey wanted to gage the level of satisfaction of people with their local institutions using a different

approach. Everyone uses the roads serviced by the District government, so the question was whether the roads in their village or cell had improved or deteriorated in the last two years? Overall, respondents were quite split. Thirty three percent (33%) felt they had improved, forty-five percent (45%) felt they had deteriorated, and nearly twenty-two percent (22%) indicated no change. This data will be more revealing when examined at the provincial.

Response	Frequency	Percent
Improved	497	33.1
Deteriorated	677	45.1
No change	326	21.7
Total	1500	100.0

Table 40: Percent of respondents indicating how roads have changed in the last two years

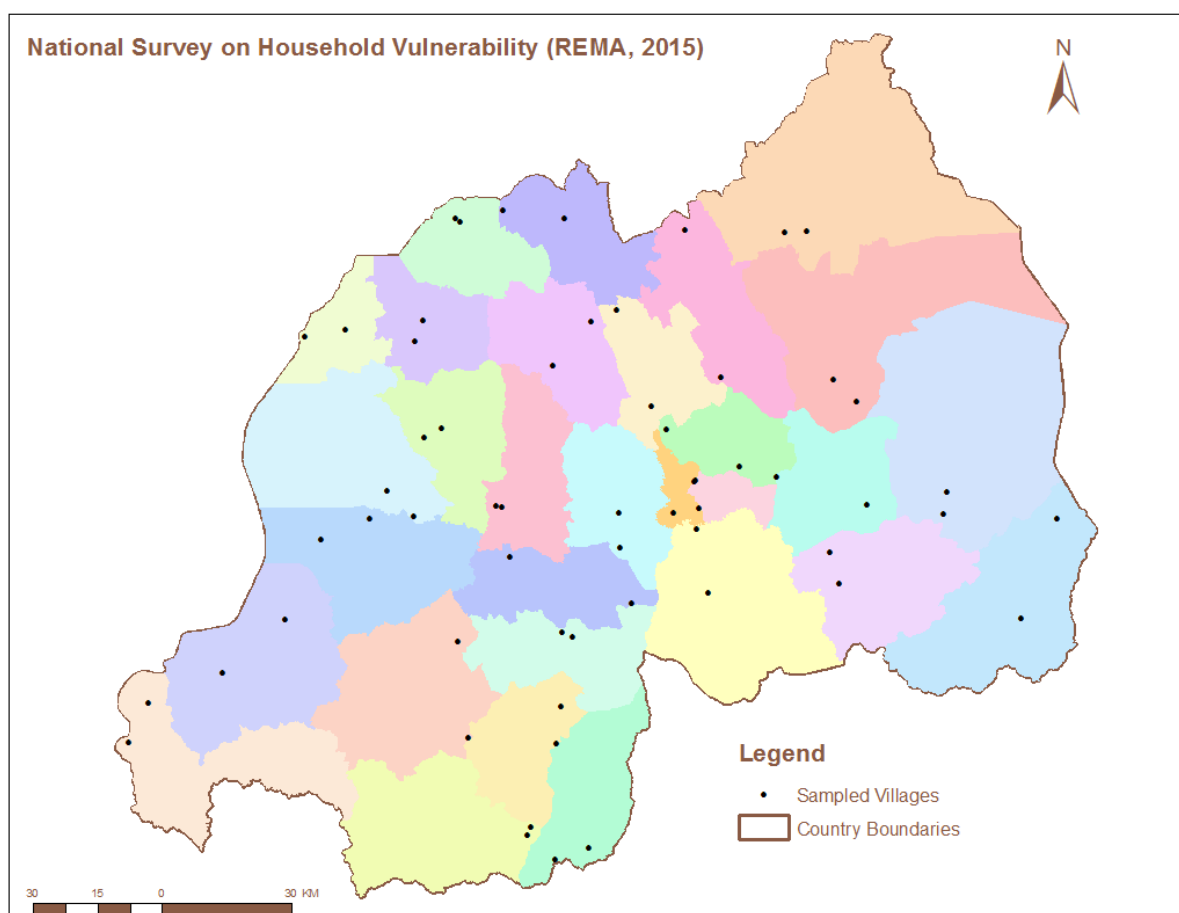## A.4 Sampled Villages in 30 Districts Where Households Were Surveyed

Figure 12: Location of the sixty sampled villages

Villages	Cells	Sectors	Districts	Provinces
Nyakabingo	Kavumu	Mageragere	Nyarugenge	Kigali city
Gahombo	Mataba	Mageragere	Nyarugenge	Kigali city
Kigarama	Nkusi	Jali	Gasabo	Kigali city
Byimana	Masoro	Ndera	Gasabo	Kigali city
Kabutare	Bwerankoni	Kigarama	Kicukiro	Kigali city
Ubumenyi	Bwerankoni	Kigarama	Kicukiro	Kigali city
Rwakaramira	Kibenga	Mayange	Bugesera	Eastern Province
Nyamabuye	Kanzenze	Ntarama	Bugesera	Eastern Province
Nyabishunzi	Sovu	Kigabiro	Rwamagana	Eastern Province
Marembo	Nyarukombe	Muyumbu	Rwamagana	Eastern Province
Bwinyana	Rusave	Murama	Kayonza	Eastern Province
Kinyinya	Rusave	Murama	Kayonza	Eastern Province
Businde	Businde	Kiramuruzi	Gatsibo	Eastern Province
Ryampunga	Murambi	Murambi	Gatsibo	Eastern Province
Kibuye	Kigarama	Katabagemu	Nyagatare	Eastern Province
Byimana	Mimuri	Mimuri	Nyagatare	Eastern Province
Rugazi	Nyange	Mugesera	Ngoma	Eastern Province
Rubago	Rubago	Rukumberi	Ngoma	Eastern Province
Efemu	Gatarama	Kigina	Kirehe	Eastern Province
Ngugu II	Mushongi	Mpanga	Kirehe	Eastern Province
Murambo	Marembo	Cyungo	Rulindo	Northern Province
Nyabuko	Kabuga	Ngoma	Rulindo	Northern Province
Kanteko	Taba	Gashenyi	Gakenke	Northern Province

|				
Gihororo	Munyana	Minazi	Gakenke	Northern Province
Butorwa I	Nyonirima	Kinigi	Musanze	Northern Province
Gasura	Nyonirima	Kinigi	Musanze	Northern Province
Nyagasozi	Gisizi	Gahunga	Burera	Northern Province
Rusebeya	Kaganda	Kinyababa	Burera	Northern Province
Gatare	Bugomba	Kaniga	Gicumbi	Northern Province
Gihira	Gaseke	Mutete	Gicumbi	Northern Province
Rugwiro	Kidahwe	Nyamiyaga	Kamonyi	Southern Province
Birembo	Mukinga	Nyamiyaga	Kamonyi	Southern Province
Rubona	Rwasare	Mushishiro	Muhanga	Southern Province
Rwuki	Rwigerero	Mushishiro	Muhanga	Southern Province
Gasiza	Kinazi	Kinazi	Ruhango	Southern Province
Kamuzimanganya	Kigarama	Mwendo	Ruhango	Southern Province
Karama	Butansinda	Kigoma	Nyanza	Southern Province
Kibaza	Butansinda	Kigoma	Nyanza	Southern Province
Gatongati	Rubona	Kigembe	Gisagara	Southern Province
Rebero	Gitega	Mukindo	Gisagara	Southern Province
Munyu	Kabona	Kinazi	Huye	Southern Province
Gakoni	Muhororo	Ruhashya	Huye	Southern Province
Gakomeye	Kizi	Kamegeri	Nyamagabe	Southern Province
Kavumu	Jenda	Kaduha	Nyamagabe	Southern Province
Nyamirama	Nyamirama	Ngera	Nyaruguru	Southern Province
Mpinga	Nyanza	Ngera	Nyaruguru	Southern Province
Kijibamba	Rwesero	Kagano	Nyamasheke	Western Province
Giseke	Muhororo	Kirimbi	Nyamasheke	Western Province
Gahinga	Gatsiro	Gihundwe	Rusizi	Western Province
Ryabadugu	Gahinga	Mururu	Rusizi	Western Province
Gihira	Kadahenda	Karaggo	Nyabihu	Western Province
Nkomane	Rugamba	Rambura	Nyabihu	Western Province
Uburezi	Mbugangari	Gisenyi	Rubavu	Western Province
Ruvuzananga	Nyarushyamba	Nyakiriba	Rubavu	Western Province
Murimba	Nyamugeyo	Kavumu	Ngororero	Western Province
Gasumo	Rugeshi	Kavumu	Ngororero	Western Province
Mara	Nyagatovu	Mubuga	Karongi	Western Province
Buhoro	Kibirizi	Rubengera	Karongi	Western Province
Kabacuzi	Kagano	Mukura	Rutsiro	Western Province
Kibari	Gitwa	Mushubati	Rutsiro	Western Province

A.5 Changes in annual warm days
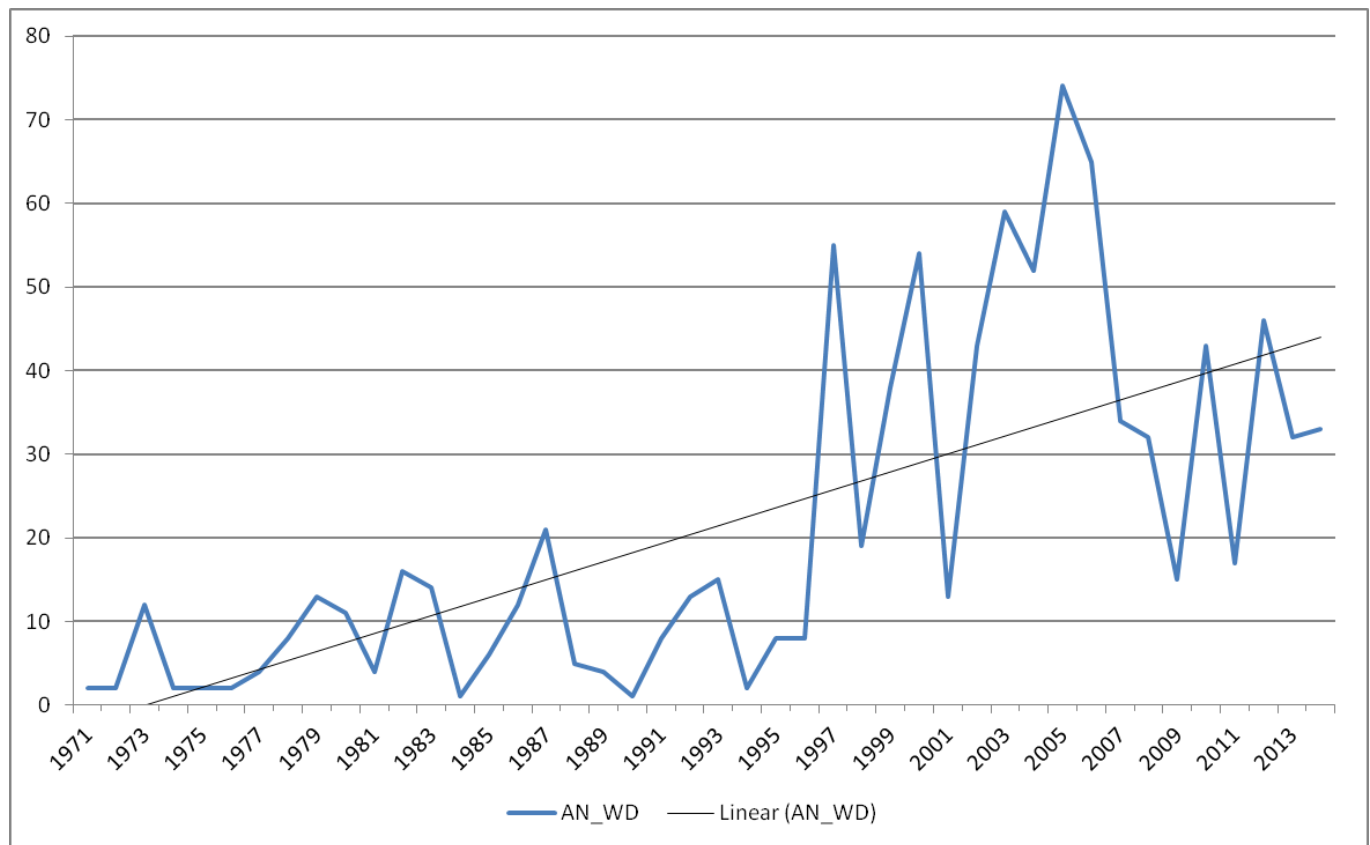
Figure 13: Changes in the number of annual warm days (days with 30°Celcius or above) in Kigali based on data from Meteo Rwanda.