REPUBLIC OF RWANDA
RWANDA ENVIRONMENT MANAGEMENT AUTHORITY

# ASSESSMENT OF CLIMATE CHANGE VULNERABILITY IN RWANDA - 2018

2019

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This is a Government of Rwanda Publication.

For bibliographic and reference purposes this publication should be referred to as :
"Assessment of climate change vulnerability in Rwanda - 2018", Rwanda Environment Management Authority, Kigali, 2019

To obtain copies of this publication, please contact:

REMA
Inyota House, KG 7 Ave
P.O. Box 7436 Kigali
Tel +250252580101
Fax +250252580017
E-mail : remainfo@rema.gov.rw
Website: www.rema.gov.rw

Cover page photo: Nyabarongo River overflowing near Ruliba Bridge, taken on the 9th May 2016

# Executive Summary

Global changes in climate are affecting Rwanda in many complex ways. These include climate related hazards such as floods, landslides and droughts as well as windstorms and severe rainstorms that have struck Rwanda in recent years with devastating effects on the population. These hazards have affected all districts and individual households across the nation – affecting the livelihoods and food security of rural and urban populations as well as the agricultural, energy, health, water, natural resource and institutional systems on which the population depends.

This report provides an examination at the country's vulnerability by taking a detailed look at climate change vulnerability in the country's 30 districts focusing on households using various indicators of household vulnerability. This report also updates REMA's national level vulnerability assessment, first prepared in 2015, using a broad range of indicators of vulnerability that were selected during the preparation of the first assessment.

Using indicators of exposure and sensitivity to climate change as well as adaptive capacity, this report provides a comprehensive data-driven picture of climate change vulnerability facing Rwanda. Data was collected through a survey of 2,407 households in all districts of the country; data has been analyzed and presented at the district and provincial levels.

This assessment provides an understanding of the relative vulnerability to climate change of the four provinces, the City of Kigali and 30 districts based on a vulnerability index. The climate change vulnerability index uses numbers to assess jurisdictions, which have then been categorized as *Low*, *Medium* and *High* vulnerability.

This report finds Southern Province as the most vulnerable among the four provinces and the City of Kigali. It also finds Huye District, in Southern Province, as the most vulnerable among the 30 districts. Four districts are assessed as having the highest vulnerability in the country – 3 of them located in Southern Province: Gisagara, Huye and Ruhango Districts together with Karongi District in Western Province.

The report identifies Northern Province as having the lowest vulnerability among the four provinces and the City of Kigali. Gasabo District is identified as having the lowest vulnerability among the 30 districts. A total of 11 districts fall into the category of low vulnerability: 3 districts in City of Kigali, 1 district in Southern Province, all 5 districts in Northern Province and two districts in Eastern Province. The remaining 15 districts have medium vulnerability.

For the **City of Kigali** both Kicukiro and Nyarugenge Districts have nearly identical values of vulnerability, with Gasabo District having a slightly lower level of vulnerability. When compared to all the other districts, the 3 districts in Kigali have low vulnerability.

In **Southern Province**, Muhanga District has the lowest vulnerability among the eight districts due to the combination of relative low impact value and high adaptive capacity. Huye District ranks as having the highest vulnerability among the 8 districts. Huye District's high

sensitivity and low adaptive capacity combine to give it the highest vulnerability score. Ruhango and Gisagara Districts have nearly identical vulnerability and rank second for vulnerability after Huye District. These three districts are in the high vulnerability category when compared to all other districts in the country.

In **Western Province**, Karongi District has the highest vulnerability among the seven districts, followed by Nyamasheke District and then by Ngororero District. This is consistent with their assessment as having a high impact from climate change. A high adaptive capacity for Ngororero District was insufficient to offset the high impact, which affected its vulnerability significantly. Vulnerability rankings for the districts of Western Province are in the category of medium vulnerability when all districts in the country are ranked, except Karongi District, which has high vulnerability.

In **Northern Province**, Gicumbi and Burera Districts share the rank of highest vulnerability among the five districts. However, all districts have high adaptive capacity, with Gakenke District having the highest and Burera District having the lowest among the districts in the province. Northern Province has the lowest vulnerability assessment of all the provinces. The high adaptive capacity of the districts helps reduce the impacts of climate change, which leads to the low vulnerability assessment for all the districts of Northern Province.

In **Eastern Province**, Gatsibo District has the lowest vulnerability followed by Rwamagana District, with Nyagatare District having the highest vulnerability. In between are Kayonza, Ngoma and Bugesera Districts, which have equal vulnerability. Kirehe District has the highest adaptive capacity, which offsets its assessment as having high impact from climate change due to high exposure and high sensitivity. Kirehe, Kayonza and Ngoma Districts all share the assessment of having the highest impact from climate change. Eastern Province was not assessed as having the highest climate change vulnerability as might have been expected, due to high values for adaptive capacity.

Leaders in the districts are urged to examine this report and its recommendations in detail and make commitments to take action and renew their commitments to fight the effects of climate change. The report is transparent – and provides considerable detail – about the factors that lead to the assessment. Action in most districts to reduce vulnerability should be focused on building the adaptive capacity in the district, and in the sectors, cells and villages, as well as at the household level. New resources, programs and targets are required – and will continue to be required – as the impacts of climate change are not decreasing. The increasing impact of climate change is likely to be felt in all parts of the country in all climate sensitive sectors and across all the systems that support household livelihoods.

This report also reviews new data collected using the National Framework for Vulnerability Assessment established in 2015 with 37 indicators of vulnerability. It analyses the changes that have taken place since data was first gathered in 2015. The analysis reveals that increases or improvements in adaptive capacity are helping to reduce the vulnerability of the country in the face of climate change. However these improvements have been offset to some extent by increases in the impact of climate change. Overall, a mixed review emerges. Recommendations are provided aimed at targeted action to reduce the sensitivity of the country to climate change factors and to build the adaptive capacity in order to reduce vulnerability and improve the level of resilience.

Thirty-seven (37) national vulnerability indicators have been analyzed to determine the direction of change between the baseline data (2015) and the current or updated data (2018):

- 17 indicators show a reduction in vulnerability (improvement);
- 11 indicators show deterioration in vulnerability;

- 5 indicators show no change in vulnerability; and
- 4 indicators provide no new data or do not allow for comparative analysis.

This is a mixed review with good signs of increasing adaptive capacity.

On the positive side, 17 indicators or 51.5% of the 33 national indicators where comparative analysis was made show an improvement – reduced vulnerability – with a large majority of adaptive capacity indicators showing an improvement.

From another perspective, 11 indicators or 33% of 33 indicators where comparative analysis was made show a deterioration of vulnerability, with a majority of exposure and sensitivity indicators showing deterioration.

More understanding will be gained as Rwanda incorporates future climate scenarios into sector analyses and strategic planning. Realization of what the future climate is likely to be will force analysts to find even more ways to increase adaptive capacity. Rwanda Meteorology Agency (Meteo Rwanda) is a very crucial institution in the provision of future climate scenarios.

Five sectors are noted for special attention in strategic planning using future climate scenarios: health, water, forestry, agriculture and energy sectors. This report also stresses that a cooperative multi-sector approach is required for robust planning to reduce vulnerability. The use of future climate forecasts is recommended in the preparation and design of new programs and projects aimed at accessing additional international climate finance for effective climate change action.

For the **health sector**, this report suggest three areas where climate impacts on the health of the population need deeper understanding, or a more widely held understanding, or at least better information. These pertain to a) health insurance coverage as part of the social safety net, b) change in prevalence of malaria hazard, and c) mortality due to diarrheal disease and malnutrition in children under age 5 (U5) who are stunted and wasted.

For the **water sector**, Rwanda faces a critical situation of water stress, which includes a low volume of artificially stored water, a high precipitation run-off rate, rough estimates only of ground water recharge rates, high demands for water in a context of low per capita water availability, and increasing need for substantial amounts of water for irrigation, industry, growing cities among other requirements. It is incumbent on the planners in the water sector to review and revise Rwanda's current Integrated Water Resources Management (IWRM) Master Plan in light of future climate probabilistic predictions.

For the **forest sector**, Rwanda faces pressures on both protected and unprotected forests including deforestation from rural households using wood to meet their energy needs. A high level of knowledge is required about the health of the current forest resources and to protect the health of the forest in the future, given future climate projections. A well informed rapid risk assessment of the health of Rwanda's forest informed by future climate predictions would provide important information for forest protection and related environmental planning.

For the **agriculture sector**, Rwanda's Strategic Plan for Agricultural Transformation (PSTA) must be increasingly well informed at every renewal opportunity by future climate scenarios and lessons learned from experience within the sector about the impacts of climate change on agricultural production. MINAGRI must have close ongoing liaison with RWFA (water sector) so that water drawdown plans for agricultural irrigation are strategically coordinated with the construction and maintenance of artificial water storage facilities and the availability of ground water resources. Plans already in MINAGRI's strategic plan that support adaptation to climate change should be strongly promoted, including plans to increased diversity in

agricultural production whereby farmers spread their risk across more crops, promotion of sustainable agriculture methodologies and promotions of “climate smart” agriculture.

For the **energy sector**, efforts to become fully informed about future climate scenarios are crucial. Energy planners should apply future climate information in strategic energy sector decision-making. This is true for the infrastructure sector as it relates to the provision of energy requirements. Rwanda can become a model for the use of climate information in energy planning given the country’s commitment to green growth and climate resilience.

All relevant stakeholders should be required by a national mandate to prepare their next sector strategies in a way that includes a comprehensive review of climate vulnerability specifically informed by future climate scenarios applied to their specific sector and their proposed programs and targets.

Districts should be encouraged to press ahead with the implementation of the ‘green economy’ plans within their District Development Strategies (DDS). Where possible districts should review their development strategies and planned projects and ensure their plans are informed by this report’s assessment of their climate vulnerabilities, and by future climate scenario.

In advance of the next assessment of vulnerability, and in collaboration with stakeholders, efforts should be undertaken to determine the expectations of change, or targets, for each of the indicators in this vulnerability assessment within the review period. Targets can be drawn, for example, from Rwanda’s Nationally Determined Contributions (NDCs) to 2030, and the 7 Years Government Programme: National Strategy for Transformation (NST 1). Stakeholders should make recommendations where targets are not available from these sources. These targets will provide a benchmark for each indicator, and will enhance the accuracy and quality of future vulnerability assessments.

# Foreword

Rwanda is committed to increasing the resilience of its people and the systems we are developing to strengthen our social and economic life and our environment in the face of climate change. As our national commitment to a green and resilient economy grows with stronger policies and programs related to climate change, so do our tools to monitor and measure our progress. Through effective monitoring we know more about the impacts of climate change and the effects of our policies and programs in order to adapt and move forward, to become even more resilient.

With this report, *National Climate Change Vulnerability and Index, 2018*, REMA is pleased to present our most recent assessment of national and local level vulnerability to climate change, including an assessment of our capacity to adapt to the impacts of climate change – adaptation that is both autonomous and stimulated by policies and programs across all sectors and areas.

The vulnerability assessment provided in this report provides the most comprehensive assessment we have prepared so far. It builds on the Baseline Climate Change Vulnerability Index for Rwanda, completed in 2015, by using the same national indicators to take stock - to update the data on our situation and our progress. It provides the first comparative examination of the extent of progress we are making in our efforts to reduce our vulnerability. This 2018 report goes even deeper than the 2015 report by providing a set of household level vulnerability indicators, with data gathered from our national survey of 2400 households. We have used this data to assesses our vulnerability at the District level. This report goes a long way towards examining and helping us understand our climate change vulnerability - District by District.

Consistent with the aims and objectives of Rwanda's NST 1 2018–2024, our commitment across multiple Ministries to mainstreaming climate change response has been well articulated. In addition our Green Growth and Climate Resilience Strategy (GGCRS) and our green fund, FONERWA, there is ample evidence of the programs, plans, projects and other initiatives we are undertaking to protect Rwanda and to grow in a sustainable way.

Government, business, non-government groups, and citizens - men and women, both rural and urban, across all sector - are aware of the challenges that climate change poses for us as a nation with our particular circumstances. We have made commitments to reduce our carbon footprint and to adapt to climate change. It is by having a comprehensive system for measuring our progress that we will be able to reflect on what we should be doing to improve our strategy and where we should be making a greater effort.

It is on the occasion of the publication of this report that I draw the attention of all citizens and decision makers from parts of Rwandan society, from all walks of life, across all sectors and in all level of government to what this report tells us. I encourage us all to examine the evidence that is provided. Please also examine the tools we are using. By issuing this report

I intend to promote a reflection on the national and local climate change vulnerabilities we face. It is by learning, understanding, and reflecting on this assessment that we will grow to be stronger as we go forward to face the challenges of climate change in Rwanda.

**Eng. Coletha U. Ruhamya**
**Director General of REMA**

# Acknowledgements


### Author
John van Mossel

### Supervision
Eng. Coletha U. Ruhamya (REMA)
Faustin Munyazikwiye (REMA)
Alphonsine Ntabana (REMA)

### Technical Coordination
Alphonse Mutabazi (REMA)
Herman Hakuzimana (REMA)
Patrick Mugabo (REMA)

### Household surveys
Aleston Kyanga (SESMEC)
Assumpta Mukaruziga (SESMEC)
Aurore Kabayiza (SESMEC)
Clarisse Impano (SESMEC)
Désiré Ndagijimana (SESMEC)
Domina Uwizera (SESMEC)
Elodie Gaju (SESMEC)
Faustin Ndayisaba (SESMEC)
Fortunée Dukuzemariya (SESMEC)
Francisca Akanyange (SESMEC)
Gaspard Hakizimana (SESMEC)
Gisèle Umutoni (SESMEC)
Godeberthe Nizeyimana (SESMEC)
Innocent Muhire (SESMEC)
Jacqueline Mukandahiro (SESMEC)
Jean Baptiste Twagiramungu (SESMEC)
Jean Claude Umuhire Dushimiyimana (SESMEC)
Juvens Irasubiza (SESMEC)
Léa Mukarurema (SESMEC)
Marguerite Nikuze (SESMEC)
Marie Josée Nyirahabimana (SESMEC)
Marie Rose Mukeshimana (SESMEC)
Marius Ndagijimana (SESMEC)
Médiatrice Mukankusi (SESMEC)
Odette Murekatete (SESMEC)
Pascasie Nyiramayonde (SESMEC)
Patience Mariza (SESMEC)
Prévert Mwumvira Mutunzi (SESMEC)
Sandra Isimbi Nkurunziza (SESMEC)
Sandra Josiane Murekatete (SESMEC)
Théodore Gashongore (SESMEC)
Vestine Uwimfura (SESMEC)
Viateur Ndagijimana (SESMEC)

### Sectoral Contributors
Alsaad Ndayizeye (RWFA)
Appolinnaire Twahirwa (REMA)
Augustin Nsangiyumva (REMA)
Brigitte Nyirambangutse (GGGI)
Camille Nyamihana (MINALOC)
Colombe Cyuzuzo (REMA - Intern)
Cyprien Ndayisaba (RTDA)
Deus Dedit Twagiramungu (MINEMA)
Didace Musoni (Meteo Rwanda)
Donatha Nibagwire (RCCDN)
Elisabeth Yambabariye (MINEMA)
Emmanuel Habimana (REMA)
Emmanuel Kamasa (RGB)
Félicien Usengumukiza (RGB)
Fidélité Ninziza (REMA)
Firmin Mugabo (FONERWA)
Godfrey Musafiri (Meteo Rwanda)
Immaculée Uwimana (MoE)
Innocent Bisangwa (MINAGRI)
Jean Claude Hafashimana (RWFA)
Jean de Dieu Mfitumukiza (REMA)
Jean Habyarimana (MINEMA)
John R. Gakwavu (RECOR)
Kévin Kamabano (REMA - Intern)
Marie Dalie Dukuze (REMA)
Marie Francoise Uwanyirigira (MINECOFIN)
Marie Leatitia Busokeye (REMA)
Martin Musonera (EDCL)
Oana Biloi (GGGI)
Patrick Umuhoza (REMA)
Rachael Businge (REMA)
Rachael Tushabe (REMA)
Sandra Sanuwera (Hinga Weze)
Serge H. Senyana (Meteo Rwanda)
Servand Niyitegeka (REMA)
Solange Umutoni (RECOR)
Sylvère Niyikora (RGB)
Valens Ndagijimana (SESMEC)
Valens Tugirimana (MINECOFIN)
Vianney Nyarubuye (REMA)
Vincent Karemera (ARECO)

### Photographs
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# 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).

**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 (Adapted from IPCC).

**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 (Adapted from USAID).

**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).

**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 re-

quire additional information such as about the observed current climate (Adapted from IPCC).

**exposure** Exposure is the character, magnitude, and rate of change and variation in the climate. Typical exposure factors include temperature, precipitation, evapo-transpiration 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).

**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. Adaptation outcomes take time to become identifiable and are often subject to evolving conditions and objectives (Adapted from IPCC Working Group II, Assessment Report Five-AR, Chapter 14 – Adaptation Needs and Options).

**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).

**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).

**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).

# Abbreviations and Acronyms

**ADR** Age Dependency Ratio
**BCM** Billion Cubic Meters
**CBD** Convention on Biological Diversity
**DDS** District Development Strategy
**EICV** Integrated Household Living Conditions
**EWS** Early Warning System
**GIZ** German Development Agency
**GWR** Ground Water Recharge
**HH** Household
**IPCC** Intergovernmental Panel on Climate Change
**IWRM** Integrated Water Resources Management
**LDCF** Least Developed Country Fund
**MEAs** Multilateral Environmental Agreements
**MIDIMAR** Ministry of Disaster Management and Refugees (former name of MINEMA)
**MINAGRI** Ministry of Agriculture
**MINALOC** Ministry of Local Government
**MINECOFIN** Ministry of Finance and Economic Planning
**MINEMA** Ministry in charge of Emergency Management
**MINIRENA** former Ministry of Natural Resources
**MINISANTE** Ministry of Health (French acronym)
**MOH** Ministry of Health
**NAP** National Adaptation Plan
**NDCs** Nationally Determined Contributions
**NISR** National Institute of Statistics of Rwanda
**NST 1** 7 Years Government Programme: National Strategy for Transformation
**OSBP** One Stop Boarder Post
**PSTA** Strategic Plan for Agricultural Transformation
**RBC** Rwanda Biomedical Centre
**RGB** Rwanda Governance Board
**RTDA** Rwanda Transport Development Agency
**RWFA** Rwanda Water and Forest Agency
**TNC** Third National Communications
**UNFCCC** United National Framework Convention on Climate Change

# 1 | Introduction

## 1.1 General context of Climate Change in Rwanda

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

The capacity and scale of adaptation to climate change depends on the vulnerability of people and natural systems to the potential impacts, which is shaped by exposure and sensitivity. The susceptibility or vulnerability of people is also shaped by their resilience or adaptive capacity. In relation to climate change, vulnerability relates to direct effects such as storms, floods, hot weather, lower or higher rainfall, where all of these effects in turn 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.

At a national level, vulnerability assessments contribute to setting development priorities and monitoring progress in addressing the impacts of climate change and building adaptive capacity. 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 and programs/projects. Also, the identification and mapping of climate related hazards and risks[1] provide clear information on the nature and characteristics of potential disasters and inform disaster management policy and planning.

## 1.2 Measuring and monitoring vulnerability to Climate Change in Rwanda

Since 2015, Rwanda has undertaken to assess social-economic and spatial vulnerability to climate change. The first initiative was the 2015, entitled “Baseline Climate Change Vulnerability Index for Rwanda”. In 2018, Rwanda sought to update that assessment and to undertake an additional assessment of vulnerability in its 30 districts to generate inputs for planning future changes and investigations, to generate climate-related vulnerability maps and to provide policy and strategy recommendations to reduce vulnerability to climate change. Specifically, REMA sought to produce an index-based ranking of vulnerabilities of Rwanda’s districts.

[1] See: MIDIMAR (2015): The National Risk Atlas of Rwanda

## 1.3 Purpose and approach

The Government of Rwanda therefore initiated a study to provide a report with three areas of focus:

- A new District vulnerability assessment and comparative Index for the 30 Districts based on new household vulnerability survey data that would be analyzed to provide the basis for an assessment report;
- An updated national-level climate change vulnerability report based on national indicators involving the collection of new data focused on real and potential climate change risks, building on the "Baseline Climate Change Vulnerability Index Report" (REMA, 2015), on the "National Disaster Risk Atlas of Rwanda" (MIDIMAR, 2015) and other relevant national and international reports and publications; and
- Policy and strategy recommendations to address current vulnerabilities.

The application of policy recommendations in this study will reduce climate change vulnerability in Rwanda. Together with the increased use of future climate information REMA hopes to develop climate scenarios for vulnerability reduction at the national level based on the outputs of this report, which will provide the basis for new programs and other initiatives.

Through its LDCF-funded project entitled: "*Building resilience of communities living in degraded forests, savannahs and wetlands of Rwanda through an ecosystem management approach*" (known as LCDF2) REMA carried out a national level climate change vulnerability assessment in the Republic of Rwanda that assessed social-economic and spatial vulnerability to climate change in the country, produce an index based ranking of vulnerabilities in its 30 Districts to be used for future changes, investigations, generate climate-related vulnerability maps and provide policy and strategy recommendations to reduce vulnerability to climate change.

## 1.4 Baseline Climate Change Vulnerability Index for Rwanda - (2015)

The "Baseline Climate Change Vulnerability Index for Rwanda" (2015) report provided a first assessment of climate change vulnerability at the national level in Rwanda, and laid 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 also provided knowledge or guidance about where to make new investments by providing key inputs for the targeting, formulating and evaluating of adaptation policies and provided information to be used in the design of new programs for adaptation and resilience, and to acquire additional resources for adaptation. There were two outputs in that study including: a) a set of national vulnerability indicators, which provided the basis for long term assessment and for a National Vulnerability Index, and b) a household-based climate change Vulnerability Index at the Provincial level in Rwanda.

## 1.5 New District Vulnerability Baseline in this 2018 Study

This 2018 study is structured similarly to the 2015 Report, with a two part focus – one part being the analysis of data from a Household Survey which provides a comprehensive approach to understanding climate change vulnerability at the District level and the preparation of a Vulnerability Index for each District that allows for a comparison across the 30 districts of Rwanda along with a ranking of the Provinces and a ranking of the districts within the provinces. The other part being the updating of data related to the National Vulnerabil-

ity indicators selected in 2015, along with a National Climate Change Assessment based on a comparison of the 2015 and the 2018 data.

The scope of this new report therefore includes:

- The District Climate Change Vulnerability Assessment and Index, including information on the methodology and tools used analyze the survey data;
- The National Climate Change Vulnerability Assessment, including the new data that provide a comparison with the 2015 baseline data – an analysis of the change; and
- Policy and strategy recommendations to stakeholders

The results of this 2018 study are presented in the next chapters of this report.

## 1.6 Stakeholder Interest

REMA is eager to share with all stakeholders the assessments provided by this report and seeks to support the recommendations – those which are useful – so that relevant stakeholders can make contributions to adaptation and increase adaptive capacity in order to reduce Rwanda's vulnerability to climate change.

As an index, this is not a comprehensive study of adaptation, but a sufficiently focused study to indicate specific systems and 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. It is hoped that this study will find resonance within various Ministries, Departments and Agencies of the Government of Rwanda and among other groups – both non governmental organisations (NGOs) and the private sector.

# 2 | District Climate Change Vulnerability Assessment

The purpose of the next two chapters is to provide the methodology and assessment tools used in the preparation of this report on District Vulnerability and to provide the Vulnerability Index for each District in Rwanda along with a baseline Vulnerability Assessment of each District.

## 2.1 Objective of an Index of District Vulnerability

The Index of Vulnerability is designed to be used as a basis for future and more detailed investigations, to stimulate policy and program reviews, to promote changes in current policies and to stimulate innovations in the area of climate change adaptation. Ultimately the index is prepared to support efforts to reduce vulnerability in Rwanda to climate change impacts, to increase adaptation efforts and to increase the resilience of Rwanda in the face of climate change impacts.

## 2.2 The Conceptual Framework

The conceptual assumption underlying this study is that climate change vulnerability is a function of impact and adaptive capacity where impact is a combination of exposure and sensitivity. This can be stated as follows:

$$Vulnerability = f(Impact, Adaptive\,Capacity)$$

It can also be stated as follows:

$$Vulnerability = f(Exposure, Sensitivity, Adaptive\,Capacity)$$

This Vulnerability Assessment and Index is based on data collected using a survey that was designed to collect data related to the exposure, sensitivity, and adaptive capacity of households in Rwanda. Data collected from households – with a sufficiently large sample – provide a picture of vulnerability at the District level.

## 2.3 Preparing a Household Survey on Climate Change Vulnerability

A questionnaire on household vulnerability was developed by this project so that data would be available that specifically related to the framework of inquiry of this project. The analysis of the household data gathered by the survey provided a picture of household vulnerability and a picture of the vulnerability at the District level.

The Household survey provided data from 2,407 households that were selected for the survey. They were located in 122 villages located across the 30 Districts of Rwanda – with an average of 80 Households surveyed in each District. For a list of villages where the survey was conducted, see Annex 3. See also Figure 1, below, which show the location of the households/villages, based on GPS co-ordinates of the households that were collected during the interviews.

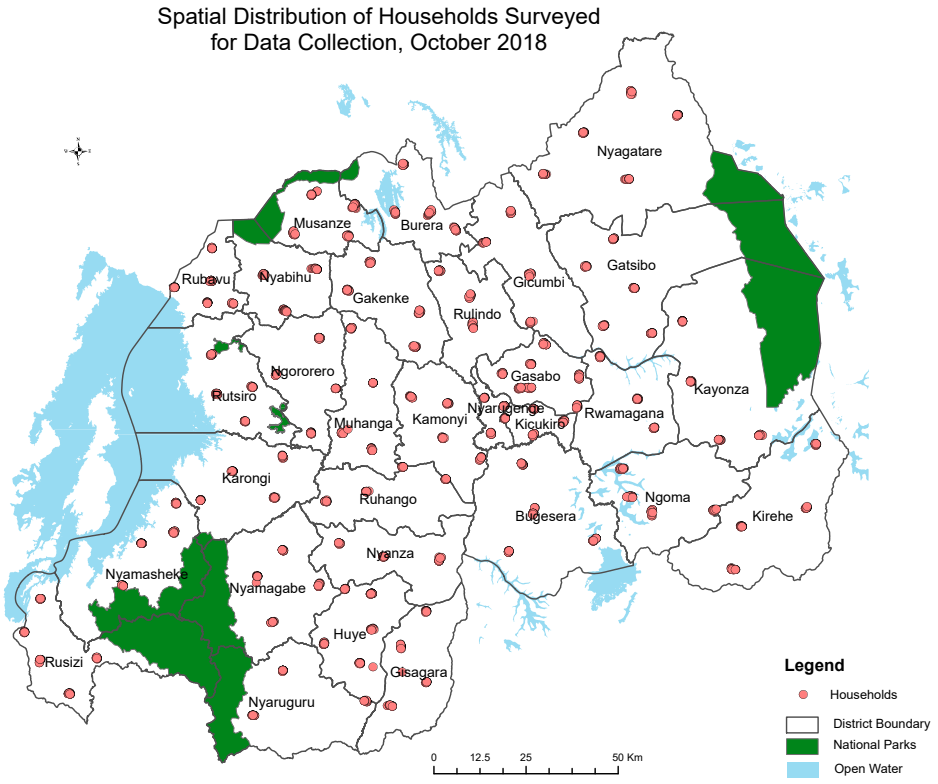



**Figure 2.1:** Spatial Distribution of Households Surveyed for Data Collection

The questionnaire covered several themes related to people's lives and the systems they use to live, including linkage to the environment and available natural resources. The questionnaire was comprised of several blocks of questions, as outlined in the Table below.

**Table 2.1:** Themes and sectors covered in the household questionnaire

| | | |
|---|---|---|
| Block 1 | Household members' details | 6 questions |
| Block 1A | Details of family members living outside village | 1 question |
| Block 1B | Disability and chronic illness | 2 questions |
| Block 2 | Sources of household income / Livelihood | 4 questions |
| Block 3 | Land ownership and access (excluding homestead) | 5 questions |
| Block 4 | House/homestead characteristics | 7 questions |
| Block 4A | Household financial assets | 4 questions |
| Block 5 | Household energy and water – access and use | 7 questions |
| Block 6 | Livestock | 5 questions |
| Block 7 | Health | 7 questions |
| Block 8 | Assessment of rural training taken and applied | 2 questions |
| Block 9 | Food security | 8 questions |
| Block 10 | Accessing farm and weather information services | 7 questions |
| Block 11 | Assessment of crop diversity and methods | 8 questions |
| Block 12 | Use of critical local infrastructure | 17 questions |
| Block 13 | Exposure to climate change | 33 questions |
| Block 14 | Sensitivity to climate change | 29 questions |
| Block 15 | Capacity to adapt to climate change impacts | 23 questions |

## 2.4 Methodology for Data Analysis

The data from the questionnaire has been used to prepare an index of vulnerability for each district. The questionnaire was designed to provide data that could be clustered and aggregated around household vulnerability indicators, where a minimum of one question or variable was linked to each Vulnerability Indicator that was selected for use in this study. The responses provided by household representatives were used for calculating vulnerability.

**For calculating Household Vulnerability**, the responses to the household survey questions were normalized. Two normalization processes were done:

1. **Normalization of metric values** - where the values of the indicator were metric (for example income, age, number of droughts) the following formula represents the normalization done: $(Value - Minimum)/(Maximum - Minimum)$;
2. **Normalization of categorical values** - where the values of indicators were categorical (Questionnaire: Block 13, 14 and 15) a five-class evaluation scheme was applied: e.g., optimal (0.1), rather positive (0.3), neutral (0.5), rather negative (0.7), critical (0.9). The values (in brackets) replaced words provided by the household's response. For example, *optimal* is replaced by 0.1, *rather positive* by 0.3.

The plan for the normalization of questionnaire values – a template for codification – is provided in Annex 2. The report on the calculation of values for each of the 36 household vulnerability indicators is also provided in Annex 1.

After normalization, each of the indicators of *Exposure*, *Sensitivity* and *Adaptive Capacity* has a value varying from 0 to 1.

The value for Exposure, Sensitivity and Adaptive Capacity is then calculated.

For each of Exposure, Sensitivity and Adaptive Capacity, the values for the respective indicators are added and then divided by the number of indicators or questionnaire responses, as follows:

1. **Exposure (E)** = Sum of the values obtained from each question related to exposure divided by the number of questions related to exposure;
2. **Sensitivity (S)** = Sum of the values obtained from each question related to sensitivity divided by the number of questions related to sensitivity;
3. **Adaptive Capacity (AC)** = Sum of the values obtained from each question related to adaptive capacity divided by the number of questions related to adaptive capacity.

**Impact (I)** and **vulnerability (V)** values were then calculated based on the vulnerability concept - that vulnerability is function of exposure, sensitivity and adaptive capacity - to produce an index where the value is a number between 0 and 1.

To calculate *Impact*, the following formula was applied:

$$I = \frac{(E + S)}{2}$$

with I = Impact, E = Exposure, and S = Sensitivity

To calculate the district vulnerability, we applied this formula:

$$V = \frac{I + AC}{2}$$

with V = Vulnerability, I = Impact, and AC = Adaptive Capacity

Before calculating the indicator value, the direction of the indicators is checked to make sure in all cases that small values mean low vulnerability and high values mean high vulnerability. Otherwise, the indicator value was amended (i.e., reversed) by (1-value).

The results shown in this report for adaptive capacity were prepared and then reversed in the final calculation of vulnerability, represented by (1-value). The reversal of the direction of AC value is represented by this formula:

$$V = \frac{I + (1 - AC)}{2}$$

The values for adaptive capacity were reversed so the values were in the right direction. In other words, a value for adaptive capacity shown in this report as 0.320 became 0.680. In order to show the results meaningfully and consistently (i.e., low value means low E, S AC or V) the converted values for adaptive capacity have been included in the tables in the next chapter of this report, though not highlighted.

**Indicated Method**: The above paragraphs lay out the "indicated" (or proposed) method for the preparation of correct statistical results. The indicated methodology was used to calculate the results from the questionnaire. However few respondents observed 'change' in response to many questions in the questionnaire about perceived change. The statistical results demonstrated only minor differences between districts. These results were not helpful in preparing an analysis; they were 'flat' and provided an obstacle to showcasing the findings, i.e., an obstacle to highlighting the differences among districts.

**Alternative Method**: An alternative methodology was therefore selected; it focused on proportions. The use of proportions provided a better portrayal of differences – district-by-district, and indicator-by-indicator, and had the advantage of showcasing the vulnerability of the districts, including those districts that increased their adaptive capacity, even where minor, showing where more adaptation effort may be needed, or where more adaptation efforts may already have been undertaken. The alternative methodology was appropriate for achieving a clearer picture of the differences among the districts while providing correct statistical results and without distorting the data. The explanation of how and where this 'proportions' approach was used is provided in Annex 1.

In preparing all the calculations, reference was made throughout to: *The GIZ Vulnerability Sourcebook, Annex*, page 53, on *Annex on Methodology*. GIZ's methodology was the basis for this study's indicated methodology and the alternative methodology was also consistent with the GIZ methodology.

The most statistically relevant values in all of the reports provided on district vulnerability are those provided for the provinces. Recall that on average 80 households were interviewed per district in an average of 4 villages per district, whereas at the provincial level more than 500 households were interviewed in each one - providing a much higher level of validity to the response. The confidence level of the survey undertaken is 90% with a margin of error of 9%, with an average of more than 360,000 people living in each district.

## 2.5 Selecting Climate Change Vulnerability Indicators

This assessment on climate change vulnerability was undertaken in order to have a first detailed look at Vulnerability in all 30 districts of Rwanda and to establish a comprehensive set of vulnerability Indicators, acquire and analyze baseline data from a household survey and prepare an initial index for each district.

Previously, in 2015, a household survey was also carried out; questionnaires were prepared and administered to 1500 households in 30 districts. That survey supported an analysis of vulnerability that was statistically valid at the provincial level. It also provided some rich data to help explain household vulnerability, adding depth to the *National Vulnerability Baseline* that was prepared at the same time.

Rather, this 2018 study undertook to establish a set of district vulnerability indicators and collect a baseline data for future use. This study sought to prepare the first ever district climate change vulnerability index for Rwanda, including a comprehensive set of vulnerability indicators, with a strong and valid set of baseline data, and an index for each of the 30 districts. Establishing a set of vulnerability indicators was particularly important in determining how data from the survey would be used. Several sources of potential vulnerability indicators were examined. These are all reported on in this document. The new baseline data from the 2018 household survey comprised the only source of data used to compile this 2018 District Climate Change Vulnerability Assessment and Index.

### 2.5.1 Links between Household Vulnerability (2018) and National Vulnerability Indicators (2015)

The new household vulnerability indicators are linked to the national vulnerability indicators presented in the Baseline Climate Change Vulnerability Index for Rwanda (2015). A review of these 37 national vulnerability indicators provided this study with 18 indicators that directly pertain to district vulnerability[1]. Of these, six (6) related to exposure, four (4) related to sensitivity and eight (8) related to adaptive capacity – with the 18 indicators cutting across all seven categories of the national vulnerability indicator framework. Thus, the district vulnerability indicators mirror the national vulnerability indicators to some extent. However they capture data beyond the scope of the national indicators.

The new household vulnerability indicators are linked to the district vulnerability indicators that were embedded in the household questionnaire administered in 2015, which provided all the data for the district-level vulnerability assessment made at that time. As the 2015 household survey was used to assess the vulnerability of provinces, it made sense to consider using some of the approach that formed that assessment. The 2015 report included a section entitled: *Household Climate Change Vulnerability Index*, which included the indicators. There were 8 indicators of exposure[2], 8 indicators of sensitivity[3] and 5 indicators of adaptive capacity[4] for a total of 21 indicators. Those indicators were reviewed but were deemed insufficient to be used "as is" for this 2018 vulnerability study; they did not ade-

[1] See list on Page 48

[2] Data from the 2015 questionnaires related to 8 indicators of exposure: on thunderstorms, heat waves, windstorms, flooding, drought episodes, shifts in rainfall start dates, change in rainfall amounts, and change in temperature

[3] Data from the 2015 questionnaires related to 8 indicators of sensitivity: family income, water sources, livelihoods, irrigation of fields, dependency level (ratio), change in the natural environment, soil fertility level and soil erosion/landslides

[4] Data from the 2015 questionnaires related to 5 indicators of adaptive capacity: change in practice after extreme weather events, change in agricultural practice, surplus production, weather or early warning information, and awareness

quately cover the wide range of climate-sensitive systems used in households. Ideas from those indicators were considered when the new district vulnerability indicators was being developed.

Additional indicators of household vulnerability were developed and selected, and then embedded into the 2018 household questionnaire. The 2018 questionnaire was revised in intentional ways to make it a stronger inquiry into **systems of household resilience and coping** with a stronger set of questions about people's access to the **health system** along with questions that deal with access to **human capital**, people's experience with the **food security system**, and the **agricultural production system**, people's access to **natural capital**, people's access to, and reliance on **social networks** and access to **social capital**, and people's experience with and access to **financial systems**, and **physical capital/assets**.

Thirty-six (36) District Vulnerability Indicators have been selected:

- 18 directly linked to the National Indicators used in 2015 and 2018; and
- 18 new indicators, including 8 indicators under 2 new areas/themes.

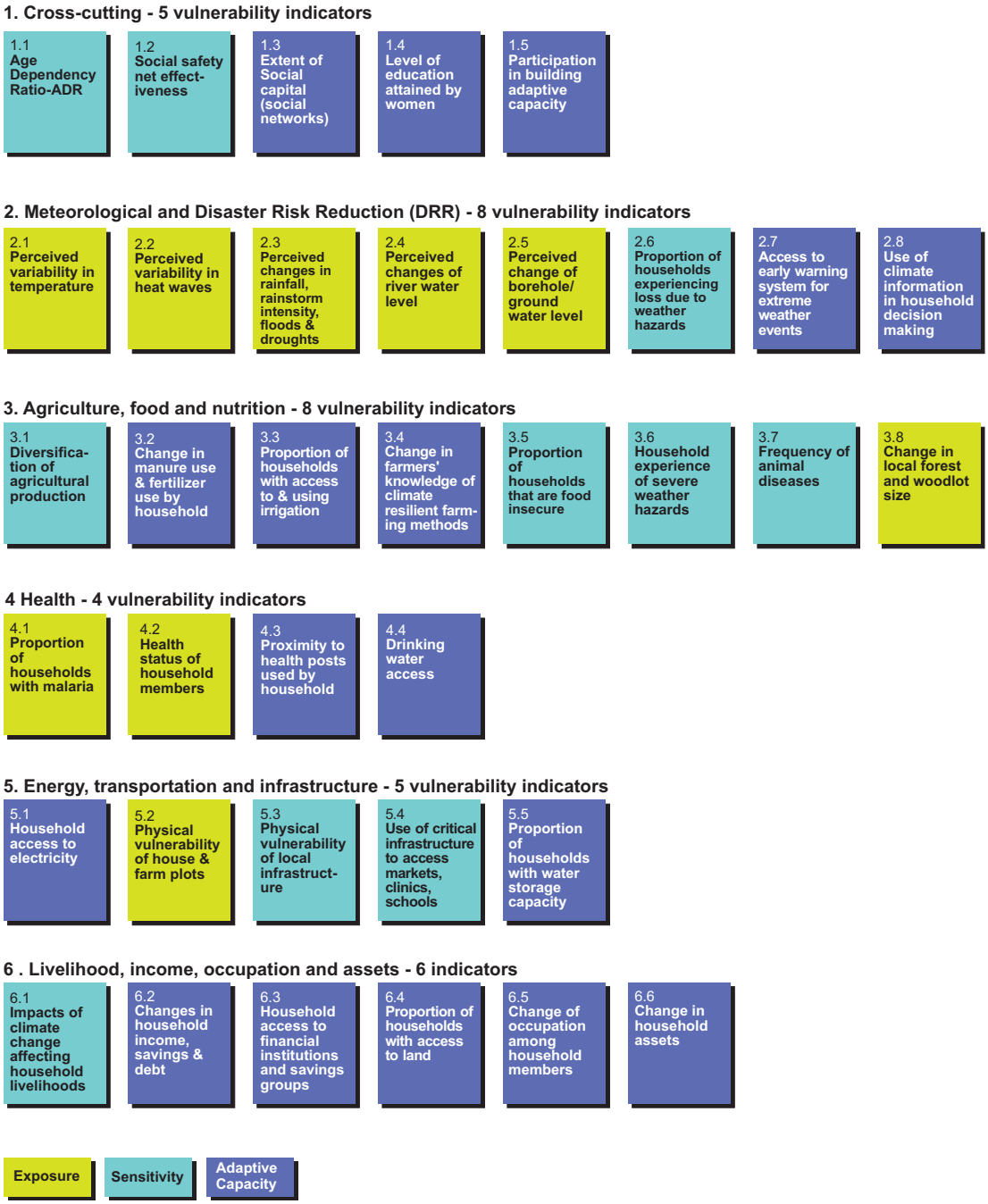
The 36 indicators cut across the 3 components of Vulnerability:

- 9 exposure (E) indicators;
- 10 sensitivity (S) indicators; and
- 17 adaptive capacity (AC) indicators.

In selecting the Indicators reference was made to various international studies. See References from Page 104.

The household climate change vulnerability indicators at household level selected for use in this study/assessment are provided on Page 10.

**Figure 2.2:** Indicators of household vulnerability*




*These 36 district climate change vulnerability indicators were selected during this 2018 assessment.

### 2.5.2 Links between the Vulnerability Indicators and the Household Questionnaire

The indicators provide the points of analysis in this report. It is through the linkage of the questionnaire data to the indicators that a value was generated for each indicator. To see the link between the Household vulnerability indicators and the responses to the household questionnaire, see the chart in **Annex 4**. The actual questionnaire is published separately

by REMA and is available on its website. This Annex lists how the questions are associated with each indicator. See the Report on the calculation of indicator value in **Annex 1** and the template for codification of the data in **Annex 2** to get the more information and a clearer picture of how the questionnaire led to the development of values for E, S and AC, and to the index of vulnerability for each district.

## 2.6 Limitations of the Report

This report presents an assessment of household vulnerability, with results represented in the various paragraphs, tables, figures and maps. The assessment is based on the values derived from responses of household members to questions presented to them in the survey questionnaire. They are not the results of any other study into the vulnerability of the districts, or a review of the resources or opportunities of the districts or an assessment of recent, current and planned projects in any district to reduce vulnerability. They are, though, the results of an inquiry into the perceptions and understanding of households whose members are important actors in the national response to the effects of climate change. Despite these limitations, this report provides an important baseline for future assessments that may examine and evaluate change in vulnerability over time in each district. It provides a robust methodology, a set of vulnerability indicators and a data set for future comparative assessment if there is a desire for consistency in approach to vulnerability assessment going forward.

This analysis is based on a treatment of all indicators as having equal value or weight. In some analysis there may be an eagerness to see some indicators weighted more than others. This has not been done in this analysis.

Also, this analysis is more oriented towards the rural sector of Rwanda than to the urban sector. In order to make it relevant to urban dwellers, question that pertained to respondents who were not farmers were skipped so as to remove the bias of having non-farmers responding to questions about agricultural and farming experience and practice. Non-farming respondents were most prevalent in the 3 districts of the City of Kigali. Where districts in the City of Kigali shows low values for indicators of adaptive capacity such as level of fertilizer use where there is less agricultural activity, a limitation of the methodology to assess District Vulnerability is highlighted.

The study results can reply to the question: 'What action should now be taken in a District?' if one looks at the values for each of the indicators that went into the calculation of exposure, sensitivity and adaptive capacity. A look at indicator values for a district allows one to see which factors affected a district's overall vulnerability or index, increasing or decreasing a district's index. These values are contained in this report in order to be transparent and allow readers to make their own observations. When values are presented in the three categories of E, S and AC, and by district and with the indicators well defined, it is hoped that the reader can gain an interpretation of the overall vulnerability of a district through a review of the numbers themselves. All values for indicators per district are presented in two digits (0.00). Presentation of the value in a three digit format (0.000) would provide a false sense of accuracy. However, when values are rolled up for each district in the charts to provide an index for exposure or sensitivity or adaptive capacity, the figures are shown in three digit format (0.000).

A further note on the results presented in this report is that several of the questions in the household questionnaire asked respondents for their perception of situation. The report on the calculation of indicator value in Annex 1 shows clearly which questions focus on respondents' perception or understanding. This presents both the strengths and weakness

of this report. It is a weakness in that the report is not a broader study of scientific data of climate change in Rwanda. However, the value is that this report reflects how citizens perceive climate change and its effects on their situation, their livelihood. This perception is important to know from a policy perspective, as it is a key factor influencing people behavior and their responses to climate change, their responses as farmers/producers, as consumers, as participants in shaping how communities respond to their environment.

The earlier report entitled: *Baseline Climate Change Vulnerability Assessment and Index*, 2015, provided a preliminary assessment of climate change at the provincial level. The current report is significantly more comprehensive in its data and assessment and the data on provinces provided in the 2015 report including the index prepare and provided in that report should not be compared to this 2018 report.

# 3 | Climate Change Vulnerability Assessment by Province and District

## 3.1 Introduction to the Provincial and District Assessments

This section provides a detailed report on the result of the Rwanda climate change vulnerability assessment by province and by district.

Each of the four provinces and the City of Kigali are presented with information on their respective levels of exposure and sensitivity – the impact of climate change, on their adaptive capacity, and on their vulnerability. The detailed data (number or values) are provided to present the assessment that has been done of each of the provinces and districts against a set of common indicators using a consistent methodology, and providing for a comparison across provinces and districts.

In addition, graphs and maps are provided later in this report that present a visual representation of the comparative vulnerability of provinces and districts.

In the provincial vulnerability assessment tables, reference is made to the 36 indicators used to analyze the data. Indicators are located in the left column of each table. Each of the indicators is represented by a short or code version of the indicator. For example: "TEMPERA-E12" is used as a code in the tables assessing Exposure. It is short for "*Perceived variability in temperature*".

A complete list of the exposure, sensitivity and adaptive capacity indicators and codes used in the provincial vulnerability assessment tables is presented in Table 3.1 on Page 14.

**Table 3.1:** Household Vulnerability Indicators and Codes used in Data Analysis

| # | *Exposure Indicators* | *Codes Used* |
|---|---|---|
| 2.1 | Perceived variability in temperature | TEMPERA-E12 |
| 2.2 | Perceived variability in heat waves | HEATWAVA-E13 |
| 2.3 | Perceived changes in rainfall, rainstorm intensity, floods and drought | PERCHANG-E14 |
| 2.4 | Perceived change in river water level | RIVERWATER-E19 |
| 2.5 | Perceived change in borehole/ground water level | BOREHOL-E20 |
| 3.8 | Change in local forest and woodlot size | WOODSIZ-E31 |
| 4.1 | Proportion of household with malaria | MALARIA-E40 |
| 4.2 | Health status of household members | HEALTHSTAT-E46 |
| 5.2 | Physical vulnerability of house and farm plots | PHYSICALVUL-E58 |
| # | *Sensitivity Indicators* | *Codes Used* |
| 1.1 | Age Dependency Ratio (ADR) | AGEDEPENDENCY-S4 |
| 1.2 | Social safety net effectiveness | SOCIALSAFETY-S6 |
| 2.6 | Proportion of households experiencing loss due to weather hazards | WEATHERHIZ-S15 |
| 3.1 | Diversification of agricultural production | AGRIDIVERSIF-S22 |
| 3.5 | Proportion of households that are food insecure | FOODINSEC-S28 |
| 3.6 | Household experience of severe weather hazards | HAZARDEFFET-S29 |
| 3.7 | Frequency of animal disease | DISEA-S30 |
| 5.3 | Physical vulnerability of local infrastructure | PHYSICALVULN-S59 |
| 5.4 | Use of critical infrastructure to access markets, clinics, schools | RANSPMARKET-S60 |
| 6.1 | Impact of climate change affecting household livelihoods | CLIMATIMPACT-S65 |
| # | *Sensitivity Indicators* | *Codes Used* |
| 1.4 | Level of education attained by women | EDUCATION-AC7 |
| 1.3 | Extent of social capital (social networks) | SOCIALCAPIT-AC9 |
| 1.5 | Participation in building adaptive capacity | PARTICIPATION-AC10 |
| 2.7 | Access to early warning system for extreme weather events | COMMUNDIS-AC16 |
| 2.8 | Use of climate information in household decision making | CLIMINFO-AC18 |
| 3.2 | Change in manure use and fertilizer use by household | ORGANMAN-AC24 |
| 3.3 | Proportion of households with access to and using irrigation | IRRIDEQU-AC26 |
| 3.4 | Change in farmers' knowledge of climate change resilient farming methods | TRAININGUSED-AC27 |
| 4.3 | Proximity to health post used by household | HALTHPOST-AC43 |
| 4.4 | Drinking water access | DRINKWATER-AC45 |
| 5.1 | Household access to electricity | ENERGYUSE-AC57 |
| 5.6 | Proportion of households with water storage capacity | WATERSTOR-AC61 |
| 6.2 | Change in household income, savings, and debt | INCOM-AC64 |
| 6.3 | Household access to financial institutions and savings groups | ACCESSFIN-AC66 |
| 6.4 | Proportion of households with access to land | ACCESSLAND-AC67 |
| 6.5 | Change in occupation among household members | OCCUPATION-AC68 |
| 6.6 | Change in household assets | HHASSET-AC69 |

## 3.2 Provincial Vulnerability Assessments

### 3.2.1 Climate Change Vulnerability Assessment for the City of Kigali

The following two tables and accompanying text present the findings – analyzed data and assessment – of the household survey on climate change vulnerability for the three districts within the City of Kigali: Nyarugenge, Gasabo and Kicukiro Districts.

**Table 3.2: City of Kigali - Exposure, Sensitivity and Impact - by district**

CITY OF KIGALI - EXPOSURE, SENSITIVITY AND IMPACT

| | Nyarugenge | Gasabo | Kicukiro | Average value/Indicator |
|---|---|---|---|---|
| Exposure indicators | | Low values = Low exposure | | |
| TEMPERA-E12 | 0.58 | 0.60 | 0.62 | 0.60 |
| HEATWAVA-E13 | 0.56 | 0.55 | 0.55 | 0.55 |
| PERCHANG-E14 | 0.57 | 0.56 | 0.59 | 0.57 |
| RIVERWATER-E19 | 0.12 | 0.04 | 0.19 | 0.12 |
| BOREHOL-E20 | 0.00 | 0.00 | 0.04 | 0.01 |
| WOODSIZ-E31 | 0.15 | 0.22 | 0.18 | 0.18 |
| MALARIA-E40 | 0.42 | 0.50 | 0.38 | 0.44 |
| HEALTHSTAT-E46 | 0.32 | 0.24 | 0.24 | 0.27 |
| PHYSICALVULE-58 | 0.07 | 0.15 | 0.14 | 0.12 |
| *Average* | *0.312* | *0.319* | *0.326* | *0.319* |
| Sensitivity indicators | | Low values = Low sensitivity | | |
| AGEDEPENDENCY-S4 | 0.50 | 0.76 | 0.74 | 0.66 |
| SOCIALSAFETY-S6 | 0.15 | 0.23 | 0.21 | 0.20 |
| WEATHERHIZ-S15 | 0.40 | 0.38 | 0.43 | 0.40 |
| AGRIDIVERSIF-S22 | 0.10 | 0.15 | 0.14 | 0.13 |
| FOODINSEC-S28 | 0.32 | 0.29 | 0.32 | 0.31 |
| HAZARDEFFET-S29 | 0.13 | 0.28 | 0.22 | 0.21 |
| DISEA-S30 | 0.17 | 0.32 | 0.11 | 0.20 |
| PHYSICALVULN-S59 | 0.27 | 0.13 | 0.20 | 0.20 |
| TRANSPMARKET-S60 | 0.50 | 0.46 | 0.49 | 0.48 |
| CLIMATIMPACT-S65 | 0.40 | 0.48 | 0.47 | 0.45 |
| *Average* | *0.294* | *0.348* | *0.331* | *0.324* |
| Impact | | Low values = Low impact | | |
| *Impact* | *0.303* | *0.333* | *0.329* | *0.322* |

### Assessment of Impact for the City of Kigali

Kicukiro District has the highest exposure value among the 3 districts in the City of Kigali, though the exposure values of all 3 Districts are not significantly different (0.31, 0,31, 0,33). Kicukiro's higher exposure value is mainly due to one variable – the perceived change in river water levels of the Nyabarongo/Akanyaru River among households due to the proximity of the River. Nyarugenge District has the lowest exposure level among the 3 districts due to its lower value for physical vulnerability of its houses and farm plots.

Nyarugenge District also has the lowest sensitivity values, mainly due to its lower age dependency ratio, its better agricultural diversity score (a small number of families practice agriculture) and the lower level of severe weather hazards experienced by its households. Gasabo has the highest sensitivity score among the three districts due to a high frequency of animal diseases, though its level of sensitivity is nearly identical to that of Kicukiro District. These 2 districts have a big proportion of their rural area.

Nyarugenge District has the lowest impact value, which is due to having the lowest value for both exposure and sensitivity.

**Table 3.3: City of Kigali - Adaptive Capacity and Vulnerability - by district**

| CITY OF KIGALI - ADAPTIVE CAPACITY AND VULNERABILITY | | | | |
|---|---|---|---|---|
| | Nyarugenge | Gasabo | Kicukiro | Average value/Indicator |
| Adaptive capacity (AC) | Low values = Low adaptive capacity | | | |
| EDUCATION-AC7 | 0.53 | 0.54 | 0.51 | 0.53 |
| SOCIALCAPIT-AC9 | 0.00 | 0.13 | 0.01 | 0.05 |
| PARTICIPATION-AC10 | 0.26 | 0.33 | 0.35 | 0.31 |
| COMMUNDIS-AC16 | 0.54 | 0.59 | 0.54 | 0.55 |
| CLIMINFO-AC18 | 0.35 | 0.35 | 0.32 | 0.34 |
| ORGANMAN-AC24 | 0.21 | 0.57 | 0.36 | 0.38 |
| IRRIDEQU-AC26 | 0.00 | 0.01 | 0.03 | 0.01 |
| TRAININGUSED-AC27 | 0.08 | 0.92 | 0.31 | 0.44 |
| HALTHPOST-AC43 | 0.82 | 0.56 | 0.57 | 0.65 |
| DRINKWATER-AC45 | 0.65 | 0.54 | 0.57 | 0.59 |
| ENERGYUSE-AC57 | 0.50 | 0.52 | 0.49 | 0.50 |
| WATERSTOR-AC61 | 0.23 | 0.18 | 0.27 | 0.23 |
| INCOM-AC64 | 0.30 | 0.34 | 0.36 | 0.33 |
| ACCESSFIN-AC66 | 0.31 | 0.42 | 0.31 | 0.34 |
| ACCESSLAND-AC67 | 0.50 | 0.73 | 0.55 | 0.59 |
| OCCUPATION-AC68 | 0.32 | 0.43 | 0.39 | 0.38 |
| HHASSET-AC69 | 0.42 | 0.42 | 0.43 | 0.42 |
| *Average* | *0.353* | *0.446* | *0.374* | *0.391* |
| Reversed adaptive capacity (1-AC) | Low values = High adaptive capacity | | | |
| *1 - AC* | *0.647* | *0.554* | *0.626* | *0.609* |
| Vulnerability | Low values = Low vulnerability | | | |
| | 0.475 | 0.444 | 0.478 | 0.465 |

### Assessment of Adaptive Capacity for City of Kigali

Nyarugenge District has the lowest adaptive capacity among the three districts due to its low value for social capital (social networks), its lower use of organic and chemical fertilizer on the farmlands within the District, and its low value for agricultural adaptation training offered and used, because few families practice agriculture. Kicukiro is in the middle of the group of three districts. The difference between Nyarugenge and Kicukiro Districts comes mainly from the high number of households having water storage, participating in tree planting, terracing or constructing drainage ditches in Kicukiro, and the roofs and walls of houses are made of a more durable material in Kicukiro than in Nyarugenge District. However Nyarugenge District has closer health posts and closer access to drinking water. Gasabo District had the highest value for adaptive capacity due to access to finance and land, the use of manure by households practicing agriculture and social capital (social networks). Gasabo district has indeed a good proportion of rural area, which favors agriculture. Despite the small number of people who received training aiming to the change of agricultural practices, the recipients of those trainings put them into practice. Many respondents indicated access to their own land with title and possessing a bank account as features of high adaptive capacity. When compared to other districts in the country, Gasabo is in the category of *high* adaptive adapacity, whereas Kicukiro is in the *medium* AC category and Nyarugenge District is in the *low* adaptive capacity category.

### Assessment of Vulnerability for City of Kigali

The vulnerability value for both Kicukiro and Nyarugenge Districts is essentially identical, with Gasabo having a slightly lower level of vulnerability. Gasabo District's relatively high adaptive capacity helped to lower its level of vulnerability. When compared to all the other

districts in the country, the 3 districts in Kigali fall into the category of *Low* Vulnerability. Potential strategies for reducing vulnerability for the most vulnerable in the City of Kigali include: in the **infrastructure sector**: increase the durability or strength of physical infrastructure in areas experiencing flooding; in the **water sector**: increase the use of water storage, including rain water storage, at household level, increase access to water including irrigation for urban and peri-urban farming; in the **health sector**: promotion of participation in *Mutuelle de Sante* is important, especially in Nyarugenge District where participation rates are the lowest among these three districts. Residents in Nyarugenge District can also be encouraged to participate more in activities to reduce vulnerability in the District and increase the strength of social networks/social capital. Further, a reduction in the number of households on very steep slopes in Kigali will reduce vulnerability, as all three districts in the City of Kigali have high and moderate slope susceptibility and exposure of housing to landslides[1].

### 3.2.2 Climate Change Vulnerability Assessment for Southern Province

The following two tables and accompanying text present the findings – analyzed data and assessment – of the household survey on climate change vulnerability for the eight districts within Southern Province: Nyanza, Gisagara, Nyaruguru, Huye, Nyamagabe, Ruhango, Muhanga and Kamonyi Districts.

[1] See also MIDIMAR (2015) The National Risk Atlas of Rwanda, page 103

**Table 3.4: Southern Province - Exposure, Sensitivity and Impact - by District**

SOUTHERN PROVINCE - EXPOSURE, SENSITIVITY AND IMPACT

| | Nyanza | Gisagara | Nyaruguru | Huye | Nyamagabe | Ruhango | Muhanga | Kamonyi | Average value/Indicator |
|---|---|---|---|---|---|---|---|---|---|
| Exposure indicators | | | | | Low values = Low exposure | | | | |
| TEMPERA-E12 | 0.65 | 0.58 | 0.55 | 0.59 | 0.59 | 0.58 | 0.61 | 0.61 | 0.60 |
| HEATWAVA-E13 | 0.61 | 0.56 | 0.52 | 0.55 | 0.54 | 0.56 | 0.55 | 0.54 | 0.55 |
| PERCHANG-E14 | 0.57 | 0.54 | 0.54 | 0.56 | 0.55 | 0.56 | 0.59 | 0.64 | 0.57 |
| RIVERWATER-E19 | 0.26 | 0.31 | 0.12 | 0.19 | 0.22 | 0.31 | 0.28 | 0.26 | 0.24 |
| BOREHOL-E20 | 0.00 | 0.06 | 0.00 | 0.00 | 0.00 | 0.13 | 0.04 | 0.03 | 0.03 |
| WOODSIZ-E31 | 0.36 | 0.32 | 0.53 | 0.37 | 0.47 | 0.32 | 0.32 | 0.20 | 0.36 |
| MALARIA-E40 | 0.76 | 0.79 | 0.56 | 0.76 | 0.51 | 0.75 | 0.54 | 0.87 | 0.69 |
| HEALTHSTAT-E46 | 0.26 | 0.29 | 0.24 | 0.21 | 0.18 | 0.22 | 0.20 | 0.30 | 0.24 |
| PHYSICALVUL-E58 | 0.38 | 0.44 | 0.42 | 0.31 | 0.35 | 0.28 | 0.37 | 0.27 | 0.35 |
| *Average* | *0.425* | *0.430* | *0.388* | *0.394* | *0.380* | *0.412* | *0.388* | *0.413* | *0.404* |
| Sensitivity indicators | | | | | Low values = Low sensitivity | | | | |
| AGEDEPENDENC-S4 | 0.61 | 0.76 | 0.43 | 0.74 | 0.50 | 0.53 | 0.64 | 0.75 | 0.62 |
| SOCIALSAFETY-S6 | 0.28 | 0.14 | 0.21 | 0.29 | 0.23 | 0.10 | 0.14 | 0.20 | 0.20 |
| WEATHERHIZ-S15 | 0.45 | 0.52 | 0.47 | 0.49 | 0.47 | 0.50 | 0.53 | 0.54 | 0.50 |
| AGRIDIVERSIF-S22 | 0.15 | 0.18 | 0.17 | 0.17 | 0.16 | 0.15 | 0.11 | 0.16 | 0.16 |
| FOODINSEC-S28 | 0.32 | 0.28 | 0.28 | 0.32 | 0.29 | 0.26 | 0.23 | 0.24 | 0.28 |
| HAZARDEFFET-S29 | 0.55 | 0.59 | 0.59 | 0.60 | 0.61 | 0.57 | 0.44 | 0.52 | 0.56 |
| DISEA-S30 | 0.16 | 0.20 | 0.08 | 0.13 | 0.05 | 0.17 | 0.10 | 0.16 | 0.13 |
| PHYSICALVULN-S59 | 0.43 | 0.53 | 0.52 | 0.60 | 0.35 | 0.51 | 0.38 | 0.17 | 0.44 |
| TRANSPMARKT-S60 | 0.48 | 0.48 | 0.49 | 0.57 | 0.45 | 0.47 | 0.49 | 0.45 | 0.49 |
| CLIMATIMPAC-S65 | 0.60 | 0.62 | 0.61 | 0.59 | 0.56 | 0.61 | 0.64 | 0.63 | 0.61 |
| *Average* | *0.405* | *0.430* | *0.385* | *0.451* | *0.368* | *0.388* | *0.369* | *0.382* | *0.397* |
| Impact | | | | | Low values = Low impact | | | | |
| *Impact* | *0.415* | *0.430* | *0.387* | *0.423* | *0.374* | *0.400* | *0.378* | *0.398* | *0.400* |

### Assessment of Impact for Southern Province

Among the 8 districts of Southern Province, the most exposed is Gisagara District followed closely by Nyanza District. Gisagara is most exposed due to having the highest values for 2 indicators: "perceived change in river water level" and "physical vulnerability of house and farm plots located on steep hillsides or near the river". Nyanza District is highly exposed due to having the highest values for 2 indicators: "perceived variability in temperature" and "perceived variability in heat waves". Nyamagabe District is the least exposed. Its low exposure is due to low values for 2 indicators: the "good health status of household members", which reduces the use of health services, and the "low proportion of households with malaria". Across the whole Province all districts experienced low exposure due to the low decline in borehole water levels, with an average score of 0.03. Across all the districts the highest exposure indicator value was for the proportion of households with malaria in Kamonyi District (*0.87*).

Huye District has the highest sensitivity value among the 8 districts. Its high sensitivity is due to having the highest values for 5 indicators: a) a relative high proportion of households with members not covered by health insurance, b) the proportion of households that are food insecure, c) household experience of severe weather hazards, d) physical vulnerability of local infrastructure (roads and bridges), and e) the long distance to get the farm produce to the markets. Moreover, the trips to the markets were not frequent because of the lack of products to sell. Two districts have nearly identical values for low sensitivity – Muhanga and Nyamagabe.

Gisagara District has the highest overall value for impact, followed closely by Huye District, whereas Nyamagabe and Muhanga have nearly identical *low* impact values. In comparison with all other districts in the country, Southern Province has 3 districts scoring *High* impact with 5 of its districts scoring *Medium* impact.

**Table 3.5: Southern Province - Adaptive Capacity and Vulnerability - by district**

SOUTHERN PROVINCE - ADAPTIVE CAPACITY AND VULNERABILITY

| | Nyanza | Gisagara | Nyaruguru | Huye | Nyamagabe | Ruhango | Muhanga | Kamonyi | Average value/Indicator |
|---|---|---|---|---|---|---|---|---|---|
| Adaptive capacity (AC) | | | | | Low values = Low adaptive capacity | | | | |
| EDUCATION-AC7 | 0.69 | 0.71 | 0.68 0.68 | 0.67 | 0.6 | 7 | 0.58 | 0.61 | 0.66 |
| SOCIALCAPIT-AC9 | 0.51 | 0.07 | 0.28 | 0.62 | 0.02 | -0.23 | 0.13 | 0.08 | 0.18 |
| PARTICIPATION-AC10 | 0.21 | 0.25 | 0.16 | 0.12 | 0.18 | 0.17 | 0.43 | 0.26 | 0.22 |
| COMMUNDIS-AC16 | 0.24 | 0.25 | 0.16 | 0.22 | 0.24 | 0.28 | 0.61 | 0.63 | 0.33 |
| CLIMINFO-AC18 | 0.45 | 0.41 | 0.45 | 0.44 | 0.44 | 0.43 | 0.29 | 0.28 | 0.40 |
| ORGANMAN-AC24 | 0.47 | 0.76 | 0.74 | 0.59 | 0.73 | 0.67 | 0.82 | 0.88 | 0.71 |
| IRRIDEQU-AC26 | 0.06 | 0.19 | 0.06 | 0.05 | 0.13 | 0.03 | 0.11 | 0.09 | 0.09 |
| TRAININGUSED-AC27 | 0.71 | 0.77 | 0.62 | 0.00 | 0.53 | 0.43 | 0.59 | 0.66 | 0.54 |
| HALTHPOST-AC43 | 0.32 | 0.31 | 0.29 | 0.29 | 0.24 | 0.39 | 0.39 | 0.28 | 0.31 |
| DRINKWATER-AC45 | 0.28 | 0.24 | 0.20 | 0.17 | 0.21 | 0.17 | 0.48 | 0.28 | 0.25 |
| ENERGYUSE-AC57 | 0.16 | 0.15 | 0.05 | 0.05 | 0.12 | 0.13 | 0.30 | 0.10 | 0.13 |
| WATERSTOR-AC61 | 0.11 | 0.03 | 0.00 | 0.01 | 0.04 | 0.00 | 0.06 | 0.03 | 0.03 |
| INCOM-AC64 | 0.31 | 0.32 | 0.25 | 0.21 | 0.24 | 0.29 | 0.44 | 0.35 | 0.30 |
| ACCESSFIN-AC66 | 0.23 | 0.31 | 0.33 | 0.21 | 0.35 | 0.23 | 0.35 | 0.33 | 0.29 |
| ACCESSLAND-AC67 | 0.55 | 0.63 | 0.71 | 0.51 | 0.79 | 0.79 | 0.82 | 0.82 | 0.70 |
| OCCUPATION-AC68 | 0.60 | 0.60 | 0.63 | 0.62 | 0.67 | 0.66 | 0.51 | 0.57 | 0.61 |
| HHASSET-AC69 | 0.29 | 0.06 | 0.05 | 0.15 | 0.08 | 0.47 | 0.48 | 0.44 | 0.25 |
| Average | 0.365 | 0.357 | 0.333 | 0.290 | 0.334 | 0.327 | 0.434 | 0.393 | 0.354 |
| Reversed adaptive capacity | | | | | Low values = High adaptive capacity | | | | |
| *1 - AC* | *0.635* | *0.643* | *0.667* | *0.710* | *0.666* | *0.673* | *0.566* | *0.607* | *0.646* |
| Vulnerability | | | | | Low values = Low vulnerability | | | | |
| | 0.525 | 0.537 | 0.527 | 0.566 | 0.520 | 0.536 | 0.472 | 0.502 | 0.523 |

#### Assessment of Adaptive Capacity for Southern Province

Huye District has the lowest adaptive capacity in the Province. It has the lowest score in 8 of the 17 indicators, though it also scored highest in the indicator for social capital (social networking). Muhanga District in contrast has the highest adaptive capacity, scoring the highest in 10 of the 17 indicators (including participation in tree planting and terracing, access to farming and weather information, use of organic manure, closer health posts and drinking water, increase in household income, use of durable material for construction). In a country-wide comparison of districts, Muhanga is the only district from Southern Province to rank as having a high adaptive capacity. All districts score low for the proportion of households with access to and using irrigation and the proportion of households with water storage capacity. The third low score throughout the Province is household access to electricity.

#### Assessment of Vulnerability for Southern Province

Muhanga District has the lowest vulnerability among the 8 districts of Southern Province due to the combination of relative low impact and high adaptive capacity. Huye District ranks as having the highest vulnerability among the 8 districts. Huye District's high sensitivity and low adaptive capacity combine to give it the highest vulnerability score. Ruhango and Gisagara Districts have nearly identical vulnerability and rank second for vulnerability after Huye. These three districts are in the high vulnerability category when compared to all other districts in the country.

Strategies for reducing Vulnerability for the most vulnerable residents of Huye District include a focus on six areas: **focus on the water sector**: increasing access to drinking water and increasing water storage capacity of households; **focus on the energy sector**: increasing access to electricity in homes; **focus on participation**: increasing citizens engagement in adaptation activities; **focus on agriculture**: promote the use and adoption of all training provided on sustainable agriculture, promote more access to land and increase the level of food security; **focus on health**: effective reduction of malaria hazard; **focus on household finance**: increasing access to financial institutions and services; **focus on infrastructure**: strengthen roads and bridges people use to go to clinics, schools and markets. In additional, the district and sectors should include climate information in their decision-making in all climate-sensitive sectors.

### 3.2.3 Climate Change Vulnerability Assessment for Western Province

The following two tables and accompanying text present the findings – analyzed data and assessment – of the household survey on climate change vulnerability for the seven districts within Western Province: Karongi, Rutsiro, Rubavu, Nyabihu, Ngororero, Rusizi, and Nyamasheke Districts.

**Table 3.6: Western Province - Exposure, Sensitivity and Impact - by district**

WESTERN PROVINCE - EXPOSURE, SENSITIVITY AND IMPACT

| | Karongi | Rutsiro | Rubavu | Nyabihu | Ngororero | Rusizi | Nyamasheke | Average value/Indicator |
|---|---|---|---|---|---|---|---|---|
| Exposure indicators | | | | | Low values = Low exposure | | | |
| TEMPERA-E12 | 0.59 | 0.61 | 0.54 | 0.52 | 0.57 | 0.62 | 0.62 | 0.58 |
| HEATWAVA-E13 | 0.56 | 0.56 | 0.52 | 0.54 | 0.52 | 0.57 | 0.56 | 0.55 |
| PERCHANG-E14 | 0.53 | 0.55 | 0.55 | 0.55 | 0.58 | 0.49 | 0.52 | 0.54 |
| RIVERWATER-E19 | 0.53 | 0.49 | 0.32 | 0.47 | 0.52 | 0.23 | 0.32 | 0.41 |
| BOREHOL-E20 | 0.16 | 0.04 | 0.06 | 0.26 | 0.03 | 0.16 | 0.06 | 0.11 |
| WOODSIZ-E31 | 0.60 | 0.57 | 0.42 | 0.41 | 0.57 | 0.42 | 0.60 | 0.51 |
| MALARIA-E40 | 0.49 | 0.26 | 0.29 | 0.42 | 0.63 | 0.80 | 0.69 | 0.51 |
| HEALTHSTAT-E46 | 0.31 | 0.28 | 0.22 | 0.26 | 0.31 | 0.35 | 0.38 | 0.30 |
| PHYSICALVUL-E58 | 0.27 | 0.27 | 0.24 | 0.45 | 0.34 | 0.19 | 0.29 | 0.29 |
| *Average* | *0.449* | *0.404* | *0.351* | *0.432* | *0.452* | *0.426* | *0.450* | *0.423* |
| Sensitivity indicators | | | | | Low values = Low sensitivity | | | |
| AGEDEPENDENCY-S4 | 0.98 | 0.69 | 0.78 | 0.74 | 0.79 | 0.81 | 0.97 | 0.82 |
| SOCIALSAFETY-S6 | 0.27 | 0.17 | 0.16 | 0.14 | 0.14 | 0.08 | 0.18 | 0.16 |
| WEATHERHIZ-S15 | 0.53 | 0.56 | 0.48 | 0.57 | 0.57 | 0.46 | 0.50 | 0.52 |
| AGRIDIVERSIF-S22 | 0.16 | 0.12 | 0.10 | 0.14 | 0.14 | 0.12 | 0.11 | 0.13 |
| FOODINSEC-S28 | 0.28 | 0.27 | 0.30 | 0.28 | 0.28 | 0.25 | 0.25 | 0.27 |
| HAZARDEFFET-S29 | 0.66 | 0.67 | 0.49 | 0.54 | 0.70 | 0.57 | 0.67 | 0.61 |
| DISEA-S30 | 0.18 | 0.14 | 0.49 | 0.06 | 0.18 | 0.24 | 0.21 | 0.21 |
| PHYSICALVULN-S59 | 0.53 | 0.54 | 0.40 | 0.64 | 0.45 | 0.28 | 0.44 | 0.47 |
| TRANSPMARKET-S60 | 0.57 | 0.54 | 0.52 | 0.48 | 0.50 | 0.51 | 0.55 | 0.52 |
| CLIMATIMPACT-S65 | 0.52 | 0.47 | 0.44 | 0.53 | 0.46 | 0.46 | 0.56 | 0.49 |
| *Average* | *0.468* | *0.417* | *0.415* | *0.412* | *0.421* | *0.378* | *0.443* | *0.422* |
| Impact | | | | | Low values = Low impact | | | |
| *Impact* | *0.459* | *0.410* | *0.383* | *0.422* | *0.437* | *0.402* | *0.447* | *0.423* |

### Assessment of Impact for Western Province

Ngororero District had the highest exposure value followed closely by Nyamasheke and Karongi Districts. Practically speaking, these 3 districts have the same level of exposure in this study, as the differences between the values shown above are not significant. Ngororero District's high exposure is mainly due to high values for indicators related to the decrease in forest and woodlot size, the perceived changes in rainfall, and rainstorm intensity, floods and drought, and perceived change in river water level. Nyamasheke District's high exposure is mainly due to high values for indicators a) the increase in temperature, b) the decrease in local forest and woodlot size and the high number of households with members not covered by any health insurance. Karongi's high exposure is mainly due to high values for indicators related to the increase in river water level (Karongi and Ngororero Districts are located near Nyabarongo River) and the decrease in local forest and woodlot size. Rubavu District has the lowest exposure ranking among the seven districts, partly because of the low number of trips to health posts and the moderate increase in river water levels.

The same three districts scoring highest for exposure also score highest for sensitivity. Karongi's highest rank for sensitivity is due to high values for a) Age Dependency Ratio (ADR), b) the high number of households with members not covered by health insurance, c) diversification of agricultural production (relative minimum use of crops that are resistant to climate change, such as bananas, coffee and tea), and d) the long distance to get the farm produce to the local market. Nyamasheke's second highest rank is due to high values for a) Age Dependency Ratio (ADR), b) the long distance to get the farm produce to the local market and lack of products to sell to the market, and c) the impact of climate change affecting household livelihoods. Ngororero's third highest rank is due to high values for the proportion of households experiencing crop loss due to weather hazards, household experience of the reduction in soil fertility and the increase of plant diseases affecting crops. Rusizi has the lowest sensitivity rank among the seven districts in Western Province, as its population crosses fewer river/bridge during their trips to markets, clinics and school, and it has a smaller proportion of households with members not covered by health insurance. It is important to note that all districts had low sensitivity values for indicator – diversification of agricultural production, meaning that all districts use crops that are resistant to climate change.

Karongi District had the highest value for impact followed by Nyamasheke District, and by Ngororero.

Western Province has the highest values among the 5 provinces for exposure, sensitivity and impact. Four of the districts in Western Province are in the "high" rank for both exposure, sensitivity and also for impact. Karongi scored the highest value of all the districts in the country for impact.

**Table 3.7: Western Province - Adaptive Capacity and Vulnerability - by district**

| WESTERN PROVINCE - ADAPTIVE CAPACITY AND VULNERABILITY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Karongi | Rutsiro | Rubavu | Nyabihu | Ngororero | Rusizi | Nyamasheke | Average value/Indicator |
| Adaptive capacity indicators | Low values = Low adaptive capacity | | | | | | | |
| EDUCATION-AC7 | 0.66 | 0.66 | 0.65 | 0.69 | 0.67 | 0.56 | 0.62 | 0.64 |
| SOCIALCAPIT-AC9 | 0.26 | 0.21 | 0.10 | 0.17 | 0.21 | 0.21 | 0.34 | 0.21 |
| PARTICIPATION-AC10 | 0.38 | 0.35 | 0.32 | 0.53 | 0.50 | 0.37 | 0.34 | 0.40 |
| COMMUNDIS-AC16 | 0.48 | 0.52 | 0.49 | 0.35 | 0.53 | 0.54 | 0.46 | 0.48 |
| CLIMINFO-AC18 | 0.34 | 0.32 | 0.34 | 0.40 | 0.31 | 0.36 | 0.38 | 0.35 |
| ORGANMAN-AC24 | 0.75 | 0.88 | 0.56 | 0.74 | 0.90 | 0.89 | 0.92 | 0.81 |
| IRRIDEQU-AC26 | 0.12 | 0.08 | 0.06 | 0.15 | 0.14 | 0.16 | 0.14 | 0.12 |
| TRAININGUSED-AC27 | 0.58 | 0.72 | 0.71 | 0.95 | 0.80 | 0.76 | 0.62 | 0.74 |
| HEALTHPOST-AC43 | 0.28 | 0.34 | 0.40 | 0.45 | 0.37 | 0.43 | 0.49 | 0.39 |
| DRINKWATER-AC45 | 0.23 | 0.20 | 0.35 | 0.31 | 0.21 | 0.38 | 0.17 | 0.26 |
| ENERGYUSE-AC57 | 0.16 | 0.25 | 0.19 | 0.05 | 0.25 | 0.34 | 0.25 | 0.21 |
| WATERSTOR-AC61 | 0.06 | 0.06 | 0.13 | 0.01 | 0.09 | 0.04 | 0.02 | 0.06 |
| INCOM-AC64 | 0.24 | 0.27 | 0.26 | 0.33 | 0.23 | 0.31 | 0.25 | 0.27 |
| ACCESSFIN-AC66 | 0.25 | 0.31 | 0.34 | 0.30 | 0.31 | 0.38 | 0.38 | 0.32 |
| ACCESSLAND-AC67 | 0.66 | 0.83 | 0.72 | 0.71 | 0.75 | 0.92 | 0.80 | 0.77 |
| OCCUPATION-AC68 | 0.52 | 0.57 | 0.46 | 0.54 | 0.57 | 0.45 | 0.50 | 0.52 |
| HHASSET-AC69 | 0.34 | 0.49 | 0.40 | 0.42 | 0.50 | 0.19 | 0.44 | 0.40 |
| *Average Value - AC* | *0.372* | *0.414* | *0.382* | *0.418* | *0.431* | *0.428* | *0.418* | *0.409* |
| Reversed average values - AC | Low values = High adaptive capacity | | | | | | | |
| Reversed AC average | 0.628 | 0.586 | 0.618 | 0.582 | 0.569 | 0.572 | 0.582 | 0.591 |
| Vulnerability | Low values = Low vulnerability | | | | | | | |
| *Vulnerability* | 0.543 | 0.498 | 0.500 | 0.502 | 0.503 | 0.487 | 0.514 | 0.507 |

#### Assessment of Adaptive Capacity for Western Province

Karongi District scored lowest for adaptive capacity (AC) meaning lowest AC, followed closely by Rubavu District. Ngororero District has the highest value; meaning highest AC. Adaptive Capacity in the Province was strengthen by average high values for the District for Indicators related to a) change in manure and fertilizer use by household, b) change in farmers' knowledge of climate change resilient farming methods and c) proportion of households with access to land with title. AC was reduced due to low average values for Indicators related to a) the extent of social capital (social networks), b) proportion of households with access to and using irrigation, c) drinking water access, d) household access to electricity, e) proportion of households with water storage capacity and e) change in household income, savings, and debt. Adaptive Capacity rankings for the districts of Western Province are in the High and Medium categories when all districts in the country are compared and ranked.

#### Assessment of Vulnerability for Western Province

Karongi District has the highest vulnerability among the seven districts of Western Province, followed by Nyamasheke District and then by Ngororero District. This is consistent with their respective impact values. A high AC value for Ngororero District was insufficient to offset the high impact value for its vulnerability value to go down significantly. Vulnerability rankings for the districts of Western Province are in the category of Medium vulnerability when all districts in the country are ranked, though Karongi District is in the category of High vulnerability. Measures to reduce vulnerability among the most vulnerable in the province include focusing on building up the adaptive capacity. In the **water sector**: vulnerability will be reduced with increased access to clean drinking water, and increased rainwater storage and use at household level, and at schools, clinics and markets; in the **health sector**: decrease the prevalence of malaria and increase access to clinics for people lest well served; in **disaster prevention**: increase citizens' participation in tree planting, and increase the size of woodlots; and for **economic development**: work towards increased access to financial resources for livelihood improvements, including access to loans for solar electricity for lighting inside households.

### 3.2.4 Climate Change Vulnerability Assessment for Northern Province

The following two tables and accompanying text present the findings – analyzed data and assessment – of the household survey on climate change vulnerability for the five Districts within Northern Province: Rulindo, Gakenke, Musanze, Burera and Gicumbi Districts.

**Table 3.8: Northern Province - Exposure, Sensitivity and Impact - by district**

NORTHERN PROVINCE - EXPOSURE, SENSITIVITY AND IMPACT

| | Rulindo | Gakenke | Musanze | Burera | Gicumbi | Average value/Indicator |
|---|---|---|---|---|---|---|
| Exposure indicators | | | Low values = Low exposure | | | |
| TEMPERA-E12 | 0.54 | 0.60 | 0.56 | 0.62 | 0.60 | 0.59 |
| HEATWAVA-E13 | 0.54 | 0.59 | 0.56 | 0.58 | 0.62 | 0.58 |
| PERCHANG-E14 | 0.48 | 0.52 | 0.50 | 0.54 | 0.58 | 0.52 |
| RIVERWATER-E19 | 0.33 | 0.46 | 0.43 | 0.29 | 0.56 | 0.42 |
| BOREHOL-E20 | 0.07 | 0.14 | 0.30 | 0.24 | 0.27 | 0.20 |
| WOODSIZ-E31 | 0.19 | 0.20 | 0.30 | 0.27 | 0.20 | 0.23 |
| MALARIA-E40 | 0.34 | 0.23 | 0.28 | 0.39 | 0.28 | 0.31 |
| HEALTHSTAT-E46 | 0.29 | 0.36 | 0.29 | 0.26 | 0.29 | 0.30 |
| PHYSICALVUL-E58 | 0.36 | 0.41 | 0.18 | 0.43 | 0.40 | 0.36 |
| *Average* | *0.350* | *0.390* | *0.378* | *0.403* | *0.424* | *0.389* |
| Sensitivity indicators | | | Low values = Low sensitivity | | | |
| AGEDEPENDENCY-S4 | 0.75 | 0.66 | 0.62 | 0.61 | 0.61 | 0.65 |
| SOCIALSAFETY-S6 | 0.07 | 0.05 | 0.19 | 0.14 | 0.11 | 0.11 |
| WEATHERHIZ-S15 | 0.49 | 0.54 | 0.49 | 0.52 | 0.56 | 0.52 |
| AGRIDIVERSIF-S22 | 0.16 | 0.15 | 0.16 | 0.18 | 0.15 | 0.16 |
| FOODINSEC-S28 | 0.23 | 0.22 | 0.23 | 0.22 | 0.27 | 0.24 |
| HAZARDEFFET-S29 | 0.55 | 0.63 | 0.52 | 0.66 | 0.60 | 0.59 |
| DISEA-S30 | 0.08 | 0.11 | 0.15 | 0.20 | 0.27 | 0.16 |
| PHYSICALVULN-S59 | 0.70 | 0.53 | 0.45 | 0.27 | 0.37 | 0.46 |
| TRANSPMARKET-S60 | 0.51 | 0.49 | 0.43 | 0.54 | 0.50 | 0.49 |
| CLIMATIMPACT-S65 | 0.58 | 0.59 | 0.40 | 0.58 | 0.62 | 0.56 |
| *Average* | *0.414* | *0.397* | *0.364* | *0.391* | *0.407* | *0.394* |
| Impact | | | Low values = Low impact | | | |
| *Impact* | 0.382 | 0.393 | 0.371 | 0.397 | 0.415 | 0.392 |

### Assessment of Impact for Northern Province

Data from the survey indicate that in Northern Province Gicumbi District ranks highest for exposure and second highest for sensitivity, giving it the highest rank for Impact. Gicumbi District's highest ranking for exposure is affected by high values for indicators of a) increase in temperature, b) frequent and longer heat waves, c) intensive rainfall, causing frequent floods, and severe droughts. Gicumbi District's second highest ranking for sensitivity is affected by high values for indicators related to a) proportion of households experiencing crop loss due to weather hazards, b) proportion of households that are food insecure, c) frequency of animal disease and d) the impact of climate change affecting household livelihoods.

Rulindo District's highest ranking for sensitivity is affected by high values for indicators related to Age Dependency Ratio (ADR) and physical vulnerability of local infrastructure (roads and bridges). However Rulindo District ranked lowest for exposure. As a result, it ranked 4$^{th}$ highest (out of 6) for impact. Burera District's second highest ranking for impact is mainly due to its second highest ranking for exposure, particularly the increase in temperature, intensive rainfalls, frequent drought episodes, house and farm plots located on steep hillsides and the proportion of households with malaria. It also ranked $^{5th}$ highest (of 6) for sensitivity.

The survey data indicates that the districts in Northern Province, when compared to the other districts, are mainly in the medium range for impact, though Gicumbi ranks in the high range for impact. The Northern Province was known as the coolest; any change in temperature is quickly noticed.

**Table 3.9: Northern Province - Adaptive Capacity and Vulnerability - by district**

NORTHERN PROVINCE - ADAPTIVE CAPACITY AND VULNERABILITY

| | Rulindo | Gakenke | Musanze | Burera | Gicumbi | Average value/Indicator |
|---|---|---|---|---|---|---|
| Adaptive capacity indicators | Low values = Low adaptive capacity | | | | | |
| EDUCATION-AC7 | 0.63 | 0.59 | 0.62 | 0.62 | 0.61 | 0.61 |
| SOCIALCAPIT-AC9 | 0.31 | 0.22 | 0.31 | 0.21 | 0.13 | 0.24 |
| PARTICIPATION-AC10 | 0.59 | 0.45 | 0.37 | 0.46 | 0.54 | 0.48 |
| COMMUNDIS-AC16 | 0.52 | 0.47 | 0.43 | 0.49 | 0.43 | 0.47 |
| CLIMINFO-AC18 | 0.41 | 0.41 | 0.40 | 0.40 | 0.34 | 0.39 |
| ORGANMAN-AC24 | 0.79 | 0.89 | 0.79 | 0.87 | 0.72 | 0.81 |
| IRRIDEQU-AC26 | 0.27 | 0.25 | 0.19 | 0.16 | 0.37 | 0.25 |
| TRAININGUSED-AC27 | 0.97 | 0.99 | 0.93 | 0.97 | 0.93 | 0.96 |
| HALTHPOST-AC43 | 0.26 | 0.63 | 0.62 | 0.42 | 0.57 | 0.50 |
| DRINKWATER-AC45 | 0.34 | 0.36 | 0.41 | 0.30 | 0.33 | 0.35 |
| ENERGYUSE-AC57 | 0.20 | 0.24 | 0.22 | 0.26 | 0.29 | 0.24 |
| WATERSTOR-AC61 | 0.01 | 0.03 | 0.04 | 0.05 | 0.08 | 0.04 |
| INCOM-AC64 | 0.45 | 0.41 | 0.43 | 0.31 | 0.45 | 0.41 |
| ACCESSFIN-AC66 | 0.43 | 0.44 | 0.44 | 0.37 | 0.41 | 0.42 |
| ACCESSLAND-AC67 | 0.94 | 0.89 | 0.84 | 0.85 | 0.83 | 0.87 |
| OCCUPATION-AC68 | 0.59 | 0.55 | 0.48 | 0.53 | 0.53 | 0.54 |
| HHASSET-AC69 | 0.43 | 0.51 | 0.38 | 0.46 | 0.45 | 0.45 |
| *Average - AC* | *0.480* | *0.489* | *0.464* | *0.455* | *0.470* | *0.472* |
| Reversed AC | Low values = High adaptive capacity | | | | | |
| *1-AC* | *0.520* | *0.511* | *0.536* | *0.545* | *0.530* | *0.528* |
| Vulnerability | Low values = Low vulnerability | | | | | |
| *Vulnerability* | *0.451* | *0.452* | *0.454* | *0.471* | *0.471* | *0.460* |

#### Assessment of Adaptive Capacity for Northern Region

All of the Districts in Northern Province have high adaptive capacity (AC) with high values compared to all the districts in Rwanda. It is the only Province where all districts scored high values for AC. In the chart above, Indicators related to: a) level of education attained by women, b) change in manure and fertilizer use by household, c) change in farmers' knowledge of climate change resilient farming methods, and d) proportion of households with access to land with title – have the highest values and contribute to the high AC.

However, indicators related to: a) the extent of social capital (social networks), b) the proportion of households with access to and using irrigation, c) household access to electricity, and d) proportion of households with water storage capacity have the lowest values. Across the 6 districts of Northern Province, Gakenke District has the highest AC value and Burera had the lowest AC value. Strategies to decrease vulnerability can focus on protection in areas of high sensitivity and building adaptive capacity.

#### Assessment of Vulnerability for Northern Region

Within Northern Province, Gicumbi and Burera Districts share the rank of highest vulnerability. The high AC values for all districts mitigate the impact values including high sensitivity, which lead to comparatively low vulnerability values for all the district of Northern Provinces. In this assessment, Northern Province has the lowest vulnerability among all the provinces. Measures to be considered for the Province include measures to reduce sensitivity and increase adaptive capacity. It would be important to focus on the most vulnerable districts of identified as Gicumbi and Burera. These include: in the **water sector**: increasing water storage capacity and use in the dry season in water deficit areas; in the **energy sector**: increase rural access to electricity; in the **agricultural sector**: decreasing crop losses such as post harvest losses, and decreasing food insecurity – in part by using more weather and climate information in decision making at all levels; decreasing animal diseases for both animals raised for family consumption and for sale in markets; and in the **infrastructure sector**: increasing the durability or resilience of local infrastructure in flood prone areas or areas susceptible to landslides; in the **health sector**: efforts to decrease malaria prevalence are also important.

### 3.2.5 Climate Change Vulnerability Assessment for Eastern Province

The following tables and accompanying text present the findings – analyzed data and assessment – of the household survey on climate change vulnerability for the seven districts of Eastern Province: Rwamagana, Nyagatare, Gatsibo, Kayonza, Kirehe, Ngoma and Bugesera Districts.

**Table 3.10: Eastern Province - Exposure, Sensitivity and Impact - by district**

EASTERN PROVINCE - EXPOSURE, SENSITIVITY AND IMPACT

| | Rwamagana | Nyagatare | Gatsibo | Kayonza | Kirehe | Ngoma | Bugesera | Average value/Indicator |
|---|---|---|---|---|---|---|---|---|
| Exposure indicators | | | | Low values = Low exposure | | | | |
| TEMPERA-E12 | 0.64 | 0.72 | 0.62 | 0.73 | 0.75 | 0.72 | 0.69 | 0.70 |
| HEATWAVA-E13 | 0.55 | 0.66 | 0.55 | 0.59 | 0.71 | 0.71 | 0.56 | 0.62 |
| PERCHANG-E14 | 0.53 | 0.56 | 0.53 | 0.55 | 0.59 | 0.55 | 0.55 | 0.55 |
| RIVERWATER-E19 | 0.14 | 0.19 | 0.05 | 0.14 | 0.30 | 0.14 | 0.23 | 0.17 |
| BOREHOL-E20 | 0.00 | 0.07 | 0.01 | 0.08 | 0.11 | 0.08 | 0.04 | 0.05 |
| WOODSIZ-E31 | 0.13 | 0.06 | 0.26 | 0.21 | 0.20 | 0.11 | 0.33 | 0.19 |
| MALARIA-E40 | 0.78 | 0.54 | 0.51 | 0.83 | 0.50 | 0.94 | 0.70 | 0.68 |
| HEALTHSTAT-E46 | 0.20 | 0.16 | 0.20 | 0.29 | 0.30 | 0.35 | 0.35 | 0.26 |
| PHYSICALVUL-E58 | 0.06 | 0.06 | 0.07 | 0.12 | 0.11 | 0.11 | 0.10 | 0.09 |
| Average - Exposure | 0.336 | 0.336 | 0.311 | 0.392 | 0.397 | 0.411 | 0.395 | 0.368 |
| Sensitivity indicators | | | | Low values = Low sensitivity | | | | |
| AGEDEPENDENCY-S4 | 0.77 | 1.04 | 0.75 | 0.88 | 0.93 | 0.99 | 0.81 | 0.88 |
| SOCIALSAFETY-S6 | 0.18 | 0.19 | 0.11 | 0.14 | 0.18 | 0.20 | 0.08 | 0.15 |
| WEATHERHIZ-S15 | 0.37 | 0.46 | 0.38 | 0.43 | 0.47 | 0.35 | 0.40 | 0.41 |
| AGRIDIVERSIF-S22 | 0.17 | 0.15 | 0.15 | 0.18 | 0.15 | 0.16 | 0.15 | 0.16 |
| FOODINSEC-S28 | 0.26 | 0.30 | 0.25 | 0.33 | 0.31 | 0.29 | 0.28 | 0.29 |
| HAZARDEFFET-S29 | 0.58 | 0.50 | 0.52 | 0.57 | 0.50 | 0.46 | 0.48 | 0.52 |
| DISEA-S30 | 0.16 | 0.18 | 0.17 | 0.21 | 0.13 | 0.14 | 0.28 | 0.18 |
| PHYSICALVULN-S59 | 0.20 | 0.26 | 0.22 | 0.31 | 0.10 | 0.03 | 0.11 | 0.18 |
| TRANSPMARKET-S60 | 0.46 | 0.46 | 0.41 | 0.48 | 0.47 | 0.46 | 0.41 | 0.45 |
| CLIMATIMPACT-S65 | 0.30 | 0.58 | 0.41 | 0.43 | 0.62 | 0.59 | 0.58 | 0.50 |
| Average - Sensitivity | 0.345 | 0.412 | 0.337 | 0.395 | 0.388 | 0.366 | 0.356 | 0.371 |
| Impact | | | | Low values = Low impact | | | | |
| *Impact* | *0.341* | *0.374* | *0.324* | *0.394* | *0.392* | *0.389* | *0.376* | *0.370* |

### Assessment of Impact for Eastern Province

Ngoma District has the highest value for exposure in Eastern Province, followed closely by three districts with nearly the same value for exposure: Kirehe, Bugesera and Kayonza. Ngoma has the highest exposure due to high values for two indicators: perceived variability in heat waves and proportion of households with malaria. Gatsibo District has the lowest exposure value due to low values for four indicators: a) perceived variability in temperature, b) perceived variability in heat waves, c) perceived changes in rainfall, rainstorm intensity, floods and drought and d) perceived change in river water level. Overall low exposure values exist for all districts in this Province for three indicators: (a) perceived change in river water level, (b) perceived change in borehole/ground water level, and (c) change in local forest and woodlot size.

Nyagatare District has the highest level of sensitivity due to high values for these three indicators: Age Dependency Ratio (ADR) (the population in age dependency, i.e. aged 0-14 and 65+ years represent 104% of those in working age (15-65 years), household experience of severe weather hazards, especially drought, and impact of climate change affecting household livelihoods causing severe crop loss. Kayonza District has the second highest level of sensitivity in this Province, whereas Gatsibo District has the lowest value for sensitivity. Low sensitivity exists in the Province for two indicators: social safety net effectiveness (small number of households with a member not covered by health insurance) and diversification of agricultural production (the households of Gatsibo District grow mostly crops that are resistant to climate change such as bananas, coffee and tea).

Kayonza has the highest value for impact followed very closely by Kirehe and Ngoma. The difference in the value for impact for these three districts is not significant, and one can say they have the same value for Impact. Gatsibo District has the lowest value for impact, which makes sense as it had the lowest values for both exposure and sensitivity.

**Table 3.11: Eastern Province - Adaptive Capacity and Vulnerability - by district**

EASTERN PROVINCE - ADAPTIVE CAPACITY AND VULNERABILITY

| | Rwamagana | Nyagatare | Gatsibo | Kayonza | Kirehe | Ngoma | Bugesera | Average value/Indicator |
|---|---|---|---|---|---|---|---|---|
| Adaptive capacity indicators | | | | Low values = Low adaptive capacity | | | | |
| EDUCATION-AC7 | 0.60 | 0.63 | 0.63 | 0.66 | 0.67 | 0.67 | 0.50 | 0.62 |
| SOCIALCAPIT-AC9 | 0.13 | 0.23 | 0.41 | 0.36 | 0.15 | 0.57 | 0.18 | 0.29 |
| PARTICIPATION-AC10 | 0.27 | 0.08 | 0.19 | 0.25 | 0.19 | 0.15 | 0.26 | 0.20 |
| COMMUNDIS-AC16 | 0.29 | 0.34 | 0.33 | 0.31 | 0.38 | 0.25 | 0.58 | 0.35 |
| CLIMINFO-AC18 | 0.40 | 0.41 | 0.41 | 0.41 | 0.42 | 0.47 | 0.32 | 0.41 |
| ORGANMAN-AC24 | 0.79 | 0.57 | 0.84 | 0.68 | 0.86 | 0.94 | 0.77 | 0.78 |
| IRRIDEQU-AC26 | 0.01 | 0.03 | 0.03 | 0.06 | 0.14 | 0.08 | 0.06 | 0.06 |
| TRAININGUSED-AC27 | 0.62 | 0.44 | 0.62 | 0.70 | 0.82 | 0.52 | 0.77 | 0.64 |
| HALTHPOST-AC43 | 0.28 | 0.27 | 0.40 | 0.29 | 0.54 | 0.45 | 0.39 | 0.38 |
| DRINKWATER-AC45 | 0.21 | 0.17 | 0.13 | 0.26 | 0.37 | 0.11 | 0.30 | 0.22 |
| ENERGYUSE-AC57 | 0.29 | 0.35 | 0.24 | 0.21 | 0.22 | 0.23 | 0.30 | 0.26 |
| WATERSTOR-AC61 | 0.06 | 0.09 | 0.21 | 0.01 | 0.02 | 0.03 | 0.11 | 0.08 |
| INCOM-AC64 | 0.48 | 0.45 | 0.50 | 0.45 | 0.37 | 0.51 | 0.19 | 0.42 |
| ACCESSFIN-AC66 | 0.35 | 0.30 | 0.31 | 0.33 | 0.32 | 0.26 | 0.35 | 0.32 |
| ACCESSLAND-AC67 | 0.75 | 0.58 | 0.80 | 0.75 | 0.80 | 0.85 | 0.67 | 0.74 |
| OCCUPATION-AC68 | 0.52 | 0.50 | 0.52 | 0.56 | 0.59 | 0.57 | 0.32 | 0.51 |
| HHASSET-AC69 | 0.27 | 0.48 | 0.34 | 0.39 | 0.26 | 0.03 | 0.50 | 0.32 |
| *Average – AC* | *0.372* | *0.348* | *0.406* | *0.393* | *0.419* | *0.393* | *0.387* | *0.388* |
| Reversed Adaptive capacity | | | | Low values = High adaptive capacity | | | | |
| *1 - AC* | *0.628* | *0.652* | *0.594* | *0.607* | *0.581* | *0.607* | *0.613* | 0*0.612* |
| *Vulnerability* | *0.484* | *0.513* | *0.459* | *0.500* | *0.487* | *0.498* | *0.494* | *0.491* |

### Assessment of Adaptive Capacity for Eastern Province

Nyagatare District has the lowest value for adaptive capacity among the seven districts of Eastern Province due to the lack of measures to mitigate climate change such as tree planting or construction of the drainage ditches, and in some extent the low proportion of households accessing their own land. Kirehe has the highest adaptive capacity among the seven districts. Kirehe District's high value is due to high values for these five indicators: level of education attained by women, the training received and used especially in irrigation, proximity to the household's closest health posts and access to drinking water. Most districts had low adaptive capacity for the proportion of households with access to and using irrigation and proportion of households with water storage capacity. The two indicators receiving the highest values for adaptive capacity in the Province on average were related to change in manure and fertilizer use by household and the proportion of households with access to own land with title. In comparison to all the other Districts in the country, the AC for Eastern Province is rated as medium.

### Assessment of Vulnerability for Eastern Province

Gatsibo District has the lowest vulnerability in Eastern Province followed by Rwamagana District. The highest vulnerability is in Nyagatare District. In between lie Kayonza, Ngoma and Bugesera Districts, which have equal vulnerability. Overall Eastern Province did not rank as the most vulnerable province in the country as might have been expected. This is mainly due to the many factors that are used in this vulnerability assessment. Vulnerability reduction strategies should focus on increasing adaptive capacity. They include measures: increasing participation in responses to climate change impacts such as tree planting, erosion control, and measures to increase rainwater harvesting and use at schools, clinics, markets and other public facilities; in the **agricultural sector**, a focus on reducing crop loss is important along with increasing the use of training provided in areas of sustainable agriculture, and efforts to diversify crop production should be maintained and strengthened for farmers spread risk over many crops; in the **health sector**, a focus on decreasing malarial prevalence is suggested along with increasing access to health posts and clinics; in the **water sector**, increasing access to drinking water is indicated as a way to reduce vulnerability. A strong focus on strengthening the **livelihoods** of the population is recommended which include a focus on education for women and girls and increasing access to financial resources for households, for example, loans to finance off-grid solar electric lighting in households.

## 3.3 Overview of District and Provincial Vulnerability Assessment

In Table 3.12, below, a complete overview is provided of the numbers related to household vulnerability at the district level obtained from the analysis of the household survey data presented above. It is an overview of the index of vulnerability. It provides values for all districts and provinces. It provides values for the level for exposure (E) and sensitivity (S), which are computed to show values for impact (I); it provides values for the level of adaptive capacity (AC) which are computed together with the value for impact to calculate the values for vulnerability (V) of the provinces and the districts within each province. Further a national vulnerability index value is presented.

**Table 3.12:** Overview of the Index of Vulnerability at District and Provincial Level

| Index of Vulnerability for Rwanda, 2018<br>Exposure (E), Sensitivity (S), Impact (I), Adaptive Capacity (AC) and Vulnerability (V)<br>Low numbers = low E, S, I, AC and V | | | | | |
|---|---|---|---|---|---|
| District/Province | E | S | I | AC | V |
| Nyarugenge | 0.312 | 0.294 | 0.303 | 0.353 | 0.475 |
| Gasabo | 0.319 | 0.348 | 0.333 | 0.446 | 0.444 |
| Kicukiro | 0.326 | 0.331 | 0.329 | 0.374 | 0.478 |
| CITY of KIGALI | 0.319 | 0.324 | 0.322 | 0.391 | 0.465 |
| Nyanza | 0.425 | 0.405 | 0.415 | 0.365 | 0.525 |
| Gisagara | 0.430 | 0.430 | 0.430 | 0.357 | 0.537 |
| Nyaruguru | 0.388 | 0.385 | 0.387 | 0.333 | 0.527 |
| Huye | 0.394 | 0.451 | 0.423 | 0.290 | 0.566 |
| Nyamagabe | 0.380 | 0.368 | 0.374 | 0.334 | 0.520 |
| Ruhango | 0.412 | 0.388 | 0.400 | 0.327 | 0.536 |
| Muhanga | 0.388 | 0.369 | 0.378 | 0.434 | 0.472 |
| Kamonyi | 0.413 | 0.382 | 0.398 | 0.393 | 0.502 |
| SOUTHERN PROVINCE | 0.404 | 0.397 | 0.400 | 0.354 | 0.523 |
| Karongi | 0.449 | 0.468 | 0.459 | 0.372 | 0.543 |
| Rutsiro | 0.404 | 0.417 | 0.410 | 0.414 | 0.498 |
| Rubavu | 0.351 | 0.415 | 0.383 | 0.382 | 0.500 |
| Nyabihu | 0.432 | 0.412 | 0.422 | 0.418 | 0.502 |
| Ngororero | 0.452 | 0.421 | 0.437 | 0.431 | 0.503 |
| Rusizi | 0.426 | 0.378 | 0.402 | 0.428 | 0.487 |
| Nyamasheke | 0.450 | 0.443 | 0.447 | 0.418 | 0.514 |
| WESTERN PROVINCE | 0.423 | 0.422 | 0.423 | 0.409 | 0.507 |
| Rulindo | 0.350 | 0.414 | 0.382 | 0.480 | 0.451 |
| Gakenke | 0.390 | 0.397 | 0.393 | 0.489 | 0.452 |
| Musanze | 0.378 | 0.364 | 0.371 | 0.464 | 0.454 |
| Burera | 0.403 | 0.391 | 0.397 | 0.455 | 0.471 |
| Gicumbi | 0.424 | 0.407 | 0.415 | 0.470 | 0.472 |
| NORTHERN PROVINCE | 0.389 | 0.394 | 0.392 | 0.472 | 0.460 |
| Rwamagana | 0.336 | 0.345 | 0.341 | 0.372 | 0.484 |
| Nyagatare | 0.336 | 0.412 | 0.374 | 0.348 | 0.513 |
| Gatsibo | 0.311 | 0.337 | 0.324 | 0.406 | 0.459 |
| Kayonza | 0.392 | 0.395 | 0.394 | 0.393 | 0.500 |
| Kirehe | 0.397 | 0.388 | 0.392 | 0.419 | 0.487 |
| Ngoma | 0.411 | 0.366 | 0.389 | 0.393 | 0.498 |
| Bugesera | 0.395 | 0.356 | 0.376 | 0.387 | 0.494 |
| EASTERN PROVINCE | 0.368 | 0.371 | 0.370 | 0.388 | 0.491 |
| | | | | | |
| National Index of Vulnerability | | | | | 0.489 |

## 3.4 Further Analysis of Vulnerability Showing Differences Among Provinces

Below are several tables showing analysis of tabulated results from the questionnaire providing further information on climate change vulnerability and showing differences among the provinces. Most of the tables are self-explanatory in terms of the basic information they convey. In most cases, the comparisons are most interesting between Southern, Northern, Eastern and Western Provinces.

### 3.4.1 Household access to electricity

The following table shows a clear difference in the availability of electricity in households for Southern Province compared to Northern, Eastern and Western Provinces. NISR's EICV5 Report confirms that Southern Province has a lower level of household access to electricity.[2] Availability of electricity is understood as reducing vulnerability at the household level through a complex impact including a positive impact on the level of education attained and overall household productivity.

**Table 3.13:** Households with access to electricity

| Percent of households with electricity available inside their house | | | | | | |
|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total |
| Yes | 220 | 91 | 184 | 138 | 199 | 832 |
| No | 39 | 503 | 386 | 240 | 407 | 1,575 |
| % having electricity | 84.9% | 15.3% | 32.3% | 36.5% | 32.8% | 34.6% |
| Total no. of respondents | 259 | 594 | 570 | 378 | 606 | 2,407 |

### 3.4.2 Household coverage by national health insurance

The table below indicates the level of participation in the national health care plan, a key component of the social safety net in Rwanda. The participation rate in Southern Province is again lowest compared to Northern, Eastern and Western Provinces. Rwanda Demographic and Health Survey (2014-2015) reported in that in 79.1% of households, at least one member was covered by health insurance. See more information on National rates of participation in health insurance in the report on Indicator 1.4 in Chapter 4.

**Table 3.14:** Participation in *Mutuelle de Santé* health insurance

| Percent of households with electricity available inside their house | | | | | | |
|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total |
| Yes | 191 | 470 | 474 | 331 | 511 | 1,977 |
| No | 68 | 124 | 96 | 47 | 95 | 430 |
| % registered | 73.7% | 79.1% | 83.2% | 87.6% | 84.3% | 82.1% |
| Total no. of respondents | 259 | 594 | 570 | 378 | 606 | 2,407 |

### 3.4.3 Household Access to Weather Information

The table below provides analysis of the survey data on the proportion of households accessing daily or weekly weather information. Access to weather information is a key component of adaptive capacity, as this information can be used in household decision-making in many areas of household life, including livelihood decisions. The rate of access to weather information in Southern Province is lowest compared to Northern, Eastern and Western Provinces.

[2] EICV5 Utilities and Amenities Thematic Report, December 2018,Table B.6, page 160

**Table 3.15:** Access to daily or weekly weather information

| Percent of households receiving daily or weekly weather information | | | | | | |
|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total |
| Yes | 82 | 219 | 285 | 177 | 305 | 1,068 |
| No | 38 | 278 | 240 | 150 | 251 | 957 |
| % receiving weather info. | 68% | 44% | 54% | 54% | 55% | 53% |
| Total no. of respondents | 120 | 497 | 525 | 327 | 556 | 2,025 |

### 3.4.4 Irrigation Access and Crop Diversity

Irrigation and crop diversity are key among the adaptation activities that can be undertaken in the agricultural sector. The table below provides information on the proportion of households surveyed having access to and using irrigation equipment. Irrigation is a very frequent demand by farmers to enable them to respond to drought. The low rate of irrigation use in Eastern Province makes since in light of low rainfall levels. The low use of irrigation in Southern Province may shed light on the high rate of vulnerability for that Province.

**Table 3.16:** Households access to and use of irrigation equipment

| Percent of households having access to and using irrigation equipment | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 3 | 54 | 68 | 92 | 34 | 251 | 10.5 |
| No | 256 | 524 | 502 | 284 | 572 | 2,138 | 89.5 |
| % access | 1.2% | 9.3% | 11.9% | 24.5% | 5.6% | | |
| Total no. of respondents | 259 | 578 | 570 | 376 | 606 | 2,389 | 100 |

The table below illustrates the diversity of crops grown by households per Province. Crop diversity is a way that farming households spread the risk of low production or crop failure. The data obtained from the 2018 household vulnerability survey indicates that households in Southern and Eastern provinces have a higher rate of growing four drought resistant crops: bean/peas, sweet potatoes, cassava and sorghum. During Focus Group Discussions undertaken as part of the household survey, participant from 26 Districts indicated that drought was one of the most significant climate hazards, which is the same frequency that respondents mentioned landslides as a climate hazard. Unlike landslides, which are quick onset hazards, drought is a slow onset hazard with impacts more widely spread across the population when it occurs. Drought response is largely in the domain of agriculture, food security and health agencies. More diversification of crop production and cultivation of drought resistant crop is a key component of adaptive capacity. One limitation of the vulnerability study undertaken was the lack of data collected on the use of drought resistant maize.

**Table 3.17:** Crop diversity with percent of households growing various crops

| Crops grown by households in the last 2 years | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Beans/peas | 110 | 479 | 435 | 306 | 543 | 1,873 | 91.2 |
| Maize | 66 | 290 | 386 | 268 | 483 | 1,493 | 72.7 |
| Sweet potato | 75 | 440 | 277 | 246 | 317 | 1,355 | 66.0 |
| Cassava | 82 | 341 | 276 | 97 | 407 | 1,203 | 58.6 |
| Irish potato | 36 | 92 | 169 | 147 | 165 | 609 | 29.7 |
| Banana | 45 | 137 | 90 | 128 | 156 | 556 | 27.1 |
| Sorghum | 37 | 198 | 24 | 90 | 204 | 553 | 26.9 |
| Plantain | 39 | 92 | 99 | 107 | 139 | 476 | 23.2 |
| Coffee | 7 | 49 | 50 | 26 | 36 | 168 | 8.2 |
| Wheat | 1 | 22 | 42 | 35 | 0 | 100 | 4.9 |
| Rice | 2 | 32 | 5 | 0 | 13 | 52 | 2.5 |
| Tea | 0 | 5 | 23 | 17 | 2 | 47 | 2.3 |
| Pyrethrum | 0 | 2 | 1 | 10 | 2 | 15 | 0.7 |

### 3.4.5 Infrastructure resilience

The following four tables focus on people's use of bridges crossing rivers to get to markets, clinics, schools, which are key activities by which of households maintain their livelihoods, maintain their health and acquire adaptive capacity. This data is a proxy for wider infrastructure resilience.

The lower value for frequency of household members crossing bridges in Eastern Province in the two tables below reflects the lower prevalence of rivers in that Province.

**Table 3.18:** Household members crossing a bridge or river to access markets

| Percentage of household members crossing a bridge/river when going to the market | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 41 | 346 | 387 | 221 | 122 | 1,117 | 46.4 |
| No | 218 | 248 | 182 | 157 | 484 | 1,289 | 53.6 |
| % crossing bridges | 15.8% | 58.2% | 68.0% | 58.5% | 20.1% | 46.4% | |
| Total no. of respondents | 259 | 594 | 569 | 378 | 606 | 2,406 | |

There is a higher frequency of households crossing bridges to get to clinics and schools in Southern and Eastern Provinces compared to frequency of crossing bridges to get to markets. This suggests a higher dependency on bridges on routes taken to markets in those two provinces.

**Table 3.19:** Household members crossing a bridge or river to access clinics/schools

| Percent of household members crossing a bridge/river when going to the clinic/school | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 39 | 272 | 272 | 217 | 122 | 922 | 38.3 |
| No | 220 | 322 | 297 | 161 | 484 | 1,484 | 61.7 |
| % crossing a bridge | 15.1% | 45.8% | 47.8% | 57.4% | 20.1% | | |
| Total no. of respondents | 259 | 594 | 569 | 378 | 606 | 2,406 | |

In the event of flooding, bridges are a key component of infrastructure connecting people to livelihood, health and educational activities. The durability of these structures is critical. The frequency of repairs observed and reported by households is a measure of attention by road authorities to rural infrastructure requirements. This data does not indicate whether the bridges used are durable or reliable, or if the repairs and upgrades are sufficient to ensure bridges are strong enough to resist flood damage. A strong focus on climate-proofing local infrastructure is a key component adaptation planning.

**Table 3.20:** Households indicating bridges as repaired or upgraded

| Percent of households observing that bridge they crossed were repaired or upgraded | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 35 | 217 | 219 | 156 | 59 | 686 | 37.7 |
| No | 145 | 235 | 281 | 165 | 307 | 1,133 | 62.3 |
| % saw bridges repaired or upgraded | 19.4% | 48.0% | 43.8% | 48.6% | 16.1% | | |
| Total no. of respondents | 180 | 452 | 500 | 321 | 366 | 1,819 | |

The table below clearly indicates that the vast majority of those interviewed walk to their markets, suggesting that local infrastructure related to walking is key to people's livelihoods, including roads and footpaths, whether they cross bridges or not.

**Table 3.21:** Means of transport used by household members to get to the market

| Means of transport used by household members to get to the market | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Walk | 234 | 590 | 549 | 367 | 564 | 2,304 | 95.7 |
| Bike | 13 | 29 | 23 | 66 | 104 | 235 | 9.8 |
| Motorcycle | 9 | 15 | 15 | 15 | 22 | 76 | 3.2 |
| Bus | 6 | 1 | 28 | 9 | 11 | 55 | 2.3 |
| Own/private car | 24 | 1 | 0 | 0 | 0 | 25 | 1.0 |
| Boat | 0 | 1 | 0 | 2 | 0 | 3 | 0.1 |
| Other | 0 | 0 | 1 | 0 | 0 | 1 | 0.0 |

### 3.4.6 Household Participation in Adaptation and Disaster Risk Reduction Activities

The following four tables illustrate the rate of household participation in adaptation and disaster risk reduction activities: tree planting, hillside terracing, repairing or constructing drainage ditch, and learning about disaster planning. Rate of participation reflect realities on the ground in some Provinces (e.g. less terracing in Eastern Province). The tables also indicate there is room to increase participation rates to reduce risks even more that what is being done at present. Southern Province has the lowest rate of participation in discussions on preventing disaster.

**Table 3.22:** Household participation in tree plantation for increased erosion control

| Percent of household participation in tree plantation for increased erosion control | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 141 | 244 | 320 | 220 | 224 | 1,149 | 47.9 |
| No | 117 | 347 | 248 | 156 | 382 | 1,250 | 52.1 |
| % participating | 54.7% | 41.3% | 56.3% | 58.5% | 37.0% | 47.9% | 100 |
| Total no. of respondents | 258 | 591 | 568 | 376 | 606 | 2,399 | |

**Table 3.23:** Household participation in constructing new hillside terraces

| Percent of Household members participating in construction of new hillside terraces | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 14 | 68 | 147 | 166 | 46 | 441 | 18.4 |
| No | 244 | 521 | 422 | 209 | 560 | 1,956 | 81.6 |
| % participating | 5.4% | 11.5% | 25.8% | 44.3% | 7.6% | 18.4% | 100 |
| Total no. of respondents | 258 | 589 | 569 | 375 | 606 | 2,397 | |

**Table 3.24:** Household participation in construction or repair of drainage ditches

| Percent of household participation in construction or repair of drainage ditches | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 89 | 85 | 200 | 154 | 78 | 606 | 25.4 |
| No | 170 | 502 | 369 | 221 | 522 | 1784 | 74.6 |
| % participating | 34.4% | 14.5% | 35.1% | 41.1% | 13.0% | 25.4% | 100 |
| Total no. of respondents | 259 | 587 | 569 | 375 | 600 | 2390 | |

**Table 3.25:** Household participation in community discussion on preventing disasters

| Percent of household participation in community discussion on preventing disasters | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 146 | 224 | 350 | 230 | 246 | 1196 | 50.1 |
| No | 113 | 359 | 219 | 142 | 360 | 1193 | 49.9 |
| % participation | 56.4% | 38.4% | 61.5% | 61.8% | 40.6% | 50.1% | 100 |
| Total no. of respondents | 259 | 583 | 569 | 372 | 606 | 2389 | |

These tables show there is potential to be realized with more mobilization of people to participate in climate change adaptation and disaster risk reduction activities. The potential is less realized in some districts compared to others where participation rates are higher.

### 3.4.7 Households affected by climate hazards

The following seven tables provide a useful overview of the extent to which households are affected by climate hazards.

**Table 3.26:** Households affected by floods

| Percentage of household indicating their village was affected by floods in last 2 years | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 48 | 123 | 150 | 160 | 83 | 564 | 23.6 |
| No | 205 | 465 | 418 | 214 | 523 | 1,825 | 76.4 |
| % saying their villages affected | 19.0% | 20.9% | 26.4% | 42.8% | 13.7% | 23.6% | 100 |
| Total no. of respondents | 253 | 588 | 568 | 374 | 606 | 2,389 | |

*The National Risk Atlas of Rwanda (MIDIMAR) of 2015, did not assess risk associated with flood due to the lack of data.*

**Table 3.27:** Households affected by drought

| Percentage of households indicating their village was affected by drought in last 2 years | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 79 | 465 | 372 | 239 | 413 | 1,568 | 65.9 |
| No | 175 | 123 | 191 | 131 | 191 | 811 | 34.1 |
| % saying their village affected | 31% | 79% | 66% | 65% | 68% | 66% | 100 |
| Total no. of respondents | 254 | 588 | 563 | 370 | 604 | 2,379 | |

*The National Risk Atlas of Rwanda (MIDIMAR) 2015, relates drought to agricultural crop production, with households that are dependent on agriculture are more likely to be affected by drought, explaining that drought exposure is understood in terms of production losses due rain deficit affecting cultivated area and volume of crop production. It finds drought exposure in these terms to be highest in Eastern Province, Kigali City and Kamonyi in Southern Province. In*

*this climate vulnerability assessment, drought is measured as a perception among household respondents and is linked to its effects on livelihoods in a more general way that how it is assessed in MIDIMAR's Risk Atlas.*

**Table 3.28:** Households affected by landslides

| Percentage of households indicating their village was affected by landslides in last 2 years | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 25 | 145 | 250 | 179 | 4 | 603 | 25.2 |
| No | 232 | 442 | 317 | 193 | 602 | 1,786 | 74.8 |
| % saying their village affected | 9.7% | 24.7% | 44.1% | 48.1% | 0.7% | 25.2% | 100 |
| Total no. of respondents | 257 | 587 | 567 | 372 | 606 | 2,389 | |

*The National Risk Atlas of Rwanda (MIDIMAR) 2015, confirms that Southern, Western and Northern Provinces are the most prone to landslides. It offers a comprehensive assessment of landslide hazard (Section 4.2, pages 42-56).*

**Table 3.29:** Households affected by heavy rains

| Percent of households indicating their village was affected by heavy rains in last 2 years | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 155 | 493 | 429 | 262 | 257 | 1,596 | 66.7 |
| No | 104 | 96 | 138 | 112 | 348 | 798 | 33.3 |
| % saying their village affected | 59.8% | 83.7% | 75.7% | 70.1% | 42.5% | 66.7% | 100 |
| Total no. of respondents | 259 | 589 | 567 | 374 | 605 | 2,394 | |

**Table 3.30:** Households affected by severe storms

| Percentage of households indicating their village was affected by severe storms in last 2 years | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 97 | 286 | 384 | 164 | 252 | 1,183 | 49.4 |
| No | 162 | 302 | 182 | 211 | 353 | 1,210 | 50.6 |
| % saying their village affected | 37.5% | 48.6% | 67.8% | 43.7% | 41.7% | 49.4% | 100 |
| Total no. of respondents | 259 | 588 | 566 | 375 | 605 | 2,393 | |

*The National Risk Atlas of Rwanda (MIDIMAR), 2015, presents data on wind storm damage by various categories based on the strengths of wind, such as strong gale force winds, moderate gale winds, night time winds, day time winds, etc. In its analysis, two Districts experienced damage from strong gale force winds – Nyamasheke and Rusizi Districts, while 13 other districts experience moderate gale force winds. It confirms the 2 Districts most affected by strong winds are in Western Province.*

**Table 3.31:** Households affected by crop loss

| Percentage of households indicating their village was affected by crop loss in last 2 years | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 92 | 425 | 410 | 277 | 378 | 1,582 | 66.7 |
| No | 156 | 166 | 148 | 94 | 225 | 789 | 33.3 |
| % saying their village affected | 37.1% | 71.9% | 73.5% | 74.7% | 62.7% | 66.7% | 100 |
| Total no. of respondents | 248 | 591 | 558 | 371 | 603 | 2,371 | |

*This report captures all forms of reported crop loss, including loss from drought, severe rain and wind storms, landslides and severe erosion/wash outs. The National Risk Atlas of Rwanda (MIDIMAR) 2015 separates crop losses into Season A and B. It does not report crop losses for all Districts or by Province in Season A. For Season B is indicates that the highest levels of estimated crop loss due to drought are in Eastern and Southern Provinces, with Season B having higher crop losses due to drought compared to Season A.*

**Table 3.32:** Households affected by heat waves

| Percent of households indicating their village was affected by heat waves in last 2 years | | | | | | | |
|---|---|---|---|---|---|---|---|
| | City of Kigali | Southern | Western | Northern | Eastern | Total | % |
| Yes | 25 | 107 | 106 | 122 | 115 | 475 | 20.1 |
| No | 233 | 471 | 455 | 249 | 479 | 1,887 | 79.9 |
| % saying their village affected | 9.7% | 18.5% | 18.9% | 32.9% | 19.4% | 20.1% | 100 |
| Total no. of respondents | 258 | 578 | 561 | 371 | 594 | 2,362 | |

## 3.5 Graphic Presentations of District and Provincial Vulnerability Assessment

The following four charts and the seven maps below them provide a graphic representation of the information provided in Table 3.12.

**Figure 3.1:** Comparison of Districts by Value for Level of Exposure

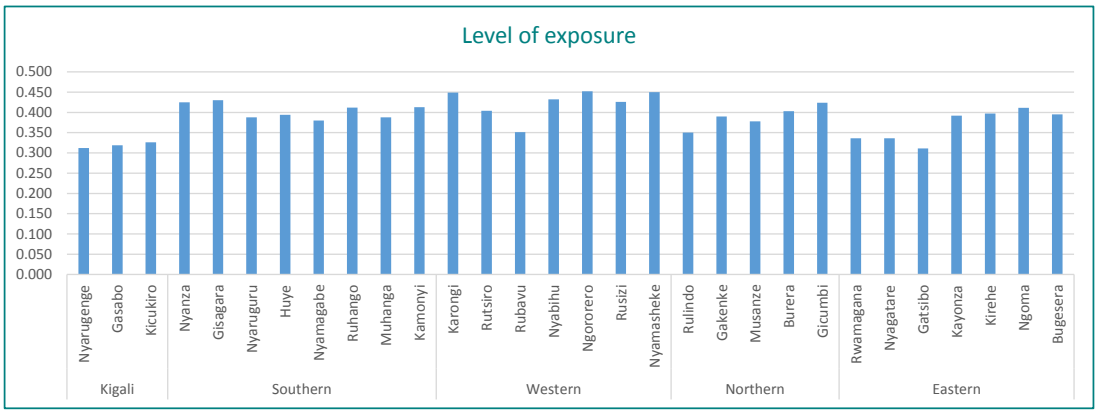


**Figure 3.2:** Comparison of Districts by Value for Level of Sensitivity

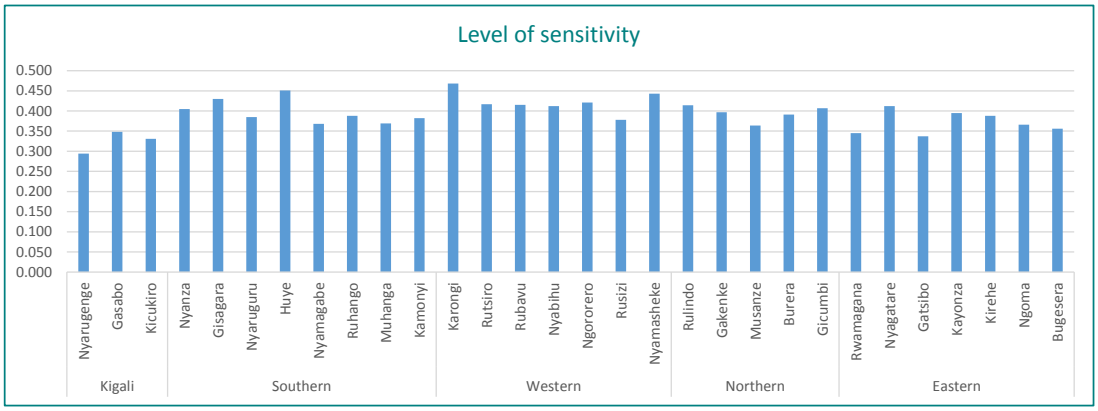



**Figure 3.3:** Comparison of Districts by Value for Level of Adaptive Capacity

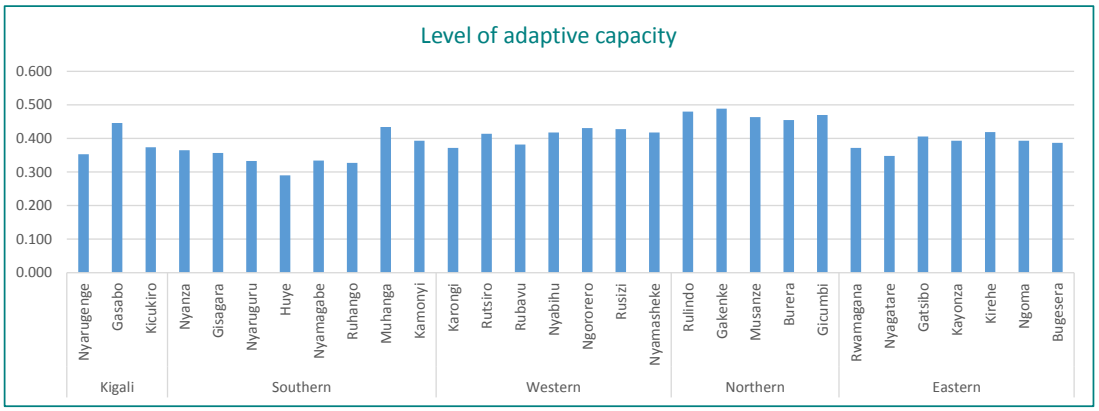



**Figure 3.4:** Comparison of Districts by Value for Level of Vulnerability

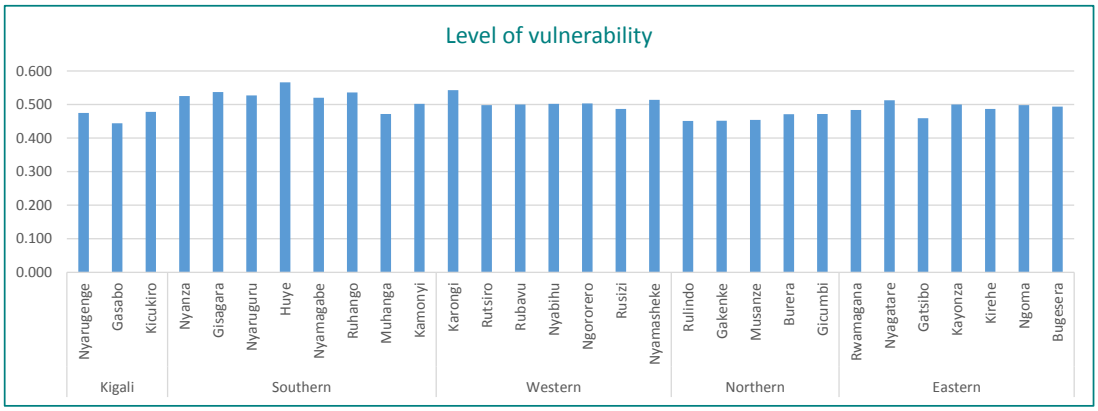
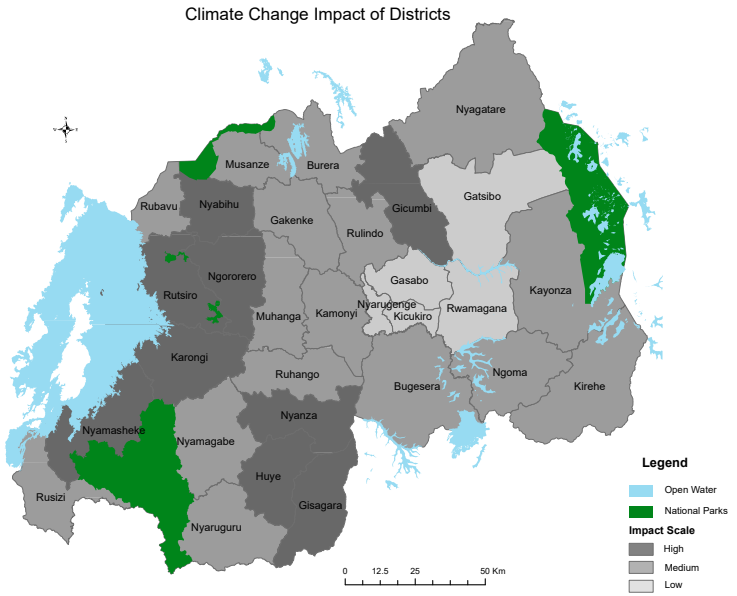
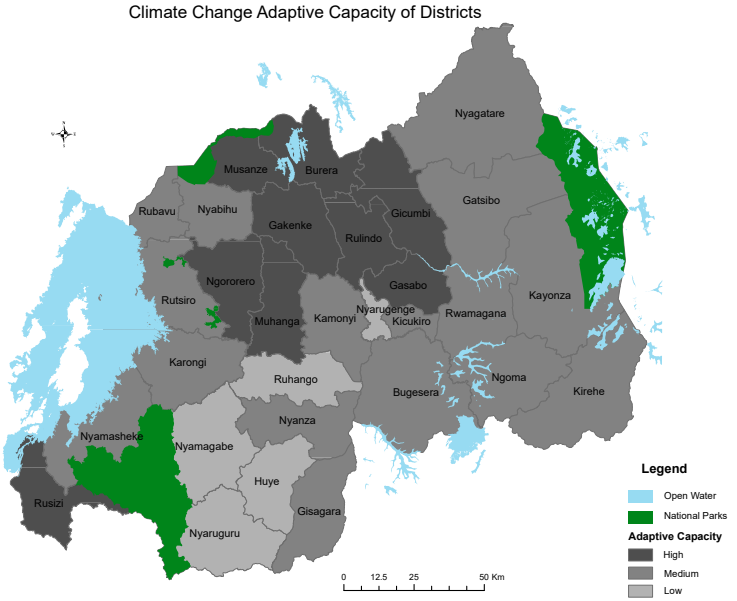


**Figure 3.5:** Map of Districts comparing level of climate change Impact



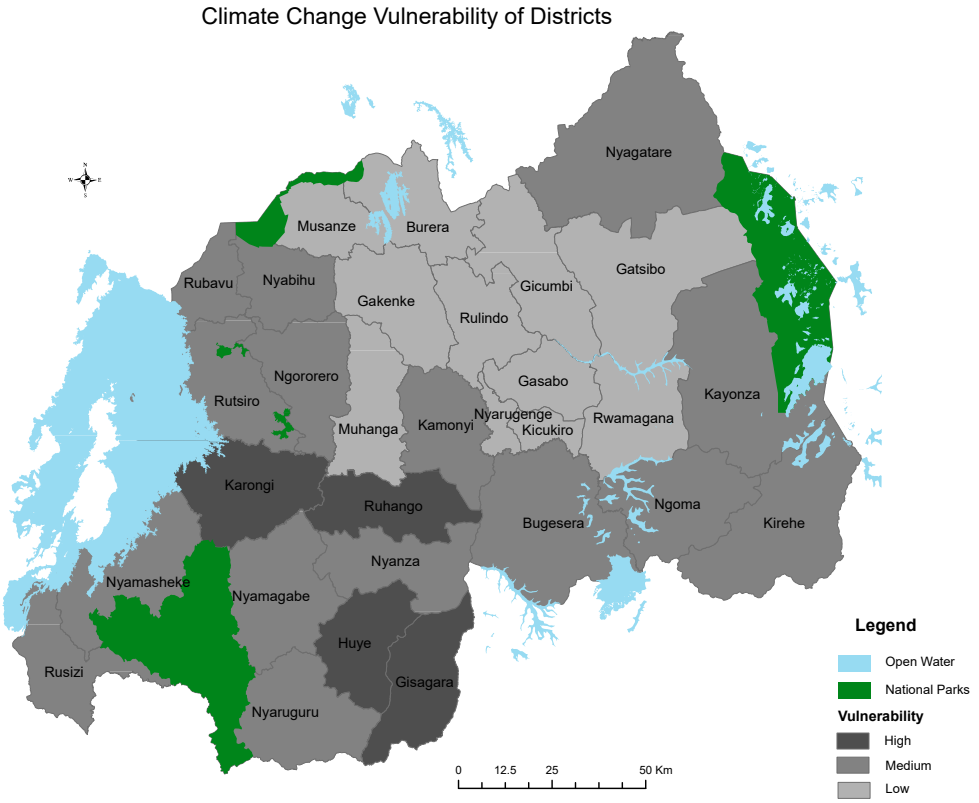

| Scale for categorizing Impact at District Level | | |
|---|---|---|
| Low | Medium | High |
| 0.303 to 0.355 | 0.356 to 0.407 | 0.408 to 0.459 |
| 5 Districts | 16 Districts | 9 Districts |
| Interval size: 0.052 | | |

**Figure 3.6:** Map of Districts comparing level of climate change adaptive capacity



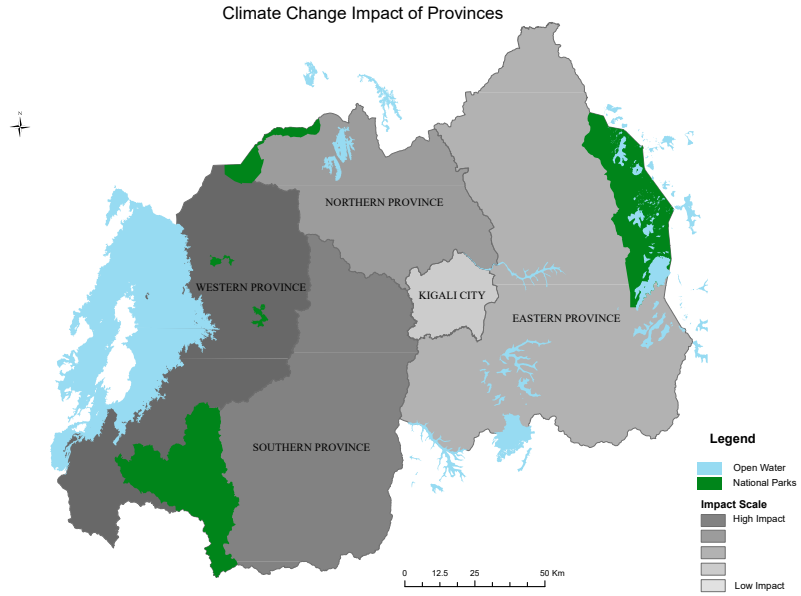

| Scale for categorizing Adaptive Capacity at District Level | | |
|---|---|---|
| Low | Medium | High |
| 0.290 to 0.356 | 0.357 to 0.420 | 0.421 to 0.489 |
| 5 Districts | 16 Districts | 9 Districts |
| Interval size: 0.0663 | | |

**Figure 3.7:** Map of Districts comparing level of climate change Vulnerability



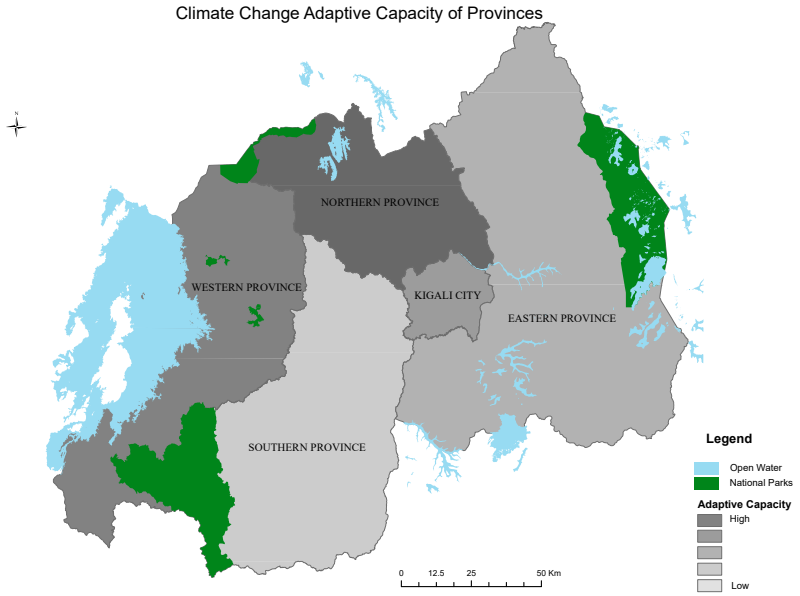

| Scale for categorizing Climate Change Vulnerability at District Level | | |
|---|---|---|
| Low | Medium | High |
| 0.444 to 0.485 | 0.486 to 0.526 | 0.527 to 0.568 |
| 11 Districts | 15 Districts | 4 Districts |
| Interval size: 0.0406 | | |

**Figure 3.8:** Map of Provinces comparing level of climate change impact



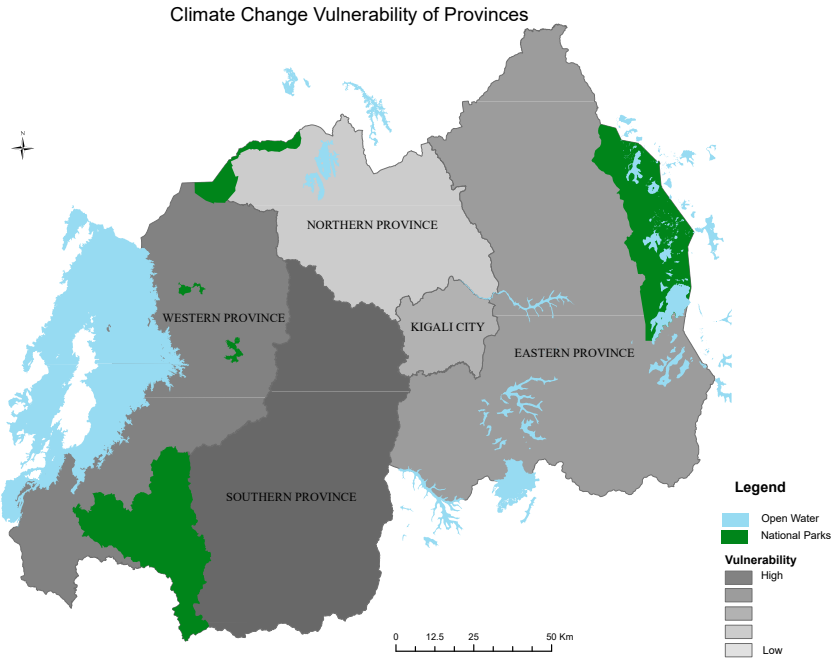

| Rank by Categories: Low, Medium, High | | |
|---|---|---|
| Low | Medium | High |
| 0.322 to 0.359 | 0.360 to 0.395 | 0.396 to 0.432 |
| City of Kigali | Eastern and Northern Provinces | Southern and Western Western Provinces |

**Figure 3.9:** Map of Provinces comparing level of climate change adaptive capacity




| Rank by Categories: Low, Medium, High | | |
|---|---|---|
| Low | Medium | High |
| 0.354 to 0.393 | 0.394 to 0.433 | 0.434 to 0.471 |
| Southern and Eastern Provinces, City of Kigali | Western Province | Northern Province |

**Figure 3.10:** Map of Provinces comparing level of climate change Vulnerability




| Rank by Categories: Low, Medium, High | | |
|---|---|---|
| Low | Medium | High |
| 0.460 to 0.481 | 0.482 to 0.502 | 0.503 to 0.523 |
| Northern Province and City of Kigali | Eastern Province | Southern and Western Province |

# 4 | National Climate Change Vulnerability Assessment

This section provides an update on the Assessment of National Vulnerability based on National Vulnerability Indicators and provides a comparison between the baseline data collected in 2015 and updated data collected in 2018. See the full list of National Vulnerability Indicators in Figure 4.1, on Page 49.

## 4.1 Background to updating of National Vulnerability Indicators and data, 2018

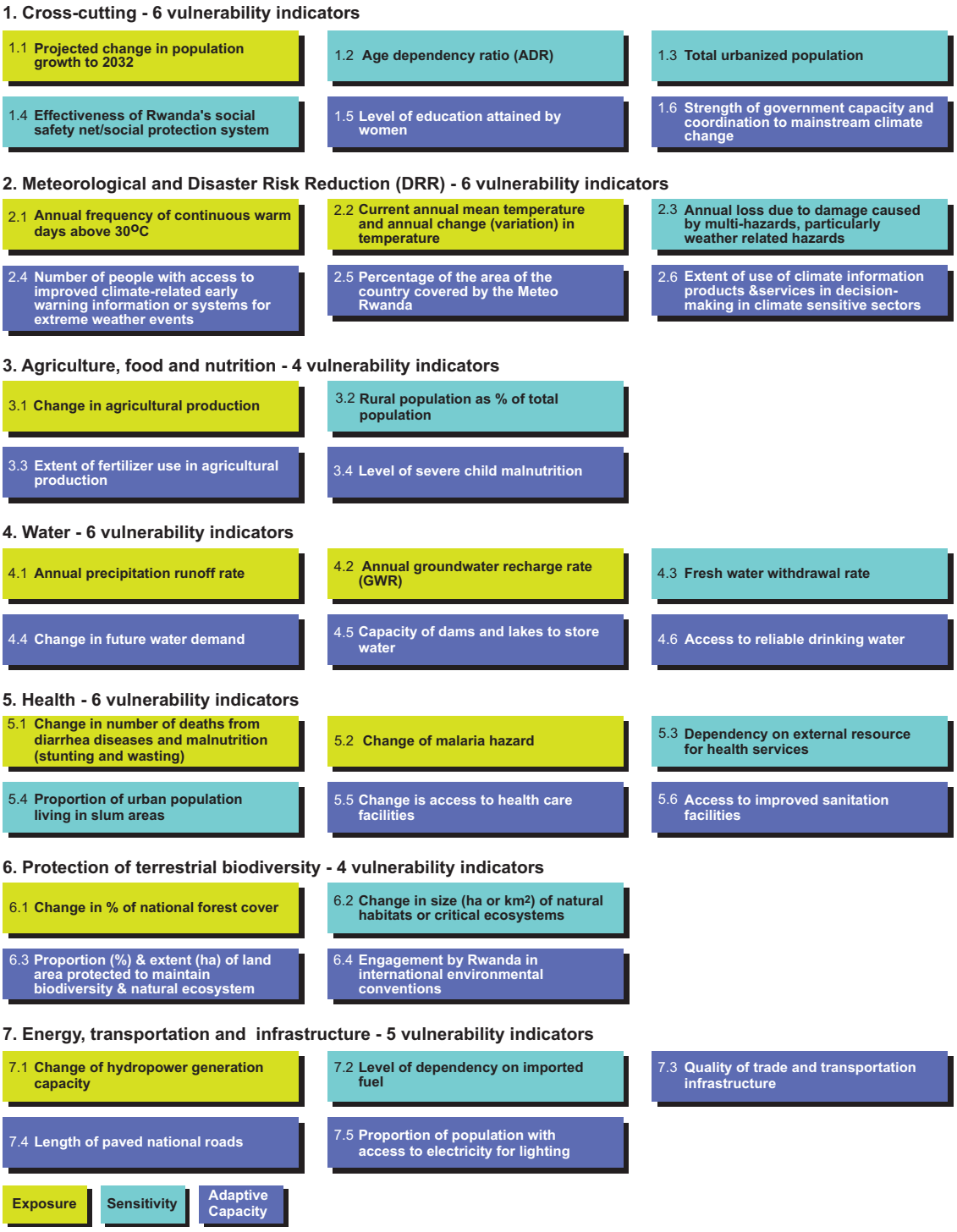
REMA's 2015 study focused primarily on the development of a national index and a baseline on climate change vulnerability in Rwanda. A key part of that study was the selection of 37 national indicators of vulnerability. Baseline data for each indicator was also collected. This current study validated those indicators by clarifying that for all, but four (4) of them, are still being used within their respective institutions and data is being collected regularly through surveys. New data, or the most recent data, was collected. This was in line with one of the recommendations of the 2015 study that the data and index be updated from time to time to assist with national assessments and planning. Where a national indicator is no longer valid, an alternative was to be sought. However, no changes in indicators were made during the course of this study. For a new indicator to be adopted, several criteria needed to be met. One is the requirement that data must be available that would have been collected in 2015, so that both baseline data (2015) and new data (2018) are available for analysis for new indicators. It was determined that it is premature to make changes to the indicators as only three years has passed. For all remaining indicators, updated data was available in 2018 to proceed with the national climate change vulnerability assessment.

For the four indicators mentioned above, one indicator was changed by the institution collecting data, which meant that the new data was not comparable to the date collected in 2015 (Indicator 1.6). For one indicator, it remains valid, but there is no new data available (Indicator 4.2). For 2 indicators, it appears the indicator remains valid but no data was available from the searches made (Indicators 5.1 and 4.4).

It is important note that in the charts that follows:

- Change in vulnerability is measured by change in data obtained;
- Indicators are a window into the issues, into changes in the particular sectors involved;
- Indicator data provide an opening into a field that affects - or is affected by - efforts to reduce climate change impacts and increase adaptive capacity;
- Indicator data are best understood from within an integrated, multi-sector framework;
- Indicators provide an overview of achievements as well as areas for improvement; and
- Rarely is data provided in the context of future climate change impacts or vulnerability despite the high probability that climate change is highly likely to increase over time.

**Figure 4.1:** National Climate Change Vulnerability Indicators*




*These 37 National Climate Change Vulnerability Indicators were selected in 2015, see: "Baseline Climate Change Vulnerability Index for Rwanda," published by Rwanda Environmental Management Authority, Kigali, 2015

## 4.2 Overview of Change in National Vulnerability - Analysis of National Vulnerability Data

Of the 37 National Indicators of Vulnerability analyzed for the direction of change between the baseline data (2015) and the current or updated data (2018):

- 17 indicators show an improvement in vulnerability;
- 11 indicators show deterioration in vulnerability;
- 5 indicators show no change in vulnerability; and
- 4 indicators provide no new data or do not allow for comparative analysis. This is a mixed review with good signs of increasing adaptive capacity.

On the positive side, 17 indicators or 51.5% of the 33 national indicators where comparative analysis was made show an improvement in vulnerability with a large majority of adaptive capacity indicators showing an improvement.

From another perspective, 11 indicators or 33% of 33 indicators where comparative analysis was made show a deterioration of vulnerability, with a majority of Exposure and Sensitivity Indicators showing deterioration.

This nuanced representation of the strength of the evidence is open to interpretation. This analysis treats the data from 2015 and 2018 as playing an equal role in creating a picture that provides the basis for a clear conclusion about the direction of the indicators, though this may not be the case in reality. Some indicators may be measuring a more critical situation or sector. However the rationale for the selection of indicators and the balance across all indictors is addressed in the 2015 Report: *Baseline Vulnerability Assessment and Index for Rwanda, 2015*.

This portrayal of national vulnerability is best understood when considered in detail – indicator by indicator – and less valuable at a high level of generality. This is definitely the case with a 'mixed review', which is the outcome of this assessment.

## 4.3 Direction of Change of National Indicators

In the analysis which follows, symbols are used to assess the direction of change observed. Here is a chart on the meaning of the symbols use.

**Table 4.1:** Definition of Symbol: Comparative Analysis of 2015-2018 data - National Indicators

| Symbol | Definition of the Symbols Used in the Analysis |
|---|---|
| ↗ | This symbol indicates improvement in the overall situation observed by comparing the data available from at least two periods. As no targets were considered in making the analysis, there is no determination of whether the improvements are significant. Whether the improvements are sufficient in light of future climate projection and impacts is also not addressed due to the lack of relevant climate projections available. These are both important considerations. |
| → | This symbol indicates that no significant change was noted in the overall situation observed by comparing the data available from at least two periods. Some observers might say that no or little change is deterioration in the situation if an improvement is needed to maintain status quo coping or resilience levels. |
| ↘ | This symbols indicates that deterioration is noted in the overall situation and is readily observed by comparing the data available from at least two periods, that the trend line between at least two sets of data indicates increased vulnerability. |
| — | This symbol indicates that no data are available to make an observation. |
| ⊘ | This symbol means that the available data are not comparable to baseline data. |

The detailed assessment is presented in the section following the figures on the next page that shows all the national vulnerability indicators.

The detailed assessment provides new data for each of the indicators. This is the detail upon which the analytical comments are made for each indicator.

The assessment of overall change in vulnerability follows the detailed assessment – summarizing improvement or deterioration in vulnerability. Data gaps will also be summarized.

## 4.4 Comparative Report and Analysis on National Vulnerability Indicator Data

Below is the 2015 and 2018 data for each of the 37 Vulnerability Indicators, along with information on the sources of the data and some additional notes to assist stakeholders in acquiring a better understanding of – and appreciation for – the approach taken.

## Group One - Cross Cutting Indicators (6)

| INDICATOR 1.1 - PROJECTED CHANGE IN POPULATION GROWTH TO 2032 ↘ | |
|---|---|
| Indicator type | Sensitivity |
| Baseline data collected in 2015 | Population growth forecast by 2032, there will be 15.40m people (low estimate), 16.33m (medium estimate), 16.88m (high estimate); The 2013 growth rate is 2.37%; the projected growth rate in 2032 is 2.18% (high scenario). |
| Source of the data in 2015 | (1) The 2012 Rwandan National Census in the NISR 2014 Statistical Yearbook.<br>(2) Thematic Report, Pop. Projections, published in Jan. 2014. |
| 2018 Data (update) | The population estimate for 2016/17 is 11,893,000, reported in EICV5. The projections to 2032 remain the same. The population in 2032 is expected to increase between 47% (low scenario) and 61% (high scenario) over what it was in 2012. In 2012, Rwanda was predicted to have an average annual growth rate of 2.6%. At that rate the population is expected to reach 21 million people by 2041.<br><br>However the population growth rate from 2012 to 2015 is also reported by NISR to be 2.1%, which is lower that the growth rate from 2002 to 2012 as fertility rates has experienced a dramatic decline. New population projections to 2032 have not been calculated yet on the basis of this lower birthrate.<br><br>Earlier reports provide population estimates for 2017 and 2020, but not 2018. For 2017, population projections (estimates) are 11.84 million (high scenario); 11.8 (medium scenario) and 11.7 (low scenario). For 2020, population projections (estimates) are 12.74 million (high scenario); 12.66 (medium scenario) and 12.42 (low scenario).<br><br>Population density is expected to increase to 645 persons /km$^2$, with the median age rising from 19 years to 24 years. It will be an older population. |
| Source of the data in 2018 | (1) EICV5 for 2016/17, published December 2018.<br>(2) Population and Housing Census 2012 (same as in 2015), plus Thematic Report – Population Projections, Jan. 2014, and EICV4 Report (Main Indicators Report) for 2013/14, published August 2015.<br>(3) NISR Mortality Assessment Survey Report, 2015, published July 2018. |

ANALYTICAL COMMENT(S)

Rwanda's population is growing close to the predicted slow growth rate. The growth in population increases pressure on all resources from agricultural lands to the availability of food and water. It stretches the resources of the health system and makes more demands on the biomass/wood energy resources of the country. In th2ese ways population growth increases vulnerability to climate change impacts. Population growth can be influenced by policy. For example, economic growth can reduce population growth; however economic growth makes its own demands on available natural resources. Until the next census results confirm the actual rate of growth and provide new population projections into the future, this indicator relies on data from the 2012 census and predictions to 2032 based on that data. The direction of population growth is clearly up, though there were indications in 2015 that the rate of growth rate between 2012 and 2015 was less than predicted in 2012.

INDICATOR 1.2 - AGE DEPENDENCE RATIO (ADR) ↗

| Indicator type | Sensitivity |
|---|---|
| Baseline data collected in 2015 | NISR's DevInfo shows the ADR for Rwanda as 93.2 in 2012, with a regional breakdown as follows: 98.9 for Eastern Province, 100.1 for Western, 92.5 for Northern, 95.5 for Southern and 60 for Kigali City. |
| Source of the data in 2015 | (1) NISR 2012 Census Data – DevInfo.<br>(2) NISR Fourth Population and Housing Census, Rwanda, 2014. |
| 2018 Data (update) | The ADR for 2016/17 for all of Rwanda is 79.9 (EICV5). EICV5 also indicates the ADR as follows: 86.9 for Eastern Province, 88.7 for Western, 80.3 for Northern, 82.5 for Southern and 53.6 for Kigali City.<br><br>Data from the household survey collected in late 2018 and reported on elsewhere in this document indicated an ADR of 74.4 among respondents. The difference between this ADR and EICV5 ADR is within range of the statistical margin of error, and can be partly explained by the decline in ADR since EICV5 data was collected.<br><br>EICV4 indicated the ADR for Rwanda was 82.7 in 2013/14 with a regional breakdown as follows: 98.1 for Eastern Province, 88.5 for Western, 84.3 for Northern, 82.9 for Southern and 60.3 for Kigali City.<br><br>Earlier, the mean dependency ratio for Rwanda was 85.7 (EICV3), and Even earlier the mean dependency ratio for Rwanda was 87.0 (EICV2). |
| Source of the data in 2018 | (1) EICV5 for 2016/17, published December 2018, Main Indicators Report - Table 1.5.<br>(2) EICV4 Report for 2013/14 prepared by NISR, published Aug 2015. |

NOTE
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). ADR is an EICV Indicator for Rwanda.

Supplementary information: Rwanda's Gini Index was reported as 0.429 in EICV5 (2016/17), as 0.448 in EICV4 (2013/14); as 0.490 in EICV3 (2010/11) and 0.522 (EICV2 – 2005/06). The Gini Index measures the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal distribution. A Gini index of 0 would imply perfect income equality, while an index of 1 would imply complete income disparity. Rwanda's change in Gini Index is moving towards more income equality.

ANALYTICAL COMMENT(S)
The ADR for Rwanda is going down, even if slowly. Overall there is a consistent year-over-year reduction in the number of younger (under 16) and older people (over 64) who are depended on the group in between (age 16 to age 64). This is change in the right direction with a reduction in dependency as measured by this indicator. Rwanda's ADR in the rural area is higher than in urban areas, through it is decreasing in the rural areas, which is also an indicator of a reduction in dependency. A reduced ADR is a positive trend for this vulnerability assessment as it indicates the population is likely more able to withstand the multi-dimensional impacts of climate change.

INDICATOR 1.3 - TOTAL URBANIZED POPULATION ↘

| Indicator type | Sensitivity |
|---|---|
| Baseline data collected in 2015 | Rwanda's urbanization rate is 16.5% - approximately half in Kigali and half outside of Kigali. Past rates show urban concentration as: 10.4% in 2000/01; 16.6% in 2005/06; 14.8% in 2010/11. |
| Source of the data in 2015 | (1) NISR 2014 Statistical handbook; NISR 2012 census data. |
| 2018 Data (update) | Urban population is expected to rise to 30% by 2032, from 1.7 million in 2012 up to 4.9 million in 2032. [Projections based on 2012 census data.]<br><br>EICV5 (2016/17) puts the urbanization rate at 18.4% with 81.6% of the population in rural areas. Kigali City's population of 1,631,000 is 73.8% urban and 26.2% rural.<br><br>EICV4 (2013/14) puts the urbanization rate at 17.3%, with 82.7% in rural areas; and Kigali at 49.88% of the total urban population (est. 1,967,354).<br><br>EICV3 (2010/11) reported the urbanization rate at 15.7%, with 84.3% of the population in rural areas. |
| Source of the data in 2018 | (1) EICV5 report (2016/17) published in December 2018.<br>(2) Fourth Population and Housing Census 2012.<br>(3) Thematic report – Population Projections, Jan. 2014. |

NOTE
This is the proportion (%) of urban population over the total country population – an EICV indicator, representing urban concentration.

ANALYTICAL COMMENT(S)
Rwanda is experiencing a high urbanization rate. Urbanization increases the resilience of populations through increased access to services, better communications, and possibly more opportunity for paid work, etc. However urbanization also creates increased demand for resources and services for people to survive in the urban areas. Some prime examples are the pressure on transportation (including demand for more imported petrol), housing, electricity, health and education, without reducing demand on rural resources, such as food and household energy. In Rwanda a very high proportion of the urban populations live in unplanned areas. Rapid urbanization stretched the resources of the country to provide increased urban services. In the context of high population growth high urbanization is not a panacea for resilience, but a shifting of burden and in some cases the creation of new problems related to the expanding cities and new demands on limited national resources. The urban area of Kigali has low exposure and sensitivity to climate change in the comparative District Vulnerability Assessment presented earlier in this report. However rates of adaptive capacity vary considerably across urban Districts. Overall, the high rate of urbanization in Rwanda is the major factor affecting the assessment provided here, which is that the high rate of urbanization increases overall vulnerability, though the extent of increased vulnerability can be further discussed and assessed.

INDICATOR 1.4 - EFFECTIVENESS OF RWANDA'S SOCIAL SAFETY NET/ SOCIAL PROTECTION SYSTEM ↗

| Indicator type | Sensitivity |
|---|---|
| Baseline data collected in 2015 | The 2014 Statistical Yearbook indicates the prevalence of health insurance at 68.8% among 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 include informal sector workers, people in poverty – a majority of the population.<br><br>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%. |
| Source of the data in 2015 | (1) NISR 2014 Statistical Yearbook; Ministry of Health Website. |
| 2018 Data (update) | Proportion of households with Health Insurance was reported to be 73.9% in 2016/17 (EICV5).<br><br>Proportion of households with Health Insurance was reported as 70% in 2013/14 (EICV4); 68.8% in 2010/11 (EICV3) and 43.3% in 2005/06 (EICV2).<br><br>RDHS reported earlier that 79.1% of households have at least one member covered by health insurance. And 97% of households have at least one member covered by *Mutuelle de Santé*.<br><br>Amongst adult men and women (age 15-49), 94.1% are covered by *Mutuelle de Santé*. |
| Source of the data in 2018 | (1) EICV5 Report for 2016/17, published December 2018 by NISR.<br>(2) EICV4 Report for 2013/14, published August 2015 by NISR.<br>(3) DevInfo Rwanda 2014 (NISR).<br>(4) Rwanda Demographic and Health Survey-RDHS Report for 2014-15, published March 2016 by NISR. |

NOTE
This is 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 is 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).

ANALYTICAL COMMENT(S)
The rate of enrollment in *Mutuelle de Santé* is increasing – and has been increasing each reporting period, according to new EICV data. The percent of households with at least one of its members covered by *Mutuelle de Santé* is also increasing. For this assessment, the impact on vulnerability to climate change impacts is positive – especially when combined with improving rural health rates.

| INDICATOR 1.5 - LEVEL OF EDUCATION ATTAINED BY WOMEN | ↗ |
|---|---|
| Indicator type | Adaptive capacity |
| Baseline data collected in 2015 | 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.<br><br>For rural women only, census data shows: 27.7% with no education, 61.8% with primary education, and 8.3% with secondary education. |
| Source of the data in 2015 | (1) NISR 2012 census data. |
| 2018 Data (update) | In 2014-2015, 19.0% of females have never attended school, 52.0% have some primary schooling, and 14.1% have completed primary school. 10.3% of females have some secondary education though only 2.9% have completed secondary school. 1.5% of females have more than secondary school education. In 2012, 22% of women had never attended school. So there is some progress. Younger women are attaining more education than in the past. The proportion of females with no education drops from 75% of women age 65 and over to 2% for girls between age 10 and age 14. Level of education attained for women in rural areas is less than in urban areas. Level of education attained by women is less in poorer households. |
| Source of the data in 2018 | (1) Rwanda Demographic and Health Survey-RDHS Final Report 2014-2015, NISR, Chapter 2.3 – Educational Attainment, Table 2.3.1 Educational Attainment of the female household population, pg. 16, (data gathered between Nov 2014 and April 2015) published March 2016. |
| NOTE<br>This is a rural capacity and gender equality indicator. | |
| ANALYTICAL COMMENT(S)<br>The trend is clear that the level of education attained by women is increasing – more women are attaining education and increasingly higher levels of education. The increase is not equal for all women, with rural and poor women attaining lower levels of education, though there are increases everywhere. The assessment is positive and signals increased resilience and adaptive capacity. | |

INDICATOR 1.6 - STRENGTH OF GOVERNMENT CAPACITY AND COORDINATION TO MAINSTREAM CLIMATE CHANGE

| | |
|---|---|
| Indicator type | Adaptive capacity |
| Baseline data collected in 2015 | Rwanda Governance Board's 2014 score for environmental protection is 95%. |
| Source of the data in 2015 | (1) The RGB Scorecard on Environmental Protection. |
| 2018 Data (update) | Under "Investment in Human and Social Development", Section 4, Climate Change and Environmental Resilience, there are 6 variables and scores with an overall score of 73.43%). Here are the six (6) component scores: 4.1-Land management (88.91%), 4.2-Climate Change Resilience (48.68%), 4.3-Environmentally Sustainable settlement and use of energy (60.27%) comprised of Sustainable Use of Energy (54.35%), and Sustainable Settlement (66.19%), and 4.4-National Environmental Protection Policy and Strategy (95.88%). |
| Source of the data in 2018 | (1) Rwanda Governance Scorecard, 5th Edition: The State of Governance in Rwanda, by Rwanda Governance Board, 2018. |

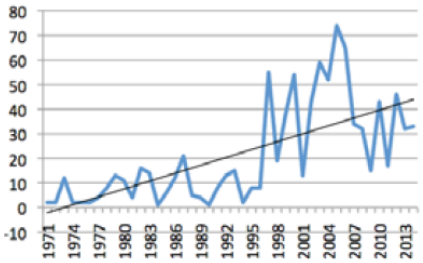
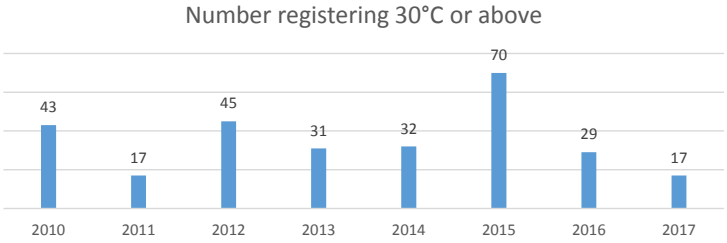
NOTE
The 2014 Rwanda Governance Board (RGB) scorecard contains sub-indicators that were new at that time for environmental protection, using three variables: % of area covered by radical terraces; % of areas covered by forests; area of land protected to maintain biodiversity.

By 2018, The scorecard has been significantly adjusted compared to REMA's previous Vulnerability assessment report. RGB's 2018 report says: "Under the pillar of investing in Human and Social Development, the indicator of Climate Change end Environmental Protection has been strengthened, made much more comprehensive and much more robust to capture real issues, which slightly impacted the scores of the pillar." (pg. ix). Also, "The variable relating to environmental protection under the indicator of climate change and environmental resilience has been adjusted to fit in the national environmental projection policy strategy to meet international standards." (pg. 33).

ANALYTICAL COMMENT(S)
Given the change in methodology, it is not possible, unfortunately, to compare data from two periods. No assessment is therefore possible.

## Group Two - Meteorological and Disaster Risk Reduction (DRR) Vulnerability Indicators (6)

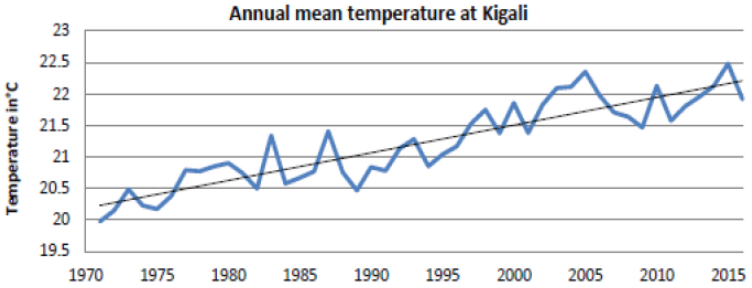
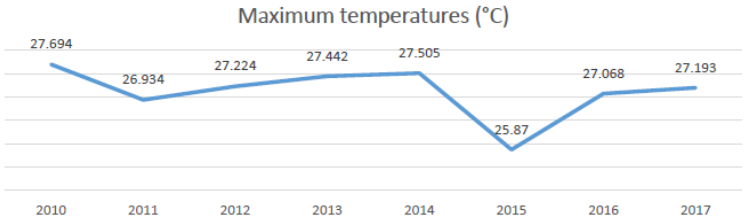
INDICATOR 2.1 - ANNUAL FREQUENCY OF WARM DAYS (ABOVE 30°C) PER YEAR ↘

| Indicator type | Exposure |
|---|---|
| Baseline data collected in 2015 | Annual frequency of warm days at Kigali airport has increased from 1971-1976 when there were on average less than 3.7 warm days (above 30°C) per year - to 2010-2014 when there were 34 warm days per year on average.<br>  |
| Source of the data in 2015 | (1) Rwanda Meteorology Agency data supplied to and analyzed by REMA. |
| 2018 Data (update) | The number of warms days (30°C and above) for the 2010- 2017 period (8 years) for Kigali airport, based on Kigali Daily Maximum temperatures, averaged 35.5 days per year. Here are the actual warm days (30°C and above) per year for the period.<br>  |
| Source of the data in 2018 | (1) Rwanda Meteorology Agency |

NOTE
The aim is to have data on the annual frequency of continuous warm days (above 30°C), which measures heat wave hazard, i.e., periods of excessive warmth; the aim is also to count annual frequency *when daily near surface temperature* exceeded the 90th percent threshold for 6 consecutive days or longer. The base period, 1961-1990, is not yet established. Trends over 30 years are most reliable to indicate climate change.

ANALYTICAL COMMENT(S)
The newly acquired data shows 3 years out of 8 with more than 40 warm days, with one of those years peaking at 70 warm days; variability is increasing while the trend line over the longer term also increases. The trend of increasing number of warm days means increasing exposure, and therefore vulnerability in many areas of life. The data would be more convincing in a graph that extends the 1971-2013 data (acquired in 2015) with the current data to the end of 2017 – which would be for a 46 year period. The data not yet measuring is number of continuous days over 30°C per year, or heat waves, rather than counting individual warm days.

INDICATOR 2.2 - CURRENT MEAN ANNUAL TEMPERATURE; ANNUAL CHANGE (VARIATION) IN TEMPERATURE ↘

| Indicator type | Exposure |
|---|---|
| Baseline data collected in 2015 | Rwanda Meteorology Agency 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 in the mean temperature of 1.06°C – an average annual increase of .06% in 10 years.<br><br>A report by REMA using Rwanda Meteorology Agency data indicates that the mean annual temperature at Kigali airport has increased gradually from 1971 to 2007 with the average value was 19.8°C in 1971 and 20.7°C in 2007 - an overall increase of 0.9°C in 27 years. |
| Source of the data in 2015 | (1) Rwanda Meteorology Agency report. (2) REMA report. |
| 2018 Data (update) | The following chart shows the trend line for temperature increase in Kigali over the 45-year period, 1970 to 2015, taking minimum and maximum daily temperatures into account. This chart builds on the data collected in 2015.<br><br>  <br><br><br>The Daily Maximum temperature data provided by Rwanda Meteorology Agency was used to prepare these figures on the avg. annual maximum temperatures for Kigali:<br><br>  <br><br><br>Five of the 8 years for which data is provided above saw temperatures above the average for this 8 year period (i.e., above 27.116°C). |
| Source of the data in 2018 | (1) The multi-year temperature chart is taken from *Rwanda's Third National Communication to the UNFCCC, Sept. 2018: Non-Technical Summary and Policy Brief*, obtained from REMA.<br>(2) Rwanda Meteorology Agency provided a table of absolute values for the 2010-2017 period for Kigali Airport based on daily maximum temperatures. |

NOTE
The aim is to include temperature projections to 2030 and 2050 from a credible East African regional climate model.

ANALYTICAL COMMENT(S)
The 45-year graph, above, shows the historic trend line for the mean annual temperatures (minimum and maximum daily temperatures) for Kigali. This provides a good picture of year-over-year change in temperature and shows clearly that the temperature in Kigali is increasing. The assessment is that Rwanda is experiencing increasing exposure and vulnerability from increased temperatures; increased climate variability is also being experienced. Future temperature scenarios to 2030, 2050 or 2080 have not yet been obtained; scenarios are crucial for knowing the extent of change in temperature to be expected; and will be highly useful for planning in many sectors.

INDICATOR 2.3 - ANNUAL LOSS DUE TO DAMAGE CAUSED BY MULTI-HAZARDS, PARTICULARLY WEATHER-RELATED HAZARDS ↘

| Indicator type | Sensitivity |
|---|---|
| Baseline data collected in 2015 | 2012 data shows there were deaths (72), injuries (122), crops (ha) damaged (2,580 ha) and houses damaged or destroyed (3,176) due to landslides, floods, fire, heavy rains, heavy rains & winds, thunderstorms & lightning. |
| Source of the data in 2015 | (1) MIDIMAR data provided the above information in its report on multi-hazards damage (published Jan 2012). |
| 2018 Data (update) | Reports on damage and loss from weather related hazards for 2014-2018 (5 years) includes number of deaths, injuries, houses damaged, crops damaged (ha.), and cattle lost for these hazards: rainstorms, windstorms, landslides, floods, hailstorms, and lightning. Data shows that in 2018, with a partial report, Rwanda has experienced the highest annual level of loss and damage in all areas where there has been consistent reporting for the last 5 years. |

| | Deaths | Injured | Houses Damaged | Crops Damaged | Lost Cattle |
|---|---|---|---|---|---|
| 2018 (partial) | 249 | 323 | 15,777 | 10,831 ha | 809 |
| 2017 | 67 | 133 | 5,768 | 5,251 ha | 587 |
| 2016 | 168 | 161 | 4,459 | 2,070 ha | 208 |
| 2015 | 121 | 175 | 2,603 | 1,759 ha | 88 |
| 2014 | 104 | 251 | 3,595 | 3,074 ha | 245 |

MINEMA's reporting in 2017 and 2018 goes beyond the 5 areas of loss and damage shown above, to include the number of damaged classrooms, health centers, roads, churches, bridges, administrative offices, water supply and electrical transmission lines. However MINEMA has yet to provide the direct or the indirect cost of loss and damage.

| | Class rooms | Health centers | Roads | Churches | Bridges | Admin. offices |
|---|---|---|---|---|---|---|
| 2018 (partial) | 67 | 3 | 32 | 24 | 63 | 10 |
| 2017 | 198 | 3 | 13 | 37 | 49 | 17 |

NISR's EICV5 report (2016/17) indicates that 13.1% of dwellings in Rwanda were affected by environmental destruction at the national level, with 14.9% of dwellings in the rural areas affected. Western Province was most affected at 18.6% of dwellings affected by environmental destruction, followed by Southern (14.8%) and by Northern and Eastern Provinces (both at 12.6%). Kigali City reported 5.3% of dwellings similarly affected. (Table 7.3).

EICV5 also reports 48.5% of households across Rwanda faced environmental problems on their cultivated plots, caused by floods, erosion, landslides, climate change, destructive rains and loss of soil fertility. Eastern Province was most affected (70.5% of cultivated plots), followed by Southern (51.9%), Western (39.7%) and Northern (30.4%) Provinces. Kigali City reported 15.8% of cultivated plots faced environmental problems (Table 7.4).

| | |
|---|---|
| Source of the data in 2018 | (1) Ministry in charge of Emergency Management-MINEMA, (formerly MIDIMAR)<br>(2) NISR's EICV5 report (2016/17), published December 2018. |

ANALYTICAL COMMENT(S)

There are clear year-over-year increases in loss and damage from hazards associated with the weather such as heavy rainfall or continuous rainfall. While a report on the costs of loss and damage in 2018 is not yet validated, the data made available by MINEMA and presented above shows a clear trend in the direction of increased loss and damage. Rwanda's vulnerability to increasing annual losses from weather or climate related hazards remains high.

| INDICATOR 2.4 - ACCESS TO IMPROVED CLIMATE-RELATED EARLY WARNING INFORMATION OR SYSTEMS FOR EXTREME WEATHER EVENTS ↗ | |
|---|---|
| Indicator type | Adaptive capacity |
| Baseline data collected in 2015 | In 2014, MIDIMAR had a pilot project running in 4 Districts; it involved a system to send SMS 'early warning' messages that aimed eventually to reach out to 2000+ people. |
| Source of the data in 2015 | (1) MIDIMAR report for UNDP project. |
| 2018 Data (update) | The current national system allows for sending Early Warning System (EWS) messages between MINEMA and 2036 people in the districts, involving these people outside of MINEMA: Rwanda Reserve Force, the Mayors and 2 Vice Mayors (one for Social Affairs and one for Economic Development) in all 30 districts, the Executive Secretary in all 30 Districts, Social Affairs Directors in all 30 Districts, the Executive Secretaries (416) for all Sectors in all 30 Districts, Social Affairs Secretariat staff (416) in all 30 Districts, the District Disaster Management Officer (DDMOs) where appointed in the Districts, and 190 Indigenous Knowledge Holders across the 30 Districts. |
| Source of the data in 2018 | (1) MINEMA Meeting notes (consultations). |
| ANALYTICAL COMMENT(S)<br>MINEMA (formerly MIDIMAR) has regularized its EWS, which is a big step forward. It is essentially a "phone tree" to key responders. An assessment of how well this EWS works in an emergency will be done in the future. It appears the EWS does not yet include radio messaging or mass alerts to cell phone subscribers. However as it develops it will no doubt incorporate new features. A positive assessment related to increased adaptive capacity. | |

INDICATOR 2.5 - PERCENTAGE OF THE AREA OF RWANDA COVERED BY THE RWANDA METEOROLOGY AGENCY ↗

| Indicator type | Adaptive capacity |
|---|---|
| Baseline data collected in 2015 | Forty-one (41) automatic weather stations across the country currently stream data to Rwanda Meteorology Agency. 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. The spatial density of weather stations in Rwanda may be the highest in East Africa. |
| Source of the data in 2015 | (1) Rwanda Meteorology Agency (website; interview notes). |
| 2018 Data (update) | Rwanda Meteorology Agency manages a weather data collection system across the country that involves, as of November 2018: 164 manual weather stations, 100 automatic rain stations, 56 automatic weather stations (which collect data on many parameters of the weather). Rwanda Meteorology Agency also has 1 C-band weather radar system, a weather data management system called CLIMSOFT and a weather forecasting system called PUMA. |
| Source of the data in 2018 | (1) Rwanda Meteorology Agency (website; interview notes) and its quarterly Newsletter, July-Sept 2017 edition. |

ANALYTICAL COMMENT(S)
Rwanda Meteorology Agency has more stations in operation than reported in 2015. The report in 2015 mentions that manual stations were closed. However that appears to have been an error. All the data for 2018 show an improvement in 2015. A positive assessment for increased adaptive capacity.

INDICATOR 2.6 - EXTENT OF USE OF CLIMATE INFORMATION PRODUCTS & SERVICES IN DECISION-MAKING IN CLIMATE SENSITIVE SECTORS ↗

| Indicator type | Adaptive capacity |
|---|---|
| Baseline data collected in 2015 | Currently, Rwanda Meteorology Agency has agreements with 8 sectoral agencies, including an MoU with Rwanda Biomedical Centre's Malaria Unit (*health*); with MINAGRI's irrigation program (*water*); with REMA (*environment*). However, no agreements exist between Rwanda Meteorology Agency and NISR, none with Rwanda Development Board (*tourism*), none with RNRA-Forestry (which has its own weather stations) and none with RNRA's-Integrated Water Resources Management (IWRM) unit. There is evidence of inconsistent delivery of dekad bulletins issued jointly with Ministry of Agriculture. Rwanda Meteorology Agency has targets under EDPRS-2 that include feeding information into MIDIMAR's Multi Hazard Early Warning System (*disaster risk reduction*). |
| Source of the data in 2015 | (1) Rwanda Meteorology Agency.<br>(2) Rwanda Natural Resources Authority (RNRA).<br>(3) REMA. |
| 2018 Data (update) | Rwanda Meteorology Agency provides *dekadal* (10 day) rainfall and temperature data (forecasts) to MINISANTE, MINAGRI, NISR, National Bank of Rwanda and MINECOFIN for use in planning and decision-making, and shares *dekad* climate data with the IGAD Climate Prediction Centre in Nairobi. Throughout 2018 Rwanda Meteorology Agency provided 10-day merged gridded rainfall data to a Crop Insurance Pilot project.<br><br>Rwanda Meteorology Agency responds to requests for historical climate data. In the first 10 months of 2018, it responded to an average of 28 requests per month. Requests for climate data were from the Education and Research sector (36.3%), Engineering sector (26.5%), Agriculture sector (23.3%), Environment sector (10.3%) and the Health Sector (3.6%).<br><br>Rwanda Meteorology Agency also works with a wide range of Ministries, departments and agencies through normal government coordinating and liaison structures.<br><br>Rwanda Meteorology Agency is increasing the usefulness of its webpage's climate portal for multi-stakeholder use – especially for transportation, health and agriculture.<br>See: http://maproom.meteorwanda.gov.rw/maproom/ |
| Source of the data in 2018 | (1) Rwanda Meteorology Agency. |

NOTE
This indicator is qualitative in nature and requires a scorecard approach to capturing where climate information is used in determining decisions. A scorecard has not yet been developed.

ANALYTICAL COMMENT(S)
There is a growing audience for weather information prepared by the Rwanda Meteorology Agency – both historical data and forecasts (detailed seasonal forecasts, future climate scenarios, probabilistic predictions), given the focus on climate change in the country. The assessment is positive for adaptive capacity.

The need for forecasts that are relevant to all regions of the country is high. Long term climate scenarios need to be prepared by Rwanda Meteorology Agency in the near future. This is an area where its services are crucial and are needed. Rwanda Meteorology Agency will hopefully develop more products - some for public policy and planning and some for paying customers – driven by demand. Key decision makers need to use climate information more regularly. Long term forecasts are crucial for strategic decision making and planning in the country.

## Group Three - Agriculture, food and nutrition vulnerability indicators (4)

| INDICATOR 3.1 - CHANGE IN AGRICULTURAL PRODUCTION | ↘ |
|---|---|
| Indicator type | Exposure |
| Baseline data collected in 2015 | 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. (MT = metric tons, weight). |
| Source of the data in 2015 | (1) MINAGRI (SPAT-3). |
| 2018 Data (update) | PSTA-4 figures indicate: Wheat production (2017) 10,219 MT (up from 9,921 MT in 2016).<br>Maize production (2017) 373,123 MT (up from 340,326 MT in 2016).<br>Cassava production (2017) 979,152 MT (up from 978,925 MT in 2016). |
| Source of the data in 2018 | (1) MINAGRI: Strategic Plan for Agricultural Transformation (PSTA-4), Annex 6, published 2018. |

NOTE
This indicators aims, eventually, to track change in production for the country's 7 key food crops – bananas, wheat, maize, rice, Irish potatoes, cassava, soya beans and other dried beans.

ANALYTICAL COMMENT(S)
production over the recent period has been increasing. However, with future population increases, more food is necessary. MINAGRI indicates that increased use of fertilizer, more irrigation and consolidation of farm lands are key components to produce more food. MINAGRI has a good monitoring system on national food production, and maintains a strategic review of production related issues. However, Rwanda remains vulnerable as a net importer of food as the cost of imported food is affected by market prices which are affected by climate change in the regions where imported foods are grown. And small scale household or small plot production remains the reliable source of food for many. With the projected population increase, limited farm land, and key food security crops being very climate sensitive, food production remains a highly vulnerable sector, highly exposed to the impacts of climate change. Agriculture is one of the most important sectors where climate forecasts (seasonal and long term) can contribute meaningfully to strategic planning for improved agricultural production. Efforts to introduce more drought resistant seeds and effort to diversify crop production continue, and MINAGRI's climate change office is increasingly actively monitoring climate change impacts in the sector.

INDICATOR 3.2 - RURAL POPULATION AS % OF TOTAL POPULATION →

| Indicator type | Sensitivity |
|---|---|
| Baseline data collected in 2015 | Rwanda had a rural population of 8.7 million in 2012 – or 83.5% of the total population. |
| Source of the data in 2015 | (1) NISR 2012 Census data. |
| 2018 Data (update) | EICV5 Report indicates that Rwanda's rural population is 81.6% of the population, a drop of 1% since EICV4 (2013/14).<br><br>The rural population is increasing but at a slower rate than the increase for the urban population. The rural population is projected to be 11.4 million in 2032, a rate of increase equal to about 30% over 20 years. The rural population will be less young in 2032 with a median age of 23 years, up from 19 years in 2012. The size of the working age rural population (16-64).<br><br>All provinces have larger rural populations than urban populations, except Kigali City. Of the remaining 4, Western Province has the least rural population at 86.8% rural. The other 3 provinces are over 90% rural; the most rural is Eastern Province, which also has the largest population of all the provinces. |
| Source of the data in 2018 | (1) Fourth Population and Housing Census 2012, Thematic report – Population Projections, Jan. 2014.<br>(2) EICV5 Report for 2016/17, published December 2018 by NISR. |

ANALYTICAL COMMENT(S)

Rwanda's rural population is increasing, and its population density is increasing. However the proportion of the rural population compared to the total population is decreasing. Rural populations are very climate sensitive given the close dependence of the population on weather factors, mainly rainfall, for household food production. An increases in rural population leads to increased pressure on limited natural resources. The assessment here might be that vulnerability is increasing due to the increase in rural population. However, the main factor leading to a "no change" assessment is the slight decline in the proportion of rural population to the total population.

INDICATOR 3.3 - EXTENT OF FERTILIZER USE ↗

| Indicator type | Adaptive capacity |
|---|---|
| Baseline data collected in 2015 | 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 MINAGRI target for fertilizer application by 2017 is 45kg/ha/yr. Percentage of coverage and effectiveness of soil conservation infrastructure – 73% (1,095,914 ha) in 2012. |
| Source of the data in 2015 | (1) MINAGRI (SPAT-3; July 2013). |
| 2018 Data (update) | Inorganic fertilizer use was at 32 Kg/ha/annum in 2016-2017, nationally, according to PSTA-4 figures.<br><br>PSTA-4 aims to raise fertilizer use to 50 kg/ha/annum by 2020 and to 75 kg/ha/annum by 2023/2024. As the land area for farming in Rwanda is not growing, projections are based on the same number of hectors each year for all crops with increases in production expected from an increase in the use of inorganic fertilizer, and better farming methods in some cases.<br><br>Note: Fertilizer use did not rise to 45 kg/ha/annum by 2017 as had been planned or anticipated in SPAT3 (2013). |
| Source of the data in 2018 | (1) MINAGRI Annual Report for FY 2016-2017: Section 1.2, Table 2 (pg. 7).<br>(2) Strategic Plan for Agricultural Transformation (PSTA-4) (Annex 2 Operational Framework, page 131). |

ANALYTICAL COMMENT(S)

In the recent past, predicted increase in the use of fertilizer was not realized in full; the increases projected in the new PSTA-4 also may not be realized. However Rwanda has seen increases in the use of fertilizer and in food production on a per hector basis in the recent past in the context of no increase in the availability of crop land. This is the key factor behind a positive assessment for this indicator.

African Ministers of Agriculture have agreed that fertilizer use should rise to 50 kg/ha/annum and Rwanda has plans to achieve that objective. Increases in fertilizer use need to be monitored closely in the context of concern for soil health and soil moisture content. The availability of conservation agriculture methods including the use of high quality compost needs to be promoted on a large scale as well as for household plots.

INDICATOR 3.4 - LEVEL OF SEVERE CHILD MALNUTRITION →

| Indicator type | Adaptive capacity |
|---|---|
| Baseline data collected in 2015 | NISR's DHS data indicates 2.85% of children in Rwanda suffered from extreme malnutrition (wasting) in 2010 – 3.3% for males and 2.4% for females under five (using weight for height values; below 2 standard deviations from the WHO's Child Growth standards population median).<br><br>NISR's DevInfo indicates 2% of children suffered from extreme malnutrition (wasting) in 2010. Earlier DevInfo figures show 4% in 1992, 7% in 2000, and 4% in 2005/06. |
| Source of the data in 2015 | (1) NISR DevInfo (2010). |
| 2018 Data (update) | NISR's DHS data shows 2.2% of children under five (U5) suffered from extreme wasting in 2014-15 (using the WHO's Child Growth standards population median: weight for height value – percentage below -2 standard deviations) – 2.4% for male and 2.0% for female – from a national sample size of 1924 males and 1889 females. |
| Source of the data in 2018 | (1) NISR's Demographic and Health Survey-DHS: 2014-2015 – Final Report, Table 11.1: Nutritional Status of Children (pg. 149), published March 2016. |

NOTE
Prevalence of wasting is viewed internationally as an indicator of a country's current capacity to deliver basic nutritional needs to the most sensitive group in society.

ANALYTICAL COMMENT(S)
The level of severe child malnutrition is not decreasing, remaining at just over 2% of children under 5 (U5) over the period since 2010. This is viewed as an indication that Rwanda's capacity to increase the delivery of basic nutritional needs to the most sensitive group in society has not been able to increase in this period and this level of vulnerability remains, though levels decreased prior to 2010. As a result the assessment at this time is "no change" in the direction of this indicator.

## Group Four - Indicators of Vulnerability of Fresh Water Supplies (6)

| INDICATOR 4.1 - ANNUAL PRECIPITATION RUN-OFF RATE ↘ | |
|---|---|
| Indicator type | Exposure |
| Baseline data collected in 2015 | Rwanda Water and Forest Agency (RWFA) - Integrated Water Resources Management - IWRM master plan provides current/recent data. The current calculation of rainfall in Rwanda at 27.505 BCM*/annum. |
| Source of the data in 2015 | (1) Rwanda Water and Forest Agency (RWFA), IWRM master plan, available online). |
| 2018 Data (update) | Rainfall estimate is 27.505 BCM/annum, with an evapo-transpiration rate of 20.7 BCM/annum means that total renewable water resources are estimated at 6.826 BCM/annum. |
| Source of the data in 2018 | (1) Documentation prepared for REMA – for Rwanda's Third National Communication (TNC) – "Report on Water Sector Vulnerability Assessment and Adaptation-VAA", February 2018, which indicates both rainfall and evapotranspiration rates, referencing Rwanda National Integrated Water Resources Master Plan, MINIRENA, 2015 (available online). |
| NOTE<br>Run-off is defined as precipitation minus evapo–transpiration and change in soil moisture storage. | |
| ANALYTICAL COMMENT(S)<br>Data in Rwanda's National Water Resources Master Plan (2015) provides the bench mark assessment of the country's Annual Precipitation Run-off Rate. There are no apparent plans to revise this figure, though the rate fluctuates from year-to-year and the trend is not known. Rwanda has a very high run-off rate, meaning a low rate of capture and storage of water. Rwanda's total annual rate of renewal it water resources is low in the current context of high water stress. With the run-off rate remaining very high, this indicator signals an area of high vulnerability, more so in the context of other indicators in the water sector (e.g. increasing demand) and in the context of climate change. | |

INDICATOR 4.2 - ANNUAL GROUND WATER RECHARGE (GWR)

| Indicator type | Exposure |
|---|---|
| Baseline data collected in 2015 | Rwanda Water and Forest Agency (RWFA) - IWRM data indicates that the GWR rate is 4.554 BCM*/annum.<br><br>Groundwater storage in Rwanda is estimated at 6.175 BCM. |
| Source of the data in 2015 | (1) Rwanda Water and Forest Agency (RWFA) – Water Resources Master Plan. |
| 2018 Data (update) | No new data. Rwanda continues with an estimated ground water recharge rate of 4.554 BCM per annum. |
| Source of the data in 2018 | (1) Documentation prepared for REMA – for Rwanda's Third National Communication (TNC) – "Report on Water Sector Vulnerability Assessment and Adaptation-VAA", February 2018, indicates Rwanda's estimated GWR rate (page 4), referencing Rwanda National Water Resources Master Plan, MINIRENA, 2015. See also master plan online. |

NOTE
GWR rate is an indicator to measure climate change impacts on fresh water supply. Soil moisture is the only source considered to affect GWR in the hydro-meteorological models. Eventually this indicator will include GWR rate in the context of future climate impact scenarios.

ANALYTICAL COMMENT(S)
There is no new data on GWR rate, so no fresh assessment of change can be made, though the GWR rate remains an area of high vulnerability. The GWR rate needs to be seen in the context of the fresh water withdrawal rate (demand), the water storage capacity, the annual precipitation run-off rate and the change in capacity to access rainwater for short term and long term strategic uses.

INDICATOR 4.3 - FRESH WATER WITHDRAWAL RATE ↘

| Indicator type | Sensitivity |
|---|---|
| Baseline data collected in 2015 | Rwanda Water and Forest Agency (RWFA) – IWRM data indicates the total renewable water resources are 6.826 BCM*/annum, with current water availability per capita at 670 $m^3$/annum. |
| Source of the data in 2015 | (1) Rwanda Water and Forest Agency (RWFA) – IWRM master plan. |
| 2018 Data (update) | The current water availability per capita has been reduced to 504 m3/annum (CM/annum), which is close to the definition of absolute water scarcity*.<br><br>Water stress is calculated to be 21.9% overall nationally which is considered to be in the 'moderate stress level' – a situation that is very likely higher in some Districts and some Provinces.<br><br>Ratio of Water Withdrawal to Water Available is 7.3% using data from Catchment level 1 and Catchment level 2. |
| Source of the data in 2018 | (1) RWFA's Baseline Study: Water Users and Water Uses in Level 2 Catchments in Rwanda, 2017; Table 4: Water Withdrawal and Availability per catchment. |

NOTE
This indicator aims to report on % of total 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.

Rwanda is classified as a water scarce country using 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. Rwanda's National Integrated Water Resources Master Plan says that almost all of the country's water resources are lost through evaporation or run-off to downstream countries. It also says that 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.

* 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, is considered absolute water scarcity.

ANALYTICAL COMMENT(S)
This is an area of high vulnerability for the country as portrayed by the above information. The water stress indicator tells us the country is close to being in an absolute water stress situation; a high vulnerability situation.

INDICATOR 4.4 - CHANGE IN FUTURE WATER DEMAND —

| Indicator type | Adaptive capacity |
|---|---|
| Baseline data collected in 2015 | The projected (2040) demand is 3.356 BCM*/annum of the total renewable water resources of 6.826 BCM*/annum projected as available. |
| Source of the data in 2015 | (1) Rwanda Water and Forest Agency (RWFA) – IWRM – National Water Resources Master Plan 2015. |
| 2018 Data (update) | The projected (2040) demand appears to remain at 3.356 BCM*/annum. No change in total projected renewable water resources is available – and remains at 6.826 BCM*/annum.<br><br>Some information is available on the future demand for water for irrigation for agriculture. It suggests a very high proportion of projected demand for water would be demanded for irrigation, close to 50% of the total projected demand for water in 2040. |
| Source of the data in 2018 | (1) REMA-commissioned VAA study on Water Resources, quoting MINIRENA's National Water Resources Master Plan 2015. |

NOTE
This indicator intends to capture aggregate demand of Rwanda's 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 extending irrigation, development of industries, expansion of domestic water supply, urbanization, population growth, etc.

Calculations of future irrigation demand suggest it could consume half of the total renewable water resources projected as available (Rwanda Irrigation Master Plan, 2010; National Water Resources Master Plan 2015).

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

ANALYTICAL COMMENT(S)
Data related to this indicator compounds the picture of vulnerability in the water sector. An assessment of increasing vulnerability is appropriate.

INDICATOR 4.5 - CAPACITY OF DAMS AND LAKES TO STORE WATER ↘

| Indicator type | Adaptive capacity |
|---|---|
| Baseline data collected in 2015 | Rwanda Water and Forest Agency (RWFA) has confirmed in 2015 that they do not have this data. |
| Source of the data in 2015 | (1) Rwanda Water and Forest Authority (RWFA) IWRM. |
| 2018 Data (update) | Baseline water storage:<br>- Inland natural lakes capacity: 253,616,771,908 $m^3$ (253.6 BCM) (2015);<br>- Dams reservoir capacity: 68,885,300 $m^3$ (48 structures) (2018);<br>- Water storage per capita (artificial dams, ponds): 6.89 $m^3$ (target is 30 $m^3$). |
| Source of the data in 2018 | (1) Assessment of Water Storage Capacity per capita in Rwanda – Final Report, RWFA, 2016 .<br>(2) Dam Monitoring Report, RWFA, 2018. |

NOTE
Total storage capacities of all dams and lakes (within the territorial control of Rwanda, i.e., not including trans boundary lakes) per capita 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.

ANALYTICAL COMMENT(S)
A study released in December 2018 puts some hard facts behind the aggregate number of BCMs of water stored in Rwanda. The report also portrays a real need for increased attention to management of the storage facilities or units. The report also shows the large shortfall in stored water compared to the target for stored water. When the water storage capacity starts to increase and reaches a threshold closer to target, the assessment can change to positive.

| INDICATOR 4.6 - ACCESS TO RELIABLE DRINKING WATER ↗ | |
|---|---|
| Indicator type | Adaptive capacity |
| Baseline data collected in 2015 | NISR data (2010) indicates 72.3% of the population has access to improved drinking water. NISR data (2011) indicates 74.2%. In MINAGRI's 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. |
| Source of the data in 2015 | (1) NISR EICV data reports; and MINAGRI (SPAT-3). |
| 2018 Data (update) | 87% of households have access to and use improved drinking water (EICV5; 2016/17), up from 84.4% of households in EICV4 report, 74.2% in the EICV3 report, and 70.3% in the EICV2 report, showing continual steady progress.<br><br>In 2016/17, at the national level, 27% of households are within 0-4 minutes walking distance from an improved drinking water source and 61% of households are within 0-14 minutes walking (one way). |
| Source of the data in 2018 | (1) EICV5 Utilities and Amenities Report, for 2016/17, published December 2018.<br>(2) EICV4 Utilities and Amenities Report, 2013-2014, published August 2015. |
| NOTE<br>This is an EICV indicator. The extent of population with access to drinking water is a strong vulnerability 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. | |
| ANALYTICAL COMMENT(S)<br>Access to drinking water across the country has been increasing or improving year-over-year for several years. This is a positive trend and points to a reduction in vulnerability in this area. Nevertheless, there is still room to improve. The situation of household access to clean water is monitored very closely by NISR and other sources and good up-to-date data exists. | |

## Group Five – Vulnerability Indicators in the Health Sector (6)

| INDICATOR 5.1 - CHANGE OF NUMBER OF DEATHS FROM DIARRHEA DISEASES AND MALNUTRITION – STUNTING AND WASTING ONLY | — |
|---|---|
| Indicator type | Exposure |
| Baseline data collected in 2015 | Diarrhea is the 3rd cause of morbidity in children under five (U5), at 26% of all morbidity cases (130,189 cases in 2013). |
| Source of the data in 2015 | (1) MINISANTE Website. |
| 2018 Data (update) | No mortality data available for deaths from diarrhea diseases and malnutrition.<br><br>12.1% of children under five (U5) had diarrhea and 1.7% of children under five (U5) had diarrhea with blood for a total of 13.8%.<br><br>Diarrhea is the 3rd cause of morbidity in children under five (U5), at 20% of all morbidity cases in Health Centers (103,044 cases in 2014). |
| Source of the data in 2018 | (1) Rwanda Demographic and Health Survey-RDHS Final Report 2014-2015, NISR, Chapter 10.5, Diarrhea, Published March 2016. (Data gathered between Nov 2014 and April 2015)<br>(2) NISR Mortality Assessment Survey Report, 2015, published July 2018.<br>(3) NISR Statistical Year Book, 2017. |
| NOTE<br>Child mortality data from NISR does not indicate cause of death. | |
| ANALYTICAL COMMENT(S)<br>Data related to this indicator does not appear to be available. It is not included in the Mortality Assessment Survey Report published by NISR. This information pertains to 'under five-U5' children – and relates to children with stunting and wasting. Rates of stunting and wasting are available, but mortality data related to stunting and wasting is not available. Also information on deaths due to malnutrition and diarrhea-related diseases was not found. While morbidity information is available, it is not what this indicator demands. Hence the decision to show this indicators as not having data available for comparative analysis. | |

INDICATOR 5.2 - CHANGE OF MALARIA HAZARD →

| Indicator type | Exposure |
|---|---|
| Baseline data collected in 2015 | 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 Centers 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. |
| Source of the data in 2015 | (1) NISR 2014 Statistical Yearbook and Rwanda Biomedical Centre (RBC). |
| 2018 Data (update) | Rwanda saw an 86% decline in malaria incidence between 2005 and 2011, an 87% decline in outpatient malaria cases in the same period, and a 74% decline in inpatient malarial deaths in the same period (Source: Rwanda Health Information Management System-RHIMS, in DHS Final Report, 2014-2015). Malaria mortality rates remained unchanged in 2015 at 5% compared to earlier data (MOH, 2016).<br><br>However, in 2012 Rwanda faced an increase of malaria cases, with a morbidity of 18.3% in 2015 (MOH, 2016). Causes cited for the increase include many factors; among them are climate factors (temperature, rainfall).<br><br>Malarial Proportional Mortality |
| Source of the data in 2018 | (1) Rwanda Demographic and Health Survey-RDHS Final Report 2014-2015, NISR, Chapter 12, Malaria, Published March 2016. (Data gathered between Nov 2014 and April 2015.)<br>(2) NISR Statistical Year Book, 2017* (quoting RHMIS). |

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|
| Under 5 (%) | 13.05 | 8.00 | 2.91 | 3.45 | 3.41 | 3.00 | 3.80 |
| Above 5 (%) | 14.17 | 6.00 | 4.26 | 5.51 | 9.40 | 5.60 | 8.70 |

NOTE
The malaria vector is climate sensitive. This index aims to measure the % rate of change rate of death from malaria.
[Eventually the indicator should be a measure of the projected relative risks of malaria deaths in 2030 and the future cost of treatment.]

ANALYTICAL COMMENT(S)
The rate of malaria hazard is currently fluctuating. Year-to-year data do not show a clear trend in one direction. Due to the climate sensitivity of the malaria vector, data related to this indicator continues to suggest that malaria is contributing to increased climate vulnerability in the country. However the direction of change at the current time is not clear, leading to the "no change" assessment. Malaria hazard rates for 2017 and 2018 needed to be added to the above data when available – to indicate whether there has been a recent improvement in the malarial hazard rate.

INDICATOR 5.3 - DEPENDENCY ON EXTERNAL RESOURCE FOR HEALTH SERVICES ↗

| Indicator type | Sensitivity |
|---|---|
| Baseline data collected in 2015 | 2012-2013 external healthcare cost dependency was 89.1%.*<br>2013-2014 external healthcare cost dependency was 84.5%.*<br>2014-2015 (revised budget) external healthcare cost dependency was 26.6% (not including loans that will be paid back).<br><br>*MINECOFIN's online data goes back a few years and data for the periods 2012-13, 2013-14 and 2014-15 can be prepared to revise the baseline, if necessary. |
| Source of the data in 2015 | (1) MINECOFIN budget documents based on MINISANTE data. |
| 2018 Data (update) | Rwanda's 2018 budget documents show planned external resources for Health at 22% of the health budget, i.e., planned domestic resources on Health. Rwanda's 2017-18 actual expenditures in Health from domestic sources compared to planned external resources for that same year has external resources at 21% of the expenditures. These figures are in line with the 2014-15 baselines of 26.6% (in baseline). |
| Source of the data in 2018 | (1) MINECOFIN budget documents prepared by National Budget/Budget Management and Reporting Unit, accessed on November 30, 2018 at MINECOFIN's website: http://www.minecofin.gov.rw/index.php?id=231 |

NOTE
This indicator tracks the proportion of Rwanda's total expenditures on health or related services that are provided by entities external to the country.

ANALYTICAL COMMENT(S)
New data was acquired in 2018. There is evidence from MINECOFIN's documents available online that Rwanda's % of dependence on external resources for operating its health care system is decreasing. As the trend is positive, this indicator receives a positive assessment, indicating that vulnerability is being reduced in this area. However the level dependence on external resources remains high and the rate of decrease in dependence is not large.

INDICATOR 5.4 - PROPORTION OF URBAN POPULATION LIVING IN SLUM AREAS ↘

| Indicator type | Sensitivity |
|---|---|
| Baseline data collected in 2015 | NISR data (2012 Census) indicates 14% (nationally) of the population lives in slum conditions, while the rate is 65.7% in Kigali. |
| Source of the data in 2015 | (1) NISR 2012 Census data. |
| 2018 Data (update) | The EICV5 report indicates that 14.2% of Rwanda's population lives in unplanned urban housing, that 52% of Rwanda's total urban population lives in unplanned urban housing; and 77.3% of Kigali's population is living in unplanned urban housing.<br><br>EICV4 report indicated that 12.8% of Rwanda's population lives in unplanned urban housing (compared to 8.4% in EICV3 report). 79% of people in Kigali live in unplanned urban housing in EICV4 (up from 62.6% in EICV3). |
| Source of the data in 2018 | (1) EICV5 Main indicator Report, 2016/17, published December 2018.<br>(2) EICV4 Report special report on Utilities and Amenities – Table 4.1. |

NOTE
This is an EICV indicator, and an SDG indicator. The proportion (%) urban population 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.)

ANALYTICAL COMMENT(S)
The trend line regarding the % of the country's population living in unplanned urban housing/areas indicates that climate sensitive urban vulnerability is increasing. Hence the assessment that this situation is leading to increased vulnerability.

INDICATOR 5.5 - CHANGE IS ACCESS TO HEALTH CARE FACILITIES ↗

| | |
|---|---|
| Indicator type | Adaptive capacity |
| Baseline data collected in 2015 | In 2005/06 it took 95.1 minutes to reach a health center and in 2010/11 it took 59.9 minutes to reach a health center. |
| Source of the data in 2015 | (1) MINISANTE website.<br>(2) NISR, 2014 Statistical Yearbook. |
| 2018 Data (update) | The estimated average (mean) time to travel on foot to a health center was around 49.9 minutes (EICV5) – a national average; this is a decrease in time from 56.9 minutes reported in EICV4, and 61.4 minutes in EICV3. However 38% of households have to walk 60 minutes or longer.<br><br>The EICV5 report indicates slightly higher average times in the rural areas at 53.5 minutes (down from 61.4 minutes in EICV4) and considerably less time in the urban areas at 33 minutes (which is up from 30.7 minutes in EICV4). |
| Source of the data in 2018 | (1) EICV5 Utilities and Amenities Report, for 2016/17, published December 2018.<br>(2) EICV4 Report, for 2013/14, published August 2015. |

NOTE
This indicator aims to measure the annual change in % of population able to access to health care facilities.

ANALYTICAL COMMENT(S)
The data indicates improvement in access to health clinics, hence the assessment that this change has contributed to a reduction in vulnerability – or an increase in adaptive capacity. This is a long term positive trend indicating improved physical access to health care. A positive assessment overall is given. However there is an unequal distribution to this accessibility, which is clearly articulated in NIRS's EICV5 report. It is not known whether future improvements in access to health care facilities will focus on increasing access for the 38% who have a longer time to travel to their health post.

| INDICATOR 5.6 - ACCESS TO IMPROVED SANITATION FACILITIES ↗ | |
|---|---|
| Indicator type | Adaptive capacity |
| Baseline data collected in 2015 | % of population using an improved sanitation facility is 95.6% including flush toilets (0.8%), private pit latrine (82.4%) and shared pit latrine (12.4%). |
| Source of the data in 2015 | (1) NISR 2012 Census data. |
| 2018 Data (update) | 86.2% of households in 2016/17 (EICV5) have access to improved sanitation, up from 83.4% in 2013/14 (EICV4), with 66.2% using improved sanitation facilities not shared in 2016/17 (up from with 63.5% in 2013/14).<br><br>Improved sanitation facilities include flush toilet (1.9%), pit latrine with solid slab at (84.3%) in EICV5 (up from 81.6% in EICV4).<br><br>93.6% of households in urban areas and 84.4% of households in rural areas use improved sanitation (EICV5) (up from 93.5 and 81.3% respectively in EICV4 report).<br><br>EICV3 reported 74.5% of households used improved sanitation facilities at national level, including flush toilet (1.7%), and pit latrine with solid slab (72.8).<br><br>Data is also available at provincial level. |
| Source of the data in 2018 | (1) EICV5 Utilities and Amenities Report, for 2016/17, published December 2018.<br>(2) EICV4 Utilities and Amenities Report, for 2013/14, published August 2015. |
| NOTE<br>The proportion (%) of the population with access to pit latrine, ideally with access to hand washing system such as *kandagira ukarabe* (i.e., disposal facilities that can effectively prevent human, animal, and insect contact with excreta and related bacteria.) | |
| ANALYTICAL COMMENT(S)<br>There is a long term positive trend line on improved sanitation, i.e., the use of improved sanitation facilities. No data is provided on change in hand washing related to improved sanitation, such as kandagira ukarabe. Due to the long term trends in the data for this indicator the assessment is positive – a reduction in vulnerability by increasing adaptive capacity. | |

## Group Six – Indicators of Terrestrial Biodiversity Protection (4)

| INDICATOR 6.1 - CHANGE IN PERCENTAGE OF NATIONAL FOREST COVER → | |
|---|---|
| Indicator type | Exposure |
| Baseline data collected in 2015 | In 2008, 28.28% of Rwanda dry land area was forest cover, including shrub land, or 17.34% excluding shrub land. (University of Rwanda-CGIS).<br><br>RNRA data for 2012 indicates 4.8% is natural forest cover, 10.9% is plantation forest cover (forest sub-total of 15.7%), 2.9% is wetlands and 9.9% is savanna shrub, for a total of 28.5%. |
| Source of the data in 2015 | (1) Rwanda Water and Forest Agency (RWFA) – Forestry Mapping study, with University of Rwanda-CGIS. |
| 2018 Data (update) | In 2015, forests covered 29.2% of Rwanda's dry land area, with planted forests at 17.4% and natural forests at 11.9%, up from a total of 25.9% in 2010, due to increases in planted forest area. The percent of natural forest has remained steady in the 6 year period.<br><br>Data produced by Rwanda for the Convention on Biological Diversity (CBD) Conference of Parties, 2018, stated that 29.8% of Rwanda's land was forested, with plantation covering 17.9%, and natural forests at 11.9%, with a goal of 30% forest cover. |
| Source of the data in 2018 | (1) Report for REMA's preparation of Third National Communication, March 2018.<br>(2) REMA's Biodiversity Focal Point and RWFA (Forestry Dept.), 2018. |

NOTE
The aim of this indicator is eventually 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.

ANALYTICAL COMMENT(S)
There is good data on national forest cover. Rwanda has almost met its goal. But progress is flat-lined. There are indications that the quality of the forest biome is degraded – and degrading due to the very high demand for biomass (wood) for household energy use both in the rural and urban areas. The effects of climate change on the biome do not appear to be addressed in the reporting on national forest cover. Given the relative lack of positive change in % of forest cover and the quality of forest cover, this indicator is assessed as 'no change'.

INDICATOR 6.2 - CHANGE IN SIZE (HA OR KM2) OF NATURAL HABITATS OR CRITICAL ECOSYSTEMS ↘

| Indicator type | Sensitivity |
|---|---|
| Baseline data collected in 2015 | In 2010 Rwanda had wetland areas in 860 areas; of these 56,120 ha are fully protected, 206,732 ha can be used under certain conditions, and 15, 689 ha can be used if an environmental impact assessment is provided. |
| Source of the data in 2015 | (1) Rwanda Water and Forest Agency (RWFA) – Environment subsector strategic plan 2013-2018, 2012, and the report of the World Bank project entitled: "Integrated Management of Critical Ecosystems" (Rwanda), 2010. |
| 2018 Data (update) | 18 ecosystems are threatened: 4 national parks (endangered or critically endangered), 3 collapsed ecosystems, 8 critically endangered ecosystems, and 3 endangered ecosystems.<br><br>National parks: Nyungwe, Volcano, Akagera, Gishwati-Mukure (245,214 ha), and national forest reserves (37,886 ha).<br><br>Total area of wetlands is 276,477 ha. This includes 74% where conditional exploitation is permitted, 6% where unconditional exploitation is permitted, and 20% which is fully protected. Wetlands, represented by marshlands, represent 6.3% of Rwanda's national territory of 26,338 $km^2$. |
| Source of the data in 2018 | (1) Rwanda TNC 2018, REMA. |

NOTE
This indicator intends to include natural habitats and wetlands that are protected plus non-protected areas that are rehabilitated and managed.

ANALYTICAL COMMENT(S)
There is no increase in the size of Rwanda's natural habitat and critical ecosystem, or in the size of the areas being rehabilitated or managed. The data suggests that the sensitivity is increasing with increasing degradation of these areas, all of which are highly sensitive to human exploitation and climate change effects.

INDICATOR 6.3 - PROPORTION OF LAND AREA PROTECTED TO MAINTAIN BIODIVERSITY AND NATURAL ECOSYSTEM ↗

| Indicator type | Adaptive capacity |
|---|---|
| Baseline data collected in 2015 | Currently 10.714% of the total dry land area is protected, and 246,181 ha of natural forestland are to be protected (published in the Official Gazette of the Republic of Rwanda) including the 3 national parks. |
| Source of the data in 2015 | (1) Rwanda Water and Forest Agency (RWFA) – Forestry and Republic of Rwanda Official Gazette, or REMA????. |
| 2018 Data (update) | Protected areas are mainly Rwanda's 4 national parks, including one new one – the total area of the 4 parks is 245,214 ha., and Rwanda's forest reserves – the total area of 6 forest reserves is 37,886 ha (Bugasa, Buhanga, Sanza, Iwawa, Rubirizi, Makera). The parks and forest reserves total a land area of 283,100 ha. |
| Source of the data in 2018 | (1) Rwanda Third National Communication (2018), Rwanda's Statement to the UNFCCC, prepared by REMA. |

NOTE
This indicator aims to take into account the landscape approach to conservation. It is a measure of the extent to which national targets established for biodiversity conservation have been met.

ANALYTICAL COMMENT(S)
While Rwanda has targets for national forest cover, mentioned above, the protection of natural ecosystems remains of concern. There has been a small increase in protected areas with the opening of a new national park in a context where land resources are scarce. Given the factors at play, it is laudable that Rwanda has increased its protected areas. Rwanda has exceeded its Gazetted target for protection of natural ecosystems. This indicator provides data that can be assessed as a positive contribution to reducing vulnerability.

INDICATOR 6.4 - ENGAGEMENT IN INTERNATIONAL ENVIRONMENTAL CONVENTIONS ↗

| | |
|---|---|
| Indicator type | Adaptive capacity |
| Baseline data collected in 2015 | Rwanda scores 87.5% on the implementation of Multilateral Environmental Agreements. |
| Source of the data in 2015 | (1) REMA qualitative report – self assessment. |
| 2018 Data (update) | REMA has confirmed that Rwanda has signed 20 Multilateral Environmental Agreements (MEAs), including 14 under the umbrella of the Rio Convention of 1992, plus 6 others. Four agreements were signed in the 1990s, 10 were signed in the 2000's, and 6 were signed after 2010, the latest signed in 2017. Rwanda's activity status reports are available for all but 4 of the 20 conventions. |
| Source of the data in 2018 | (1) REMA provided a qualitative report on agreements signed, together with the implementation status of each. |

NOTE
This indicator is a 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.

ANALYTICAL COMMENT(S)
Rwanda is endeavoring to be an active player in the area of MEAs and reporting on its activities. There has been positive movement since 2015. This indicator provides data that allows for a positive assessment and a positive contribution to reducing vulnerability.

## Group Seven - Indicators of Vulnerability in Energy and Transportation sectors, including Infrastructure (5)

INDICATOR 7.1 - CHANGE OF HYDROPOWER GENERATION CAPACITY ↗

| Indicator type | Exposure |
|---|---|
| Baseline data collected in 2015 | 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. |
| Source of the data in 2015 | (1) Rwanda Energy Group – report by Engineer Donath Harerimana. |
| 2018 Data (update) | At the end of 2017, Rwanda had 94.78 MW of installed capacity for hydroelectricity production with 47.5 MW capacity available, representing 45.1% of all electricity generation capacity. |
| Source of the data in 2018 | (1) "Rwanda Energy Sector Vulnerability and Adaptation to Climate Change – Final Report: Rwanda's Third National Communication to UNFCCC", prepared for REMA, January 2018. |

NOTE
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. The index eventually wants to show the projected risk of hydropower generation capacity weighted by the importance of hydropower to the country.

ANALYTICAL COMMENT(S)
Hydropower is providing a smaller share of electricity requirements in Rwanda now than in the previous period. Also, the target for installed hydropower capacity was not met in the reporting period. Water resources are available, though providing installed hydropower capacity is expensive and involves large environmental and human displacement considerations. Rwanda has plans to access electricity from the expanding East Africa grid as a key means to access more electrical power. It has also promoted small-scale off grid solar power in rural areas on an innovative basis. In this context, Rwanda has not increased its dependence on a water sensitive resources in the electricity sector. As a result this indicator has been given a positive assessment.

Rwanda may yet try to reach its potential for sustainable hydropower generating capacity. Current hydropower production – and any future increase in hydropower to meet ever growing electricity needs – operates in a context of highly vulnerable to climate sensitive water resources and high water stress.

INDICATOR 7.2 - LEVEL OF DEPENDENCY ON IMPORTED FUEL ↘

| Indicator type | Sensitivity |
|---|---|
| Baseline data collected in 2015 | 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.<br><br>100% of Rwanda's petroleum-based fuel is imported. One of the uses of imported petroleum is to generate electricity. |
| Source of the data in 2015 | (1) Rwanda Energy Group – report by Engineer Donath Harerimana. |
| 2018 Data (update) | Rwanda imports all (100%) of its petroleum products requirements from abroad since there is no local production.<br><br>The consumption of petroleum in Rwanda stands as of 2018 at 23 million liters per month ( 275m liters per year). This includes petroleum products used to generate electricity. Petroleum constitutes about 20% of total national imports (by value) and has been steadily rising in the past five years, with an average annual increase of 12 per cent.<br><br>The current national energy balance statistics show that biomass (mostly wood fuel) accounts for about 83% of the total energy consumption, followed by petroleum at 9.7% (including petroleum products used to generate electricity), electricity at 1.3% and others at about less than 0,5%. In rural areas, the reliance on biomass is over 90%. For most Rwandans, wood fuel remains the leading source of energy for cooking. |
| Source of the data in 2018 | (1) REG website, accessed Nov. 15, 2018: https://www.reg.rw/what-wedo/petroleum/ |

NOTE
A high proportion of energy use is 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.

(Eventually the aim is to measure proportion of total energy requirements from domestically produced renewable energy sources or % change in energy from biomass, i.e. renewable natural resources.)

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% (2013).

ANALYTICAL COMMENT(S)
Rwanda remains 100% dependent on imported fuel (petroleum). This situation is not likely to change. Its use (importation) of petroleum is increasing at a rapid rate and plans are underway to provide new means of acquiring petroleum (pipeline). Rwanda's vulnerability is high related to oil prices and supply issues/crises. Rwanda's increase in sustainable renewable energy is small and slow, especially if wood resources are not considered a sustainable source. This indicator provides data that suggest an assessment of highly vulnerable and increasing vulnerability.

INDICATOR 7.3 - QUALITY OF TRADE AND TRANSPORT INFRASTRUCTURE ↗

| | |
|---|---|
| Indicator type | Adaptive capacity |
| Baseline data collected in 2015 | None |
| Source of the data in 2015 | (1) No data source established. |
| 2018 Data (update) | An indicator and data source has been identified in 2018 that corresponds suitably to the original indicator in the 2015 National Climate Change Vulnerability Index.<br><br>Rwanda Transport Development Agency (RTDA) has a Regional integration Program which includes the construction of One Stop Boarder Post (OSBP). One Stop Border posts are a key part of Rwanda's trade and transportation infrastructure. OSBPs are aimed at reducing transport related non-tariff barriers affecting international trade by facilitating trade and the flow of people.<br><br>Currently trade with DRC represents 65.8% of Rwanda's external trade, trade with Uganda represents 26.9% and trade with Tanzania represents 7.3% of Rwanda's external trade.<br><br>RTDA has a key performance indicator related to OSBP with baseline data from 2012. OSBP Infrastructure on the following borders were availed: Rusumo between Rwanda and Tanzania, Kagitumba between Rwanda and Uganda, Nemba and Ruhwa between Rwanda and Burundi and Rubavu (La corniche border) between Rwanda and DRC but only Rusumo and Kagitumba are operating as One stop Border Post. The OSBP at Gatuna on the Uganda border is currently being completed and Rusizi I and II OSBPs are under design phase with implementation scheduled in 2020.<br><br>RTDA's target is to have seven (7) OSBPs fully operational. |
| Source of the data in 2018 | (1) RTDA's 2016-17 Annual Report.<br>(2) Notes from consultation with RTDA. |

NOTE
The "quality of trade and transport infrastructure" indicator is derived from the World Bank's "Logistic Performance Index" (LPI), which scores the performance in the country's trade and transport infrastructure using an overall score from 1 to 5, with higher scores representing better infrastructure performance. The World Bank indicator includes quality of trade and transport-related infrastructure, ease of arranging competitively priced shipments, and reflects the perception of logistics professionals. An indicator used in Rwanda that corresponds to this one from the World Bank and which meets the criteria for indicator choice was identified in 2018.

ANALYTICAL COMMENT(S)
Progress has been made in terms of identifying an indicator that can approximate the indicator used internationally (World Bank). Further Rwanda's performance with respect to this indicator is positive. Progress has been made in improving regional integration through the OSBPs. This indicator therefore provides data that allows for a positive assessment of reduced vulnerability. This indicator needs to be reviewed for its durability over multiple years.

INDICATOR 7.4 - LENGTH OF PAVED ROADS ↗

| Indicator type | Adaptive capacity |
|---|---|
| Baseline data collected in 2015 | In 2011-12 there were 1,171 km of national paved roads; in 2012-13 there were 1,210 km; in 2013-14 there were 1,216 km; and in 2014-15 there were 1,242 km of national roads paved. |
| Source of the data in 2015 | (1) RTDA Key Performance Indicator data sheet, provided by RTDA staff. |
| 2018 Data (update) | 2018 data indicates 1385 km of national paved roads are in place, with past data indicating values slightly at variance with data collected in 2015. National paved roads: |
| Source of the data in 2018 | (1) "Rwanda Energy Sector Vulnerability and Adaptation to Climate Change – Final Report: Rwanda's Third National Communication to UNFCCC", prepared for REMA.<br>(2) Data acquired from RTDA, Jan. 2019. |

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|
| Km | 1,205 | 1,205 | 1,224 | 1,211 | 1,213 | 1,279 | 1,305 | 1,355 | 1,385 |

NOTE
This indicator specifically aims to show the annual change in the length of paved roads. The indicator can also include the km of national roads in good condition and the length of paved roads as a proportion (%) of all the country's roads, measured in length (km).

ANALYTICAL COMMENT(S)
There is a steady trend line of increases to Rwanda's paved national roads. There has been a 15% increase in the number of kilometers of national paved roads since 2010. This assessment has not yet examined road conditions or paved roads as a proportion of all of the country's roads. However given the steady increase in paved national roads, the assessment for this indicators is positive, a contribution to reducing vulnerability. A new strategy to make Rwanda's road transportation infrastructure climate resilient is being developed.

INDICATOR 7.5 - PROPORTION OF POPULATION WITH ACCESS TO ELECTRICITY FOR LIGHTING ↗

| Indicator type | Adaptive capacity |
|---|---|
| Baseline data collected in 2015 | NISR (4th Population and Housing Census, 2012) shows that 16.8% of Rwandan households use electricity as the primary source of energy for lighting. EICV 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%.<br><br>NISR's 2014 Statistical Yearbook shows showed there was an increase of 19% in electricity customers since 2011. |
| Source of the data in 2015 | (1) NISR (2012) – 4th Population and Housing Census. |
| 2018 Data (update) | As of 2016/17, the EICV5 report indicated that the use of electricity as the energy source for lighting in the home has risen to 27.1%, nationally. In the earlier EICV4 period, 19.8% of households in Rwanda used electricity as their primary source of lighting.<br><br>In EICV5, for urban areas, 75.6% of households use electricity for lighting (up from 71.8% in EICV4), and in the rural areas, 15.5% of household use electricity for lighting in EICV5 (up from 9.1 in EICV4).<br><br>In Kigali the rate of electricity use for lighting in the household is 78% in EICV5 (up from 73.3% in EICV4). Data is also available for each District. |
| Source of the data in 2018 | (1) NISR's EICV4 Report on Utilities and Amenities, published in 2015 with data collected in 2013-2014.<br>(2) EICV5 Utilities and Amenities Report, for 2016/17, published December 2018. |

ANALYTICAL COMMENT(S)

There is a steady trend line showing increase in the use of electricity for lighting at the household level. Progress in renewable energy (electricity) from solar is small but increasing. While households in rural areas are increasingly able to access electricity, it remains expensive and households rely on a variety of energy sources for lighting, including batteries for torches and paraffin. Data for this indicator suggests a positive assessment and a reduction in vulnerability with increasing access to electricity.

## 4.5 Analysis of Change in National Vulnerability

The analysis of national Vulnerability is presented by showing an assessment of data for 37 indicators in three groups – Exposure, Sensitivity and Adaptive Capacity – with the direction of change indicated by the symbols provided for each indictor. In summary, 17 indicators show reduced vulnerability, 11 indicators show increased vulnerability. 5 indicators show no change in vulnerability and 4 indicators do not provide data to make an assessment.

### 4.5.1 Exposure indicators

There are 10 Indicators of Exposure at the national level. Below is the list of those indicators and symbols indicating the direction of change between the baseline (2015) and the current review (2018).

Comparative analysis suggests that 5 indicators show deterioration in vulnerability; 2 indicators show no change in vulnerability; 1 indicator suggests improvement in vulnerability and 2 indicators provide no new data or do not allow for comparative analysis.

**Table 4.2:** Summary of change in National Exposure Indicators

| | | |
|---|---|---|
| Indicator 1.1 | Projected change in population growth to 2032 | ↘ |
| Indicator 2.1 | Annual frequency of warm days (above 30°C) per year | ↘ |
| Indicator 2.2 | Current mean annual temperature; annual change (variation) in temperature | ↘ |
| Indicator 3.1 | Change in agricultural production | ↘ |
| Indicator 4.1 | Annual precipitation run-off rate | ↘ |
| Indicator 4.2 | Annual Ground Water Recharge (GWR) | ⊘ |
| Indicator 5.1 | Change of number of deaths from diarrhea diseases and malnutrition – stunting and wasting only | — |
| Indicator 5.2 | Change of malaria hazard | → |
| Indicator 6.1 | Change in % of national forest cover | → |
| Indicator 7.1 | Change of hydropower generation capacity | ↗ |

### 4.5.2 Sensitivity indicators

There are 10 Indicators of Sensitivity at the national level. Below is the list of those indicators and symbols indicating the direction of change between the baseline (2015) and the current review (2018).

Comparative analysis suggests that 6 indicators show deterioration in vulnerability; 1 indicator shows no change in vulnerability; and 3 indicators suggest an improvement with reduced vulnerability.

**Table 4.3:** Summary of change in National Sensitivity Indicators

| | | |
|---|---|---|
| Indicator 1.2 | Age Dependency Ratio (ADR) | ↗ |
| Indicator 1.3 | Total urbanized population | ↘ |
| Indicator 1.4 | Effectiveness of Rwanda's social safety net/social protection system | ↗ |
| Indicator 2.3 | Annual loss due to damage caused by multi-hazards, particularly weather-related hazards | ↘ |
| Indicator 3.2 | Rural population as % of total population | → |
| Indicator 4.3 | Fresh water withdrawal rate | ↘ |
| Indicator 5.3 | Dependency on external resources for health services | ↗ |
| Indicator 5.4 | Proportion of urban population living in slum areas | ↘ |
| Indicator 6.2 | Change in size (ha or $km^2$) of natural habitats or critical ecosystems | ↘ |
| Indicator 7.2 | Level of dependency on imported fuel | ↘ |

### 4.5.3 Adaptive Capacity indicators

There are 17 indicators of adaptive capacity at the national level. Above is the list of the symbols used to indicate the direction of change between the baseline (2015) and the current review (2018) as a result of comparative assessment.

The comparative analysis suggests that 13 indicators suggest an improvement in vulnerability; 2 indicators show no change in vulnerability; 0 indicators shows deterioration in vulnerability; and 2 indicators have no data to allow for a comparative analysis.

**Table 4.4:** Summary of change in National Adaptive Capacity Indicators

| | | |
|---|---|---|
| Indicator 1.5 | Level of education attained by women | ↗ |
| Indicator 1.6 | Strength of government capacity and coordination to mainstream climate change | ⊘ |
| Indicator 2.4 | Access to improved climate-related early warning information or systems – for extreme weather events | ↗ |
| Indicator 2.5 | Percentage of the area of Rwanda covered by the Rwanda Meteorology Agency | ↗ |
| Indicator 2.6 | Extent of use of climate information products and services in decision-making in climate sensitive sectors | ↗ |
| Indicator 3.3 | Extent of fertilizer use | ↗ |
| Indicator 3.4 | Level of severe child malnutrition | → |
| Indicator 4.4 | Change in future water demand | ⊘ |
| Indicator 4.5 | Capacity of dams and lakes to store water | ↗ |
| Indicator 4.6 | Access to reliable drinking water | ↗ |
| Indicator 5.5 | Change is access to health care facilities | ↗ |
| Indicator 5.6 | Access to improved sanitation facilities | ↗ |
| Indicator 6.3 | Proportion of land area protected to maintain biodiversity and natural ecosystem | ↗ |
| Indicator 6.4 | Engagement in international environmental conventions | ↗ |
| Indicator 7.3 | Quality of trade and transport infrastructure | ↗ |
| Indicator 7.4 | Length of paved roads | ↗ |
| Indicator 7.5 | Proportion of population with access to electricity for lighting | ↗ |

# 5 | Policy Recommendations

The two vulnerability assessments undertaken and presented in this report provide the Government of Rwanda with a robust set of observations about the vulnerability of the country to the impacts of climate change and about the current adaptive capacity to reduce the level of vulnerability. This report also sheds light on areas where effective action might be taken to reduce vulnerability, reduce risk of hazards, and increase adaptive capacity. Across the 37 indicators of vulnerability at the national level and the 36 indicators of vulnerability at the household level and presented at the district level, this report provides a comprehensive assessment of climate risk and vulnerability with substantial data to reinforce the observations and conclusions.

The main approach to taking action based on these assessments needs to involve multi-sector groups of people as well as open-minded sector specialists to gain an understanding of the issues raised and an appreciation for the complexities of finding solutions or determining actions. A comprehensive approach needs to be taken in response to all climate change related issues. This need for collaboration should not deter planning and action, however.

The primary value of the data and the assessment presented in this report is achieved if efforts are undertaken to ensure this information feeds into national planning and into the programs of the agencies set up to be leaders on climate action. With the comparative assessments provided in this report, especially related to the national vulnerability indicators, there is increasing clarity on the areas that need priority attention and where well-planned response or actions would be potentially very beneficial to the country as it works to become increasingly climate resilient. Here are the specific recommendations.

## 5.1 Recommendations

### 5.1.1 Central recommendation

**Future climate scenarios to 2030, 2050 and 2080** should be used in all sectors and by all stakeholders in strategic planning and decision-making. Many specific recommendations below relate to this one and require the participation, leadership and cooperation of the Rwanda Meteorology Agency in both sector-specific and multi-sector dialogue, learning and planning using future climate scenarios[1].

[1] These proposed efforts will build on current initiatives of Rwanda Meteorological Agency (RMA), including the Rwanda Climate Services for Agriculture, supported by CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) in collaboration with Rwanda Agriculture Board (RAB), the International Research Institute for Climate and Society (IRI) ENACTS Program at Columbia University and the International Center for Tropical Agriculture (CIAT). RMA is also in a partnership with the Climate Prediction Analysis System project of the Intergovernmental Authority on Development (IGAD) Climate Prediction Applications Center (ICPAC) in partnership with the World Meteorological Organization.

## 5.2 Other recommendations

### 5.2.1 Use Future Climate Scenarios for Multi-sector Strategic Planning

1. Climate scenarios to the years 2030 and 2050 are urgently needed by key stakeholders and sector Ministries for use in strategic planning. Rwanda will be well served when the Rwanda Meteorology Agency acquires the capacity to prepare and explain future probabilistic climate change scenarios that are consistent with local historic climate records and with regional scenarios prepared by the IGAD Climate Prediction and Applications Centre (ICPAC) and the WMO Regional Office for Eastern and Southern Africa.
2. Key sectors in Rwanda should use long-term climate scenarios to make strategic decisions and plans. All relevant stakeholders should be required by a national mandate to prepare their next sector strategies in a way that integrates information from future climate scenarios in their review of how climate change and climate vulnerability affects their sector, consistent with Rwanda's Green Growth and Climate Resilience Strategy. A review of the national indicators presented in this report shows specific areas where future climate scenarios are needed in order to prepare informed estimates of how climate change will affect a sector and to estimate additional costs associated with new requirements to meet the new demands. Future climate scenarios are becoming a prerequisite as an international norm for strategic planning in health, water resources, agriculture, energy, economic development, and infrastructure management, among other sectors.
3. Future climate scenarios are also crucial for projects being considered for funding by FONERWA. FONERWA-funded projects must be well informed by, and take into account future climate scenarios and the bio-physical impacts of climate change on Rwanda.
4. Future climate scenarios are also crucial for Rwanda's acquisition of international climate finance from the Green Climate Fund-GCF, the Global Environment Facility-GEF, the World Bank and other sources of climate finance. The use of future climate scenarios will boost the confidence of international agencies in Rwanda's national planning capacity and in specific proposals generated in Rwanda for international climate finance consideration.

### 5.2.2 Reduce Climate Change Vulnerability in the Health Sector

1. Climate change impacts on the health of the population of Rwanda need to be better and more widely understood, with information about climate change shared among stakeholders in this sector. Planners in the health sector should provide health strategies informed by future climate scenarios; and to do this they must have access to future climate scenarios. This report has indicated that future climate change impacts will increase the need for: a) higher levels of health insurance coverage to strengthen the social safety net, b) reduction in the prevalence of malaria hazard, and c) reduction in mortality due to diarrheal disease and malnutrition in children under age 5 (U5) who are stunted and wasted.
2. Enrollment in Mutuelle de Sante is increasing for at least one family member per household; this is a positive story as health insurance is a key feature of social solidarity in Rwanda and a key part of the social safety net or social protection system. However more household members need to be enrolled for better coverage of the population. As climate change impacts hit harder, the need for access to health care service is likely to increase. The health of the population is very climate sensitive. Ensuring health insurance coverage for all is even more important in times of water stress, heat stress, changing patterns of disease prevalence and increasing climate related hazards.

3. A clear picture of the spatial distribution of health insurance coverage and gaps in coverage is required to identify correlations among high prevalence of malaria, U5 wasting, mortality due to diarrheal disease and malnutrition in U5 children, and among other climate sensitive indicators of public health.
4. Future climate scenarios must be used by Rwanda Biomedical Center, the authority responsible for malarial control, so they are informed about potential increases in malarial hazard due to rising temperature, and aware of the resources required to prevent or treat future increases in malarial rates.

### 5.2.3 Reduce Climate Change Vulnerability in the Water Sector

1. Planners in the water sector must review and revise their data about water demand and supply in the future in light of information from future climate scenarios. Rwanda faces a critical situation of water stress along with a low volume of artificially stored water, a high precipitation run-off rate, low ground water recharge rates, high demands for water in the context of low per capita water availability, and an increasing need for substantial amounts of water for irrigation, industry, growing cities and other key requirements. Rwanda's current National Water Resources Management master plan is a key document in this sector. Rwanda's water resources master plan must be fully climate-informed. Senior water resources managers must be highly informed about climate change.
2. Rwanda's water decisions need to be informed by the National Water Resources Management master plan that has taken future climate scenarios into consideration so that future water needs are better understood. Future climate scenarios will inform such areas as: strategic planning for artificial water storage infrastructure, the issuing of water withdrawal permits, including for irrigation and industrial purposes, planning for the provision of water to towns and cities, and strategic plans for water capture and storage for energy production. Water use planning that is climate informed will be required at all levels, at the Sector level, as well as by District and Province.
3. In light of the current high levels of water stress, a climate-informed National Water Resources Management master plan is crucial to planning for future drought in Rwanda. Water needs will likely rise with increased temperatures. This will likely affect ground water levels, evapotranspiration rates and soil moisture levels. The links between a climate-informed National Water Resources Management master plan and agriculture production planning are very important. Explicit cooperation is needed on a multi-sector basis for the inclusion of future climate information into strategic planning in areas of mutual concern.

### 5.2.4 Reduce Climate Change Vulnerability in the Forest Sector

1. It is critical that measures are implemented to enhance the health of the existing forests in Rwanda, specifically measures that are informed by future climate change scenarios. Rwanda's forests or biome are a highly climate-sensitive resource, and are already distressed. The impacts of climate change are highly likely to negatively affect the quality of Rwanda's forests from a biodiversity perspective, and also the extent of biomass in the forest, in a context where Rwanda is unable to significantly increase the number of hectors of forest in the country – both natural forests and plantation forests.
2. All aspects of Rwanda's new forest sector strategy that are well informed by future climate scenarios must be rigorously implemented to provide for enhanced forest health and forest protection. Current intense pressures on protected and unprotected forests, such as deforestation to meet rural household energy needs, together with pressure from future climate change mean that future vulnerability assessments and future climate knowledge are crucial to protect the health of Rwanda's forest for the future.

3. Rwanda's Forest and Water Agency (Forest Sector) should proceed with climate-informed strategic plans in order to ensure forests are assisted in making the transition to a warmer climate so that Rwanda's forest resources remain in place for the long term. Important choices about reforestation, forest rehabilitation, and forest conservation need to be fully climate informed. RFWA (Forest Sector) should regularly update its forest sector strategy with new information on climate change including future climate scenarios.
4. Rwanda's targets, aspirations and obligations related to forests must be fully climate-informed, meaning that climate change considerations must be fully integrated into short and long term plans for enhancing the health of the forest biome, including measures to protect critical ecosystem, increase biodiversity, protect natural habitat and strengthen the protection systems of protected areas. RFWA's (Forest Sector) should explore options for acquiring international payments for ecosystem services (e.g. REDD funding) related to rigorous forest protection, and adopt international Monitoring, Reporting and Verification (MRV) protocols.

### 5.2.5 Reduce Climate Change Vulnerability in the Agricultural Sector

1. Agriculture is highly climate sensitive and at every renewal opportunity Rwanda's agricultural strategy (PSTA) must be increasingly well informed by future climate change scenarios and lessons learned from experience within the sector about the impacts of climate change on agricultural production.
2. MINAGRI staff at the District level should be strongly represented at the multi-sector stakeholder workshops where seasonal forecasts from Rwanda Meteorological Agency are reviewed in order to devise advisories for residents on how best to adapt in each upcoming period. (See also Recommendation 8.2.6.) Our questionnaire results showed that two-thirds of households surveyed are affected by three climate change phenomena: heavy rains, drought, and also by crop loss. These are the areas where farmers could be most positively affected by advice and assistance on a seasonal basis.
3. MINAGRI and RWFA (Water Sector) need to undertake close ongoing liaison so that water drawdown plans for irrigation for agricultural production are strategically coordinated with the construction and maintenance of artificial water storage facilities and the availability of ground water resources, where these are the envisaged sources of water for irrigation. In all irrigation plans, low carbon energy sources (e.g. solar) should be employed.
4. Plans already in MINAGRI's strategic plan (PSTA) that support adaptation in the agricultural sector should be strongly promoted. These include conservation agriculture, use of manure, use of low carbon technology, methods to increase soil moisture content, drought tolerant seeds requiring low volumes of inorganic fertilizer, small scale solar irrigation technologies, postharvest loss reduction methods and other similar technologies. These sustainable agriculture technologies should be promoted as important climate change responses.
5. MINAGRI should support increased diversity in agricultural production to help farmers spread their risk across more crops. With a high number of farmers producing beans/peas (legumes), maize, sweet potatoes and cassava (in all Districts), and also Irish potatoes and bananas (in Eastern, Southern and Northern Regions), there is already some agricultural crop diversity; this diversity should be promoted and can be extended to include sorghum and plantain.

### 5.2.6 Reduce Climate Change Vulnerability in the Energy Sector

1. Rwanda's energy requirements and energy production capacities are highly climate sensitive and vulnerable to external shock and climate shocks. Rwanda's energy sector

should be fully climate informed. Energy planners need to be very well informed of future climate predictions and enabled to apply future climate information in strategic energy sector decision making. This also applies to the Infrastructure sector as it relates to the provision of energy requirements.
2. Rwanda can become a model for the use of climate information in energy planning given the country's commitment to green growth and climate resilience. Active and on-going multi-sector planning is critical to meet both urban and rural energy needs.
3. Rwanda Energy Group (REG) makes it very clear in its communications that rural energy requirements are extremely dependent on biomass or wood energy. Rural households and most urban households rely on wood and charcoal for cooking and other domestic activities. Critical coordination on rural energy needs must involve energy agencies such as REG and Rwanda's Forest and Water Agency-RFWA-Forest Sector. As rural energy supplies are highly climate sensitive and vulnerable, this coordination must be fully informed about future climate scenarios for Rwanda.
4. Similarly, with water for energy generation, energy production agencies such as REG must be engaged with the RWFA-Water Sector. All plans for increased hydroelectric energy production in Rwanda, at any scale, must consider the projected risk from climate change impacts weighted by the importance assigned to hydropower options.
5. Appropriate agencies in the energy sector should be called upon to explain why Southern Province has a relatively low level of access to electricity.

### 5.2.7 Reduce Climate Change Vulnerability in Other Sectors

1. Relevant stakeholders should reflect on this report and assess where they can take action to reduce climate vulnerability in the sphere of their own work and programs. These stakeholders should play a meaningful role in improving plans and performance in their sector – particularly by including climate-related vulnerability reduction, climate change adaptation, and climate risk and hazard reduction in all plans, programs and projects.
2. Stakeholders should also become advocates for climate vulnerability reduction and promoters of the use of climate information in decision-making where they have influence – at national, Provincial and District levels, and also at the Sector and Cell levels.
3. Developers of new projects should be encouraged to use the findings of this report to introduce adaptation and vulnerability reduction measures into their proposals and demonstrate alignment with national goals related to green economy and climate resilience.

### 5.2.8 Reduce Climate Change Vulnerability in the Districts of Rwanda

1. Districts and MINALOC should press ahead with the implementation of the 'green economy' components of their District Development Strategies (DDS).
2. Districts should review their development strategies and planned projects to ensure their plans are informed both by this report's assessment of their climate vulnerabilities, and by future climate scenarios.
3. Districts should undertake measures that will ensure their district development plans are informed by this report's assessment of their climate vulnerability. Specifically:
   (a) District staff should reflect on this report to find ways of reducing climate-related vulnerability in their District;
   (b) Districts should engage local leaders, as well as non-governmental groups and private sector representatives that are active in the District to put forward their interpretation of the findings of this report and to articulate how they can help to reduce vulnerability and build adaptive capacity in the District.

4. Districts should undertake long-term programs and related annualized activities that will enhance local knowledge about climate change, increase public engagement on building adaptive capacity and increase the commitment and resources of development partners to reducing vulnerability.
   (a) Districts should undertake pilot community-based adaptation planning exercises that aim to manage climate risks and build adaptation capacity, thus enabling the bottom-up flow of information to enhance District priority-setting;
   (b) Districts should host quarterly multi-stakeholder workshops that focus on seasonal forecasts from the Rwanda Meteorology Agency, and engage in interpreting seasonal climate forecasts and prepare advisories for the District's population on measures they can take to adapt to the likely weather conditions in the season ahead (participatory scenario planning)[2];
   (c) All Districts should encourage more participation by the public in efforts to reduce vulnerability through involvement in public works including: tree planting, constructing new hillside terraces, constructing or repairing drainage ditches, repairing and strengthening bridges people use to get to schools, markets and clinics; citizens should be encouraged to contribute to discussions about how to prevent damage from climate related hazards.

### 5.2.9 Strengthen the data collection process for future Vulnerability Assessments

1. NISR should be encouraged to increase its regular data gathering on issues related to climate change, to assist the national effort to monitor climate change impacts and monitor advances in climate change vulnerability reduction. Currently NISR is the information source for 14 of the 37 national indicators included in this vulnerability assessment, and it should be lauded for its efforts.
2. The process of preparing Rwanda's forthcoming National Adaptation Plan (NAP) should support the next Vulnerability Assessment by including ways to update data related to the National Vulnerability Indicators used in this study.
   (a) Since Rwanda requires considerable information from a wide range of stakeholders for international reporting and communications, such as the preparation of National Communications for the UNFCCC, data provided by stakeholders should include updates to all relevant National Vulnerability Indicators in this study.
   (b) In advance of the next Vulnerability Assessment, and in collaboration with stakeholders, a process should be undertaken whereby expectations of change – or targets – are established for all the Indicators in this Vulnerability Assessment, i.e., what is a reasonable amount of change to expect within a review period. Targets can be drawn, for example, from Rwanda's Nationally Determined Contributions (NDCs) to 2030, and from the National Strategy for Transformation - 1 (NST-1). Stakeholders should recommend targets where they are not readily available. These targets will provide a benchmark for each indicator, and will enhance the accuracy and quality of future vulnerability assessments.
   (c) A gender-based assessment of household vulnerability should be undertaken using the household survey data provided by this study, or included in the Terms of Reference of the next assessment of climate change vulnerability.

[2]This initiative can be modeled on Kenya's use of participatory scenario planning (PAP) which has been mainstreamed in all 47 Kenya Counties as a seasonal decision making platform, since 2014. The PSP approach supports interpreting and using seasonal forecasts for adaptation decision making at the sub-national level. See https://careclimatechange.org/publications/kenya-climate-information-services-country-report/

## 5.3 Recommended Vulnerability Reduction Scenarios for Consideration by Districts

It is anticipated that on the basis of this report, Districts will make an effort to consider measures they can implement to increase the resilience of vulnerable people and areas – specifically to reduce climate change vulnerability in their District. This recommendation is presented because Districts can and must reduce their vulnerability to climate change, specifically by increasing their adaptive capacity.

As part of the Recommendations, vulnerability reduction scenarios are presented to promote discussion in each District and to provide a strong basis for concrete measureable results-based action.

The options presented below have been developed with reference to the finding of this report and are consistent with the Recommendations presented in this report.

### 5.3.1 Adopt Priority Sectors

Each District is requested to consider adopting 2-3 priority Sectors where their District has a low score in the vulnerability assessment report provided in this report. For those Districts that are already taking some action, the strong invitation is to do more, and to base further action on the evidence provided in this report.

### 5.3.2 Use Criteria for Selecting Options

Districts should adopt measures to reduce their vulnerability based on specific criteria. Here are some suggested criteria. Vulnerability reduction measures should:

1. Effectively address key areas of climate change vulnerability documented in their District;
2. Focus on 2-3 sectors highlighted in this report, and prioritize their actions in these sectors;
3. Use weather forecasts and climate scenarios to make decision on measures, as recommended in this report;
4. Select cost sensitive approaches based on feasibility assessments, thereby reducing vulnerabilities without incurring high costs, while finding new financial resources to fund all measures to be adopted; and
5. Select participatory approaches that engage men and women citizens and youth, and facilitate learning widely to spread benefits and achieve ownership of goals and objectives and also the expected benefits.

### 5.3.3 Consider the Time Frame

A 4 to 5-year time frame is suggested in which Districts would apply the measures they select. They should take no more than 1 year to plan the implementation of the additional vulnerability reduction measures and undertake initial start-up; Districts should then anticipate 3 years for implementation; plus 1 year for wrap up and final reporting; Districts should plan annual monitoring and evaluation activities to keep their measures on track towards a high level of achievement, with the numbers to prove that results were achieved.

### 5.3.4 Focus on Learning

Once Districts adopt additional vulnerability reduction measures, they should also engage in an explicit process for learning by stakeholders in the District, including stakeholders across all sectors. There should also be quarterly monitoring and an annual evaluation of the vulnerability reduction initiatives undertaken by the District. This monitoring and evluation effort should assess progress made, provide a basis for Districts to improve their vulnerability reduction plans so there can be increased effectiveness of the initiatives or measures being implemented through removal of barriers to high level of achievement, to enable lessons to be learned and to enable Districts to consider scaling up successful initiatives to other vulnerable areas or groups within the District.

### 5.3.5 Choose Among Options to Reduce Vulnerability and Increase Adaptive Capacity

It is anticipated that Districts will choose more than one option to focus on after examining the feasibility and opportunity to incorporate vulnerability reduction and resilience enhancing outcomes into their plans. It is anticipated that Districts will also chose options from more than one sector as vulnerability to climate change was indicated in more than one sector in every District. Also, to gain a deep understanding of vulnerability reduction and how to build adaptive capacity requires all sectors to be involved, to work together and to learn more about how climate change impacts the population. The trend line of climate change going forward suggests that the impacts will continue to increase.

The options presented below are realistic approaches set within the framework of Rwanda's current development priorities and plans. They contain the 'way forward' for effective action on vulnerability reduction for the most vulnerable communities and households; they represent basic actions for significant vulnerability reduction for all Districts.

| HEALTH SECTOR OPTIONS | |
|---|---|
| Vulnerability and Rationale | Rwanda's rate of malaria prevalence has declined over several years but the decline has now stalled, and rates of malaria prevalence have even increased, due in part to climate change factors. |
| Anticipated Outcomes | (1) Reduced prevalence of malaria in most vulnerable areas and communities.<br>(2) Increased nutritional intake for vulnerable children under five who are stunted and wasted. |
| Vulnerability Indicators | (1) Proportion of vulnerable households with malaria;<br>(2) Health status of vulnerable household members (level of stunting and wasting among children under 5 years old) |
| Targets | Achieve targets set out by the Ministry of Health, for:<br>(1) Low malaria prevalence; and<br>(2) Recommended intake of key nutrients with improved nutritional practices.<br><br>Targets should be specified for each District, with high priority assigned to action in highly vulnerable areas, and to highly vulnerable communities and households. |

| AGRICULTURE SECTOR OPTIONS | |
|---|---|
| Vulnerability and Rationale | In the national context where there is virtually no increase in available agricultural land and where increased fertilizer use is among the few factors providing hope for an increase in agriculture production, the risks associated with climate change need to be reduced systematically and aggressively in ways that also increase the sustainability of agricultural production. This requires the full positive contribution of all farmers. |
| Anticipated Outcomes | (1) Increased use of high quality compost and manure mixed with fertilizer using conservation farming norms prioritizing farmers with small or hillside plots;<br>(2) Increased use of post-harvest storage by food insecure small scale farmers;<br>(3) Increased crop diversity, including drought and heat tolerant crops;<br>(4) Increased use of agro-forestry and inter-cropping methods by small scale farmers; and<br>(5) Increased follow-up to all training on sustainable, climate resilient agriculture methods - to increase farmer adoption rates. |
| Vulnerability Indicators | (1) Change in manure and fertilizer use by vulnerable households/farmers;<br>(2) Change in proportion of households experiencing food insecurity;<br>(3) Change in diversity of agricultural production;<br>(4) Change in farmers knowledge of climate resilient farming methods;<br>(5) Change in rate of participation in building adaptive capacity. |
| Targets | Achieve targets set by Ministry of Agriculture (MINAGRI) for:<br>(1) Use of organic manure and crop waste; use of fertilizer;<br>(2) Prevalence of & access to post-harvest storage among vulnerable small scale farmers;<br>(3) Crop diversity including use of drought and heat tolerant crops and seeds;<br>(4) Use of agro-forestry and intercropping methods; and<br>(5) Effective adoption of agricultural practice taught in training programs.<br><br>Targets should be specified for each District, with high priority assigned to highly vulnerable areas, and to highly vulnerable communities, households and farmers/farms. |

| ENERGY SECTOR OPTIONS | |
|---|---|
| Vulnerability and Rationale | Access to off-grid electricity can be delivered at economic rates in vulnerable areas without the high cost of installing the grid. Electricity builds household resilience. More efficient energy use in households can also be economical for households. The impact from both outcomes will increase resilience of households and natural capital/systems. |
| Anticipated Outcomes | (1) Increased access to off-grid electricity for lighting in households;<br>(2) Increased access to and use of high efficiency stoves burning wood or charcoal. |
| Vulnerability Indicators | (1) Proportion of households with access to electricity;<br>(2) Change in local forest and woodlot size. |
| Targets | The goal would be to:<br>(1) Achieve targets of the Ministry of Infrastructure for access to off-grid electricity by vulnerable households;<br>(2) Achieve targets of the Rwanda Water and Forestry Agency for availability of sustainable forest resources to supply biomass that meets the energy needs of rural households.<br><br>Targets should be specified for each District with high priority assigned to action in highly vulnerable areas, and to highly vulnerable households. |

| FOREST SECTOR OPTIONS | |
|---|---|
| Vulnerability and Rationale | Rural energy demand requires significant use of biomass/forest resources; sustainable harvesting of these resources is crucial at this time when climate change is also a large threat. Significant and continual effort must be taken to increase the availability of renewable forest resources from resilience forests, ensuring they are sustainably used. |
| Anticipated Outcomes | (1) Increased tree planting in protected woodlots and around farm plots on hillsides;<br>(2) Increased quality of national forests, with increase sustainability of forest under pressure from climate change |
| Vulnerability Indicators | (1) Change in local forest and woodlot size;<br>(2) Change in rate of community participation in building adaptive capacity;<br>(3) Change in physical vulnerability of houses and farm plots. |
| Targets | Achieve targets of the Rwanda Water and Forestry Agency for:<br>(1) Sustainable use of woodlots and forests; sustainability of national forests;<br>(2) Rehabilitation of forests and natural biome;<br>(3) Increased number of hectares of sustainable woodlots and forests.<br><br>Targets should be specified for each District, with high priority assigned to action in highly vulnerable areas, and to highly vulnerable communities. |

| WATER SECTOR OPTIONS | |
|---|---|
| Vulnerability and Rationale | Rwanda is short of artificially stored water; demands for water for irrigation are growing; there is a need for all current water storage facilities to be well maintained and provide water resources, while new facilities for catching rain water runoff are put in place to meet the growing demand. Incentives for community and household rain water collection need to be increased as does access to clean drinking water among vulnerable communities. |
| Anticipated Outcomes | (1) Increased maintenance of all artificial water storage structures in the country for maximum storage and availability in drought conditions;<br>(2) Increased number of small-scale low-cost water storage facilities available and used;<br>(3) Increased rain water storage capacity – and use – at household level;<br>(4) Increased access to clean water for households. |
| Vulnerability Indicators | (1) Level of vulnerability of local infrastructure, specifically artificially stored water structures (e.g., dams with reservoirs);<br>(2) Proportion of households with usable water storage capacity;<br>(3) Proportion of households with access to clean drinking water near or in their home. |
| Targets | Achieve or exceed targets of the Rwanda Water and Forestry Agency for:<br>(1) Maintenance of artificial water storage structures;<br>(2) New construction of small-scale low-cost artificial water storage structures;<br>(3) Access to clean drinking water.<br><br>Achieve or exceed targets of the MINAGRI for construction and maintenance of small scale water storage structures for agricultural uses.<br>Targets should be specified for each District with high priority assigned to action in highly vulnerable areas, and to highly vulnerable communities and households. |

| OPTIONS FOR MULTI-SECTOR INITIATIVES | |
|---|---|
| Vulnerability and Rationale | Multi-sector initiatives are needed to provide concrete experience for all District and Ministry staff and for District leaders as evidence that cross- and multi-sector approaches are required to enhance climate change resilience and reduce vulnerability. The use of seasonal climate information in decision making is a pivotal learning opportunity and provides a concrete basis for outreach and the provision of advice for rural households facing increased climate risk. |
| Anticipated Outcomes | (1) Advisories prepared for farmers and producers by participatory workshops involving representatives of relevant sectors and communities, focused on managing household/farm assets and productive activities, based on Meteo-Rwanda's Seasonal Forecasts;<br>(2) Increased implementation of 'green' components of District Development Strategies; with a strong planning process used for renewing the DDSs with increased targets for climate resilience and climate risk reduction, using climate scenarios to 2030 and 2050 (temperature & rainfall) to set targets and priorities. |
| Vulnerability Indicators | (1) Use of climate information in Sector, Cell and District-level decision making;<br>(2) Access to Early Warning System (EWS) for extreme weather events;<br>(3) Impacts of climate change affecting household livelihoods. |
| Targets | (1) Districts should start the process of holding multi-sector workshops involving community representatives aimed at preparing seasonal advisories for farming households;<br>(2) District should achieve or exceed targets for the 'green' components of District Development Strategies. |

# 6 | Conclusion

This report on Vulnerability Assessment in Rwanda has reviewed vulnerability to Climate Change at Household level and at National level to provide a comprehensive data-driven picture of the situation facing the country. The focus has been on examining elements at both levels associated with Rwanda's Exposure and Sensitivity to Climate Change as well as its Adaptive Capacity.

The assessment presents the reader with an understanding of the relative vulnerability of the four Provinces and the City of Kigali, and of the 30 Districts using an Index approach that uses numbers to rank jurisdictions, to rank Provinces and to rank Districts. Districts are ranked within Provinces and also ranked in comparison to each other and categorized as Low, Medium and High Vulnerability.

The report finds Southern Province as the most vulnerable among the four Provinces and the City of Kigali. It also finds Huye District in Southern Province as the most vulnerable among the 30 Districts. The report identifies four Districts as having the highest Vulnerability, with 3 of them located in Southern District – Gisagara, Huye and Ruhango, together with Karongi District in Western Province. The report identifies Northern Province as having the lowest relative Vulnerability among the four Provinces and the City of Kigali. Gasabo District is identified as having the lowest vulnerability among the 30 Districts. A total of 11 Districts fall into the category of low vulnerability: 3 Districts in City of Kigali, 1 District in Southern Province, all 5 Districts in Northern Province and two in Eastern Province.

The report provides sufficient detail about the factors supporting this set of observations. Districts are urged to examine the report and make commitments to take action or renew their commitments, as appropriate. Recommendations to Districts are contained in the report. Action to reduce vulnerability should be focused on building the adaptive capacity of all levels between households and the District. New resources, programs and commitments are required as the impacts of climate change are not decreasing. The increasing impact of climate change is likely to be felt in all parts of the country, in all climate sensitive sectors, and across all the systems that support household livelihoods.

This report also reviews new data collected using the national framework for vulnerability assessment established in 2015 with 37 indicators of vulnerability. It analyses the changes that have taken place since data was gathered in 2015 and concludes that data related to the adaptive capacity indicators show progress and improvement in the vulnerability situation facing the country. However these improvements have been offset to some extent by increases in the impact of climate change. Overall, a mixed review emerges. However more indicators – 46% (17 of 37, or 46%) show reduced vulnerability that those showing increased vulnerability – 30% (11 of 37), while 13.5% (5 of 37) of the indicators show no change, and 11% (4 of 37) do not allow for assessment given the lack of data available.

Recommendations are provided in nine areas all aimed at enabling the country to make significant strides going forward to reduce vulnerability primarily through the building of adaptive capacity, through some innovation in monitoring, and through the use of climate information in decision making at all levels. More understanding will be gained as Rwanda incorporates future climate change forecasts into sector analysis and strategic planning to find even more ways to increase adaptive capacity. The Rwanda Meteorology Agency is a very crucial institution in the provision of future climate forecasts.

Five sectors are noted for special attention including the use of future climate change forecasts in strategic planning: Health, Water, Forestry, Agriculture and Energy Sectors. This report also stresses that a cooperative multi-sector approach is increasingly required for robust planning to reduce vulnerability. The use of future climate forecasts in the preparation and design of new programs and projects is recommended. This aims at improving Rwanda's access to international climate finance for effective climate change action.

Further, a recommended Scenario is presented that integrates many of the recommendations in an applied or practical way that is relevant to effective vulnerability reduction at the local level in Rwanda. The Scenario could be applied in other geographic areas where there is motivation, commitment and/or available resources to address local vulnerability in a multi-sector approach. The report provides the basis for other scenarios to be developed based on similar criteria.

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# ANNEXES

# Annex 1 - Calculation of Values for the Household Vulnerability Indicators

| | Indicator | Use of proportion (Alternative method) | Transformed | Notes on methodology used |
|---|---|---|---|---|
| 1.1 | Age Dependency Ratio (Sensitivity) | No | No | 'ADP' was calculated by adding respondents 0-14 years old and those over 65 years, and dividing that sum by the number of people between 15 and 64, i.e., NISR's method. |
| 1.2 | Social safety net (Sensitivity) | Yes | No | The proportion of HH with at least one member not covered by any health insurance. |
| 1.3 | Social Capital (AC) | Yes | | Calculated as the difference between the proportions of HH receiving money from a member living outside the village minus proportion of HH sending money to a member living outside the village plus the proportion of HH that have membership in an agriculture cooperative, and then divided by 2. The negative value is justified by the way the indicator is calculated – for example, in Ruhango district they send more money than they receive. |
| 1.4 | Education levels attained by women (AC) | No | Yes | the normalization methodology was used, then the value was transformed (1 – value) |
| 1.5 | Participation in building adaptive capacity (AC) | Yes | No | Adding the proportion of HH involved in: i) tree planting, ii) construction or repair of drainage ditches, and iii) terracing, then dividing by 3 (averaged). |
| 2.1 | Temperature change (Exposure) | Yes | No | Taken from one variable – proportion of those negatively affected. |
| 2.2 | Heat wave (Exposure) | Yes | No | Taken from one variable – proportion of those negatively affected. |
| 2.3 | Perceived change in rainfall etc. (Exposure) | Yes | No | Proportion of those negatively affected – across several variables – then averaged. |
| 2.4 | Perceived river level change (Exposure) | Yes | No | Proportion of those who observed a decrease in river level - both large and small decreases. |
| 2.5 | Perceived change in borehole water level (Exposure) | | | Proportion of those who observed a decrease in borehole water level - both large and small decreases. |

| | | | | |
|---|---|---|---|---|
| 2.6 | Experience of loss due to weather hazards (Sensitivity) | Yes | No | The average of the proportion of HH which were negatively affected by weather hazard – taken from the responses to 10 questions: 4.5, 11.6, 12.10, 12.16.1, 12.16.2, 12.16.3, 12.16.4, 12.16.5, 12.16.6, and 12.16.7. For these questions, the "Yes" responses were considered and averaged. Also, the responses were considered to 20 questions in Block 14, specifically the proportion of HH responding to these questions were averaged:<br>14.1A - who responded "Yes";<br>14.1B - who responded "Much more and Somewhat more frequent";<br>14.2A - who responded "Yes";<br>14.2B - who responded "Yes";<br>14.2C - who responded "A big and small increase";<br>14.3A - who responded "Yes";<br>14.3B - who responded "A big and small increase";<br>14.4A - who responded "Yes";<br>14.4B - who responded "Much more frequent";<br>14.4C - who responded "A big increase";<br>14.5A - who responded "Yes";<br>14.5B - who responded "A big increase";<br>14.6A - who responded "Yes";<br>14.6B - who responded "A big increase";<br>14.7A - who responded "Yes";<br>14.7B - who responded "A big increase";<br>14.8A - who responded " Yes";<br>14.8B - who responded "A big increase";<br>14.9A - who responded "Yes";<br>14.9B - who responded "A large and small increase". |
| 2.7 | Early warning (AC) | Yes | No | Proportion of those positively affected by access to early warning system. |
| 2.8 | Climate information (AC) | Yes | No | Proportion of those positively affected by access to climate information. |
| 3.1 | Agricultural Diversity (Sensitivity) | No | No | The normalization methodology was used, no transformation, as high values mean high vulnerability. |
| 3.2 | Manure and fertilizer use (AC) | No | No | Information provided by Q11.2 (Yes/No) is not quite the same kind of information as provided in 11.3 and 11.4 – change in amount used, therefore data from Q11.3 and 11.4 only was combined, but not 11.2, even though 11.2 should well demonstrate differences between districts. |
| 3.3 | Access to Irrigation (AC) | Yes | No | Proportion of respondents positively affected. |
| 3.4 | Training (AC) | Yes | No | Proportion of those who were trained, who also applied the training they received. |

| | | | | |
|---|---|---|---|---|
| 3.5 | Food security (Sensitivity) | Yes to some of the 12 variables used, no to others | No | For the animal raised, we focused on animals that provided more income or food (variables 6.1, 6.2.1, and 6.2.2). The alternative methodology was used.<br>Also the variables 9.1 to 9.8 were considered – Length of period with insufficient food, normalized but not transformed:<br>· Food assistance (9.1): Proportion of those who receives the assistance, not transformed. Proportion of food needs provided from own production (9.2), then transformed.<br>· Proportion of food needs from market (9.3): proportions, no transformation.<br>· Proportion of food needs from food assistance (9.4): Proportions, no transformation.<br>· Number of weeks without enough food from own sources (9.5): Normalization, no transformation,<br>· No. of meals a day during dry season (9.6): normalization ,no transformation<br>· Financial assistance (9.7): proportion of those who received financial assistance, not transformed.<br>· Availability of food in the market, even if the prices are too high (9.8): Proportion of No responses, No transformation.<br><br>Proportion of HH with kitchen garden (Question 11.5), only HH without a kitchen garden were considered, no transformation.<br>Then averaged the values from the above 12 variables. |
| 3.6 | Experience of severe weather hazards (Sensitivity) | No | No | |
| 3.7 | Animal Diseases (Sensitivity) | Yes | No | Proportion of HH negatively affected for each animal, averaged. |
| 3.8 | Woodlot size (Exposure) | Yes | No | Proportion of those observing negative change. |
| 4.1 | Malaria (Exposure) | Yes | No | Proportion of those negatively affected. |
| 4.2 | Health Status (Exposure) | Yes | No | Used HHs indicating family member(s) has disability(ies), together with frequency of use of health post; specifically considered the proportion of HH with the frequency >4 for both variables, then averaged them. |
| 4.3 | Health post access (AC) | No | Yes | Use the normalized method, transformed. |
| 4.4 | Drinking Water access (AC) | Yes | No | Used proportion having water in their house or nearby, within 500 meters. |
| 5.1 | Energy Use (AC) | No | No | Added then averaged all those using energy sources that are an alternative to wood (biogas, electricity and bottled gas for cooking; and electricity, biogas and solar for lighting). |
| 5.2 | Physical vulnerability of houses (Exposure) | Yes | No | Used proportion of homes on steep slopes and close to rivers. |
| 5.3 | Physical vulnerability of local infrastructure (Sensitivity) | No | No | |
| 5.4 | Transportation to market (Sensitivity) | No | No | HH using critical infrastructure and seen repaired done – used normalized method (means of transport to market was not used as most people walk); this variable was tabulated. Used 12.6: length of time to get farm produce to the local market; and 12.7: number of time to go to the market to sell farm produce - normalized, not transformed. |
| 5.4 | Water storage (AC) | Yes | No | Proportion of HH with tanks, and perception of positive change in water catchment capacity (low numbers). |

| | | | | |
|---|---|---|---|---|
| 6.1 | Change in income, debt, savings (AC) | Yes | No | Complex, average of several variables combined, took proportion of HH who observed an increase in income. |
| 6.2 | Impact on Livelihood (Sensitivity) | Yes | No | Proportion saying they have experienced a decrease in income. |
| 6.3 | Access to Finance (AC) | Yes | No | Proportion of those with a bank account, tontine members, etc., including those getting funds from the government; averaged, not transformed. |
| 6.4 | Access to land (AC) | Yes | No | Proportion of those with access to land (with title), not transformed. |
| 6.5 | Occupation (AC) | No | Yes | Considered only Occupation; the value was normalized, and transformed (1-x). The indicator "Change in occupation" was left out because of very low numbers. |
| 6.6 | Household assets (AC) | Yes | No | Proportion who have a house built with dried bricks and with bricks, then averaged. |

# Annex 2 - Template for Codification

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| BLOCK 1 | | |
| Q1: Age dependancy ratio | The sum of the population aged 0-14 and 65+ years divided by the population aged 15-64 years (NISR) | S |
| Q2: Social safety net effectiveness in the Districts | The number of households with at least 1 member not covered by health insurance | S |
| Q3: Social capital (social networks) | The number of family members living away from the HH remaining funds to HH minus number of family members living away who are supported by the HH | AC |
| Q4: Participation in building adaptive capacity | The number of HH which Participated in tree planting, construction or repair of drainage ditches or in terracing | AC |
| Q5: Principal occupation | Government/clerk/policeman/teacher/student/child minder: 0.1<br>General labourer/Job seeker/Cow minder: 0.3<br>Inactive: 0.5<br>Carpenter/Mason/Cooker: 0.7<br>Farmer/Driver: 0.9 | AC |
| Q6: Highest level of education attained by women | College or University Graduate or higher completed: 0.1<br>Vocational training, Secondary school completed: 0.3<br>Primary school completed: 0.5<br>Literate, and primary not completed: 0.7<br>Illiterate, and primary not completed: 0.9 | AC |
| Q7: Family members living outside the village | Household both received & sent money: 0.1<br>Household sent money to member: 0.3<br>No member living outside the village: 0.5<br>Household neither received nor sent money: 0.7<br>Household received money from member: 0.9 | AC |

BLOCK 1.A

| | | |
|---|---|---|
| Disability | Tabulation | |
| Chronic or debilitating Illnesses | Tabulation | |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| BLOCK 2 | | |
| Q8: Household income (2.1) | Salaried employment: 0.1<br>Income from own non-agriculture enterprise(s) or service: 0.3<br>Interest income, rental income, pension: 0.4<br>Casual wage employment: 0.5<br>Selling of grain, animals, livestock or natural products: 0.6<br>Selling of logs, wood, timber, charcoal, fish: 0.7<br>Mining, aggregates, remittances, transfer from friends/family: 0.8<br>Direct Support, charity: 0.9 | AC |
| Q 2.2 | Tabulation | |
| Q9: More cash savings now than 2 years ago (2.3) | A large increase in savings: 0.1<br>A small increase of savings: 0.3<br>No change: 0.5<br>A small increase of debt: 0.7<br>A large increase of debt: 0.9 | AC |
| Q10: A change in income this past year compared to two years ago (2.4) | A large increase in income: 0.1<br>A small increase in income: 0.3<br>No change: 0.5<br>A small decrease in income: 0.7<br>A large decrease in income: 0.9 | AC |
| BLOCK 3 | | |
| Q11: Land ownership and access (3.1, 3.2, 3.3, 3.4) | Land owned with title: 0.1<br>Land (farm plots) located on steep hillside: 0.3<br>Access to rented or borrowed land: 0.5<br>Access to agricultural cooperative land: 0.7<br>No access to land: 0.9 | AC |
| Q12: Increase or decrease in the amount of land accessed to in the last 2 years (3.5) | A large increase in land: 0.1<br>A small increase in land: 0.3<br>No change: 0.5<br>A small decrease in land: 0.7<br>A large decrease in land: 0.9 | AC |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| BLOCK 4 | | |
| Q13: House walls (4.1, 4.2) | Dried bricks with splinth of concrete/cement: 0.1<br>Dried bricks with splinth of stone: 0.3<br>Bricks/wood/sticks with splinth of stone/concrete/cement: 0.5<br>Bricks with splinth of dried bricks: 0.7<br>Wood/sticks/no splinth: 0.9 | AC |
| Q14: Roof material (4.3) | Modern iron sheet: 0.1<br>Iron sheet: 0.3<br>Tiles: 0.5<br>Grass: 0.9 | AC |
| Q15: Number of rooms added (4.4) | 4 rooms added: 0.1<br>3 rooms added: 0.3<br>2 rooms added: 0.5<br>1 room added: 0.7<br>No room added: 0.9 | AC |
| Q16: Times of house repairment in the last 2 years due flood/rain/landslide (4.5) | 0 time: 0.1<br>1 time: 0.3<br>2 times: 0.5<br>3 times: 0.7<br>4 times or more: 0.9 | S |
| Q17: House/homestead located on a steep slope, within 200 m of a river, a stream, or a lake (4.6, 4.7) | House not located on a steep slope, OUTSIDE 200 m of river: 0.1<br>House NOT located ON A STEEP SLOPE within 200 m of a river, a stream House located on a steep slope OUTSIDE 200 M OF RIVER: 0.5<br>House located on a steep slope and within 200 m of river: 0.9 | E |
| BLOCK 4B | | |
| Q18: Financial Assets (4.8 to 4.11) | House insurance: 0.1<br>Bank account: 0.3<br>SACCO account: 0.5<br>Tontine: 0.7<br>None of each: 0.9 | AC |
| BLOCK 5 | | |
| Q 5.1 | Tabulation | |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| Q19: Energy Source for Cooking (5.2.1) | Electricity: 0.1<br>Biogas/Bottled gas: 0.3<br>Charcoal: 0.5<br>Wood: 0.7<br>Gasenyi/Ibarizo/other: 0.9 | AC |
| Q20: Energy Source for Lighting (5.2.2) | Electricity: 0.1<br>Solar: 0.3<br>Biogas: 0.5<br>Kerosene/Battery: 0.7<br>Wood: 0.9 | AC |
| Q21: Access to clean water (5.3 - 5.6) | Water storage tanks within the household: 0.1<br>Clean water within the household: 0.3<br>Clean water within 500 m: 0.5<br>Clean water beyond 500 m: 0.7<br>No clean water: 0.9 | AC |

BLOCK 6

| | | |
|---|---|---|
| Q22: Animal raised (6.1) | Cow(s) with one of the 2 other: 0.1<br>Cow(s): 0.3<br>Pig(s)/Goat(s)/Sheeps(2): 0.5<br>Poultry (Chicken/duck/rabbit): 0.7<br>No animal raised: 0.9 | S |
| Q23: Animal that provides the most household food (6.2.1) | Cow(s): 0.1<br>Pig(s)/Goat(s)/Sheeps(2): 0.3<br>Poultry (Chicken/duck/rabbit): 0.5<br>No animal raised: 0.9 | S |
| Q24: Animal sales that provide the most household income (6.2.2) | Cow(s): 0.1<br>Pig(s)/Goat(s)/Sheeps(2): 0.3<br>Poultry (Chicken/duck/rabbit): 0.5<br>No animal raised: 0.7/0.9 | S |
| Q25: Diseases and pest that affected the animals in the past year (6.3) | No diseases affecting any animals: 0.1<br>Disease affecting 1-2 animals only once or twice each: 0.3<br>Disease affecting 3-4 animals once or twice each: 0.5<br>Diseased affecting 4-5 animals once or twice each: 0.7<br>Diseased affecting 5 more animals more than twice each: 0.9 | S |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| BLOCK 7 | | |
| Q26: Health insurance plans (7.1) | MMI, CORAR, MEDIPLAN: 0.3<br>Mutuelle de Sante: 0.5<br>No health insurance: 0.9 | S |
| Q 7.2 | Tabulation | |
| Q27: Household disease (7.3) | No disease: 0.1<br>Diarrhea: 0.3<br>Pneumonia: 0.5<br>Malaria: 0.7<br>At least 2 diseases: 0.9 | E |
| Q28: Times that household uses health services in the past 2 years (7.4) | No one: 0.1<br>1 time: 0.3<br>2 times: 0.5<br>3 times: 0.7<br>4 times and more: 0.9 | E |
| Q29: Time to get to the nearest health services (7.5) | Less than 15 min: 0.1<br>15-30 min: 0.3<br>30-45 min: 0.5<br>45-1 hour: 0.7<br>More than 1 hour: 0.9 | AC |
| BLOCK 8 | | |
| Q30: Rural training taken and applied (8.1, 8.2) | Terracing and slope maintenance/Mulching (gusasira) of soils: 0.1<br>Small-scale irrigation/Rainwater collecting/harvesting: 0.3<br>Inter-cropping methods/Tree planting/Pest and weed control/Agro-forestry methods (planting trees and/or fruit trees with crops)/Organic manure use/Accounting and improved business management for farming : 0.5<br>Improved grain drying, storage/Improved seed preservation/Food processing or food preservation/Increasing intensity and diversification of farm production: 0.7<br>No rural training taken and applied: 0.9<br><br>For those who took training but didn't apply it, we will tabulate the training taken, and we will report that follow-up was missing or not effective. | AC |
| BLOCK 9 | | |
| 9.1 | Tabulation | |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| Q31: Food security (9.2, 9.3, 9.4) | More than 90% of the needs are from own production: 0.1<br>Less than 50% of the needs are from the market, other portion from own production: 0.3<br>More than 50% of the needs from the markets, other portion from own production: 0.5<br>Less than 50% of the needs from assistance, other portion from own production: 0.7<br>More than 50% of the needs from the assistance, other portion from own production: 0.9 | S |
| Q32: Number of weeks with insufficient food (9.7) | No one: 0.1<br>1 week: 0.3<br>2-4 weeks: 0.5<br>5-8 weeks: 0.7<br>More than 8 weeks: 0.9 | S |
| Q33: Number of daily meals during the dry season (9.6) | At least 3 meals: 0.1<br>2 meals: 0.3<br>1 meal: 0.5<br>1 meal in 2 days: 0.9 | S |

BLOCK 10

| | | |
|---|---|---|
| Q 10.1 | Tabulation | |
| Q 10.2 | Tabulation | |
| Q 10.3 | Tabulation | |
| Q34: Change in the level of technical advice in the last year (10.4) | A large increase in technical advice: 0.1<br>A small increase in technical advice: 0.3<br>No change in technical advice: 0.5<br>A small decrease in technical advice: 0.7<br>A large decrease in technical advice: 0.9 | AC |
| Q 10.5 | Tabulation | |
| Q35: Number of functional mobile phone (10.6) | 4 and more mobile phones : 0.1<br>3 mobile phones: 0.3<br>2 mobile phones: 0.5<br>1 mobile phone: 0.7<br>No mobile phone: 0.9 | AC |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| BLOCK 11 | | |
| Q36: Crops introduced in the last 2 years (11.1a) (11.1b, 11.1c) | Banana/coffee/tea/plantain/pyrethrum: 0.1<br>Cassava: 0.3<br>Irish potato/Sweet potato/Beans/Peas: 0.5<br>Maize/Sorghum: 0.7<br>Rice/Wheat: 0.9<br>Least climate sensitive as 0.1, and most climate sensitive as 0.9 | S |
| Q 11.2 | Tabulation | |
| Q 11.3 | Tabulation | |
| Q 11.4 | Tabulation | |
| Q 11.5 | Tabulation | |
| Q 11.6 | Tabulation | |
| Q 11.7 | Tabulation | |
| Q37: Quantity of organic manure used this year compared to 2 years ago (11.3) | A large amount more manure used: 0.1<br>A small amount more manure used: 0.3<br>No change in manure used: 0.5<br>A small amount less manure used: 0.7<br>A large amount less manure used: 0.9 | AC |
| BLOCK 12 | | |
| Q38: Improved of the roads in the village (12.1) | A large improvement: 0.1<br>A small improvement: 0.3<br>No change/No improvement: 0.5<br>A small deterioration of the roads: 0.7<br>A large deterioration of the roads: 0.9 | S |
| Q 12.3 | Tabulation | |
| Q 12.4 | Tabulation | |
| Q 12.5 | Tabulation | |
| Q39: Time to bring farm produce to the market (12.6) | Less than 1 hour: 0.1<br>1-2 hours: 0.3<br>2-3 hours: 0.5<br>3-4 hours: 0.7<br>4 hours and more: 0.9 | S |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| Q40: Number of times a household member went to the market to sell crops or animals during the last year (12.7) | 12 and more times: 0.1<br>6-11 times: 0.3<br>2-5 times: 0.5<br>1 time: 0.7<br>0 time: 0.9 | S |
| Q 12.8 and 12.9 | Tabulation | |
| Q41: Means of transport to the market (12.9) | Own car: 0.1<br>Public transport (bus/minibus/Boat): 0.3<br>Motorcycle: 0.5<br>Bike: 0.7<br>On feet: 0.9 | S |
| Q 12.10 to Q 12.19 | Tabulation | |

BLOCK 13

| | | |
|---|---|---|
| Q42A: Change in the temperature in the last 2-3 years (13.1a) | Much cooler: 0.1<br>Cooler: 0.3<br>No change: 0.5<br>Warmer: 0.7<br>Much hotter: 0.9 | E |
| Q42B: Impact of temperature change on the household's livehood (13.1b) | High positive impact: 0.1<br>Positive impact: 0.3<br>No impact: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | E |
| 43A: Change in the amount rainfall in village in the last 2-3 years (13.2a) | No change: 0.1<br>Small amount more: 0.3<br>Small amount less: 0.5<br>Much more: 0.7<br>Much amount less: 0.9 | E |
| Q43B: Impact of the rainfall change on household's livehood (13.2b) | High positive impact: 0.1<br>Positive impact: 0.3<br>No impact: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q44A: Shim in the start date of the rainy season in the past 2-3 years (13.3a) | No change: 0.1<br>Few days earlier or few days delayed: 0.5<br>Many days earlier or many days delayed: 0.9 | E |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| Q44B: Impact in the shift in the start date of the rainy season | High positive impact: 0.1<br>Positive impact: 0.3<br>No impact: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q45A: Change in the intensity of rainstorm (13.3a) | Much less intensive: 0.1<br>Somewhat less intensive: 0.3<br>Same: 0.5<br>Somewhat more intensive: 0.7<br>Much more intensive: 0.9 | E |
| Q45B: Change of the frequency of the rainstorm (13.4b) | Much less frequent: 0.1<br>Somewhat less frequent: 0.3<br>No change: 0.5<br>Somewhat more frequent: 0.7<br>Much more frequent: 0.9 | E |
| Intensity of rainstorm (13.4c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No impact: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q46A: Change in drought event frequency in the past 2-3 years in the village (13.5a) | Much less frequent: 0.1<br>Somewhat less frequent: 0.3<br>No change: 0.5<br>Somewhat more frequent: 0.7<br>Much more frequent: 0.9 | E |
| Q46B: Change in drought event severity in the past 2-3 years in the village (13.5b) | Much less severe: 0.1<br>Somewhat less severe: 0.3<br>No change: 0.5<br>Somewhat more severe: 0.7<br>Much more severe: 0.9 | E |
| Q46C: Impact on the household's livelihood of change in drought event in the past 2-3 years in the village (13.5c) | Reduced drought: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>Increased drought: 0.9 | S |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| Q47A: Change in flood event frequency in the past 2-3 years in the village (13.6a) | Much less frequent: 0.1<br>Somewhat less frequent: 0.3<br>No change: 0.5<br>Somewhat more frequent: 0.7<br>Much more frequent: 0.9 | E |
| Q47B: Change in flood events in the past 2-3 years in the village (13.6b) | Much less flooding: 0.1<br>Somewhat less flooding: 0.3<br>No change: 0.5<br>Somewhat more flooding: 0.7<br>Much more flooding: 0.9 | E |
| Q47C: Impact on the household's livelihood of change in flood event in the past 2-3 years in the village (13.6c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q48A: Change in windstorm event severity in the past 2-3 years in the village (13.7a) | Much less severe: 0.1<br>Somewhat less severe: 0.3<br>No change: 0.5<br>Somewhat more severe: 0.7<br>Much more severe: 0.9 | E |
| Q48B: Change in windstorm event frequency in the past 2-3 years in the village (13.7b) | Much less frequent: 0.1<br>Somewhat less frequent: 0.3<br>No change: 0.5<br>Somewhat more frequent: 0.7<br>Much more frequent: 0.9 | E |
| Q48C: Impact on the household's livelihood of change in windstorm events in the past 2-3 years in the village (13.7c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q49A: Change in heat wave event frequency in the past 2-3 years in the village (13.8a) | Much less frequent: 0.1<br>Somewhat less frequent: 0.3<br>No change: 0.5<br>Somewhat more frequent: 0.7<br>Much more frequent: 0.9 | E |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| Q49B: Change in heat wave event severity in the past 2-3 years in the village (13.8b) | Much less severe: 0.1<br>Somewhat less severe: 0.3<br>No change: 0.5<br>Somewhat more severe: 0.7<br>Much more severe: 0.9 | E |
| Q49C: Impact on the household's livelihood of change in heat wave events in the past 2-3 years in the village (13.8c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q50A: Change in the severity of thunder storm with lightning events (13.9a) | Much less severe: 0.1<br>Somewhat less severe: 0.3<br>No change: 0.5<br>Somewhat more severe: 0.7<br>Much more severe: 0.9 | E |
| Q50B: Change in the thunder storm event frequency in the past 2-3 years in the village (13.9b) | Much less frequent: 0.1<br>Somewhat less frequent: 0.3<br>No change: 0.5<br>Somewhat more frequent: 0.7<br>Much more frequent: 0.9 | E |
| Q50C: Impact on the household's livelihood of change in thunder storm events in the past 2-3 years in the village (13.9c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |

BLOCK 14

| | | |
|---|---|---|
| Q51A: Change in the soil erosion (14.1b) | A large decrease: 0.1<br>A small decrease No change: 0.5<br>A small increase: 0.7<br>A large increase: 0.9 | S |
| Q51B: Impact on the household's livelihood of change in soil erosion events in the past 2-3 years in the village (14.1c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| Q52A: Change in the landslide event frequency in the past 2-3 years in the village (14.2a) | Much less frequent: 0.1<br>Somewhat less frequent: 0.3<br>No change: 0.5<br>Somewhat more frequent: 0.7<br>Much more frequent: 0.9 | S |
| Q52B: Change in the landslide event in the past 2-3 years in the village (14.2b) | A large decrease: 0.1<br>A small decrease No change: 0.5<br>A small increase: 0.7<br>A large increase: 0.9 | S |
| Q52C: Impact on the household's livelihood of change in landslide events in the past 2-3 years in the village (14.2c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q53A: Change in soil fertility in the farm plots (14.3b) | A big increase: 0.1<br>A small increase: 0.3<br>Same/no change: 0.5<br>A small decrease: 0.7<br>A large decrease: 0.9 | S |
| Q53B: Impact of the change in soil fertility in the farm plots (14.3c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q54A: Change in local river water levels frequency (14.4a) | Much more frequent: 0.1<br>Somewhat more frequent: 0.3<br>Same/no change: 0.5<br>Somewhat less frequent: 0.7<br>Much less frequent: 0.9 | E |
| Q54B: Change in local river water levels (14.4b) | A big increase: 0.1<br>A small increase: 0.3<br>Same/no change: 0.5<br>A small decrease:0.7<br>A large decrease: 0.9 | E |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| Q54C: Impact of change in local river water levels (14.4c) | High positive impact: 0.1<br>positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q55A: Change in the size of local forest or woodlot (14.5b) | A big increase: 0.1<br>A small increase: 0.3<br>Same/no change: 0.5<br>A small decrease:0.7<br>A large decrease: 0.9 | AC |
| Q55B: Impact of change in the size of local forest or woodlot (14.5c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q56A: Change in the amount of crop damaging weeds (14.6b) | A large decrease: 0.1<br>A small decrease No change: 0.5<br>A small increase: 0.7<br>A large increase: 0.9 | S |
| Q56B: Impact of change in the amount of crop damaging | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | A |
| Q57A: Change in amount of plant disease affecting crops (14.7b) | A large decrease: 0.1<br>A small decrease No change: 0.5<br>A small increase: 0.7<br>A large increase: 0.9 | S |
| Q57B: Impact of change in amount of plant disease affecting crops (14.7c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q58A: Change in the amount of pests affecting crops in the last 2-3 years (14.8b) | A large decrease: 0.1<br>A small decrease No change: 0.5<br>A small increase: 0.7<br>A large increase: 0.9 | S |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| Q58B: Impact of change in the amount of pests affecting crops in the last 2-3 years (14.8c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q59A: Change in the borehole water levels in the last 2-3 years (14.9b) | A large increase: 0.1<br>A small increase: 0.3<br>No change: 0.5<br>A small decrease: 0.7<br>A large decrease: 0.9 | E |
| Q59B: Impact of change in the borehole water levels in the last 2-3 years (14.9c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |

BLOCK 15

| | | |
|---|---|---|
| Q60A: Change in irrigation being used in the last 2-3 years in the village (15.1b) | A big increase: 0.1<br>A small increase: 0.3<br>Same/no change: 0.5<br>A small decrease: 0.7<br>A large decrease: 0.9 | AC |
| Q60B: Impact of change in irrigation being used in the last 2-3 years in the village (15.1c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q61A: Change in the amount of water catchment being done in the last 2-3 years in the village (15.2b) | A big increase: 0.1<br>A small increase: 0.3<br>Same/no change: 0.5<br>A small decrease: 0.7<br>A large decrease: 0.9 | AC |
| Q61B: Impact in change in the amount of water catchment being done in the last 2-3 years in the village (15.2c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| Q62: Change in the household income in the last 2-3 years (15.3) | Large increase: 0.1<br>Small increase: 0.3<br>Same/no change: 0.5<br>Small decrease: 0.7<br>Large decrease: 0.9 | AC |
| Q63: Change in the household savings in the last 2-3 years (15.4) | Large increase: 0.1<br>Small increase: 0.3<br>Same/no change: 0.5<br>Small decrease: 0.7<br>Large decrease: 0.9 | AC |
| Q64: Change in the amount of household assets (15.5) | Large increase: 0.1<br>Small increase: 0.3<br>Same/no change: 0.5<br>Small decrease: 0.7<br>Large decrease: 0.9 | AC |
| Q65: Change in the amount of agricultural products sold in the last 2-3 years (15.6) | Large increase: 0.1<br>Small increase: 0.3<br>Same/no change: 0.5<br>Small decrease: 0.7<br>Large decrease: 0.9 | S |
| Q66A: Change in the agricultural practices in the last 2-3 years (15.7b) | Very major change: 0.1<br>Major change: 0.3<br>Minor change: 0.5<br>Minimal/very small change: 0.7<br>No Change: 0.9 | AC |
| Q66B: Results of change in the agricultural practices in the last 2-3 years (15.7c) | Large increase in production: 0.1<br>Small increase in production: 0.3<br>No change/Same: 0.5<br>Small decrease in production: 0.7<br>Large decrease in production: 0.9 | S |
| Q67A: Changes that the household made in response to extreme or harsh weather events or conditions (15.8b) | Very major change: 0.1<br>Major change: 0.3<br>Minor change: 0.5<br>Minimal/very small change: 0.7<br>No Change: 0.9 | AC |

| BLOCKS | RESPONSE CODE | TYPE (E, S, AC) |
|---|---|---|
| Q67B: Impact of changes made by the household in response to extreme or harsh weather events or conditions (15.8c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |
| Q68A: Changes in the way the community responded to extreme or harsh weather events or conditions in the last 2-3 years (15.9b) | Very major change: 0.1<br>Major change: 0.3<br>Minor change: 0.5<br>Minimal/very small change: 0.7<br>No Change: 0.9 | AC |
| Q68B: Impact of the changes in the way the community responded to extreme or harsh weather events or conditions in the last 2-3 years (15.9c) | High positive impact: 0.1<br>Positive impact: 0.3<br>No change: 0.5<br>Negative impact: 0.7<br>High negative impact: 0.9 | S |

# Annex 3 - Villages where Household Survey was administered

| Districts | Sectors | Cells | Villages | Sampled households | Households per District |
|---|---|---|---|---|---|
| Gasabo | Nduba | Butare | Kigabiro | 20 | 120 |
| | Rutunga | Ndatemwa | Kabarera | 20 | |
| | Jabana | Kabuye | Rebero | 20 | |
| | Gikomero | Gicaca | Nyagisozi | 20 | |
| | Kinyinya | Gacuriro | Urugarama | 20 | |
| | Kinyinya | Murama | Binunga | 20 | |
| Kicukiro | Kanombe | Rubirizi | Bukunzi | 18 | 73 |
| | Kigarama | Bwerankori | Nyenyeri | 18 | |
| | Masaka | Cyimo | Cyimo | 19 | |
| | Gahanga | Rwabutenge | Gashubi | 18 | |
| Nyarugenge | Kanyinya | Nzove | Rutagara II | 22 | 66 |
| | Gitega | Gacyamo | Kivumu | 22 | |
| | Mageragere | Kankuba | Kamatamu | 22 | |
| Nyamagabe | Mugano | Gitondorero | Gitondorero | 20 | 78 |
| | Musebeya | Nyarurambi | Giheta | 19 | |
| | Tare | Kaganza | Ruganza | 19 | |
| | Cyanika | Gitega | Gasharu | 20 | |
| Gisagara | Gikonko | Cyiri | Curusi | 18 | 72 |
| | Save | Zivu | Musekera | 18 | |
| | Muganza | Cyumba | Mutorerwa | 18 | |
| | Kansi | Akaboti | Agacyamu | 18 | |
| Huye | Maraba | Kabuye | Nyarusange | 20 | 80 |
| | Ngoma | Kaburemera | Karambi | 20 | |
| | Ruhashya | Gatovu | Kigoma | 20 | |
| | Rwaniro | Mwendo | Cyarera | 20 | |
| Ruhango | Kinazi | Gisali | Kaduha | 18 | 72 |
| | Kabagali | Rwoga | Rusebeya | 18 | |
| | Mbuye | Gisanga | Karama | 18 | |
| | Byimana | Kamusenyi | Gitanga | 18 | |
| Muhanga | Nyabinoni | Nyarusozi | Mugeni | 18 | 72 |
| | Nyamabuye | Remera | Kinyenkanda | 18 | |
| | Kabacuzi | Kavumu | Kabuga | 18 | |
| | Mushishiro | Rwigerero | Rwuki | 18 | |
| Kamonyi | Rukoma | Buguri | Nyabuvomo | 19 | 76 |
| | Mugina | Mugina | Kireka | 19 | |
| | Nyamiyaga | Kidahwe | Rugwiro | 19 | |
| | Karama | Bunyonga | Bunyonga | 19 | |
| Nyanza | Busasamana | Kavumu | Mugandamure A | 20 | 78 |
| | Nyagisozi | Kirambi | Mpaza | 20 | |
| | Cyabakamyi | Nyarurama | Nyakabingo | 20 | |
| | Kibirizi | Mututu | Kabeza | 18 | |
| Nyaruguru | Nyabimata | Mishungero | Muyira | 22 | 66 |
| | Ngera | Nyamirama | Nyamirama | 22 | |
| | Ruramba | Gabiro | Bukoro | 22 | |
| Gakenke | Busengo | Butereri | Rugendabali | 20 | 80 |
| | Janja | Gatwa | Gitega | 20 | |
| | Rushashi | Burimba | Kabuye | 20 | |
| | Ruli | Jango | Kinyonzo | 20 | |
| Rulindo | Base | Cyohoha | Bukangano | 22 | 67 |
| | Buyoga | Karama | Kigarama | 22 | |
| | Mbogo | Mushari | Nkurura | 23 | |
| Burera | Kinyababa | Bugamba | Kabingo | 20 | 79 |
| | Gitovu | Mariba | Buhembe | 19 | |
| | Rwerere | Gashoro | Rugezi | 20 | |
| | Gatebe | Gabiro | Ginga | 20 | |
| Musanze | Kinigi | Nyonirima | Nyagisenyi | 20 | 80 |
| | Gataraga | Murago | Rukingo | 20 | |
| | Gacaca | Gakoro | Gahama | 20 | |
| | Rwaza | Kabushinge | Busana | 20 | |
| Gicumbi | Mukarange | Gatenga | Nyange | 18 | 72 |
| | Rukomo | Cyuru | Bukamba | 18 | |
| | Manyagiro | Nyiragifumba | Kiyovu | 18 | |
| | Mutete | Gaseke | Gihira | 18 | |

| | | | | | |
|---|---|---|---|---|---|
| Gatsibo | Kabarore | Simbwa | Kibondo I | 20 | 100 |
| | Rugarama | Matare | Matare | 20 | |
| | Muhura | Bibare | Cyahafi | 20 | |
| | Kageyo | Busetsa | Kayenzi | 20 | |
| | Kiziguro | Rubona | Iramba | 20 | |
| Nyagatare | Rwempasha | Gasinga | Gasinga | 22 | 110 |
| | Rwimiyaga | Kirebe | Kirebe | 22 | |
| | Karangazi | Mbare | Kajumo | 22 | |
| | Karama | Nyakiga | Karama Centre | 22 | |
| | Tabagwe | Nyabitekeri | Kiyovu | 22 | |
| Kirehe | Mpanga | Mushongi | Ngugu I | 20 | 80 |
| | Musaza | Gasarabwayi | Nyakariba I | 21 | |
| | Nyarubuye | Nyabitare | Rugarama | 20 | |
| | Kirehe | Kirehe | Mirambi | 19 | |
| Bugesera | Nyamata | Kayumba | Karambi | 21 | 84 |
| | Mayange | Kagenge | Gakindo | 21 | |
| | Ruhuha | Kindama | Saruduha | 21 | |
| | Rweru | Batima | Gasororo | 21 | |
| Rwamagana | Munyiginya | Cyarukamba | Ndago | 18 | 72 |
| | Fumbwe | Nyarubuye | Murambi | 18 | |
| | Kigabiro | Sovu | Nyabishunzi | 18 | |
| | Muvumbu | Nyarukombe | Marembo | 18 | |
| Kayonza | Ndego | Byimana | Nyamata | 20 | 80 |
| | Murundi | Murundi | Kibari | 20 | |
| | Mukarange | Kayonza | Gakurazo | 20 | |
| | Murama | Rusave | Kinyinya | 20 | |
| Ngoma | Murama | Kigabiro | Nyagasozi | 20 | 80 |
| | Sake | Kibonde | Nyagasani | 20 | |
| | Rukumberi | Rubago | Rubago | 20 | |
| | Mugesera | Nyange | Rugazi | 20 | |
| Nyabihu | Karago | Busoro | Gasasa | 21 | 66 |
| | Rugera | Tyazo | Mucaca | 23 | |
| | Muringa | Nkomane | Mabare | 22 | |
| Rutsiro | Kigeyo | Rukaragata | Rwambeho | 20 | 77 |
| | Musaza | Gisiza | Gasharu | 20 | |
| | Manihira | Muyira | Kagarama | 18 | |
| | Mushubati | Gitwa | Mubuga | 19 | |
| Nyamasheke | Rangiro | Jurwe | Gasebeya | 21 | 85 |
| | Macuba | Vugangoma | Bitega | 22 | |
| | Kirimbi | Karengera | Kaburiro | 21 | |
| | Gihombo | Butare | Rugaragara | 21 | |
| Karongi | Rugabano | Gitovu | Nyabagoyi | 20 | 77 |
| | Gitesi | Kanunga | Karongi | 19 | |
| | Gishyita | Ngoma | Murambi | 19 | |
| | Ruganda | Kinyovu | Kanyegenyege | 19 | |
| Rusizi | Butare | Gatereri | Karama | 18 | 90 |
| | Nzahaha | Kigenge | Gihungwe | 18 | |
| | Mururu | Gahinga | Ryabadugu | 18 | |
| | Gihundwe | Gatsiro | Gahinga | 18 | |
| | Gashonga | Kabakobwa | Rango | 18 | |
| Rubavu | Kanama | Karambo | Mutanda | 21 | 96 |
| | Busasamana | Gacurabwenge | Busanganya | 18 | |
| | Gisenyi | Mbugangari | Uburezi | 19 | |
| | Nyakiriba | Nyarushyamba | Ruvuzananga | 19 | |
| | Nyundo | Nyundo | Nyakagezi | 19 | |
| Ngororero | Gatumba | Cyome | Mpara | 19 | 79 |
| | Hindiro | Rugendabari | Mituga | 22 | |
| | Nyange | Vuganyana | Karambo | 19 | |
| | Kavumu | Rugeshi | Gasumo | 19 | |
| | | | 122 | 2407 | 2407 |

# Annex 4 - How the Household Vulnerability Indicators link to the Survey Questionnaire

| E, S, AC | Potential indicator(s) related to District Vulnerability (number corresponds to National Vulnerability Indicator) | Data source in questionnaire for this Indicator - Survey reference Questionnaire number | Survey Questions | | | |
|---|---|---|---|---|---|---|
| Cross cutting issues - 5 indicators | | | | | | |
| S | 1.1 Age Dependency Ratio (ADR) in the District - compose ratio using Rwanda method | HH Q 1.1 | 1.1: Number of family members in the HH, and age of HH members, including HH members with disabilities and chronic illnesses. | | | |
| S | 1.2 Social safety net effectiveness in the Districts - create sub-index | HH Q 7.1, 7.2 | 7.1: Proportion of HH covered by health insurance programs, with added detail (7.2) on how HH pays for health care if not enrolled in insurance programs | | | |
| AC | 1.3 Extent of Social capital (social networks) - create subindex | HH Q 12.8, 1.3, 1.4 | 12.8 proportion of HH that have membership in an agriculture cooperative | 1.3-1.4: number of family members living away from the HH remitting funds to HH minus number of family members living away who are supported by the HH. | | |
| AC | 1.4 Level of education attained by women in the District | HH Q 1.1 | 1.1: Level of education attained by women in the HH | | | |
| AC | 1.5 New - Participation in building adaptive capacity - create sub-index | HH Q 12.10, 12.11, 12.12 | 12.10 Participated in tree planting | 12.11 participated in construction or repair of drainage ditches | 12.12 Participated in terracing | |
| Meteorological and Disaster Risk Reduction (DRR) - 8 indicators | | | | | | |
| E | 2.1 Perceived variability in temperature | HH Q13.1b) | 13.1b) Extent of change in temperature observed | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| E | 2.2 Perceived variability in heat waves | HH Q 13.8b) | 13.8 b) Extent of change in heat waves | | | |
| E | 2.3 Perceived variability of rainfall, rainstorm storm intensity. Floods and drought | HH Q 13.2 to 13.6 (b for all - plus c) for 13.5 and 13.6 | 13.2b) Extent of change in rainfall amount observed; 13.3b) Change in start date of rains/rainy season;13.4b) change in rainstorm intensity; 13.5 and 13.6 b) and c), change in frequency and severity of drought and flood events. | | | |
| E | 2.4 River water level changing | HH Q 14.4 (b) and c) | 14.4: Observed change in local river water levels near HH's village - proportion of HH observing change, frequency of change | | | |
| E | 2.5 Borehole water level change | HH Q 14.9 b) | 14.9 b): Observed changes in HH borehole water levels - extent of HH observing change | | | |
| S | 2.6 Proportion of HH experiencing loss due to weather hazards - create subindex | HH Q 4.5, 11.6, 12.9, 12.15, 14.1c) to 14.9c)...except 14.2 and 14.4 when it is d) | 4.5: Proportion of HH who made house repairs due to damage from storms/weather events - flood/rain/landslide. | 11.6: Proportion who experienced a severe weather-event-related crop loss. | 12.9 Proportion of villages affected negatively by flooding or land slide in the last 2 years<br>12.15: Proportion of HHs that experienced a major loss due to one or more of the following: flood, drought, landslide, heavy rains, severe windstorm, severe crop loss, long period of very high heat (heat wave)? | 14.1-14.9c) - except 14.2 and 14.4 in which case it is d): impact of change on HH livelihoods |

| | | | | | | |
|---|---|---|---|---|---|---|
| AC | 2.7 Access to early warning system for extreme weather events | HH Q 12.13, 10.2, 10.3, 10.4 | 12.13: Proportion of HH participating in any community discussions in the last 2 years on preventing disasters, or how to respond to disasters when they happen | 10.2 to 10.4: Access to farming info and weather info on radio and from other sources; access to technical advice on how to use weather information in decision making. | | |
| AC | 2.8 Use of climate information in HH decision making - create sub-index | HH Q 15.8, 15.9, 15.8 and 15.9: HH and community changes due to extreme events, extent of change and impact of change on livelihood of the HH | | | | |
| Agriculture and Food security - 8 Indicators | | | | | | |
| S | 3.1 Level of diversification of agriculture production (types of crops), i.e., risk spreading - create sub-index | HH Q 11.1, 15.6 11.1a, 11.1b) 11.1c) Diversity of food crops grown, change in food crops grown, type of seeds adopted | 15.6 change in amount of agricultural produce sold | | | |
| AC | 3.2 Manure use and fertilizer use by HH in District - create sub-index | HH Q 11.2-11.4 | 11.2 Proportion of District HH using organic manure on farm plots; 11.3 change in amount of manure used; 11.4 change in amount for inorganic fertilizer used. | | | |
| AC | 3.3 Proportion of population surveyed with access to and using irrigation - create subindex | HH Q 12.15, 15.1 | 12.14 proportion of HH with access to and use of irrigation equipment for their plots KEEP | 15.1b) observed changes in the amount of irrigation being used | | |
| AC | 3.4-increased knowledge among farmers about climate resilient farming methods - create sub-index | HH Q 8.1, 8.2, 15.7 | 8.1, 8.2 What training has been used by HH members. All training options provided are building adaptive capacity if used. We can construct a sub-index of increased AC | 15.7 action taken to change agricultural practices | | |

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| S | 3.5 Proportion of households that are food insecure and requiring food assistance create sub-index | HH Q 6.1, 6.2, 9.1-9.10, 11.5 | 6.1 - 6.2: What animals are raised by the HH - indicate which animals for HH consumption and which ones for selling, indicating which animals provides most income and most food | 9.1-9.8 - extent of food security of HH - create subindex from responses - food assistance vs financial assistance vs own production vs market purchased food; length of period with insufficient food; specific foods eaten during period of insufficient food; number of meals per day eaten during period of insufficient food | 11.5 proportion of HH with a kitchen garden (diversification; nutrition) | |
| S | 3.6 proportion of households experiencing effects of climate driven hazards - create subindex | HH Q 14.3b), 14.6b-14.8b | 14.3 b) Observed change in the soil fertility, weeds plant disease, pests | 14.6 b) observed changes in the amount of weeds that damage crop | 14.7 b) observed changes in the amount of plant disease affecting crops | 14.8 b) observed changes in the amount of pests affecting crops |
| S | 3.7 Livestock raised and frequency of animals to diseases | HH Q 6.3 | 6.3 Proportion of HH experiencing diseases and pest affecting HH livestock, and frequency of diseases/pests affecting each kind of animal | | | |
| E | 3.8 Change in forest and woodlot size in the District | HH Q 14.5 b) | 14.5 Observed changes in the local forest size or woodlot size in the last 2-3 years; extent of change | | | |
| Health - 5 indicators | | | | | | |
| E | 4.1 proportion of population with malaria | HH Q 7.3 | 7.3 Household members affected by climate sensitive illness/disease: malaria, hold/cold stress, pneumonia, diarrhea. | | | |

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| E | 4.2 Health status of HHs in the District - create sub-index | HH Q 1A.1, 7.4 | 1A.1: Number of person per HH with disability or chronic/debilitating disease; proportion of HH, and extrapolate the proportion of population in the District with disability or chronic/debilitating disease | 7.4: Frequency of HH members using services of their closest health post in last 2 years | | |
| AC | 4.3 Proximity to health posts used in District - create subindex | HH Q 7.5 | 7.5 Time it take to get to closest clinic or health post used (private or public), and distance/proximity to closest clinic/health post used. | | | |
| AC | 4.4 Drinking water (e.g. WASAC) access in home or close to home - create subindex | HH Q 5.3, 5.4 | 5.3-5.4 Access to clean WASAC water in HH or in close proximity | | | |
| Energy Transportation and Infrastructure - 5 indicators | | | | | | |
| AC | 5.1 Access to electricity in District, and extent of energy use by HH - by kind of energy - create sub index | HH Q 5.1, 5.2 | 5.1, 5.2 Proportion of HH in District with access to electricity in homes; energy sources used in HH for lighting and cooking | | | |
| E | 5.2 Physical Vulnerability of House and Farm plots in District - create sub-index | HH Q 3.4, 4.6, 4.7 | 3.4 Change in amt of land HH can access in last 2 years 4.6-4.7: HH home located on steep slope or close by (within 200 m) a river, stream or lake - i.e., vulnerability of home | | | |
| S | 5.3 Physical vulnerability of local infrastructure in District - create sub-index | HH Q 12.1 to 12.5 | 12.1-12.5: Use of critical infrastructure - (e.g. roads & bridges) to get to clinic, school and market, and if the roads have been upgraded/repaired or bridges raised in last 2 years | | | |

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| S | 5.4 Proportion of pop that has to use critical infrastructure (bridges) to get to market, clinic, school - create subindex | HH Q 12.8, 12.6, 12.7 | 12.8 Means of transportation used by HH to get to market 12.6 Distance that HH member travel to get farm produce to their local market? | 12.7 Length of time it take HH members to get farm produce to their market (hours) | | |
| AC | 5.5 proportion of HH with water storage capacity - create sub-index | HH Q 5.5-5.6, 15.2 | 5.5-5.6: Number of water tanks at HH and change in number of water tanks at HH in the last 2 years | 15.2 observed changes in the amount of water catchment being done (e.g., storage bins, or small ponds/dams) | | |
| Livelihood, Income, Occupation and Assets - 6 indicator | | | | | | |
| S | 6.1 Impacts of climate change affecting Household livelihoods | HH Q 13.1c) - 13.3 c), then 13.4d) to 13.9d) 15.7c) to 15.9c) | 13.1c) - 13.3 c), then 13.4d) to 13.9d), then 15.7c) to 15.9c) | | | |
| AC | 6.2 Changes in Income, Savings and Debt - create sub-index | HH Q 2.1, 2.2, 2.3, 2.4, 15.3-15.5. | 2.1 Sources of HH income (all sources; 2.2- main sources of HH income; 2.3 increases in HH savings or HH debt ; 2.4 extent of change of HH income in last 2 years. | 15.3-15.5 change in HH income and size of change; change in HH savings and extent of change; change in ownership (buy/sell) of HH assets and extent of change. | | |
| AC | 6.3 HH access to financial institutions / savings groups | HH Q 4.8-4.11 | 4.8-4.11: Sub-index of HH access to financial resources - bank account, SACCO, tontine, insurance, etc., and ability of HH to receive funds provided by government social (cash) programs. | | | |

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| AC | 6.4 Proportion of population with access to land | HH Q 3.1 to 3.3, 3.5 | 3.1-3.3 Proportion owning land (with title); proportion with access to agricultural cooperative farm land; proportion with access to rented or borrowed land - create sub index of proportion with access to land for farming. | 3.5 change in the amount of land you have had access to in the last 2 years | | |
| AC | 6.5 change of Occupation amongst HH members - create sub-index | HH Q 1.1, 1.2 | 1.1 Occupations of HH members and 1.2 change in occupation in last 2 years | | | |
| AC | 6.6 Change in HH assets - create sub-index | HH Q 4.1 to 4.4 | 4.1-4.3 House construction durability; proportion with durable roofing material (mitral) | 4.4 change in size of homes (proxy for increased income) | | |