CLIMATE CHANGE ADAPTATION AND URBAN POOR: A CASE STUDY OF BANNYAHE SLUM, KIGALI, RWANDA

ROGER ISHIMWE

School of Urban Planning, McGill University

This work is submitted to the School of Urban Planning of McGill University, in partial fulfilment of the requirement for the degree of Master of Urban Planning.

Supervisors:

Prof, Lisa Bornstein (Primary supervisor)

Dr. Tapan Dhar (Co-supervisor)

August 2021

Abstract

Climate change presents serious threats to human wellbeing, particularly in the context of informal settlements. This SRP investigates Bannyahe slum, a low-income informal neighbourhood in Kigali, Rwanda, highly vulnerable to heavy rain-induced flood events. The study uses a qualitative assessment of how slum dwellers understand and perceive climate change and how they tackle these at the community level. This assessment relies on three sources of information: academic and grey literature, observation, and interviews with residents and key informants. This study documents that Bannyahe's residents have limited climate change knowledge due to a lack of education and training. Despite this, inspired by past experiential knowledge, they adopt small-scale adaptation actions to withstand the impacts of heavy rain, such as using durable building materials (e.g., cementing floors and walls), installing water barrels, and digging canals to divert floodwater from their buildings. The SRP also reports the community reactions against the government decision of relocation, which impacts them socially and economically. The study recommends a more collaborative approach between authorities and community members to improve Bannyahe's adaptive conditions to climate change. Besides indigenous adaptation experience, adequate training and knowledge of climate change are also required for informal settlements. Thus, the study finally suggests a two-way dialogue for sharing knowledge and skills development to create trust between locals and policymakers, which is currently missing in many slum areas, like Bannyahe, in the Global South.

Key words: Community-based adaptation, slums, relocation, upgrading, Bannyahe, Kigali

ACKNOWLEDGEMENTS

I thank Almighty God for keeping me heathy and strong during my stay. Without his favour and blessings, I would not have made it this far.

With sincere appreciation, I do acknowledge the scholarships received from Oeuvre Durable, and MasterCard Foundation program at McGill University that allowed me to finish this work and complete my studies.

I am greatly indebted to my supervisors, Prof. Lisa Bornstein and Dr. Tapan Dhar for their help, advice, and guidance all through this research. without their valuable comments, this research would not have been completed.

My gratitude is extended to researchers and leaders in Rwanda who helped during data collection. I want to thank in particular all residents of Bannyahe (Kangondo), who contributed to this research thought their willingness to participate in the interview.

I would like to express my heartfelt thanks to my wonderful classmates in MUP 2019-2021, and MCF-McGill friends for their supports and encouragements. I am proud of being part of such wonderful cohort. It was a nice and unforgettable moments together.

Lastly, to my precious and loving family, I express my deepest love thankfulness for your love and endless support. To my father, mother, brother, and sisters, words cannot express my deep love for you.

May God bless you all.

Roger Ishimwe, August 2021

Contents

Abstract i
ACKNOWLEDGEMENTS ii
List of Tables iiv
List of Figures iiv
I. INTRODUCTION 1
II. RESEARCH METHODOLOGY 6

2.1 Research strategy 6
2.2 Selection of the Case Study Locale 8
2.3 Population and Sampling 9
2.4 Data Analysis 11

III. LITERATURE REVIEW 13

3.1 Climate change adaptation in informal settlements 13
3.2 Adaptation and informal settlements in Kigali 19
3.3 Conceptual framework 19

IV. BANNAYAHE: THE CHARACTERISTICS OF A KIGALI SLUM 21

4.1 Climate risks in Rwandan cities 21
4.2 Bannyahe: introducing the study area 24
4.3 Effects of and responses to climate change in Bannyahe 30
4.4 Responses of Bannyahe residents 34
4.5 Local government and NGOs measures to support adaption in slums 37
4.6 Summary 39

VII. RECOMMENDATIONS AND CONCLUSIONS 40

7.1 Key findings 40
7.2 Recommendations 41

REFERENCES 42

List of Tables

Table 1. Socio-economic factors of sampled residents 28
Table 2. Accessibility to technology by sample residents 29

List of Figures

Figure 1. Research design 7
Figure 2. Data analysis techniques 11
Figure 3 Topographic regions of Rwanda 22
Figure 4 Aerial view of Bannyahe slum (in the foreground) and Kibagabaga modern residences (in upper left corner) 25
Figure 5 *Location of Bannyahe* 26
Figure 6. Population density of Gasabo district 27
Figure 7. Average time spent listening to the radio 29
Figure 8. Flooding in Kigali, 2019 30
Figure 8. Open canal 32
Figure 9. Housing: pre- and post-relocation 33
Figure 10. Climate change and climate change adaptation perception among interviewed residents 35
Figure 11. Old (left) timber and improved (right) cement block housing construction in Bannyahe 36

I. INTRODUCTION

According to the United Nations (UN), 55 percent of the world's population currently lives in urban areas and, if pre-pandemic projections hold true, the proportion will increase to 68 percent by 2050. Nearly 90 percent of this increase is expected to take place in low- and middle-income countries of Asia and Africa. In these countries, urban areas host more than a third of the world's total population (Satterthwaite 2007). The highest urbanization rate in the world is found in African countries (UNHABITAT, 2008), where by 2050, the urban population is expected to triple, recording an increase of 0.8 billion population (UN DESA Population Division, 2010). On average, 60 percent of Africa's urban population live in slums – which is higher than the 34 percent rate in other developing countries (United Nations, 2015). Cities on the continent are not producing enough housing to accommodate rapid growth, which makes growth of slums seemingly inevitable (Yuen and Kumassa, 2011 p.278; Lall, et al., 2017 p.14). The already poor conditions in slums, such as inadequate housing and sanitation, are worsened by their siting in hazard-prone areas that are subject to intense climate change-related effects. Residents of the slums are more exposed to hazards than those living elsewhere, even in the same city. For example, heavy floods and landslides have displaced or killed many people living in informal settlements in East African cities in Rwanda, Kenya, Uganda, Ethiopia, Burundi, and Tanzania (Douglas, 2008). Flash floods killed more than 100 people in Addis Ababa, Ethiopia in August 2006 and over 200 in August 2009. In Kampala, Uganda, seasonal flash floods regularly destroy gardens, block roads, and contribute to water and air contamination that spreads of diseases like cholera and malaria (Lwasa et al, 2018).

The capital city of Rwanda, Kigali, also regularly suffers from flooding, erosion, and landslides, with associated negative effects on the physical environment and on the health, shelter, earnings, schooling, and general well-being of slum residents. This study will explore various climate change-related dynamics, such as flooding and landslides, affecting slums in Kigali, Rwanda. It will also look at some adaptation actions done by slums residents, and challenges they face in the process.

Are African cities prepared for climate change and its effects?

Many observers suggest that African cities suffer from lack of capacity to tackle climate change and its effects. The IPCC (2018) report said that climate change will compound current risks.

Broader variation in climate will cause more frequent and severe storms, rain, flooding, and drought cycles. Therefore, as climate will worsen in the coming years, adapting to the changes is the solution at hand for Africa and the rest of the world (ODI and CDN, 2014). Africa is determined to find sustainable solutions for climate change risks and overall development. As it is stated in Africa's Agenda 2063, 'Africa shall address the global challenge of climate change by prioritizing adaptation in all our actions….to ensure implementation of actions for survival of the most vulnerable populations…and for sustainable development and shared prosperity' (Agenda 2063, p.4).

In September 2020, at the launch of Global Centre for Adaptation (GCA) Africa, Kristalina Georgieva, the managing director of IMF (international Monetary Fund) stated that "Sub-Saharan Africa is more vulnerable than any other region to climate change, threatening lives and livelihoods, and undermining economic growth." She linked this high level of vulnerability to low levels of adaptation undertaken thus far, calling for improvement in climate change adaptation and resilience. She added, "after the current crisis, boosting resilience is an urgent priority so it's vital we share the knowledge and best practices that can help accelerate climate adaptation" (AfDB, 2020).

Many observers concur that African countries and cities have been slow to adapt. A complex web of interacting factors—economic, demographic, educational, and forms of governance—means the pace, extent, and forms of support for climate change adaptation levels vary within countries and across regions of Africa. Low levels of development and weak state capacity are given as reasons for the low level of adaptation observed throughout much of sub-Saharan Africa (ODI and CDN, 2014). Almost 500 million Africans live in extreme poverty as per World Bank's measure of earning less than US$1.9 per day (Welborn 2018). This population is consistently vulnerable to climate-related disasters and is seen as having little to no capacity to adapt, and choice, given limited incomes, know-how, and influence. According to Petteri Taalas, the General Secretary of the World Meteorological Organization, "climate change is having a growing impact on the African continent, hitting the most vulnerable hardest, and contributing to food insecurity, population displacement and stress on water resources"(UNFCC, 2020).

Governments throughout sub-Saharan Africa are widely seen as lacking the capacity to respond to widespread and deepening vulnerability. Kithiia (2011) contends, for instance, that limited

adaptive capacity in African cities is due to structural factors such as inefficient and poor resource management by local governments. Ludi et al. (2012) suggest that parts of the African continent struggle with lack of relevant information and skills to address vulnerabilities and promote adaptation. They point to the prevalence of general, rather than locally specific, climate change models and a shortage of local staff with skills in the development and planning of adaptation policies. Under-resourcing of meteorological agencies and lack of in-country advanced knowledge about climate science aggravate difficulties in providing baseline information to support climate change adaptation in many African cities (Brown et al., 2010).

Yet there are signs that capacity and efforts are expanding. African countries have launched various adaptation initiatives through National Adaptation Programs (NAPs). In NAPs, civil society organisations and communities play a significant role in the formulation of national adaptation plans and strategies. A good example is Rwanda's National Strategy on Climate Change and Low Carbon Development, developed in 2012 and discussed further in this report.

One tension observed in the NAPs is between central, national coordination of programs and the local input needed for customization of policies to fit specific locales. As Dube and Sekhwela (2008) observe, national policies can act as a barrier to locally produced adaptation strategies, especially where traditional, cultural, and contextual factors are ignored. To better assure locally pertinent strategies, observers focus on the scaling down of disaster risk reduction (DDR) platforms from the national to local levels. Castro et al. (2012) recommend that African government extend political outreach to ensure that institutions and citizens participate in decision making and that their opinions are incorporated.

Fortunately, since the release of the fourth assessment report (AR4) of the IPCC in 2007, there has been remarkable progress in Africa around local inputs and implementing community-based adaptation. Research has revealed that learning approaches that combine scientific and local traditional knowledge, that co-produce relevant knowledge, can support adaptation (Niang et al., 2014). Successful use of participatory approaches for adaptation requires time and resources from the entities involved; attention to the politics of stakeholders and management of any imbalances in power; attention to the challenges of multi-disciplinarity; and a balancing the weight of a consensus approach and role of conflicts (Aylett, 2010). Therefore, learning throughout the adaptation planning and implementation process requires emphasis on ways of sharing experiences between stakeholders and communities in different

ways (Niang et al., 2014). It involves using different tools, ranging from simple, locally available telephones and radios to sophisticated systems (such as the internet) (Harvey et al., 2012).

Making provisions for local input and customization of adaption plans is not the only challenge. UNIDSR (2011) raises the question of timing in reducing risks and supporting recovery; the report suggests that African countries reorganise their DDR techniques, such as early warning systems, social safety nets, emerging risk transfer schemes, disaster risk contingency funds, and migration, to support the intended population on time. Bailey (2013) also sees the big challenge as whether the political and institutional will exists to translate early warning into early action. Recognition of the need to (a) link DDR and climate change adaptation and (b) focus on local level strategies are positive steps for adaptation in Africa (Hunde 2012).

Another pressing issue is to apply such advances to the areas of informal settlement, places vulnerable to disasters where people often lack financial and educational resources, political standing, and/or land tenure to engage in government-sponsored adaptation programs. In informally settled areas, how do residents and government officials view climate-related challenges? How do they develop adaptation plans? Specifically, what governmental or NGO measures allow for local input into adaptation plans? What adaptation is undertaken by residents? By government? In what ways do participants' views on the local challenges, adaptation, and government (in)action mesh with existing literature on limited adaptive capacity and progress?

In responding to such questions, this supervised research project looks at local climate challenges, adaptation activities, and perspectives on appropriate policy measures in Bannyahe, Kigali's largest informal settlement. Three objectives structure the research:

1. To identify climate change impacts on the welfare of Kigali's slum dwellers.
2. To assess slum dwellers' understanding of current and emerging impacts of climate change, and climate change adaptation.
3. To examine climate change adaptation actions put forward by the government, as well as community-based adaptation actions of slum communities.

A case study methodology was employed in which research entailed: (a) review of literature on slums, adaptation to climate change, and the intersection of the two, (b) review of policy documents and spatial data for the selected case locale of Bannyahe, (c) interviews with

residents, and (d) analysis of the resulting primary and secondary information. Due to travel restrictions, all research for this project was done remotely; the author benefited from visits to the case study locale in 2018, prior to this project, that allowed first-hand insights into the physical layout, social dynamics, and general 'feel' of the case study area.

This supervised research project (SRP) is presented in six parts. Following this introduction, chapter 2 sets out the overall research design and specific methods employed. Chapter 3 reviews literature on slums, effects of climate change in slums, climate change adaptation strategies associated with them. The review also explores literature on the potential and limitations of community-based adaptation as a strategy to help slum dwellers withstand climate change-related effects and sets out a conceptual framework for the case study research and analysis. Chapter 4 describes the case study locale, Bannyahe (officially known as Kangodo and Kibiraro), drawing on secondary and primary data to depict the physical, social, economic, and environmental aspects of daily life. Chapter 5 turns to adaptation, using interview and photographic data to document adaptation efforts, particularly those undertaken by area residents. Chapter 6 draws together the findings, highlights key research takeaways, and presents recommendations.

II. RESEARCH METHODOLOGY

The main objective of this research was to assess climate changes related risks that urban slums face and provide recommendations for policymakers on how such risks can be minimized using best adaptation options that include community members of slums and help them improve their adaptation abilities. To accomplish this objective, three interconnected objectives were articulated as highlighted in chapter one, as follows:

1. To identify climate change impacts on the welfare of Kigali's slum dwellers.
2. To assess slum dwellers' understanding of current and emerging impacts of climate change, and climate change adaptation.
3. To examine climate change adaptation actions put forward by the government, as well as community-based adaptation actions of slum communities.

This chapter delivers details on the research strategy adopted to address those objectives. Selection of an appropriate case study locale and empirical data were necessary. Thus, this chapter discussed the overall research strategy, the selection of Bannyahe as a case, and the various data collection methods used. Additionally, data analysis methods are discussed in this chapter.

2.1 Research strategy

This overall strategy combines descriptive and explanatory research on a specific locale. A case study strategy was chosen as it is the best way for a researcher to describe a real-life problem in a unique setting. Researchers believe that, assuming the case being studied is uncommon, results from a single case can be generalized for a group where a case has been drawn (Kumar, 2011). The research intends to explore climate change effects faced by the population from the slum of Bannyahe. It assesses Bannyahe residents' knowledge of climate change and climate change adaptation. It identifies community members responses to climate change-related effects, including through government-initiated programs and community-based adaptation. In this manner, the research sought to identify measures by which the vulnerability of slum dwellers to climate change-related risks can be minimized. The study mostly employed the qualitative research method to collect subjective information (thoughts, ideas, and perceptions).

Figure 1 below highlights three main steps through which the research was carried out. The first step consists of a review of different literature related to slums in general, effects of climate change in slums, and climate change adaptation strategies (both governmental and community-based). This review is to place the research into scientific, academic, and real-world contexts and drew upon both general literature and that specific to Kigali, such as Rwandan policy documents and reports. The second step was document conditions in the case study locale. While some secondary spatial data were available, the research mainly entailed collection of primary data in the form of interviews with Bannyahe residents and key informants from government, academic institutions, and NGOs as key players in disaster management. Interviewing was entirely remote because of travel restrictions caused by covid-19. Data were analysed to identify vulnerabilities, resources, attitudes to and understanding of climate change, and, crucially, community-based, government and other stakeholders' adaptation actions and their contributions to minimizing the effects of climate changes.

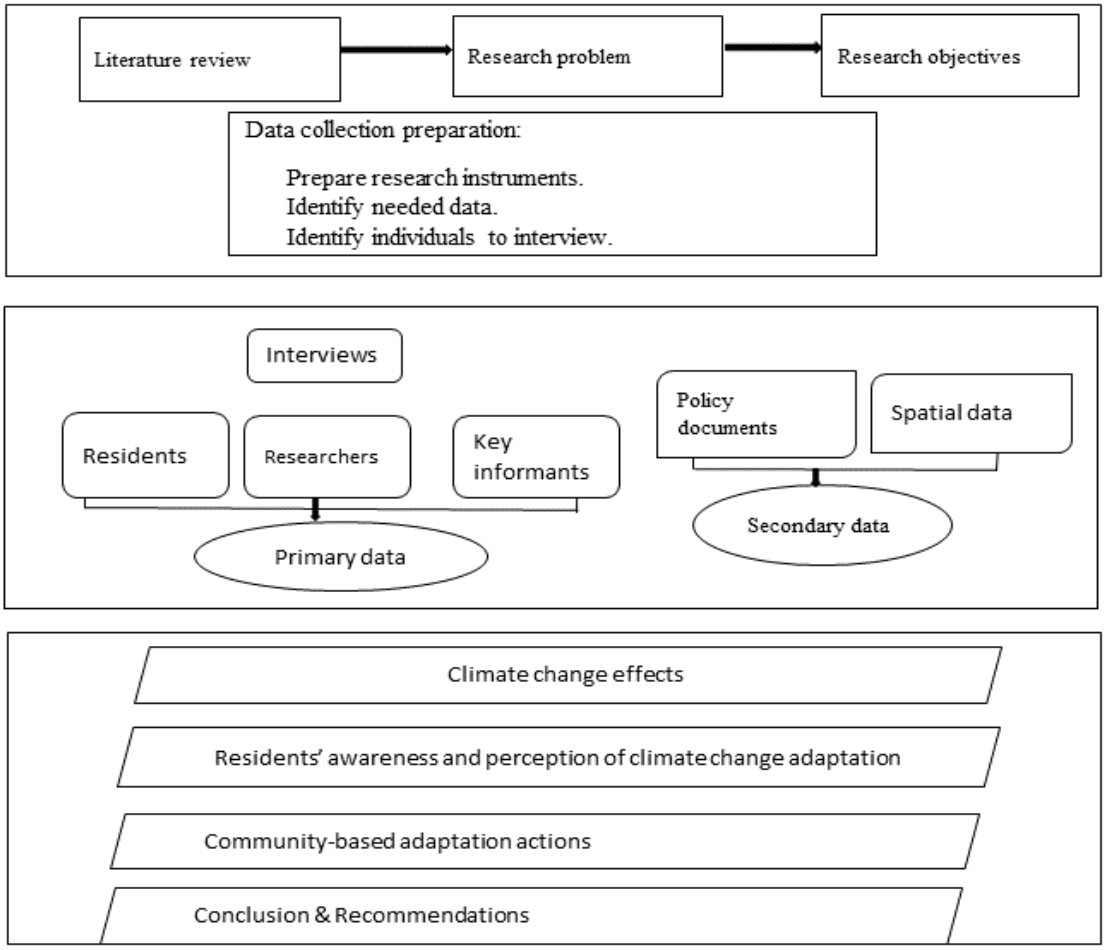


Figure 1. Research design

2.2 Selection of the Case Study Locale

The research objectives – to document climate change impacts, understandings, and adaptation action of slum dwellers in Kigali – meant selection of a study area known as a 'slum', characterised by informal housing, and subject to climate change risks of flooding and landslides. Secondary considerations related to the researcher's familiarity with the locale and its residents, particularly important given Covid-19 restrictions on field research. Bannyahe, the city's largest slum, was an ideal case.

Bannyahe is informally built, densely settled, and situated in low-lying areas close to the city's marshland. Residents have low incomes and limited resources. Many have recently relocated to Kigali from rural areas. Heavy rains cause flooding in the slum, which, when severe, results in damage or destruction of homes and infrastructure (where present) and, sometimes, loss of lives. Other effects, such as limited access to fresh water during drought periods, may also be felt. Government is aware of risks associated hazardous events and residents get temporary support from government, including shelter for few nights, food, and clothes, when disasters occur. NGOs and neighbours may also give assistance to affected residents. However, as far as could be identified at the outset of the research, aside from relocation of some residents, such as occurred in 2020, the government has undertaken little to help people in Bannyahe prepare for future events.

The area is well-suited to the purpose of this research, to explore different climate change-related impacts faced by slum areas in Kigali, investigate thoroughly residents' understanding of climate change adaptation, and document community-based actions put forward to adapt to climate variability. Past government assistance also permits examination of slum dwellers' perception of different government policies proposed to address climate change, the extent to which residents have contributed to the policy formulation process, and the effects of such policies on residents' adaptation efforts and general welfare. The researcher's prior knowledge of the area was also important. The researcher had visited Bannyahe in 2018 and knew residents to contact for virtual entry to the community, crucial given that the study was done remotely between August 2020 and 2021.

2.3 Population and Sampling

This study targeted two categories of participants: All of the population living in Bannyahe slum, and key informants from governmental, Non-Governmental Organisations (NGOs), as well as climate change-related research centres. However, due to time limitations, only ten residents of Bannyahe, two researchers, two governmental officials, and one NGO representative were interviewed. Residents to be interviewed were selected using cluster random sampling, where homeownership (tenants and homeowners), time spent in the neighbourhood, and gender (male and female) formed the clusters to minimize possible bias. Therefore, the sample frame consists of adults (in this study people above 23 years old) who resided in Bannyahe for over five years and were still staying in the area by the time of the interview. It included both males and females who either own a house or lease one.

Since climate change adaptation is both an academic, national, and local agenda, researchers, government officials, and those working in organizations that provide support in case of disaster outbreaks can deliver information about this issue. Conversing with those who work closely with the community was a way to corroborate information received from community members. Thus, purposive sampling was used to select key informants from key governmental, NGO and research entities.

2.3.1 Data Collection Techniques

As presented in the research design (see figure 3), both primary and secondary sources were used to collect the required data. This study was entirely remote due to the circumstances caused by Covid19. Therefore, interviews were conducted between March and June 2021 via telephones calls, WhatsApp, and Skype calls to gather first-hand information. The interviews involved asking questions prepared by the researcher and extracting information, as well as getting opinions from respondents. All interview protocols, informed consent procedures, data uses, and data storage were reviewed by and received approval from McGill University's Research Ethics Board.

Secondary data from various official documents, media publications, and academic sources were also helpful. The details are as follows.

2.3.2 Interviews with residents and key informants

Interviews were scheduled and conducted with selected individuals living in Bannyahe slum. Interviews were structured to better comprehend the knowledge and perception of slum dwellers, the effects of climate change-related hazards, as well as their adaptive ability and actions. The interview with these residents helped to identify those who were already affected by hazards, pinpoint various actions to minimize effects, and explore adjustments to prepare for the next hazards. The questions asked covered a wide range of information about climate change-related hazards and adaption mechanisms such as creating and maintaining water canals, domestic water harvesting, building strong house foundations and walls. The information was very useful to validate residents' endurance of effects associated with climate change, and their efforts towards adaptation. Since interviews were done remotely and there was a possibility of sensitive questions, all respondents were reminded at the start of an interview of their right to not answer a question or withdraw from the study at any point.

In contrast, interviews with key informants were primarily to identify various actions done in case of a hazardous event and learn policies in place to ensure climate change adaptation and risk mitigation. Information provided by key informants is crucial to the smooth progress of any study (Yin, 2003). Key informants contributed much to of this study by providing rich, detailed information. Provision of in-depth information was fostered through interview questions that offered respondents a chance to explain and express their own opinions concerning climate change adaptation in slums and other underprivileged places. The interview with key informants was a nice way to get policy perspectives and academic opinions regarding adaptation to climate change in poor zones, especially in Kigali city.

2.3.3 Secondary data

The secondary data were mainly collected from government official plans, research papers, and media releases, and other information on climate change adaptation in poor zones. The main sources of government official documents were the former Ministry of Disaster Management and Refugee Affairs (MIDMAR), currently Ministry of Environmental Management (MINEMA), the City of Kigali, the Rwanda Housing Authority (RHA), the Rwanda Green Fund (FONERWA), the Ministry of Infrastructure (MINIFRA), and the Rwanda Environment Management Authority (REMA).

2.3.4 Field observations

The researcher visited the case study area between June and September of 2018 and observed physical elements as well as spatial conditions. The conditions, such as existing water canals, closeness and condition of houses, and sanitation, were observed. This observational data, as first-hand information, supported the information collected from interviews.

2.4 Data Analysis

The chart below provides details of the general approach to data analysis used to achieve the objectives of the study.

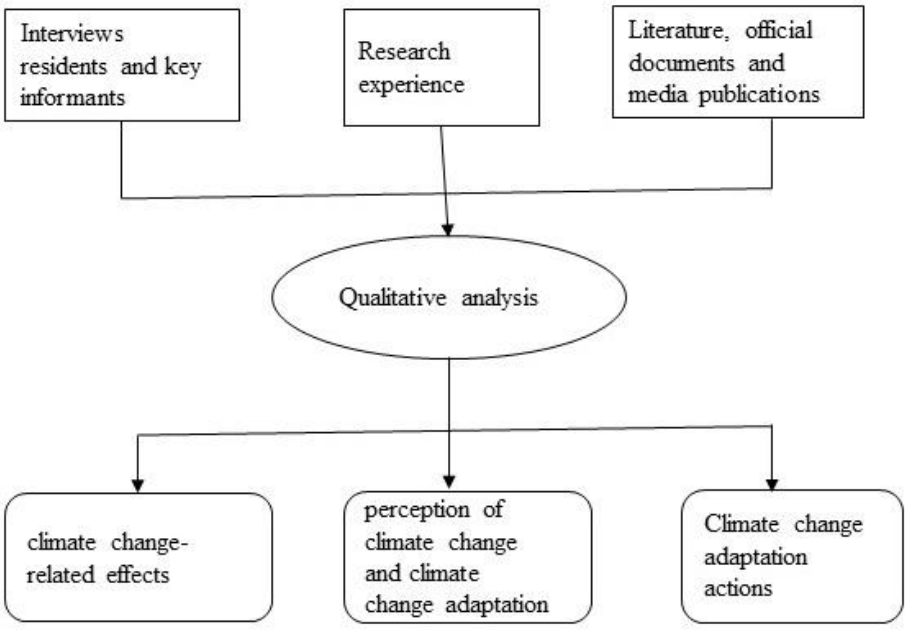


Figure 2. Data analysis techniques

Data and analysis related to the objectives of the study, namely to:

a. Identify the main climate change-related effects that Bannyahe residents face, such as flooding, and the impacts they have on residents. This information was extracted from residents' responses to interview questions and from secondary data source such as government documents and media releases.
b. Assess residents' awareness of climate change and climate change adaptation, which was also obtained from interviews conducted with residents of Bannyahe.

c. Based on the identified disaster risks and residents' knowledge of climate change and climate change adaptation, the study examined climate change adaptation actions put in place to minimize those risks. Data were analysed using qualitative analysis methods to achieve the intended objectives.

Theoretical insights and policy recommendations were drawn from a synthesis of the various data and analyses, including the review and analysis of literature, policy, spatial data, and interview material.

III. LITERATURE REVIEW

This chapter describes the theoretical foundation of the study. It presents concepts and approaches related to climate change adaptation and informal settlements. It outlines different climate change adaptation approaches in general and those particular to informal settlements. Adaptation strategies employed in sub-Saharan Africa, and in Rwandan cities, are highlighted both for illustration and as a basis for the case study research. Finally, the chapter presents the conceptual framework formulated from various studies.

3.1 Climate change adaptation in informal settlements

3.1.1 The meaning of climate change adaptation

Although adaptation to climate change may have gained popularity recently, the need to take advantage of new opportunities and minimize unfavourable effects of environmental change is as old as humankind (Smithers and Smit, 1997). Adaptation as a concept does not end with lessening climate change related risks for natural and human environments, but is, rather, a crucial part in the development of any society as it helps in the management of social, economic, and political variables (Pelling, 2003). Although definitions of climate change adaption may differ slightly according to different researchers, the central idea among many definitions is the ability of individuals to reduce negative effects of climate change. For instance, IPCC (2018 p.870) defines "adaptation as the adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their impacts". This implies changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with climate change. It involves adjustments to reduce the vulnerability of communities, regions, or activities to climatic change and variability. Therefore, adaptation goes beyond just a simple concept and involves a complex of many inter-linked steps at different scales of interventions (Moser and Ekstron. 2010).

3.1.2 Climate change risks in informal settlement

The World Bank Group report on Global Facility and Disaster Reduction and Recovery declares that the climate change-related risks encountered by urban poor are connected to their limited economic base, low access to risk-reducing infrastructure and services, location, as well as ineffective governance and disaster reduction management (World Bank, 2015). Such risks

combine the likelihood of a series of events and their pervasive consequences (Beer and Ziolkowski, 1995). Therefore, climate change risks include the direct effects of climate and immediate impacts arising from the climatic event. At the local scale, these effects may include heavy rain that cause flooding; drought; and landslides. In the aftermath of these hazards, slum dwellers endure consequences such as famine caused by the damage of crops, lack of shelter as some houses are destroyed, and/or a worsening of pre-existing poor conditions.

Poor housing and unfavorable locations (such as in marshland and on steep slopes) are the major indicators of slums conditions as presented in the literature. For instance, the UN-HABITAT (2006) describes a slum as a settlement where the residents lack adequate housing and basic services. In its description, a slum is where people living under the same roof fulfil one or more of the following conditions: inadequate access to safe water; insecure housing status; overcrowding; poor structural quality of housing; poor access to transport infrastructure; and poor sanitation. Furthermore, as many slum dwellers do not have academic qualifications, they are unable to find good formal employment. Therefore, there is a high rate of unemployment among slum residents, which pushes many of them into notified and non-notified low paying jobs such as house cleaning, automobile washing, laborers, and retailing. Because of the above-outlined conditions, the standards of living of people residing in slums are generally poor.

3.1.3 Perceptions of climate change and climate change adaptation among the urban poor

Talking only to environmentalists, researchers, and policymakers may lead to the conclusion that climate change adaptation is a well-understood global concept. But this is not the case. According to World Bank figures, over 10% of the world population (approximately over 700 million) live under $2 per day, and this rate goes even over 50% if the standard is raised to $5 (World Bank, 2020). A large proportion of this population is concentrated in slums of low and middle-income countries, especially Sub-Saharan Africa, where many people know little to nothing about climate change adaptation as championed by the world's experts. They may, however, practically exhibit similar actions, in their own fashion, to those outlined in climate change adaptation guiding documents. Or they may, as Lizarralde et al. (2020, 2021) and Aragon-Duran (2020) contend, have distinct priorities, strategies, and tactics to those advocated by experts.

3.1.4 Challenges of climate change adaptation in informal settlements

Informal settlement or slum is used to refer to areas in modern cities that are overcrowded with poor housing and lack adequate access to pure water, sanitation, and other infrastructure (Huchzermeyer,2011). These areas host around a quarter of all global urban residents. They originate mostly from rapid and uncontrolled urbanization (UN-Habitat, 2012; United Nations, 2014); and have inferior living conditions that present health and long-term environmental risks to dwellers (UN-Habitat, 2015b). Such places are usually built in geographically sensitive areas and do not comply with existing construction regulations (Patel, 2013). As a result, residents are vulnerable to various climate change-related impacts. For example, these areas are located close to riverbanks; on steep slopes; on the coastal margins, and the housing conditions are poor (Wilbanks et al., 2007). Consequently, this kind of living condition cannot resist the increasingly extreme weather events. A good example is constant flooding that follows heavy rain in Kigali city. Although the effects of the rain are felt by all city residents, the rate of risks is higher to slums dwellers located on steep slopes and in wetlands. Houses and other infrastructure are damaged or completely destroyed, and people sometimes lose their lives.

Informal settlements are mostly occupied by poor people who were forced into those precarious conditions for various reasons, such as unaffordable housing, unemployment, and poor land tenure system (Wilbanks et al., 2007). These people are usually left out of planning processes, including from the deliberations around policies that have direct impact on them. This latter set of policies include climate change adaptation initiatives that are planned by governments and other stakeholders with little or no contribution from the people they will most affect. Such initiatives have provoked strong resistance from community members, who claim a place in the planning process, if only as an opponent to government propositions. A good example is the case of Kigali city's efforts to relocate people of Bannyahe slum, where residents opposed the measures.

There are other cases where community members have worked together with governments and other stakeholders and the results were satisfying. Some examples are discussed in the paragraphs below.

3.1.5 Community-based vs Government-led adaptation strategies

Studies recommend various adaptation strategies appropriate for slums to reduce exposure and vulnerability of the poor sensitive communities to climate change-related effects. Such strategies include providing basic infrastructure as well as community-led upgrading of informal settlements; such efforts aim at improving housing conditions and empowering the agency of low-income communities to employ locally produced tools and skills in dealing with those effects (Revi et al., 2014). For better implementation, researchers advise local governments to work with community members in upgrading their homes as part of a wider approach of community-based adaption and to build on their experiences to generate locally produced solutions (Revi et al., 2014). This community-oriented approach is, however, the opposite of how many governments deal with slum problems. For instance, some governments deliberately ignore helping slum residents to solve different problems, and some demolish slums, forcing residents into new places, often at the city's outskirts, which repurposing the vacated land for lucrative ends. The most used adaptation strategies include:

Upgrading

Slum areas' deteriorating conditions are largely what differentiate them from the rest of the city. Such conditions are also one of the main factors that increase the severity of climate change in slums as discussed above. Therefore, improving these conditions could reduce their sensitivity to hazards. How such improvements are performed matters much to their efficiency and significance in achieving expected goals. On the one hand, sometimes governments centrally plan and execute slum upgrading projects or provide guidelines to the residents with the ability and capacity to improve their quarters. In this case, there is little or no community engagement in planning. On the other hand, community organizations may decide to come together to plan their upgrading. They may use locally available tools and skills and call for external support where necessary. The contribution of central government authorities here is minimized.

Whether government or community-led upgrading, the aim is to provide residents with formal legal addresses, providing access to basic infrastructure and services, which eventually minimizes the vulnerability of the community to various risks and makes it more resilient and adaptive. Slum dwellers generally prefer upgrading to relocation as it improves their conditions

without having to move to a new place, and lose their existing social networks, livelihoods, or acquired services (Goodfellow, 2014).

Upgrading is one way of adapting to unfavorable conditions, it means improving the power to deal with current and emerging hazards such as climate change-related effects. Upgrading goes beyond rebuilding houses, rather involves supplying infrastructures such as water collection centers, waterways, and other facilities that increase the ability of the community to withstand prevalent conditions like hazards (Almansi, 2009). Two main types of upgrading include government-led and community-led upgrading. Features differentiating them are discussed below.

Government-led upgrading

The government sometimes decides to perform upgrading. If well done, this reduces health and environmental risks such as stormwater, poor sanitation, and other poor slum conditions. It also stops or minimizes to a greater extent the risk of eviction although sometimes there is short-term displacement while upgrading is performed, which leads to permanent transfer for some residents, particularly renters (Patel, 2013). Since it improves the living conditions of people, upgrading equally reduces climate change risks, and improves people's capacities to cope and adapt (Sattherwaite et al., 2018). A good example is the Indian government's Basic Services for the Urban Poor (BSUP) initiative (Patel, 2013). Upgrading is done by the government usually takes short time to complete. Although it is sometimes criticized for not incorporating suggestions of community members. It is worth noting that if not well performed, upgrading can end up evicting people or result in increased shelter costs (for services, in rent) though the goal was to avoid such outcomes.

Community-led upgrading

There are many adaptation actions done by slum residents in their communities that go overlooked. For instance, activities such as tree planting, house renovations, community-managed toilets, and washing facilities in different slums are usually underrated as adaptation measures. Community members direct actions towards solving or minimizing the risks related to a given condition. Apart from doing physical works, community organizations have been influential in pressuring local governments to provide basic infrastructure, as shown in the instances that follow. Community organizations also helped in gathering relevant data from

slums to plan for upgrading (see Patel and Baptist, 2013). Many other community organizations played an epic role in upgrading various slums. For instance, In Zimbabwe, the Epworth Homeless People's Federation gathered data were used by the local board to provide in situ plan for an informal settlement (Chitekwe-Biti et al., 2012); the South African SDI Alliance was offered two extensive government tenders to describe and count over a hundred informal settlement for city-wide planning (SDI, 2016); and many similar projects have been carried out by Kenyan Homeless People's Federation (Lines and Makau, 2017; Weru, 2004). In terms of climate change adaption for slums, community members should not be omitted. As they are the direct victims of such extreme weather events, their contribution in planning adaptation actions is equally important. This approach is, however, criticized for its time-consuming and slow decision-making (Dodman & Mitlin, 2011). This is because many people must be consulted before making any decision. Many slum residents are poor and unable to sponsor big adaptation projects alone. Therefore, external support from government and, non-governmental organizations is essential.3.1.6 Bulldozing and Relocation

Bulldozing slum structures is a top-down approach to removing people from specific locations. Bulldozing is often associated with forced eviction, which usually exacerbate the poor conditions of dwellers. Sometimes evictees are not shown where to go next, and they are likely to return to the same place or move to other risky areas.

However, a few examples indicate that government can better plan for safe relocation. They can help people settle into places free from climate change-related risks and other poor living conditions. For instance, in Solo Indonesia, the government provided financial support to people living in areas facing constant floods to go settle in a safe place (Taylor, 2015); in Windhoek Namibia, the price of formal plots was reduced to accommodate poor residents, which reduced the number people living in risky areas (Mitlin and Muller, 2004).

The challenge remains where and how to undertake relocation as a way to get slum dwellers out of the dangers of climate change. Governments struggle to find land to develop housing for low-income people in urban areas, and when they succeed, these sites are usually located at urban peripheries where land is relatively cheap (Page.J., et al. 2020 p.7). People usually do not like being moved, but it is possible if they are organized and fully involved in the process of finding solutions (Lines and Makau, 2017).

3.2 Adaptation and informal settlements in Kigali

Literature on adaptation in Kigali parallels the wider global literature. While further details on Kigali and the Bannyahe slum are presented in the next chapter, broad similarities are outlined here. In the case of Bannyahe, the major climatic event residents encounter is heavy rain, which causes flooding and destroys properties such as houses and crops. Floods are associated with its location close to the marshland, topography, poor housing style, and the low ability of residents to cope with such hazards. The city of Kigali has opted to raze all slum neighbourhoods marked as prone to flooding and other climate change-related effects. Relocation of residents with houses to secure places was and is planned. But, as the international literature also documents, slum residents were not adequately consulted throughout the planning process, which triggered strong opposition to the policy when it was announced in 2017 (Esmail and Corbun, 2019). An additional dynamic is that the conditions of Bannyahe and other slums in Kigali have improved over time, and the work of residents played an important role in this transition (e.g., the planting of grass and other vegetation); relocation would mean losing the effort and expense incurred to upgrading the area over the past 15 years. Planned retreat – the relocation of residents from areas prone to climate change-related hazards – for Bannyahe also encountered impediments common to efforts elsewhere; the government's idea was of relocating residents to a safe place 15 kilometers away, a relocation adamantly opposed by many residents.

3.3 Conceptual framework

This research adopts a framework of institutional adaptations (MCRI, 2004-2008)) for dryland river basins in Canada and Chile by researchers from the University of Regina (Saskatchewan, Canada). This model helps to identify the relationship between exposures of the system, adaptive capacity, and vulnerability (see figure 1). Usually, climate change adaptation efforts aim to address the implications of potential changes in the intensity, frequency, and duration of weather, and climate change events. Such events combined with vulnerability and exposure of the system to hazards cause extreme risks to human society (Cordona et al., 2012). On the one hand, for any climate change adaptation plan to be effective, there is a need for a meticulous understanding of dimensions of vulnerability and exposure, and how these dimensions evolve. The difference between exposure to hazards and the capacity to adapt to them is what mainly defines the vulnerability of certain individuals and groups. On the other hand, adaptive capacity

is influenced by several factors as shown on the diagram. As can be seen from the diagram, if increasing the adaptive capacity of the community would reduce their exposure to hazards, that can finally reduce their vulnerability. Researchers define exposure as an inventory of elements in an area that is likely to experience hazards, and these areas must be inhabited by people or have economic resources (UNISDR, 2009b). For this study, this framework is appropriate, though the list of 'adaptive capacity resources may need to be expanded to better capture relevant dynamics, skills, and perspectives of those living in at-risk informal settlements.

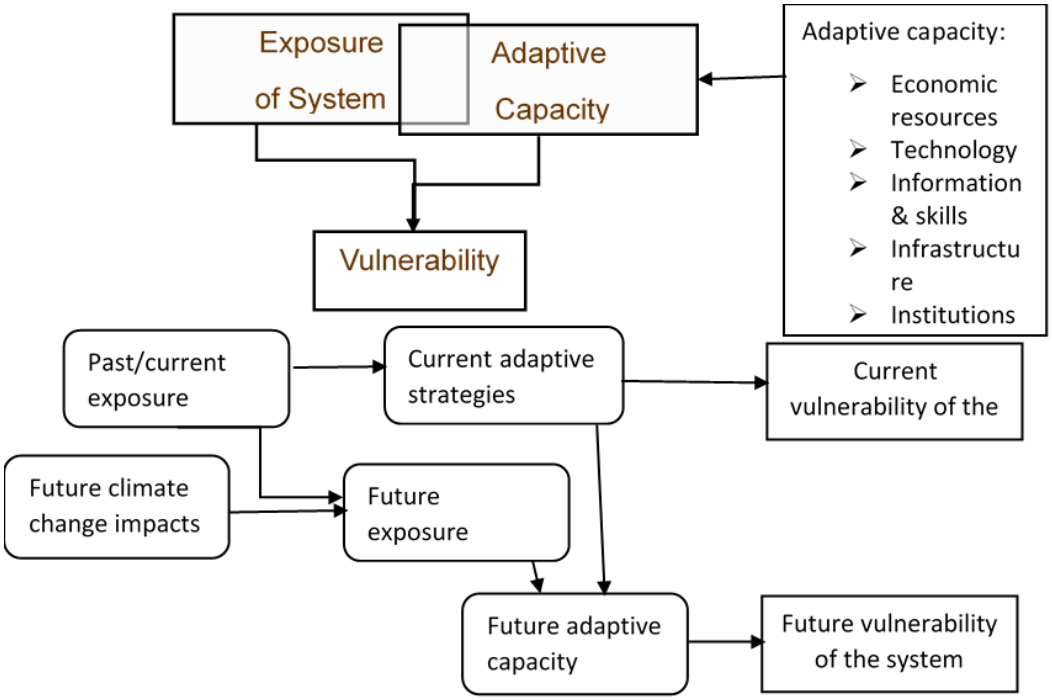


Figure 4: a conceptual framework (Source: a comparative study of dryland river basins in Canada & Chile, 2004-2008; IPCC,2012)

IV. BANNAYAHE: THE CHARACTERISTICS OF A KIGALI SLUM

This chapter provides a description of neighbourhood characteristics, daily life, risks, and policies towards them for the case study area. The perspective starts broad, to situate the reader in the perhaps unfamiliar context of Rwanda, and then narrows in on the Bannyahe neighbourhood. Data are drawn from secondary sources and the interviews conducted during 2021. Physical and environmental characteristics of the area, socio-demographic aspects of the population, and people's perceptions of their environment are the foci of this chapter. Measures to address risks, to adapt, are covered in the subsequent chapter.

4.1 Climate risks in Rwandan cities

Rwanda is a small country located in East Africa, just a few degrees south of the equator, bordered by the Democratic Republic of Congo in the West, Tanzania in the East, Uganda in the North, and Burundi in the South. Due to a terrain that is characterized by many rolling green hills and steep to gentle slopes, the country is termed "land of a thousand hills". The topography of Rwanda is unevenly distributed throughout regions. The Congo-Nile watershed and volcanic region, extending from the west to the north of the country, is dominated by many high mountains (such as Muhungwe mountain and five volcanoes) separated by V-shaped valleys. Crossing through the centre to the east, "the central plateau" region is composed of steep and gently rolling hills with elevated plateau. It is one of the most populated regions in the country and includes Kigali city. Finally, the Eastern plains are low-lying and the least populated part of the country. As a result of its topography and too much seasonal rainfall, the Congo-Nile crest and central plateau experience more floods and landslides than the rest of the country.

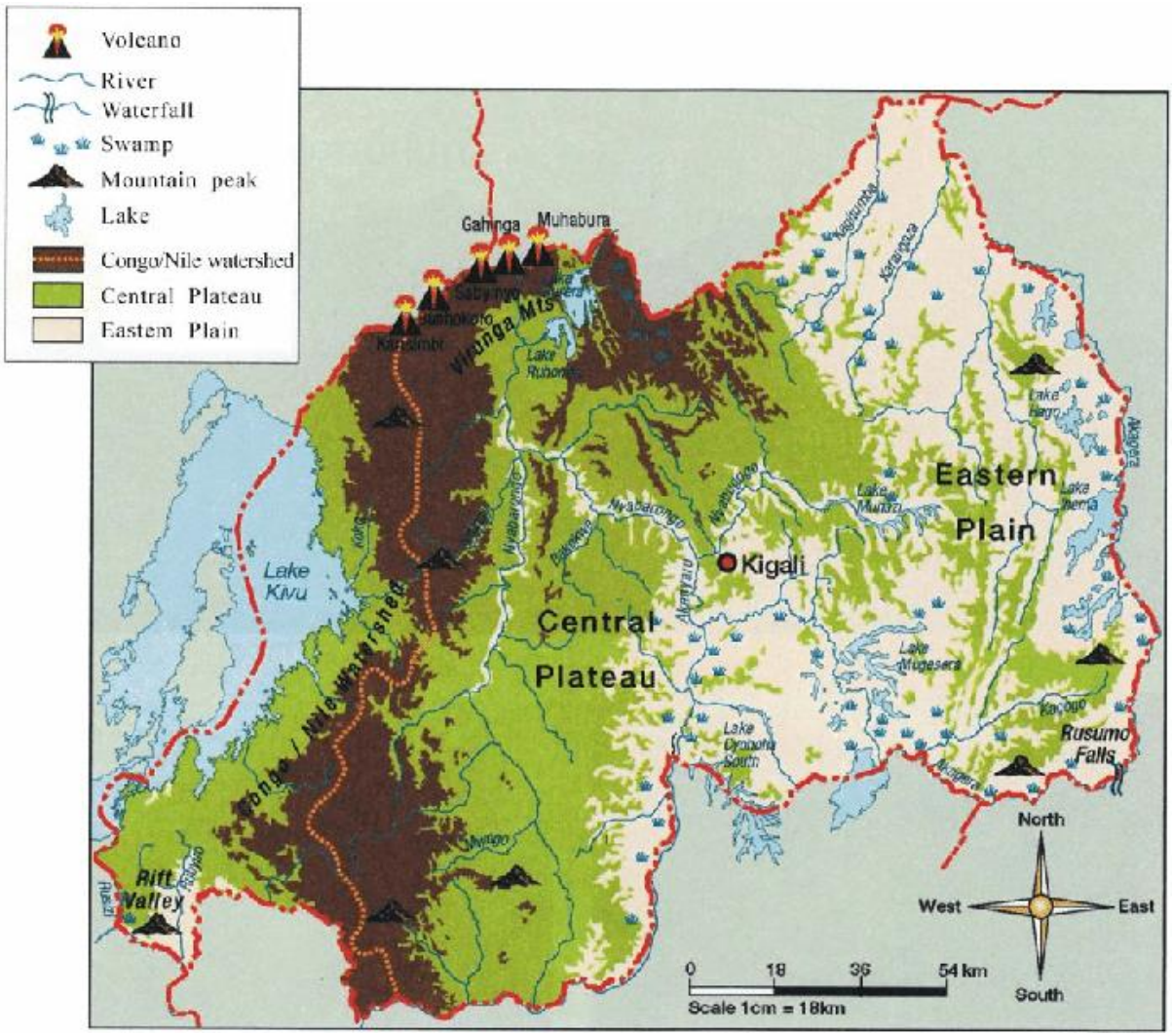


Figure 3 topographic regions of Rwanda

Rwanda's government is aware of both geographic factors, such as location and the topography of the country, and human factors, like population increase and deforestation, as influences on the way climate change affects different places and groups. Therefore, measures to minimize climate change-related effects have been proposed. Adaptation is recognized as the core of such initiatives. For instance, the recent Rwanda National Environmental and Climate Change Policy (NECCP) recognizes climate change variability as contributing to frequent droughts, floods, and other extreme weather events FONERWA, 2019). NECCP thus encourages strengthening adaptation mechanisms in planning and implementation as one of the best ways to reduce future climate change-related effects on biodiversity, infrastructure, and people (*National Environment and Climate Change Policy,* 2019). Nonetheless, many government initiatives are countrywide policies and mostly focus on measures such as relocation and the building of hard infrastructure such as water canals, and street walls, giving little attention to

area-specific community-based adaption. Therefore, there is a need for bottom-up policies inspired by local people's narratives and integrate to a significant extent the locally produced skills.

With an annual urbanization growth rate of 4%, almost half of Rwandans are expected to stay in urban centres, and more than 50% of them will be hosted by Kigali, the largest and capital city (NISR, 2012). Kigali city is built on relatively hilly terrain ranging between 1400 meters and 1850 meters above sea level, and hilltops are separated by relatively large valleys (Manirakiza et al., 2019). Due to this topography, around 19 percent of the city's-built space is located at the windward mountainsides and sensitive to landslides (CoK, 2013b), while valleys experience constant flooding during rainy seasons (usually Late February to Early May and from late August or Early September to Early January).

The rapid urbanization of the capital city was initially due to the return of refugees in the post-1994 genocide against Tutsi, which led to the growth of large unplanned neighbourhoods. Consequently, many residents live in old houses located in hazard-prone zones known as "*utujagali*" or slums. Over the last few decades, there has been an abrupt increase in disasters in Rwanda and Kigali in particular, primarily due to heavy rain and storm wind. For example, in December 2019, in Kigali, more than 10 people died in one night and at least 100 homes were destroyed by torrential rain. On 28th January 2020, three people died, and several properties were swept away due to the same cause.

Environmental bodies and city authorities emphasized that settling on the risky landscape was the major reason for such tragedies. Because of the poor conditions and health risks connected to these slums, some researchers argue that the houses should be demolished, and areas upgraded (Manirakiza et al., 2019). Although demolition would be a logistic, humanitarian, and political challenge given that slums host over 70% of all urban residents in Kigali (UN, 2018), city authorities started an extensive plan to relocate families from areas defined as marshlands or otherwise highly risky. Over 5000 households were supposed to be moved as reported by the city officials. Slum dwellers are seen, in Kigali and elsewhere, as among the most vulnerable to many disasters (including those linked to climate change) yet the least adaptive (Pandey, R. et al., 2018). This means that the vast majority of *utujagali* residents are vulnerable to climate change effects and have low adaptive capacity.

Various Rwandan policies and reports specify the effects of climate change and how to minimize them. A few examples include the 2019 National Environment and Climate Change Policy, and 2020 Kigali Land Use Plan. However, none of these documents focus on slum dwellers, the climate change related impacts they face, and how they adapt to them. Therefore, there is a need for exploratory research to investigate climate change impacts and climate change adaptation among these most vulnerable low-income slum residents.

4.2 Bannyahe: introducing the study area

4.2.1 Physical characteristics

The study area is Bannyahe, an informally built *utujagali*. Most of its residents have low incomes and limited resources. Officially the slum is located in Kangodo and Kibiraro neighbourhoods, in Nyarutarama cell, Remera sector, in Gasabo district, and is Kigali's largest slum. Bannyahe is a colloquial Kinyarwanda name that roughly means "where is the toilet". Bannyahe was named after the poor sanitation and unhygienic conditions of the neighbourhood. Its name is usually considered as impolite among city officials and planners, although this research uses the term, as do area residents.

Two upscale Kigali neighbourhoods, Nyarutarama and Kibagabaga, border Bannyahe. The upscale residential area of Nyarutarama is host to several embassies, while Kibagabaga, on the other side, is a residential quarter for many government officials, as well as wealthy foreign and local individuals. These two areas are served by modern infrastructure, such as roads, streetlights, and sidewalks.

Bannyahe, which is situated between them, differs completely from its neighbours, with poor roads, poor houses, poor sanitation, and many other unfavourable conditions. Such conditions cause several risks in case of disasters like heavy rain. Destruction of houses, water overflow, and sometimes the death of people occurs. This devastation is the case for Bannyahe and many other slum neighbourhoods in Kigali. which are destinations for immigrants from rural parts of the country. These people are ill equipped to deal with additional hardships – many slum residents do not have permanent jobs and lack academic qualifications.

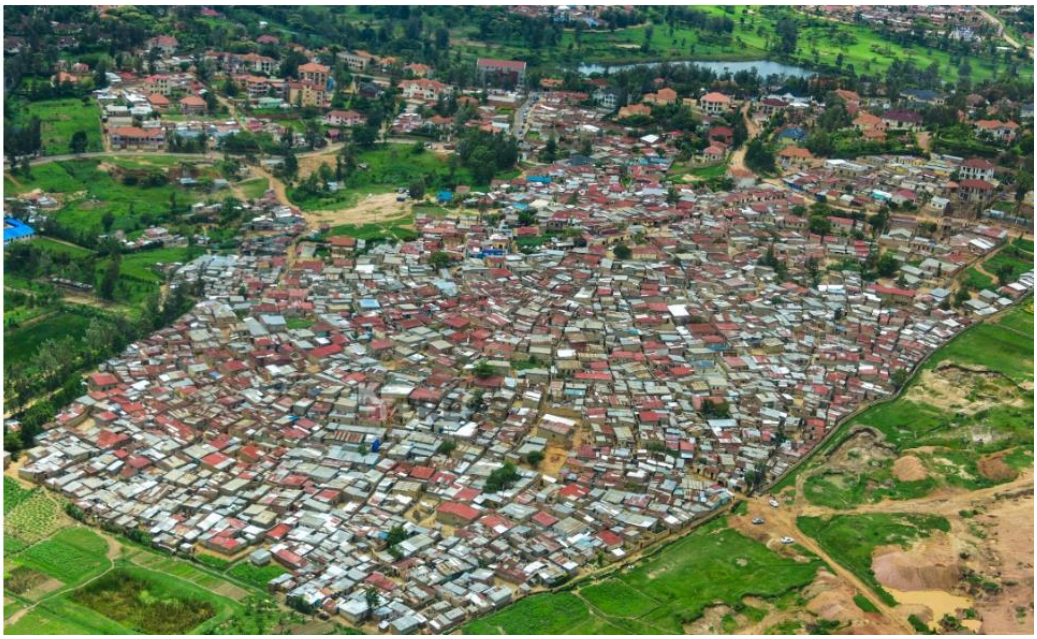


Figure 4 Aerial view of Bannyahe slum (in the foreground) and Kibagabaga modern residences (in upper left corner)

Due to the landscape of Kigali, most of the built space is in floodplains and on mountain slopes. Seasonal and periodic heavy rains cause flooding and landslides in different parts of Kigali. Bannyahe slum is located close to the wetland (see figure 3), which makes the neighbourhood one of the most affected areas by hazards such as floods, droughts, and strong winds. Impacts include destruction of homes and crops, power outages, and, sometimes, loss of lives. In the case of such disasters, residents get temporary support, such as shelter, food, and clothes, from government, NGOs, and neighbours.

Over recent years, the city of Kigali has been proposing relocation as a way of protecting residents from climate change-related effects. The city authority has ordered all activities in marshlands to vacate for safety and conservation purposes. In the case of Bannyahe, relocation plans included preparation of new places of residence for those relocated. However, the resolution was heavily opposed by several residents, most notably some homeowners.

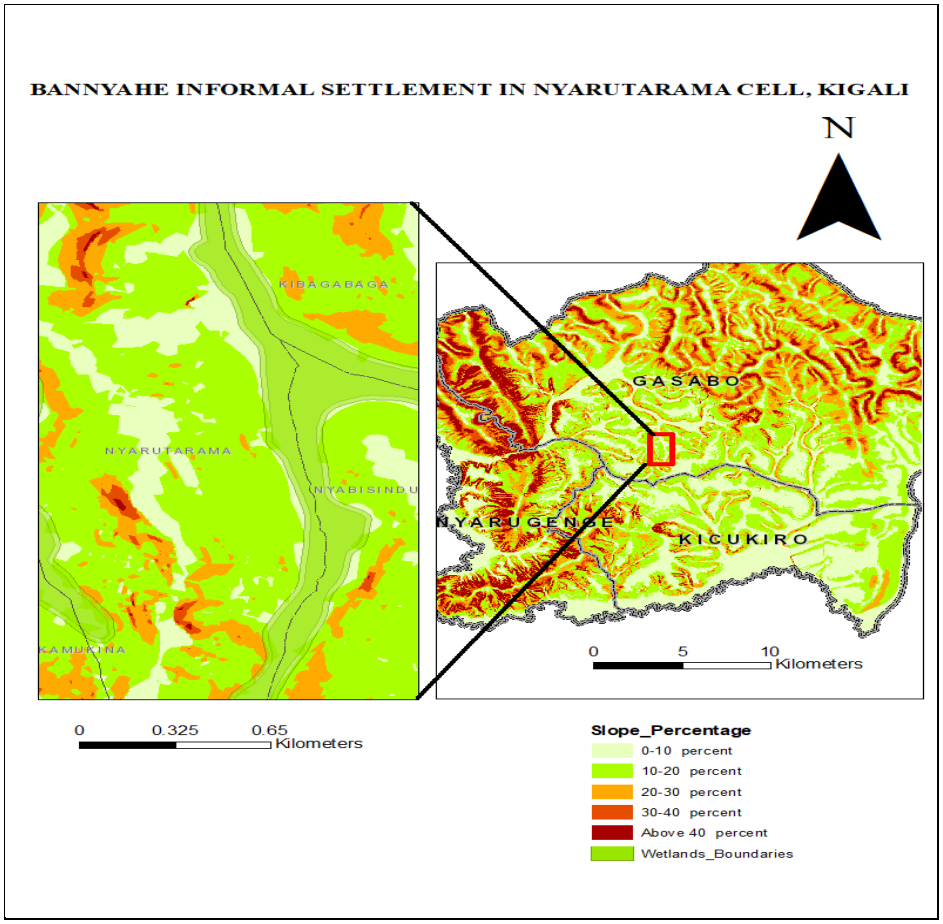


Figure 5 *location of bannyahe*

4.2.2 Demographic attributes of the study area residents

Bannyahe is located in Gasabo district, which recorded more than 500,000 inhabitants in the last census, with an average density of over 1200 people per km^2 (NISR, 2012). With a density of over 6,000 inhabitants per km^2 in some places, Remera sector, which hosts Bannyahe slum, is one of the most thickly populated places in the district and city (see the figure 6). The Bannyahe neighborhood (officially known as Kangodo and Kibiraro) was initially home for about 4000 residents before the eviction of some families in early 2020 by the city authorities due to flooding hazards.

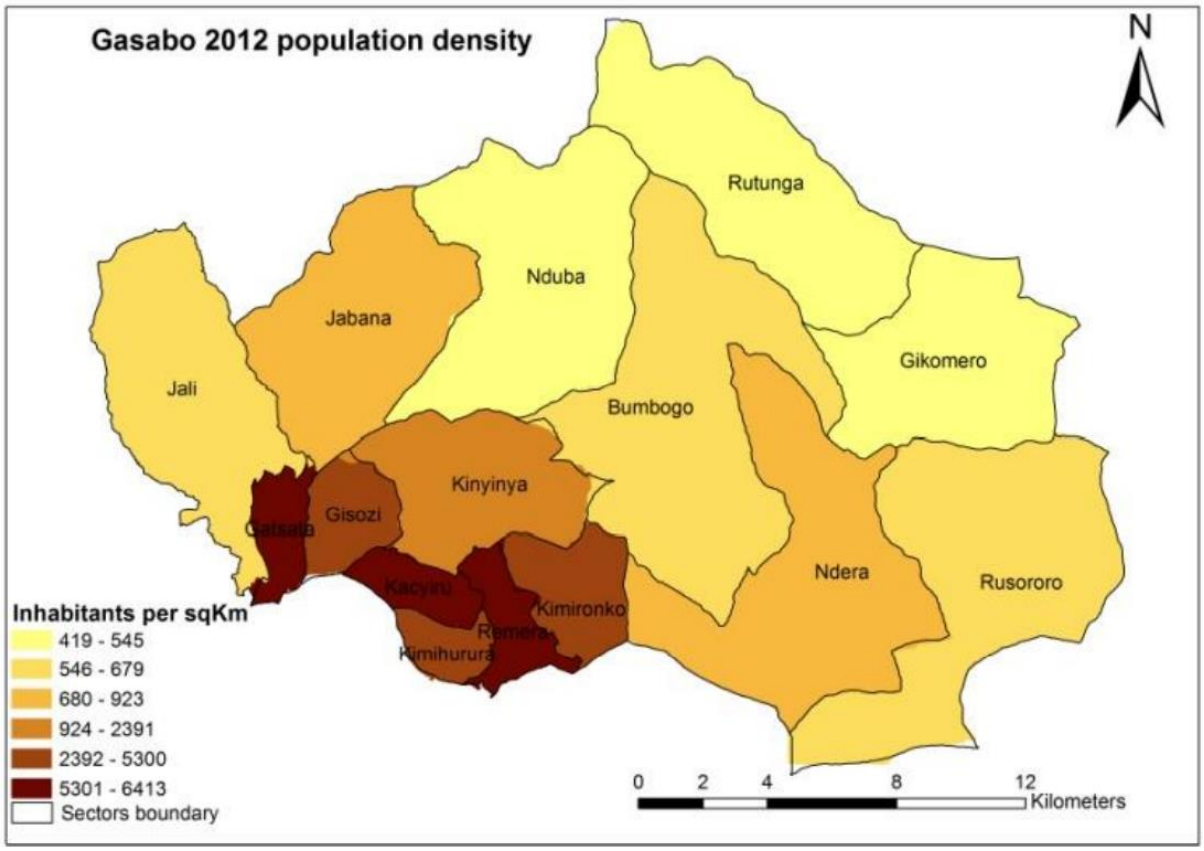


Figure 6. Population density of Gasabo district

In the context of the city of Kigali, informal or slum housing is any area with: vegetation covering less than 40% of the total gross surface of an individual household's plot; an inadequate rainwater harvesting system (more than 60% of individual households do not have rainwater harvesting); an average individual household's plot size of less than 300m^2 with no side setbacks between houses; or location in an unplanned settlement (MIDMAR, 2012b). The government considers all such places as prone to disasters (MIDMAR, 2012b). Thus, all slum areas, including Bannyahe, fall under disaster-prone zones.

Bannyahe does not stand alone from other slums in developing countries, however, some features are specific. The table below summarizes the general social-economic characteristics of the residents interviewed.

Table 1. Socio-economic factors of sampled residents

Socio-economic factor	Number of residents (total:10)	Socio-economic factor	Number of residents (total:10)
Age		High school level	3
21-35	4	Graduate level	0
Above 35	6		
		Households' monthly income	
Education background		Below 10000	2
No education	4	10000-30000	6
Primary school level	3	Over 30000	2

(Note: exchange rate: 1USD=930Rwf)

Table 1 communicates the age, education, and income information of the interviewed dwellers. As can be seen from the table, over half of the residents who were interviewed are above 35 years. Low levels of education are apparent as only 3 out of 10 residents completed high school and none completed any university level. This limited schooling influences the types of jobs they can do, which in many cases are low paying. As a result of low wages, their monthly income is also low as shown in the table. In simple words, many Bannyahe slum dwellers have unstable income, which exacerbates their vulnerability to disasters; poor people are among the most vulnerable and least adaptive to climate change adaptation as discussed in the literature. Knowing people's income status helps to plan for support to provide in different circumstances such as disasters outbreak. Usually, the poorest are the one that are helped first in case of emergencies, as residents reported.

4.2.3 Access to modern technology among residents

Technology plays an essential role in the daily life of human beings. In climate change adaptation and risk reduction, technology is equally important. For example, the third International Conference on Early Warning (EWC III) described dissemination and communication as one of the four elements of people-centred early warning systems (UNISDR, 2006). It suggests that for any warning system to be effective, it must reach people at risk. The rate at which people have access to modern technology can also affect the effectiveness of a disaster reduction and adaptation strategy and adaptation potentials at individual, household, and community levels. The following table provides data on the accessibility to some modern technological tools for Bannyahe's sample residents.

Table 2. Accessibility to technology by sample residents

Technological tools	Number of people with access (total:10)
Radio only	1
Telephone with inbuilt radio	6
Television	2
Smartphone	2
Computer	0
Internet	2

Table 2 shows that there is low accessibility among sampled residents to modern technological tools. However, at least 7 out ten respondents have access to a radio. This fact is important as it communicates how to better reach people either in case of a disaster warning or while transmitting different adaptation skills. Since many people reported having radio access, and it is one of the most used tools for communication in Rwanda, the study went further to examine how often residents listen to radio per day. Also, a large percentage of the residents have not completed formal education and confirmed that they are unable to read the complicated language used in official documents and announcements. Therefore, it is worth knowing how well this group of people can be reached through other modes of communication such as audio-visuals sources. The results are displayed on the chart below.

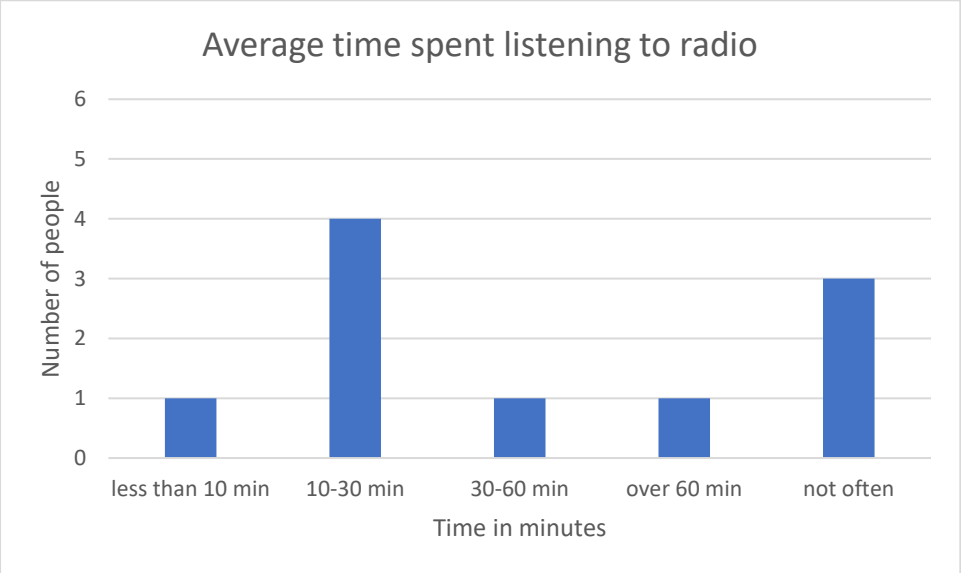


Figure 7. Average time spent listening to the radio

As clearly displayed on the chart, for the people who have access to the radio, many spend between 10 to 30 minutes per day listening. When asked about the reason why they spend relatively little time listening to the radio, many reported that it is because their jobs keep them busy, and they do not get time to listen to the radio. As such, even radio communication does not sufficiently reach residents. hence, relying entirely on radio for communication may not yield adequate results.

4.3 Effects of and responses to climate change in Bannyahe

4.3.1 Extreme weather events and their effects

The physical characteristics of the area, as well as those of residents, explain why it remains one of the most sensitive areas in Rwanda. This area has had series of extreme weather events mostly connected to heavy rain. These events left out many effects on the physical and human setup and lead to life loss and damage of properties. For example, recently, rain has killed people and destroyed properties in different parts of the city including Bannyahe.

Figure 8. Flooding in Kigali, 2019

Between April and May 2018, over 28 people died because of rain, on December 25, 2019, twelve people were killed, 113 dwellings were damaged, roads and water and power were cut off in Kigali because of rain that fell for four straight hours (source: Rwanda- flood list), and

MINEMA asserted this will continue if nothing is done. According to residents, extreme weather is a source of fear and disruption, as the comments below attest.

> *We were home preparing for Christmas celebration and the sky was looking gloomy that night, we knew it was probably going to rain, but the intensity wasn't anywhere close to what we expected, it was too heavy, I was so terrified, we couldn't sleep, water flooded into our house but didn't collapse although many other houses collapsed*. – a Bannyahe resident

> *I remember one day it rained. I was home alone with our two kids. My husband wasn't and only got home around the dawn because roads were flooded. I stayed up all night thinking that he might not be able to make it back. We were lucky that he came back but we heard on the following morning that some people were killed by rain that night."* – a Bannyahe resident said.

These comments show that these climate change-related hazards affect people physically and mentally.

4.3.2 Government Responses

Water Canals

Water management is done principally through canalisation of water. There are two main water canals, "Ruhurura", that border the neighbourhood and take water from both Nyarutarama residences (the uphill modern neighborhood) and Bannyahe. Residents testified to the importance of these canals in reducing flood risks and their shortcomings. One resident said, for instance: "*We know the importance of these canals. Water used to flow everywhere in this neighborhood. Even if it has not stopped … at least it is not as bad as it used to be*".

Shortcomings of the system include limited capacity, the funnelling of excess water to specific zones, barriers to movement, and accumulation of solid waste. Residents observe that water sometimes outstrips the capacity of the Ruhurura and flows into the neighbourhood. Residents have reported that, with time, the canals widen, spreading towards nearby homes and create a danger to their houses. Others observe that the canals also create physical movement barriers; the existing overpasses are not safe for many people. Since the two water canals in Bannyahe are not covered, the canals constitute a safety risk for young kids and people with reduced

mobility. Some people also dump garbage in the canals that blocks the water from flowing and creates unhygienic conditions.

Figure 9. Open canal

Temporary Assistance and Relocation

When it rains and houses collapse, the city responds with measures design to address immediate needs, intermediate transitional phases, and longer-term adaptation. Short term measures include temporary shelter for those displaced and who cannot afford a new place immediately. Government and NGOs such as the Red Cross also provide other materials such as house utensils and food.

Intermediate measures entail immediate relocation of residents identified as at risk. For instance, over 180 families were relocated from Bannyahe at the beginning of 2020 and given 90,000 Rwandan francs each (nearly 100 USD) to cover three months' rent. Pauline Umwari, the executive Administrator of Gasabo district in March 2020, explained that the heavy rains that had just destroyed houses in the city of Kigali *"will continue to fall … and we have taken the initiative to relocate people from high-risk zones before these disasters can happen"* (*Kigali Today*, March 13, 2020).

The intermediate measure was supposed to help the families while newer, safer long-term housing was constructed. Umwali Pauline said *"We have prepared around 25 million Rwandan francs to help residents rent houses for three months as new houses are being finalized, this is*

a firm decision that cannot be changed because we must save our people before it gets worse." The government has favoured relocation these climate change-related hazards. The city of Kigali passed a resolution to move people from Bannyahe to new apartments being built in Busanza area, 15 km away. Relocation was seen as a means to get residents out of climate change-related dangers as the new place is much safer and new apartments are more hazard resistant than houses in Bannyahe.

Figure 10. Housing: pre- and post-relocation

Responses to the government relocation measures were mixed. Homeowners with more than one house in Bannyahe lamented the government program, claiming it would lead to income loss. One of the respondents said:

> *If they want me to move, I will, but here I have a big house that I live in and five more to rent so that I can support my family. In Busanza, the city wants to give me a two-bedroom apartment which is not even enough for me and my six children. How will I survive with no other source of income since I do not have any academic qualification to apply for jobs*.

Another tenant added, "*This place is the only one I could afford in this expensive city, if it is cleared off, maybe I will be homeless and sleep under bridges.*" One researcher thought that instead of investing in construction of apartments, it would have been better to help people upgrade the risk-prone neighbourhood and make it, and the people in it, adaptive to hazards. The logic is clear in the researchers comment:

> *I think it would have been better to invest in people's adaptation than building a new place. Looking at the landscape of our city, it almost impossible to relocate all*

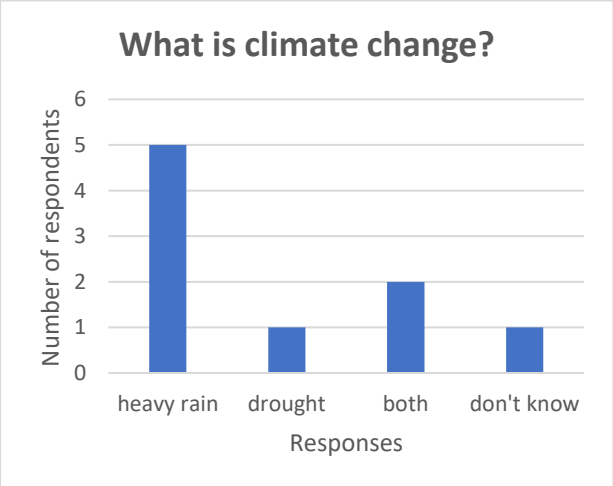
people in prone disaster areas. People can be helped to improve housing, create water canals, plant trees to reduce the intensity of floods, and that way is much sustainable than moving them in new areas.

4.4 Responses of Bannyahe residents

4.4.1 Perceptions of climate change and adaptation

While few probably disagree with the need for measures to minimize the effects of climate change and ensure long-term sustainable development, a question remains whether people at the proverbial 'bottom of the ladder' understand what experts mean in policy drafts. Active and informed civil society can play an irreplaceable role in promoting adaptation, as the global literature shows. However, in climate change adaption planning, the perception of poor and uneducated people is often understudied.

This study reveals that many residents in Bannyahe slum do not feel that they understand the meaning of climate change and climate change adaptation (see figure 10). As seen in figure 7 (on the left), residents do not understand climate change in its broader sense, and rather see it in their context. They believe unquestionably that all the hazards they face are the result of climate change, hence climate change is interpreted as a factor in their daily struggles. Half of the respondents answered that climate change means heavy rain, probably because that is the hazard they face regularly. In figure 7 (on the right), even if some adaptation action actions prevail in the vicinity, most respondents did not feel comfortable stating that they understood the meaning of adaptation.



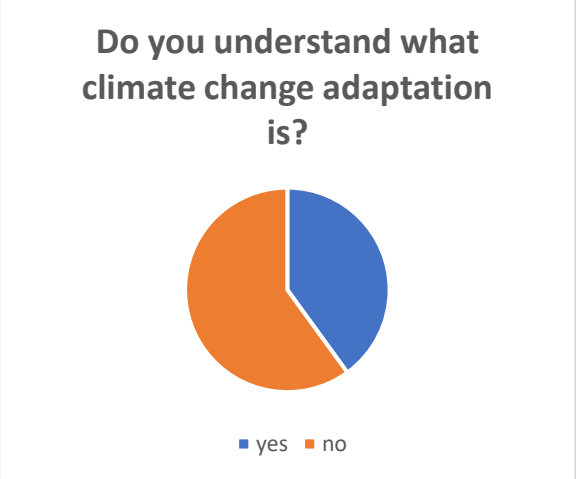


Figure 11. Climate change and climate change adaptation perception among interviewed residents

Some respondents said they did not understand the concept but provided examples of adaptations undertaken, as illustrated in the following comments from on resident who reconstructed their house after being hit hard by heavy rain: *"…. I am not sure what climate change adaption is, but I sometimes hear it on the radio,… yes, I cemented my house to avoid it collapsing again…"* This response may indicate that the yes/no format of the question was intimidating but also suggests that people's adaptation does not depend on understanding the concept of climate change adaptation, and rather on what issues they are facing. Their actions are to deal with an adverse situation. This suggests that rather than broad language and encouragement to adapt, it may be more effective to show people how to organize their knowledge to adjust to their day-to-day struggles.

4.4.2 Climate Change Adaptation by Residents

People have different adaptation needs, depending on where they live, how they maintain their livelihoods, the situations they face, and the roles they play in their families and communities. However, an effective adaptation strategy considers such differing needs of all groups to ensure that actions are directed where they are needed the most. Ensuring that the poor people can adapt to current and forthcoming climate change-related effects is the vital part. Bannyahe residents do try to do some actions in their powers to prepare for the next hazards, even if their efforts alone are likely to be insufficient.

In the interviews, they highlighted some of these actions, often linked to previous hazard experience, as follows.

Digging water canals

As discussed in prior sections, Bannyahe faces heavy rains, which cause floods and related property damage, water contamination, injuries, and deaths. Residents' actions are, as a result, often directed to reducing the impacts of water on their properties. "*The last time it rained, water entered my house, I had to dig a small waterway in front of the house to direct rainwater and create a small bump on the entrance to restrict water from entering the house next time*," one resident said. Individual households dig small canals in front of their homes to direct water

flow down to the marshland and they create small bumps at the entrance to stop water from entering their houses

Upgrading buildings

Apart from houses being very close to each other in Bannyahe slum, they are also built using semi-permanent materials. In the interview, one long-time resident said: "*When we started settling here, many houses were built using only timbers and covered with grasses…".* Although presently there is no house covered with grasses, a few are still built of scrap timbers or burnt bricks (amatafari), while the remaining majority were build using mud bricks (Rukarakara). The reliance on old wood and rukarakara poses a high risk of destruction in cases of strong winds and heavy rain; most of the planks are partly decayed and mudbricks, as produced locally, easily soak up in the water. In addition, the roofs of many houses are made of iron sheeting, usually relatively old and torn, which lets rain enter.

After experiencing different hazards and facing effects such as destruction of houses, residents started work on their houses, rebuilding the destroyed ones. Those capable rebuilt them entirely, using hard materials such as bricks and stones. Some residents have added cement to the floor or layers of sand and cement to walls of their houses to increase their resistance to water, improvements visible in site observations (see figure below). As one resident described,

> *…every time after rain and strong wind, you could see few houses with collapsed walls or roofs…, then people started building using strong materials like stones, sand, mud bricks… to harden houses and reduce the risk of collapsing.*

Figure 12. Old (left) timber and improved (right) cement block housing construction in Bannyahe

Unfortunately, the relocation notice released in 2017 by the city of Kigali froze any renovation work, and residents are unable to add anything to the current state of their houses.

Household water harvesting system

Creating a canal can prevent a certain amount of rainwater from overflowing but is not alone sufficient. Residents are advised to collect water from their homes in any possible way. Measures that reduce excess water overflow can also help residents with access to water for home use and watering crops. For this reason, residents with financial means are helped to purchase water tanks, and those who cannot buy are helped to get them on loan. Though a favoured strategy, tanks are not possible for many homes due to the proximity of other dwellings.

4.5 Local government and NGOs measures to support climate change adaption in slums

4.5.1 Training residents about climate change and climate change adaptation

Local government and NGOs in Kigali state that using expert knowledge to support residents' local adaptation efforts is essential. Interviews with residents, officials and researchers exposed a major gap between what experts know, what they want the community to know, and what the community knows about climate change and climate change adaptation. While there are many possible explanations for this gap, one of them is how communication is done. At present, local government and NGOs communicate about climate change and adaptation via radio and television; community meetings; and written documents. Each is described below.

Using radio and television

One of the respondents highlighted that radio and television are used a lot to teach people how to adjust their actions to face different climate change adaptation. "*Firstly, we use radio and television to communicate urgent news such as possible hazard outbreaks and ask people to be alert, and we also use them for our ordinary teaching of how to fight and adjust with climate change effects*," said the disaster management officer. *"We chose them as the widest way to reach more people at a time"* he added. While it is true that radio and television do cover a wide territory quickly, this may differ given the character of the area and the people. For example, among the residents that were interviewed in Bannyahe, many reported that they do

not have access to television and do not spend a long time listening to the radio, which reduces their chance of learning from radio and television-centred approaches.

Through community meetings and gatherings

Community meetings and gathering can draw on area-specific insights of inhabitants, contributing to community-based learning. It includes communicating climate change adaptation skills through regular and extraordinary community meetings. Its advantages include giving people the opportunity to ask questions; providing information specific to that area; evaluating the progress of adaptation activities; and providing a forum for suggesting improvements to an area. It is used in Bannyahe neighbourhood via weekly and monthly meetings, and extraordinary ones following disaster occurrences. Concerns about the effectiveness of meetings as a communication route were voiced by respondents and include that they have low attendance (they usually take place during working hours), are time-consuming (a small content is covered at a time) and are inconsistent in content delivery (changing attendees and facilitators mean that those there this week may not be the same as who will come next time). Another challenge is that people claim that their opinions are usually not considered by authorities while taking final decisions. As a resident explained,

> *We had many meetings meeting with Gasabo district representatives, we even met with the mayor of Kigali and members of parliament, but nothing changed, none of the prepositions we provided was considered. I feel like I am tired of attending these meetings.*

Using written documents

Widely-used written formats for communication around climate change in Rwanda include official plans, official gazettes, and newspaper articles. The relevant institution publishes the information to be communicated as a written notice. Only people who can read can get the direct message. Therefore, the technique is best relevant for literate people, while it is unfavourable for those who cannot read and write, which is the case for many Bannyahe and other slum dwellers. Even those who can read have a limited time to do so, as they are busy in other daily activities. Written materials are also less reflective; people with concerns do not have a direct way to report them.

In sum, no specific technique is seen as standing alone. A combination of techniques and mediums, taking into consideration area and population characteristics, is likely important to communicating relevant skills to the community.

4.6 Summary

The research reveals a government orientation towards low-cost infrastructure (the canals) and emergency support to address climate change risks in the short and medium term. The long-term solution, support by legislation, programs, and some financial allocations, is to relocate those at risk from informal slum areas. Residents and some observers question the logic, wondering whether measures to allow continued residence in Bannyahe could be pursued. They note investments made over many years in improving the area, proximity to jobs, and small-scale actions to improve their ability to withstand heavy rains and flooding. Though residents said they had limited knowledge of climate change and climate change adaptation, small scale adaptation actions inspired by the previous hazards were prevalent in the neighbourhood. Such actions included changing the building materials of their homes and digging water ways. The limited knowledge of climate change and climate change adaptation can be attributed to various factors such as inadequate training about these concepts, the quality of methods and channels of communication used to edify people, the academic levels of residents, and the fluctuating community members (especially tenants).

VII. RECOMMENDATIONS AND CONCLUSIONS

7.1 Key findings

The purpose of this research was to identify various climate change-related effects faced by people living in Bannyahe slum, in Gasabo district, in the city of Kigali. A second aim was to assess the knowledge and understanding of residents about climate change and climate change adaptation. Third, the research aimed to identify what actions done by Bannyahe residents to cope with adverse effects of climate change.

Although climate change is a universal issue, poor slum dwellers are among those who are highly vulnerable and hence need extra support. Having detailed information about what climate change-related problems they have is an important step towards understanding the constraints under which they live, their aspirations, and their (existing and latent) capacity to face present and forthcoming hazards. While field research was limited to remotely accessible, information, as dictated by restrictions on travel during the pandemic, the findings are still important as a basis for further work.

Inhabitants of Bannyahe slum regularly face heavy rain, historically aberrant, that cause damages to property and threaten human safety and well-being. This exposure is exacerbated by the nature of landscape, which is close to marshlands, and the characteristics of the housing, which tend to be self-constructed for scrap wood, locally produced baked mud bricks, and steel roofing sheets. Low-lying areas with precarious housing and severe storms mean that Bannyahe residents, just like many other slum dwellers all over the world, suffer from climate change related effects. Interviews suggest that people feel these effects as materially and psychologically traumatic, highlighting in the interviews their fears and potential loss of loved ones.

The research also revealed a limited knowledge of climate change and climate change adaptation among Bannyahe residents. Most saw heavy rains as the clearest expression of climate change. The majoriy said they could not define adaptation. The limited knowledge of climate change and adaptation can be attributed to various factors such as inadequate training about these concepts, the quality of methods and channels of communication used to edify people, the limited academic levels of residents, and the fluctuating community members involved in neighbourhood improvements (especially tenants and newcomers). It is an

unsurprising finding given low levels of schooling, high levels of rural immigration, and long hours spent by residents in income-generation, but nonetheless important.

Despite lack of professed knowledge of adaptation, Bannyahe's inhabitants commonly undertake small scale adaptation actions inspired by the previous hazards. They improve the materials of their buildings, introducing cement into floors and walls, install water barrels when they can, and dig small water canals to divert water from the homes. Further, many profess interest in staying in the neighbourhood and developing a means to withstand climate hazards.

7.2 Recommendations

Literature, policy review, primary data suggest a series of recommendations for improving adaptation in slum areas. First, a more collaborative approach between authorities and community members is highly recommended to improve adaptive conditions of Bannyahe to climate change. From the interviews, residents stated that being left out in decision making is one of the biggest hindrances towards viable adaptation strategies. For instance, residents stated that if supported, upgrading the neighbourhood would mean more than relocation for their safety. Such collaborative approaches are likely important to other slum areas and adaptation approaches elsewhere in the Global South.

Equipping residents with adequate knowledge of climate change and climate change adaptation needs to be improved. This could involve breaking down materials to be taught into more simplified pieces that are easy to grasp, as well as narrowing the transmission channels down to the resident level. Grassroots teaching in small groups of residents could be explored, though it was not piloted or seen as part of the research. Also, for a better understanding, there is a need to used local examples – residents responded to previous events and local experiences rather than more complicated scenarios drawn from elsewhere. More significantly, literature suggests that this teaching must be a two-way dialogue of sharing knowledge, skills and suggestions between experts and community members, to determine the best way to deal with an issue on the table. In the end, the collective conclusions agreed upon must be implemented as agreed or any change must be communicated back to community member ahead. This is crucial as it creates trust between community and policymakers which is currently missing in Bannyahe.

References

ADF, (2010): TC2.1: Climate change and human development. In: "Acting on Climate Change for Sustainable Development in Africa". *Report of the Proceedings of the Seventh African Development Forum* (ADF VII), 10-15 October 2010, UN Conference Centre, Addis Ababa, Ethiopia. Organized by the African Union Commission (AUC), the African Development Bank (AfDB) and the United Nations Economic Commission for Africa (UNECA) with the United Nations Environment Programme, UNECA, Addis Ababa, Ethiopia, pp. 30-32.

Adger,W.N., N. Brooks, G. Bentham, M.Agnew, and S. Eriksen, (2003a). New Indicators of Vulnerability and Adaptive Capacity. *Technical Report No. 7, Tyndall Centre for Climate Research, School of Environmental Sciences, University of East Anglia*, Norwich, UK, 128.

Almansi, F., (2009) Regularizing land tenure within upgrading programmes in Argentina; the cases of Promeba and Rosario Hábitat. *Environment and Urbanization*, 21(2), 389-414.

Aragon-Duran, E., G. Lizarralde, G. Gonzalez-Camacho, A, Olivera-Ranero, L. Bornstein, B. Herzao, D. Labbe, (2020). "The language of risk and the risk of language: mismatches in risk response in Cuban coastal villages," *Int'l J. of Disaster Risk Reduction*, 2020, https://doi.org/10.1016/j.ijdrr.2020.101712.

Aylett, A., (2010). Conflict, collaboration and climate change: participatory democracy and urban environmental struggles in Durban, South Africa. *International Journal of Urban and Regional Research*, 34(3), 478-495.

Bailey, R., (2013). Managing Famine Risk: Linking Early Warning to Early Action. A Chatham House Report. *The Royal Institute of International Affairs, Chatham House*,.London, UK, 100 pp.

Barron, S., G. Canete, J. Carmichael, D. Flanders, E. Pond, S. Sheppard, and K. Tatebe, (2012). A climate change adaptation planning process for low-lying, communities vulnerable to sea level rise. *Sustainability*, 4(12), 2176-2208. ISSN 2071-1050

Bartlett, S., D. Dodman, J. Hardoy, D. Satterthwaite, and C. Tacoli, (2009). Social Aspects of Climate Change in Urban Areas in Low- and Middle-Income Nations. Paper presented at the *World Bank Fifth Urban Research Symposium.* "Cities and Climate Change: Responding to an Urgent Agenda," 28-30 June 2009, Marseilles, France, Research Cluster 5, 44 pp.

Beer, T. and Ziolkowski, F. (1995) Environmental risk assessment – an Australian perspective, in Norton. T.W., Beer, T. and Dovers, S.R., Risk and Uncertainty in Environmental Management. *Centre for Resource and Environmental Studies*. Canberra, 3-13.

Begon, M., Harper, J., Townsend C. (1990). *Ecology, individuals, populations, and communities.* Blackwell, London.

Brown, H.C.P., Nkem, J.N., Sonwa, D., and Bele, Y. (2010). Institutional adaptive capacity and climate change response in the Congo Basin forests of Cameroon. *Mitigation and Adaptation Strategies for Global Change* 15(3). 263-282.

Burton, I., Huq.S., Lim,B., Pilifosova,O, and Schipper,E.L. (2002).. From impacts assessment to adaptation priorities: the shaping of adaptation policy. *Climate Policy,* 2(2). 145-159.

Byamukama, B., Carey, C., Dr, Cole, M., Dyszynski, J., & Warnest, M., Dr. (2011). *National Strategy on Climate Change and Low Carbon Development for Rwanda*. doi:10.4210/SSEE.PBS.2011.0002

Cardona, O.D.,M.K. van Aalst, J. Birkmann, M. Fordham, G. McGregor, R. Perez, R.S. Pulwarty, E.L.F. Schipper, B.T. Sinh, H. Decamps, M. Keim, I. Davis, K.L. Ebi, A. Lavell, R. Mechler, M. Pelling, J. Pohl, A. Oliver-Smith, F. Thomalla. (2012). Determinants of risk: Exposure and vulnerability. Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation [Field, C.B., et al. (Eds.)]. *A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC)*. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 65-108.

Castro, A.P., D. Taylor, and D.W. Brokensha (eds.), 2012: *Climate Change and Threatened Communities: Vulnerability, Capacity and Action*. Practical Action, Bourton on Dunsmore, UK, 224 pp.

Chinowsky, P., C. Hayles,A. Schweikert, N. Strzepek, K. Strzepek, and C.A. Schlosser, (2011). Climate change: comparative impact on developing and developed *countries. Engineering Project Organization Journal*, 1(1), 67-80.

Chitekwe-Biti B., P. Mudimu, G.M. Nyama and T. Jera, (2012). Developing an informal settlement upgrading protocol in Zimbabwe – the Epworth story. *Environment and Urbanization* 24(1) 131 – 148 http://journals.sagepub.com/doi/full/10.1177/0956247812437138

Collins, K. and Ison, R. (2009). Jumping off Arnstein's ladder: social learning as a new policy paradigm for climate change adaptation. *Environmental Policy and Governance*, 19(6), 358-373.

De Bruin, K., R.B. Dellink, A. Ruijs, L. Boldwidt, A. van Buuren, J. Graveland, R.S. de Groot, P.J. Kuikman, S. Reinhard, R.P. Roetter, V.C. Tassone, A. Verhagen, and E.C. van Ierland, (2009). Adapting to climate change in the Netherlands: an inventory of climate adaptation options and ranking of alternatives. *Climatic Change*, 95(1-2), 23-45.

Dessai, S. and M. Hulme,M. (2004). Does climate adaptation policy need probabilities? *Climate Policy*, 4(2), 107-128.

Douglas, I., K. Alam, M. Maghenda, Y. Mcdonnell, L. Mclean, and J. Campbell, (2008). Unjust waters: climate change, flooding, and the urban poor in Africa. *Environment and Urbanization*, 20(1), 187-205.

Dube, O.P. and. Sekhwela, B.M. (2008). Indigenous knowledge, institutions, and practices for coping with variable climate in the Limpopo Basin of Botswana. In*: Climate Change and Adaptation* [Leary, N., J. Adejuwon, V. Barros, I. Burton, J. Kulkarni, and R. Lasco et al, (Eds.)]. Earthscan, London, UK and Sterling,VA, USA, pp. 71-89.

Esmail, S., & Corburn, J. (2019). Struggles to remain In Kigali's "UNPLANNED" Settlements: The case of bannyahe. *Environment and Urbanization*, *32*(1), 19–36. https://doi.org/10.1177/0956247819886229

FEMA. (2010). Hazard Mitigation Assistance Unified Guidance. *Federal Emergency Management Agency (FEMA), Department of Homeland Security*, FEMA, Washington, DC, USA, 168 pp.

Fünfgeld, H. and McEvoy,D. (2011). Framing Climate Change Adaptation in Policy and Practice. VCCCAR Working Paper 1, VCCCAR Project: *Framing Adaptation in the Victorian Context*. Victorian Centre for Climate Change Adaptation Research (VCCCAR), Melbourne, Australia, 65 pp.

GoR (2011). Green Growth and Climate Resilience. *National Strategy for Climate Change and Low Carbon Development.* Kigali, Rwanda Environment Management Authority.

Hamin, E.M. and Gurran,N. (2009). Urban form and climate change: balancing adaptation and mitigation in the U.S. and Australia. *Habitat International*, 33(3), 238-245.

Harvey, B., J. Ensor, L. Carlile, B. Garside, Z. Patterson, and L.O. Naess, (2012). Climate Change Communication and Social Learning – Review and Strategy Development for CCAFS. *CCAFS working Paper No. 22, CGIAR Research Program on Climate Change,Agriculture and Food Security* (CCAFS). Copenhagen, Denmark, 51 pp.

Kagire, E. (2020, June 2). *Relocation from "BANNYAHE" high risk ZONE BEGINS*. KT PRESS. https://www.ktpress.rw/2020/03/relocation-from-bannyahe-high-risk-zone-begins/. Huchzermeyer, M. (2011). *Cities with Slums: From Informal Settlement Eradication to a right to the city in Africa.* New York: Juta Academic.

Hunde, M. (2012). Integrating community-based disaster risk reduction and climate change adaptation into local development planning. Proceedings of "Communicating Community Based Adaptation," *Sixth International Conference on Community-Based Adaptation, 16-22, April 2012, Hanoi, Vietnam, Session 7, Abstract 3.* Organised by the International Institute for Environment and Development in the UK, the Ministry of Agriculture and Rural Development (MARD) of Vietnam, the Ministry of Natural Resources and Environment (MONRE) of Vietnam, and the Bangladesh Centre for Advanced Studies, IIED, London, UK, pp. 20-21.

Huntjens, P., Pahl-Wostl, C., and Grin,J. (2010). Climate change adaptation in European river basins. *Regional Environmental Change*, 10(4), 263-284.

IPCC. (2007). Climate Change 2007. *Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Parry, M.L., et al., (Eds.)]. Cambridge University Press, Cambridge, UK, pp. 7-22

IPCC (2007b). Climate Change 2007: *Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Parry, M.L., et al. (Eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, 976 pp.

Kiparsky, M., Milman,A., and Vicuña,S. (2012). Climate and water: knowledge of impacts to action on adaptation. *Annual Review of Environment and Resources*, 37(1), 163-194.

Kithiia, J.(2011). Climate change risk responses in East African cities: need, barriers, and opportunities. *Current Opinion in Environmental Sustainability*, 3(3), 176- 180

Kumar, R. (2011). *Research Methodology: a step-by-step guide for the beginners* (3rd ed.) London. SAGE Publication ltd

Laukkonen, J., Blanco,P.K., Lenhart,J., Keiner,M., Cavric,B., and Kinuthia-Njenga,C. (2009). Combining climate change adaptation and mitigation measures at the local level. *Habitat International*, 33(3), 287-292.

Levin, K., B. Cashore, S. Bernstein, and G. Auld (2012). Overcoming the tragedy of super wicked problems: constraining our future selves to ameliorate global climate change. *Policy Science* 45: 123-152.

Lines, K. and Makau, J. (2017). Muungano nguvu yetu (unity is strength): 20 years of the Kenyan federation of slum dwellers, *IIED Working Paper*. IIED, London, 88 pages available at http://pubs.iied.org/10807IIED/

Lizarralde, G., Bornstein, L., Robertson, M., Gould, K., Herazo, B., Petter, A.-M., González, G. (2021). Does climate change cause disasters? How citizens, academics, and leaders explain climate-related risk and disasters in Latin America and the Caribbean. *International Journal of Disaster Risk Reduction, 58*, 102-173.

Lizarralde, G., Páez, H., Lopez, A., Lopez, O., Bornstein, L., Gould, K., Muñoz, L. (2020). We said, they said: The politics of conceptual frameworks in disasters and climate change in Colombia and Latin America. *Disaster Prevention and Management, 29*(6).

Ludi, E., Jones, E., and Levine, S. (2012). Changing Focus? How to Take Adaptive Capacity Seriously. Evidence from Africa Shows that Development Interventions Could Do More. *ODI Briefing Paper 71*. Overseas Development Institute (ODI), London, UK, 4 pp.

MacLean, D., (2008). ICTs, Adaptation to Climate Change, and Sustainable Development at the Edges. *IISD Commentary*. International Institute for Sustainable Development (IISD), Winnipeg, MB, Canada, 5 pp.

Manirakiza, V., Mugabe, L., Nsabimana, A., & Nzayirambaho, M. (2019). City Profile: Kigali, Rwanda. *Environment and Urbanization ASIA, 10*(2), 290-307. doi:10.1177/0975425319867485

MIDMAR. (2012b). *Field report on informal settlements*: *Case study: The city of Kigali. Kigali, Rwanda.*

Mitlin, D. and A. Muller 2004: Windhoek, Namibia: towards progressive urban land policies in Southern Africa , International Development Planning Review 26(2) 167-186

Moser, S.C. and J.A. Ekstrom, 2010: A framework to diagnose barriers to climate change adaptation. Proceedings of the National Academy of Sciences of the United States of America, 107(51), 22026-22031.

FONERWA. (2019). *National Environment and Climate Change Policy*. Retrieved October 10, 2020, from

http://www.fonerwa.org/sites/default/files/Rwanda%20National%20Environment%20and%20Climate%20Change%20Policy%202019.pdf

News, F. L.(2019, December 28). *FloodList news*. *FloodList*. https://floodlist.com/africa/rwanda-flash-floods-kigali-december-2019.

Niang, I., O.C. Ruppel, M.A. Abdrabo, A. Essel, C. Lennard, J. Padgham, and P. Urquhart, (2014). Africa. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. *Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Barros, V.R., et al. (Eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1199-1265.

NISR. (2012). *Fourth population and housing census: 2012*. Kigali: National Institute of Statistics of Rwanda. Retrieved from http://www.statistics.gov.rw/survey-period/fourth-population-and-housing-census-2012

Noble, I.R., S. Huq, Y.A. Anokhin, J. Carmin, D. Goudou, F.P. Lansigan, B. Osman-Elasha, and A. Villamizar, (2014). Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. *Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., et al. (Eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 833-868.

ones, H.P., D.G. Hole, and E.S. Zavaleta, (2012). Harnessing nature to help people adapt to climate change. *Nature Climate Change*, 2, 504-509.

Paavola, J. (2008). Livelihoods, vulnerability, and adaptation to climate change in Morogoro, Tanzania. *Environmental Science and Policy*, 11(7), 642-654.

Pandey, R., Alatalo, J. M., Thapliyal, K., Chauhan, S., Archie, K. M., Gupta, A. K., . . . Kumar, M. (2018). Climate change vulnerability in urban slum communities: Investigating household adaptation and decision-making capacity in the Indian Himalaya. *Ecological Indicators, 90*, 379-391. doi:10.1016/j.ecolind.2018.03.031

Patel, K. (2013). *Topic Guide: Provision and improvement of housing for the poor. Evidence on Demand*. UK. 63 pp.

Patel, S.B., Saluja, J., and Kapadia, O. (2018). Transit-led peri-urban Affordable Housing for all. *Environment and Urbanization.* 30(1). http://journals.sagepub.com/doi/full/10.1177/0956247817738188

Pelling, M. (2003). 'Paradigms of Risk' in Pelling, M. (ed.). *Natural Disasters and Development in a Globalising World*. Routledge: London, UK

Revi, A., D.E. Satterthwaite, F. Aragón-Durand, J. Corfee-Morlot, R.B.R. Kiunsi, M. Pelling, D.C. Roberts, and W. Solecki, (2014). Urban areas. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Field, C.B., et at. (Eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 535-612.

Satterthwaite, D. (2007). The transition to a predominantly urban world and its underpinnings. *Human Settlements Discussion Paper – Urban Change 4*. International Institute for Environment and Development (IIED). London. U.K

Satterthwaite, D. et al (2018). *Responding to climate change in cities and in their informal settlements and economies*. IIED and IIED-América Latina. Retrieved from https://pubs.iied.org/sites/default/files/pdfs/migrate/G04328.pdf

SDI. (2016). *Annual Report 2016: Twentieth Anniversary Edition*. Slum Dwellers International. Cape Town, South Africa. Available from: http://knowyourcity.info/wp-content/uploads/2016/11/SDIAnnual-Report-2016.pdf

Sietz, D., Boschutz,M., and Klein, R.J.T., (2011a). Mainstreaming climate adaptation into development assistance: rationale, institutional barriers, and opportunities in Mozambique. *Environmental Science and Policy*, 14(4), 493-502.

Smithers, J., Smit, B. (1997). 'Human Adaptation to Climatic Variability and Change'. *Global Environmental Change*, 7 (2) 129-146.

Taylor, J. (2015). Tale of two cities: comparing alternative approaches to reducing the vulnerability of riverbank communities in two Indonesian cities. *Environment and Urbanization*, 27(2): 621- 636.

UN DESA Population Division. (2010). *World Urbanization Prospects: The 2009 Revision.* United Nations Department of Economic and Social Affairs (UN DESA) Population Division. United Nations Publications, New York, NY, USA, 47 pp.

UN DESA Population Division. (2011). *World Population Prospects: The 2010 Revision*. Highlights and Advanced Tables. United Nations Department of Economic and Social Affairs (UN DESA) Population Division, United Nations Publications, New York, NY, USA, 142 pp

United Nations. (2015). Millenium *Development Goals Indicators. Indicator 7.10 Proportion of Urban Population Living in Slums*. http://mdgs.un.org/unsd/mdg/seriesdetail.aspx?srid=710.

UN. (2018). *The sustainable development goals report*. New York, NY: United Nations. Retrieved from https:// unstats.un.org/sdgs/files/report/2018/TheSustainableDevelopmentGoalsReport2018-EN.pdf

UNFCCC. (2010). *Synthesis Report on Efforts Undertaken to Assess the Costs and Benefit of Adaptation Options, and Views on Lessons Learned, Good Practices, Gaps and Needs.* UNFCCC Secretariat, Bonn, Germany.

UN-HABITAT. (2008). State of the World's Cities 2008/2009. *Harmonious Cities*. Earthscan, London, UK and Sterling, VA, USA/

UN-HABITAT. (2011). Cities and Climate Change: *Global Report on Human Settlements 2011*. United Nations Human Settlements Programme (UN-HABITAT), Nairobi, Kenya, 268.

UN-Habitat. (2015b). informal settlements. *Habitat III Issue Paper 22*. UN-HABITAT.Nairobi, Kenya.:

UN-Habitat. (2015f). *Global report 2015: Increasing synergy for greater national ownership.* UN-Habitat. Nairobi,Kenya

UNISDR, 2011: Effective Measures to Build Resilience in Africa to Adapt to Climate Change. *Briefing Note 04*. United Nations International Strategy for Disaster Reduction (UNISDR), Geneva, Switzerland, 8 pp

United Nations, Department of Economic and Social Affairs, Population Division (2015). World Urbanization Prospects: The 2014 Revision, (ST/ESA/SER.A/366).

UN-HABITAT. (2012). State of the world's cities 2012/2013: *Prosperity of cities*. UN-HABITAT. Nairobi, Kenya.

Lall, S.V., Vernon, J., Henderson, and Anthony J. V. (2017). "*Africa's Cities: Opening Doors to the World*." World Bank, Washington, DC.

MCRI, (2004-2008). *Institutional Adaptations to Climate Change: Comparative Study of Dryland River Basins in Canada and Chile*. Saskatoon. www.parc.ca.

Turner, W.R., Bradley, B.A., Estes, L.D., Hole, D.G., Oppenheimer, M., and Wilcove, D.S. (2010). Climate change: helping nature survive the human response. *Conservation Letters*, 3(5), 304-312.

Watson, R.T., Zinyowera, M.C., Moss, R.H., Dokken, D..,J (eds) (1996). Climate change 1995—impacts, adaptations, and mitigation of climate change: scientific-technical analyses. *Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, New York. USA

WEF. (2013). *Global Risks 2013*. World Economic Forum. Geneva, Switzerland.

WEF. (2014). *Global Risks 2014*. World Economic Forum. Geneva, Switzerland.

Weru, J., (2004). Community federations and city upgrading: the work of Pamoja Trust and Muungano in Kenya. *Environment and Urbanization*, 16(1) 47-62.

Wilbanks, T.J., Romero, P. Lankao, M., Bao, F., Berkhout, S., Cairncross, J., Ceron, P., Kapshe, M., MuirWood, R., and Zapata-Marti, R., (2007). Industry, settlement and society. In Parry, M.L., et al., (Eds). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge, UK, 357-390

World Bank. (2015). *Investing in Urban Resilience*: Protecting and Promoting Development in a Changing World. Washington DC

World Bank. (2020). P*overty and shared prosperity.* Washington DC. World Bank

Yin.K.R. (2003). *Case study Research: Design and Methods* (3rd ed.). London. SAGE publications

Yuen, B. and A. Kumssa, A (eds.) (2011). Climate Change and Sustainable Urban Development in Africa and Asia. *Springer Science*. Dordrecht, Netherlands, 278 pp.

Lwasa S., Buyana, K., Kasaija. P., and Mutyaba, J. (2018). Scenarios for adaptation and mitigation in urban Africa under 1.5°C global warming. *Current Opin. Environ. Sustain*. 30 52–58.

ODI and CDKN. (2014). *The IPCC's Fifth Assessment Report*: what's in it for Africa?., https://cdkn.org/resource/highlightsafrica-ar5/?loclang=en_gb.

AUC. (2015). *Agenda 2063 popular version: The Africa we want*. African Union Commission. Addis Ababa, Ethiopia.

Welborn, L. (2018). *Africa and climate change*: Projecting vulnerability and adaptive capacity. Institute for Security Studies.

Group, A. D. B. (2020, September 17). *Gca africa*. *African Development Bank* - Building today, a better Africa tomorrow. https://www.afdb.org/en/events/gca-africa.

UNFCCC (2020, October 27). *Climate Change Is an Increasing Threat to Africa*. Retrieved from https://unfccc.int/news/climate-change-is-an-increasing-threat-to-africa.

IPCC. (2018*). Adaptation to Climate Change in the Context of Sustainable Development and Equity.* https://www.ipcc.ch/site/assets/uploads/2018/03/wg2TARchap18.pdf

UN-HABITAT (2006). *State of the World's cities 2006/2007: 30 years of shaping the habitat agenda*. Nairobi, Kenya. Retrieved from https://unhabitat.org/sites/default/files/download-manager-files/.pdf

Goodfellow, T. (2014): Rwanda's political settlement and the urban transition: expropriation, construction and taxation in Kigali. *Journal of Eastern African Studies*, DOI: 10.1080/17531055.2014.891714

Dodman, D., & Mitlin, D. (2011). CHALLENGES for Community-based ADAPTATION: Discovering the potential for transformation. *Journal of International Development*, *25*(5), 640–659. https://doi.org/10.1002/jid.1772

Page.J., Gutman.J., Madden.p., Ghandi.D. (2020). Urban economic growth in Africa: A framework for analyzing constraints to agglomeration. *African Growth Initiative at Brookings.* https://www.brookings.edu/wp-content/uploads/2020/09/20.09.28_urban_economic_growth_in_africa_FINAL.pdf

UNISDR. (March 2006). EWC III. Early warning-from concept to action: *The Conclusions of the Third International Conference on Early Warning*. Bonn, Germany. https://www.unisdr.org/2006/ppew/inforesources/ewc3_website/upload/downloads/Early_warning_complete2.pdf