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EFFECT OF COMMUNITY ENGAGEMENT AND AVERAGE MONTHLY RAINFALL ON ENVIRONMENT-RELATED DISASTER RISK REDUCTION; CASE OF UMUGANDA IN GASABO DISTRICT, RWANDA

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ABSTRACT

The purpose of this study was to assess the effect of community engagement and average monthly rainfall on environment-related disaster risk reduction, using the example of Umuganda, Gasabo District, Rwanda. Community engagement is measured by community participation rate and monetary value of community participation activities (Umuganda value). The stress and release model of hazard reduction theory was applied in this study, especially in relation to vulnerable (stressed) tenants. Case studies and descriptive studies were used in conducting the study. Data were collected through relevant secondary sources from relevant ministries and other reliable sources. 30-item dataset from 2017-2019 was used for data analysis for this study. Collected data were analyzed by SPSS for descriptive statistics, correlation, and regression. Additionally, the Arc-view GIS 10.2 Geographic Information System (GIS) was used to visualize the imagery, showing the spatial patterns and relationships of the data. Descriptive, correlation and regression analysis were performed and results tabulated before appropriate interpretation and discussion. The study results yielded an R-squared (R2) value of 0.456. This means that 45.6% of the variability in disaster effects can be explained by the three independent variables selected for this study. Multiple regression analysis further showed that community participation rate had a negative and significant effect on reducing the risk of environmental hazards in Gasabo District, Rwanda (β = -33.286, 0.004p). The monetary value of community engagement activities (Umuganda value) had a significant negative impact on reducing the risk of environmental hazards in Gasabo District, Rwanda (β = -2.566, 0.025p). Finally, the results of this study show that rainfall has a significant positive impact in reducing the risk of environmental hazards in Gasabo district, Rwanda (β = 39.274, 0.000p). Therefore, the study recommends the following measures: Relevant ministries, departments and agencies should focus on improving community engagement strategies to increase community participation in disaster risk reduction. Also encourage empowerment that increases the value of community engagement activities. To meet the challenges posed by seasonal rainfall, Rwanda's Gasabo District Management Office should take precautionary measures to reduce the risk of environmental disasters while ensuring emergency relief is in place. A detailed analysis should be carried out during a particular year and activities with clear results recorded for that year. They should then be carefully matched with qualified community members to be completed within a specified time period.

Key Words: community engagement, participation, vulnerability, environmental hazards, average monthly rainfall, environment-related disaster risk reduction, disaster risk

INTRODUCTION

Globally, risks for human activities are typically located in mountainous and hilly areas (Knapen et al., 2006). Land use and its influence on the surroundings is one of the issues that is increasingly being centred on in the context of ongoing global changes. Rapid population boom leading to the enlargement of human settlements and consequently rapid urbanization in developing countries plays a necessary function in world land use (Masek et al., 2000), which leads to adjustments in ecological procedures domestically and globally.

The reasons for failure are closely related to topography, climate, biology, hydrology and human factors. Land use and land cover change associated with human activities can alter hydrological strategies and increase the scope for failure, as seen in global discontent (Zhang et al., 2007). This situation is exacerbated by the consequences of climate change in the region, which increases disaster risk for community contributors as people and property are exposed to natural disasters.

According to the Global Risks Report via Whiting, K & Myers, J (2019), environmental threats pinnacle the listing of catastrophe dangers for the third consecutive year, each in terms of affect and probability. "Of all the risks, the most apparent are those associated to the environment, the world is sleepwalking closer to disaster," the file warns. Environmental troubles characterize three (by probability) and four (by impact) of the pinnacle 5 risks. After unheard of heatwaves, storms and flooding round the world in 2018, intense climate occasions topped the listing of most possibly risks, ranking 1/3 in terms of impact.

The report showed that the threat posed by local weather changes is inadequately addressed due to high greenhouse gas emissions. The lack of acceptance of applied science for mitigating and regulating local weather trade puts community individuals at risk of disaster and increases concern over environmental protection failures. This non-climate phenomenon is currently alarming, alarming, and accelerating biodiversity loss. over the last decade, especially in many parts of the world (Victoria, 2003). This is due to the growing focus on active roles replacing passive ones in building resilient communities. The role of community engagement before, during and after failure cannot be underestimated. Thus, high-quality disaster risk management involves reversing the global pattern of disasters and rising loss ratios, creating a culture of safe and resilient communities, and achieving lasting improvement for all. community involvement is essential to achieve this (Victoria, 2003).) (Ambuchi, 2011).

For years, top-down approaches have failed to meet immediate needs and failed to consider possible local resources and capabilities, thereby increasing people's vulnerability. Improve disaster response by strengthening preparedness and becoming familiar with early warning systems. According to a 2012 study conducted by the Japan International Cooperation Agency (JICA), Japanese authorities have been actively involved in implementing local adaptation and mitigation measures for weather exchange as part of their resource programs. rice field. Reliable development assistance (ODA) to growing countries. These types of efforts are recognized as secondary methods to local climate change. One of his approaches to the additional benefits of local weather trading is through extensive adaptation and mitigation. For example, mangrove planting/reforestation provides development benefits to communities by providing firewood and marine resources to improve their livelihoods. They offer additional climatic benefits as mitigation measures to increase CO2 sinks, limit greenhouse gases in the environment, and ultimately reduce the risk of sea level rise from global warming. (Gu et al., 2022; Korkietpitak, 2012). This measure can provide a myriad of solutions for sustainable development while combating climate change.

Through the Participatory Sustainable Forest Management Project in Como Province, Burkina Faso (2007-2012), the Government of Burkina Faso has implemented sustainable forest

management in the face of serious challenges. listen. To address these issues, JICA conducted a development study and proposed a design and methodology for a participatory forest management map overlaying selected forests in Como State. This is a technical cooperation mission that forms the basis of program implementation. JICA supports activities aimed at building the capacity of local communities and government institutions to improve the technical skills and livelihoods of local people (Wily, 2002).

Community involvement includes individual and community participation in choosing issues that affect lives. This includes open communication and working with people rather than for them. People often make meaningful contributions when they feel rewarded for their efforts (Tiwari et al., (2014), (Gilmore et al., 2020)). Mobey and Parker (2002) and others work to help organizations understand key success factors, systematically and quantitatively assess these necessary It shows that we need to anticipate negative effects and choose fantastic ones. Once projects are successful, adopt approaches to address them (Quick and Bryson, 2022; Reed et al. They are also interested in expanding the entire disaster management cycle. This has fundamentally increased the potential of affected communities to prepare for future dangers and respond accurately to emergencies at the household and community level. Community-based disaster management therefore requires the involvement of community members and the improvement of larger frameworks and structures for community ownership of disaster management technology (Sarabia et al., 2016., 2020).

The link between disaster risk reduction and development can be felt when communities are able to manage their vulnerable situations and their motivations, while working diligently with the external guidance and support provided by governments and other non-governmental organizations. It is important to involve community members, primarily the most vulnerable sectors and groups, in the overall methodology of risk assessment, identification of mitigation and preparedness, decision-making and implementation, as communities benefit directly.

Statement of the Problem

The idea of community involvement in community projects has gained momentum in the process of reducing the risk of environmental disasters. Recommended by contemporary development scholars because they believe that the expected outcome of any program can only be fully achieved if people meaningfully participate in it. Participation is achieved through substantial involvement of local community members in the selection, design, planning and implementation of programs, projects and programs that affect them, with more continuous and comprehensive feedback in development activities. (Haupt and Khan, 2006; Quick and Bryson, 2022; Reed et al., 2018). According to (Munyaneza, Nzeyimana and Wali, 2013), value can be gained or lost by taking risks arising from specific actions, activities and/or omissions (foreseeable or unforeseeable). Therefore, the strategic selection of appropriate risk mitigation strategies is important in determining how organizations can successfully manage the risks that affect them.

Lack of communication, coordination and participation between different levels of government – Regional, national, provincial and/or village risk assessment and capacity are a significant obstacle to reducing the risks of environmental disasters (Becker, 2012). Based on the research of Pfeiffer (2012), Becker recommends a more comprehensive approach that includes multiple administrative levels to collect capacity assessment information. Emphasizing the role of local government initiatives in reducing environmental risk, Becker recommends that micro-level leaders encourage public participation and active planning and ensure adequate local resource allocation and multi-stakeholder participation. stakeholders.

Public participation and community initiatives have been highlighted by a recent United Nations report which suggested that leadership and capacity at the local level can reduce the threat of

natural disasters and increase awareness, identification and disaster reduction. risks (UNISDR, 2012). Ineffective leadership, political pressures and lack of communication and coordination between the executive, emergency management organizations and other stakeholders in the sector can be major barriers to public engagement, leading to incomplete understanding of capacities and hindering a holistic and systemic approach to DRR (Becker, 2012 Kusumasari et al., 2010) (Haupt & Khan, 2006). Embracing public engagement as an enabler for building community resilience makes our literature review participatory.

Based on the latest report of the 2016 Rwandan Council Survey of Citizens' Perceptions of Umuganda Outcomes, Umuganda Impact Assessments 2007-2016, the Citizens Report Card reports on the attendance, the impact of the Umuganda program and general perceptions of the Umuganda program by Rwandans. citizen project. The survey showed that over 75% of respondents in four districts (Gisagara, Kirehe, Rulindo and Rutsiro) were satisfied with Umuganda's performance, while 19 districts, including Gasabo district, scored between 50% and 75%; The other 7 districts (Nyamagabe, Rusizi, Nyamasheke, Nyaruguru, Musanze and Gicumbi) achieved less than 50%.

This means that about 1/3 of the population did not like the results of Umuganda. Umuganda's MINALOC strategy document highlighted some of the challenges facing the program including poor mentality and reluctance to engage in manual labour (some believe that community work should be done by the disadvantaged, illiterate and unemployed); poor organization of community work; lack of action programs; they appreciate the decline of community work and the untapped potential of young people.

During the 2016 CRC survey, 78.6% of respondents agreed that it is better to diversify the activities of the Umuganda program according to the skills and needs of the participants/citizens, 68.9% said that not all not participate, 52.6% agreed that the Umuganda program should be changed to match current reality/norms, 39.1% thought the Umuganda program was good but had little effect, and 14% thought the Umuganda program was good but poorly organized (BAMUREBE, 2017; GRACE, 2017)).

Despite government efforts to strengthen communities through community participation in community projects, communities are not sufficiently engaged in such projects. For example, in Gasabo district in Rwanda, not all community members participate in the Umuganda program to discuss the projects they intend to participate in. During the many meetings the researcher attended as part of the project, he noticed that most of the participants in these meetings were older people. Most community members barely attend the meetings that officials call to discuss and implement such projects. Most participants do this to avoid being punished by local authorities.

Therefore, they have no obligation to implement the project. It was also noted that although the region had an action plan, members rarely adhered to it due to lack of project implementation skills, which in turn affected the quality of results. Due to the COVID 19 pandemic, the Rwandan government had suspended all Umuganda events across the country since February 2020. According to the MINEMA Disaster Impact Report 2020, disaster impacts have increased from 166 in 2019 to 453 in 2020. According to O'Neill, K et al. (2016), the Fargo, ND metro area is expected to collect millions of sands over 5 years. red region. River. Communities can successfully mitigate floods and avoid potentially catastrophic economic, physical and spiritual consequences. This clearly shows that community participation plays an important role in reducing the risk of environmental disaster. This study aimed to assess the effect of community engagement and average monthly rainfall in environmental disaster risk, using Umuganda, Gasabo District, Rwanda as a case study.

Objectives

The aim of the study was to assess the effect of community engagement and average monthly rainfall in environmental related disaster risks reduction, Case of Umuganda in Gasabo district, Rwanda

The specific objectives of the study were:

1. To analyze the extent to which community participation rates influences environmental-related disaster risks reduction in Gasabo district, Rwanda
2. To assess the extent to which monetary value of community engagement activities influences environmental-related disaster risks reduction in Gasabo district, Rwanda
3. To analyze rainfall-related disasters occurrence in Gasabo district, Rwanda

Conceptual framework

Burns and Burns (2012) define a conceptual framework as a set of interrelated ideas (theory) about how a particular phenomenon works or its parts. It is a diagram, flowchart or metaphorical illustration that explains the relationship between the identified factors and the variables relevant to the study (Oso & Onen, 2011; Burns et al., 2012)

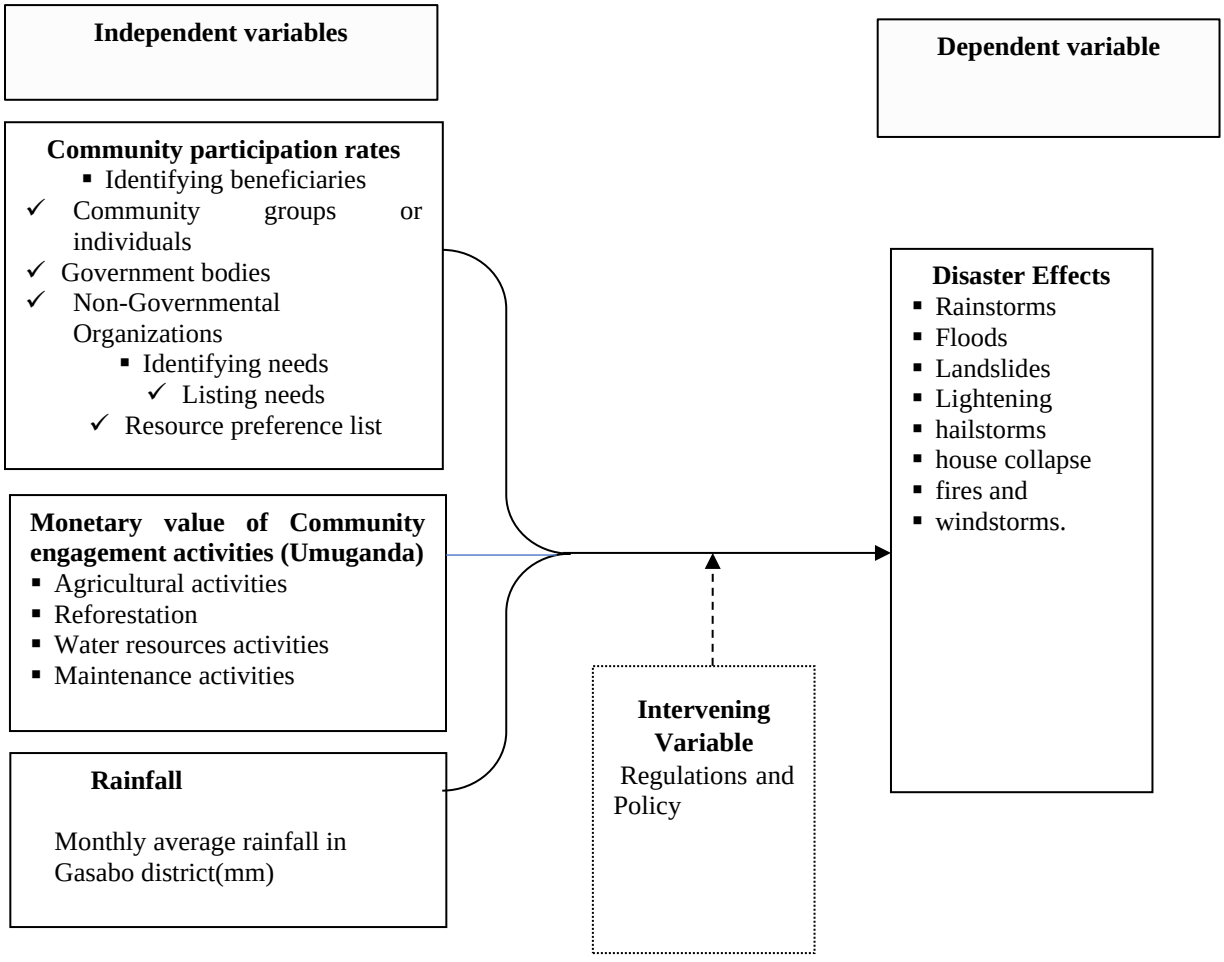


Figure 1: Conceptual framework

LITERATURE REVIEW

Theoretical Review of Community Engagement and Disaster Risk Reduction

The pressure and release model of risk reduction theory

Risk reduction theory and participation theory were merged into the participatory risk reduction conceptual model that was applied in this study. The stress-relaxation model of Blaieke et al. (1994) is an inversion of the deflationary model and shows how it proceeds to ensure safe conditions from underlying and dynamic causes through sustainable and managerial risk and mitigation interventions

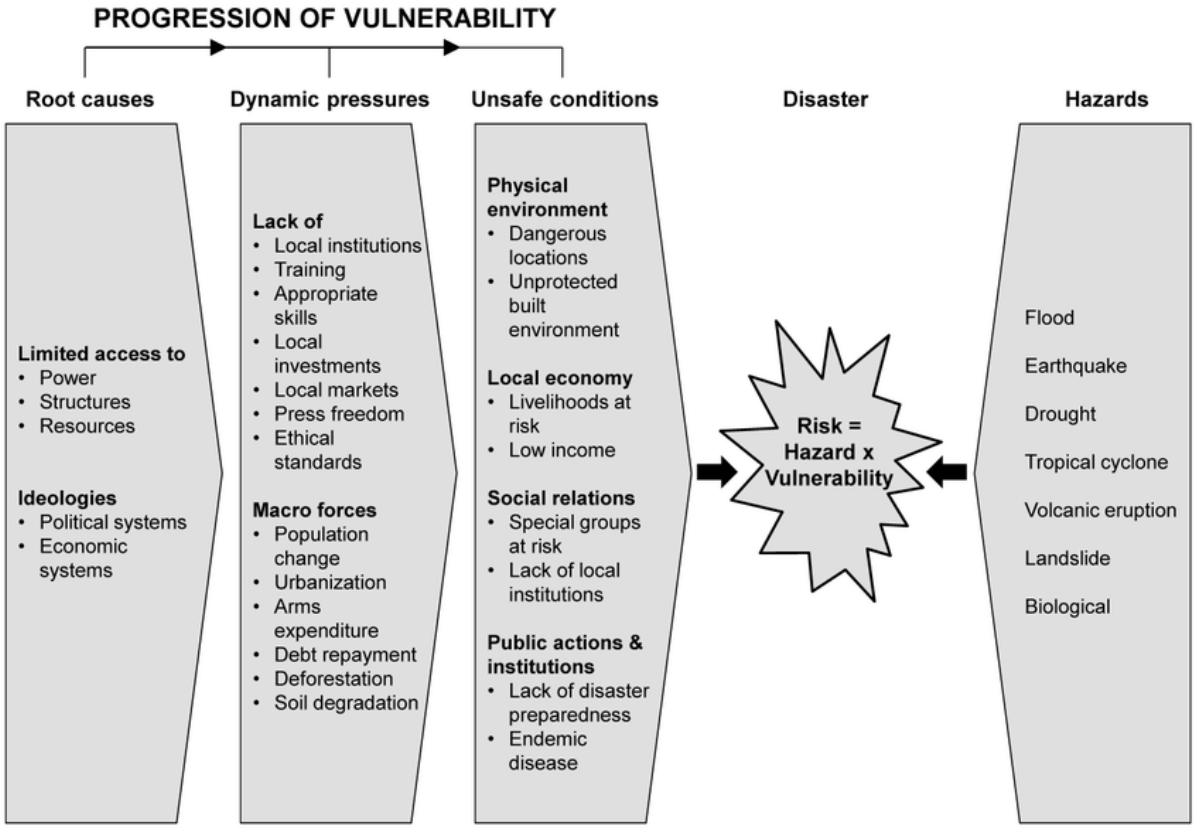


Figure 1**: Pressure and Release Model (**Blaieke, et al, 1994)

Participation theory (Arnstein, 1969) recognizes that levels of participation differ from best commitment. This leads to (Burns, et al.1994) Changing Arnstein's doctrine of participation to the doctrine of empowerment, citizens can effectively engage in different levels of participation to ensure the achievement of desired goals. It is clear from the model that community involvement plays an important role in identifying the root causes and reducing the negative impacts of dynamic stress and hazardous conditions, thereby acting as a buffer and reducing the vulnerability of members.

Community Engagement

The most effective strategy for community participation is community organization. Community-based risk reduction and disaster management initiatives have come to the fore (Carlisle, 2010; Lane and Tribe, 2010; Pasick et al., 2010) (Pandey, 2019). In the absence of evidence, the selection of recruitment methods and consultation procedures should be based on the purpose of the recruitment. Specifically, what kind of community participation is necessary, and for what

purpose? The lack of a comparison of engagement methods may indicate that adapting each technique to the community is more important than adopting best practices. In practice, the effectiveness of this approach may depend on the target group and health behaviors (Pasick et al., 2010). This review identified approaches to community engagement based on extensive field research (Jabbar and Abelson, 2011), principles of participatory engagement (Goldberg, 2011), and consultation (Carlisle, 2010). Based on these findings, recommendations were made for planning, designing, implementing, and evaluating community engagement programs in the context of ethnocultural engagement projects. Yacoob and Walker (2011) argue that community engagement also responds to traditional perceptions of the public's powerlessness to influence government decisions. Inadequate water and sanitation and lack of public funding for essential services (Peng et al., 2020; Quick and Bryson, 2022; Reed et al., 2018).

Monetary value of Community Engagement activities in Rwanda (Umuganda)

According to the impact evaluation of the Umuganda survey (2016), the value of MINALOC's combined Umuganda activities was Rwandan francs 106 billion or "US$127 million" between 2007 and 2016. Upon completion of community works, the monetary value monitoring committee evaluates the implementation using the Umuganda evaluation metric. These indicators include agricultural activity, reforestation, water resources activity and road maintenance. Umuganda has become a major contributor to infrastructure development, economic impact, environmental protection, governance impact and social protection programs.

In addition, Umuganda contributed to construction of houses for vulnerable groups, implementation of water supply projects, construction of new classrooms for 9 YBEs and 12 YBEs, health centres, of administrative offices, construction of genocide memorials and police stations, road maintenance, tree planting, radicalization of rice terraces and other soil erosion control infrastructure (Heidger , 2018; Rutikanga, 2019; Tsinda, Chenoweth and Abbott, 2020).

In terms of economic impact, the Umuganda campaign was valued at 106 billion Rwandan francs or "127 million dollars" between 2007 and 2016. This is a great advantage, since the resources that can now be paid for these activities are reallocated for further development. He further noted the benefits of good roads (93.3%), bridges to facilitate the transportation of people (56.5%), soil stabilization (52%) and increased agricultural productivity (7%), achieved reforestation (22.1%) (Uwihangana et al., 2020). Most of Umuganda's activities across the country are largely related to environmental protection. Typically, people are involved in cleaning streets, mowing grass, trimming shrubs along roads, planting trees and restoring public buildings (Uwimbabazi42, 2019)

Environmental Disasters

Environmental disasters have a significant negative impact on the ecosystem. Although these disasters are often short-lived, they can have lasting effects on the flora and fauna living in the devastated environments. There are things you don't have. In other cases, environmental damage can be limited and habitat restored (Masindi and Muedi, 2018). For years, humans have attempted to destructively manipulate the natural environment to meet essential economic needs.

This is done regardless of the risk of such infringement. This situation is exacerbated by rapid demographic changes and economic development, which can lead to ecological imbalances, especially in urban areas. These factors combine and lead to environmental degradation, increased risk and ultimately disaster. Such calamities can lead to other secondary calamities and increase misery in society. The influence of demographic, social and economic factors on nature cannot be ignored.

According to the World Health Organization, the impact of natural disasters on the global economy increased to $50 billion annually by the end of the 20th century (World Bank, 2016). The

intersection of rapid urbanization and natural disasters has occurred repeatedly in the past decade. Surrounded by mountains, bare and forested, Port-au-Prince has been hit by several earthquakes since the devastating 2010 earthquake that killed between 200,000 and 250,000 Haitians and caused an estimated $444 billion in damage between 8 and 14. . Devastating Floods Recently, devastating floods have occurred in Manila due to the lack of trees and soil to absorb the storm (Stewart, M.P., 2012).

Certain types of disasters also appear to be on the rise. Over the past 30 years, detection technology has become "reasonably comprehensive and consistent," with reports of major floods decreasing from less than 50 to less than 200 per year. The number of tropical storms increased from 10 to about 15. The annual number of global tornadoes and tsunamis in the United States has increased significantly.

The cost of financing increased rapidly. More and more people are suffering from what meteorologists call the "heat island effect," as experienced by the earthquake in Japan and Hurricane Katrina in the United States, said Gerhard Behrs, former head of GeoRisk at Munich Re. degrees Celsius above room temperature. This phenomenon tends to worsen storms. For example, 20 years of urbanization is enough to double the intensity of small storms in Houston, Texas and increase the risk of flooding. A similar dynamic occurred in China where Last month's flooding brought 16 to 18 inches of rain in some areas, killing 37 people and causing $1 in damage. Some Chinese researchers have attributed the intensity of this typhoon to the effects of urbanization (Nielsen-Gammon, Escobedo, Ott, Dedrick, & Van Fleet, 2020; WEI, 2017).

Environmental hazards are divided into two general categories. Some disasters are caused by natural weather and weather phenomena. These include fires, landslides, floods, earthquakes, droughts, tornadoes, tsunamis, and volcanic eruptions. Although human activity has nothing to do with the cause of these natural disasters, in some cases human activity amplifies the impact. For example, the 200 Indian Ocean tsunami devastated coral reefs and had the greatest impact on urban development. When healthy, coral reefs act as buffers and control the force of high waves (Athukorala and Resosudarmo, 2005).

Another type of environmental disaster is man-made disasters. Examples of man-made environmental disasters include oil and chemical spills and nuclear accidents. Moreover, war and terrorism can be a disaster for the ecosystem. In many cases, man-made environmental disasters have a more lasting impact on the environment than natural phenomena. After the 200 tsunamis, the United Nations began developing a tsunami warning system in the Indian Ocean to warn citizens of another large wave approaching the coast. Humans have long believed that their scientific ingenuity could defy the forces of nature. However, as the population grows and its demands on natural resources continue to deplete the country's resources, the number and intensity of environmental disasters will increase (Athukorala and Resosudarmo, 2005).

Role of rainfall in environmental-related disaster risks reduction

According to the Global Assessment Report on Climate Change Disaster Risk Reduction and Poverty Reduction [United Nations 2009, published on 17 May 2009], global exposure and vulnerability to climate conditions and the number of disasters continue to increase. It is mainly due to the following. The causes of unplanned settlement and the climate change environment are also starting to have an impact. Poor people, both as individuals and as nations, lose the most in disasters because they lack the knowledge, resources, skills, and social safety nets they need to protect their assets and livelihoods. Hellmuth M.E et al (2011) agree with the Global Assessment Report that climate-related disasters are the most common natural disasters that cause severe

human and economic losses. Their frequency and economic impact have steadily increased in recent decades, exceeding the capacity of governments and humanitarian organizations to respond.

Extreme events such as floods and droughts have become increasingly common in Rwanda over the past 30 years. Extreme rainfall changes in East Africa. Droughts and heavy rains have been frequent in the past 30-60 years. Floods and landslides are increasingly reported in the highlands of the western and northern states, while drought affects the eastern states.

Rwanda is a country prone to various weather-related diseases such as malaria, meningitis and cholera. Malaria affects a large part of the population and is the second leading cause of death (after AIDS), accounting for 23.27% of all deaths. In the future, malaria is expected to invade East Africa at high altitudes (above 2000 m) and increase the prevalence of malaria (Climate Change Knowledge Portal, 2021).

Empirical review

According to Goldemberg F. and Oswaldo, J. (2010) communities provide direct employment of members in completed geothermal projects. Significant benefits or payments to the community, costs for the acquisition of project land, response to inquiries, and the ability of others to the way we work together benefit the project. These community concerns and expectations require organizations to develop robust communication strategies when communicating with stakeholders. As Greenwood, M. (2007) explains, all stakeholders have different interests and expectations and should be treated as such.

Mwangi, E. (2011) explained that the focus of the community changes throughout the project as development progresses. For example, obtaining land permits during the exploration can be difficult. Negotiating land use and other agreements; identifying and resolving issues related to cultural heritage; Informing people about research activities and schedules. Effectiveness of the document and potential for future development. During project development, communities are involved in essential environmental, socio-economic, and cultural oversight or development, compliance with land-use obligations and other agreements, and consultation and participation.

Danny, D. (201) states that community stakeholder participation and interaction is an essential part of geothermal resource development and an integral part of all projects. Geothermal energy can ultimately serve the surrounding community members and work with communities and regulators to create programs that simplify the permitting process. According to Khatri S.S. (2009), long-term benefits include engaging community stakeholders in consensus building and project support, enabling faster and cheaper permitting processes, and making projects more environmentally friendly.

According to Gicheru CM (2012), community participation at all stages of project implementation should be prioritized to reduce environmental risks. The dissemination of information, the participation of community members in all stages of the implementation of water projects and the use of local knowledge in the implementation of water projects are important, because in this way more sustainable long-term projects are completed (Mwakila M.W, 2008).

According to the International Rescue Committee (2012), regional training centers should be established to strengthen community involvement and information on best practices and innovations should be documented. Community capacity should be built on the link between increasing participation in water resource management and increasing the functionality and ultimate sustainability of water facilities to ensure the sustainability of water facilities.

Strengthens regional education and uses regional education to promote community participation in the management of water conservation facilities. Steps and processes must be initiated to

institutionalize regional learning as a strategy to identify good practices, innovate and share knowledge (Baur P. and Woodhouse, 2009). It is also a way to raise awareness of advocacy issues and influence policy change at the national level.

RESEARCH METHODOLOGY

The study was conducted in the Gasabo region of Rwanda (see Figure 2). Gasabo district is located in the northeast of Kigali city. The district borders Kicukiro District, Nyarugenge District, Rwamagana District, Rulindo District and Gicumbi District. This study employed quantitative approaches with both descriptive and correlational designs. A descriptive design was chosen to determine how disaster impacts on the one hand and community engagement and Umuganda values on the other are related. A descriptive design was appropriate, as researchers are particularly interested in the nature of the phenomenon (Khan, 2008). Quantitative data were collected using secondary sources.

The population covered by this survey is the entire population of Gasabo District, Rwanda (529,561 people), as recorded in the Fourth Census, Houses and Apartments (2012). This corresponds to 6.8% of the population of Kigali City and 5% of the population of Rwanda. It is also composed of 51.7% male and 8.3% female. This study relied on secondary data that was collected from relevant offices in Gasabo district.

Community participation was measured by participation rates and value of community engagement activities. The unit of analysis for community participation rate was participation in community activities in the Gasabo district. At the end of the month, as members participated in various community engagement (Umuganda) activities, participation was measured and calculated as a percentage compared to the total number of community residents who were able to participate in these activities. The unit of analysis for monetary value of community participation activities was the value of activities performed during community participation. Values were measured by sector committees selected on the basis of defined criteria at the end of the month after activities in Rwandan francs. Daily rainfall data were collected by the Gasabo Meteorological Service (Rwanda) for the applicable period from July 2017 to December 2019. Rainfall was recorded in millimeters (mm) by local weather stations. Finally, the unit of analysis for disaster effects was the number of different effects that occurred in the Gasabo district recorded and accounted for by MIDMAR. The disaster outcomes considered in this study were storms, floods, landslides, lightning strikes, hail, house collapses, fires, and storms.

Statistical Software Package for the Social Sciences (SPSS) Version 26 was used as the analysis platform. Descriptive statistics was used to calculate measures of central tendency and variance, combined with the standard deviation of each variable. Inferential statistics relied on correlation and regression. Correlation was used to determine the degree of association between the studied variables, and regression determined the causal relationship between the variables. Linear Multiple regression determined the causal relationship between dependent and independent variables.

DATA ANALYSIS RESULTS AND FINDINGS

Community engagement in Gasabo district

This section presents the activities the community is usually engaged during Umuganda, community participation rates, and the monetary value of community engagement activities (Umuganda) in Gasabo district, Rwanda.

Community engagement activities (Umuganda)

The data was analyzed by reviewing the action plan for the upcoming year 2020-2021 for Gasabo district, Rwanda. The analysis was based on the plan since it provided more accurate information

after COVID 19. The table shows a tally of all the upcoming Umuganda activities on each of the 15 sectors in Gasabo district as per the Gasabo district Action plan 2020-21. The tallying as captured in Table 1 represents a summary of the number of activities planned for the whole fiscal year for each sector, in the Gasabo district.

Table 1: Gasabo Action Plan Activities Analysis 2020-2021

GASABO ACTION PLAN ACTIVITIES ANALYSIS 2020_2021																
PERIOD; July 2020 to June 2021																
Activities	Jabana	Kinyinya	Rutunga	Kimironko	Kacyiru	Gatsata	Bumbogo	Ndubaa	Kimihurura	Ndera	Gikomero	Remera	Rusororo	Gisozi	Jali	SUM	%
Cleaning activities/Waste collection	2	1	0	4	1	2	5	0	3	0	1	1	0	2	0	**22**	13.6
Construct/Maintanance of roads	2	1	6	7	5	1	13	2	4	2	2	1	1	5	2	**54**	33.3
Construct/Repair bridges	0	0	0	1	1	0	1	0	0	0	0	1	0	1	1	**6**	3.7
Construct schools	1	1	0	0	0	1	2	1	0	0	1	0	1	0	1	**9**	5.6
Police accommodation constructions	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	**1**	0.6
Office construction/Repairs	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	**2**	1.2
Build homes for vulnerables	1	0	6	0	0	1	6	1	0	1	1	0	0	0	0	**17**	10.5
Build animal houses for vulnerables	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	**2**	1.2
Plant trees	2	0	0	0	0	1	1	1	0	0	1	0	1	0	0	**7**	4.3
Prevent soil erosion	0	0	0	0	0	2	5	0	0	0	0	0	0	0	1	**8**	4.9
Maintain toilets	1	2	0	0	0	0	0	1	0	2	0	1	0	0	0	**7**	4.3
Kitchen gardens	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	**3**	1.9
Maintain water channels	0	1	5	1	1	0	1	0	5	0	0	2	0	2	0	**18**	11.1
Maintain Cemeteries	0	0	2	0	0	0	0	0	0	0	0	0	2	2	0	**6**	3.7
Total number of activities in each sector	**9**	**7**	**20**	**13**	**8**	**8**	**34**	**7**	**12**	**7**	**7**	**7**	**6**	**12**	**5**	**162**	
% activities contribution per sector	**5.6**	**4.3**	**12.3**	**8.0**	**4.9**	**4.9**	**21.0**	**4.3**	**7.4**	**4.3**	**4.3**	**4.3**	**3.7**	**7.4**	**3.1**		
Percentage contribution per sector	**1.3**	**6.2**	**2.2**	**40.9**	**22.0**	**0.5**	**8.4**	**2.0**	**1.1**	**2.1**	**4.6**	**2.5**	**0.8**	**1.1**	**4.3**		

Source: Gasabo district action plan, 2020-2021

Hence, Table 1 presents the community engagement activities, measured by level of prioritization, planned for the fiscal year 2020-2021 for Gasabo district, Rwanda. The table shows Cleaning/waste collection (13.6%), Construction/maintenance of roads (33.3%), building homes for the vulnerable (10.5), and maintaining water channels (11.1%) for the upcoming fiscal year 2020-21 have been given priorities compared to the rest of the activities. While environmental activities like Planting trees (4.3%) and preventing soil erosion (4.9%) have been given less priority. The table also indicates a variation of resource allocation per sector. Some sectors for example Bumbogo sector have 34 activities planned compared to Jali sector with 5 activities planned for the whole year.

Community participation rates (Umuganda)

This s presents a monthly analysis of the community participation rates, graphical representation and GIS visualization map in Gasabo district for the period July 2017-Dec 2019.

Table 2: Community participation rates in Gasabo district (July 2017-Dec 2019)

Period	Cycles (Six months)	Participation rates (Six months averages)
July 2017-Dec 2017	Cycle 1	89.68%
Jan 2018-June 2018	Cycle 2	90.53%
July 2018-Dec 2018	Cycle 3	93.06%
Jan 2019-June 2019	Cycle 4	91.20%
July 2019-Dec 2019	Cycle 5	90.60%

Source: Field Data (2022)

Table 2 shows the community participation rates for Gasabo district for a period of 30 months (July 2017-Dec 2019) which represented five cycles during the study period. The six months average shows that the community participation rates steadily increased from July 2017 until Dec 2018 then slowed down in the last two cycles. That is 89.68 (cycle 1), 90.53(cycle 2) and 93.06(Cycle 3) compared to 91.20(cycle 4) and 90.60(cycle 5). The data shows that cycle 3 (July -Dec 2018) was a peak period for community participation in various community engagement activities in Gasabo district.

Figure 1: Graphical representation of the Monthly community participation rates (%) in Gasabo district (July 2017-Dec 2019)

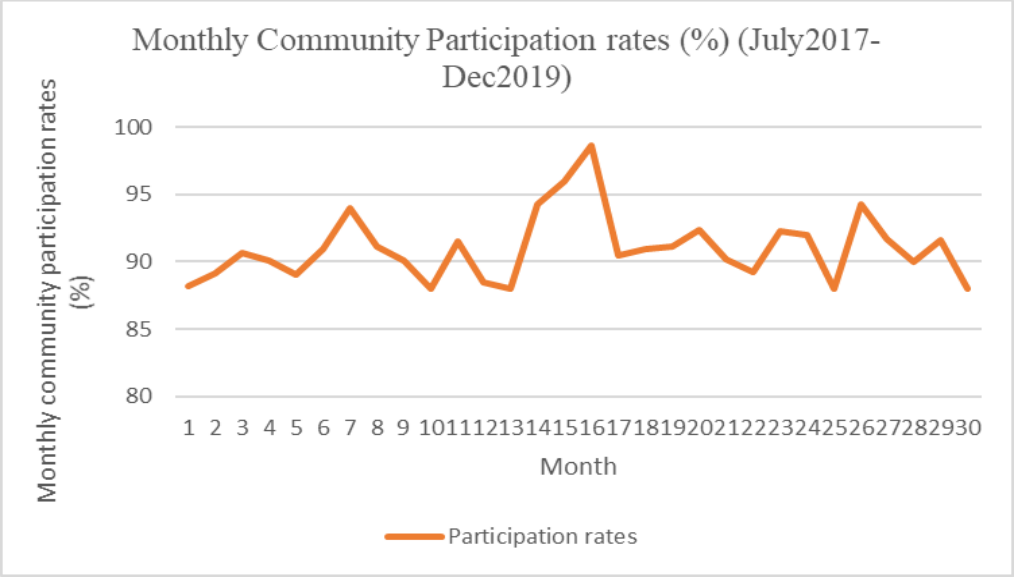
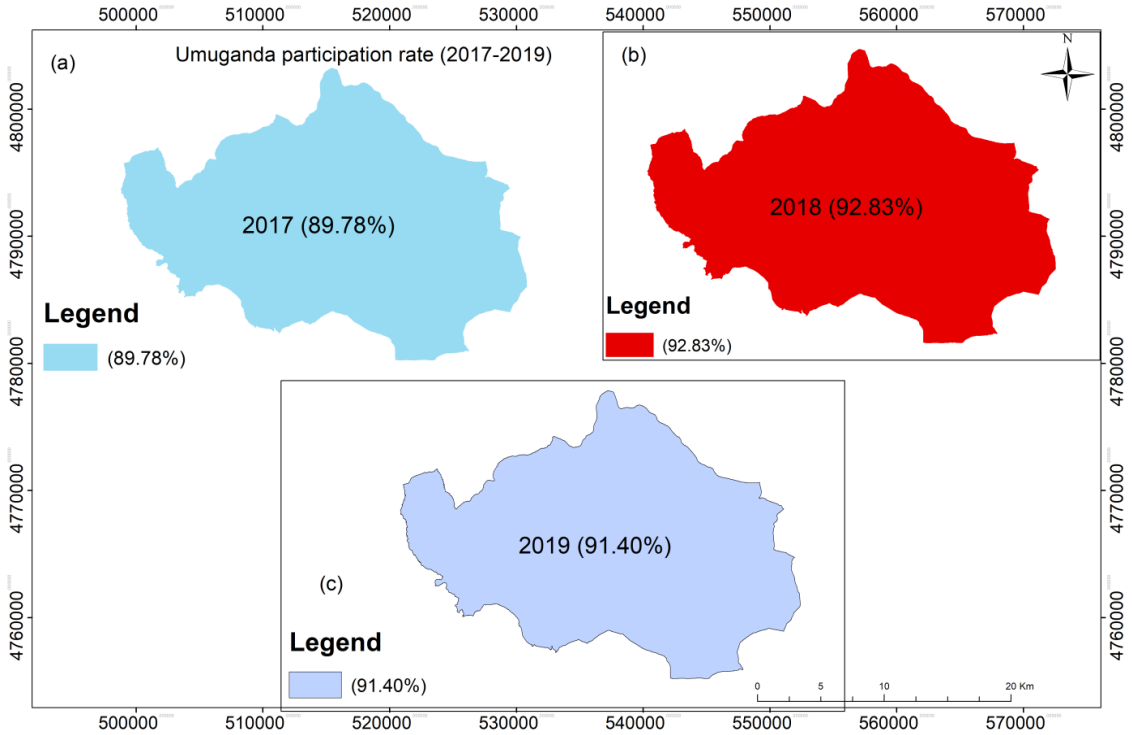


Figure 1 shows the graphical representation of community participation rates (%) in Gasabo district for the period July 2017-Dec 2019. The graph displays a cyclical nature of the community participation rates in Gasabo district. It is easily noticeable that a rise in participation rate in a particular month(s) is preceded by a decrease in community participation rates in the coming month(s). It can as well be observed from the graph that participation rate peaked around 14^{th}, 15^{th}, 16^{th} and 17^{th} months.

The yearly aggregate percentage participation rates may also be observed spatially as in the following GIS presentation. In fact, this is a spatial summary of the data capture given in figure 2.

Figure 2: GIS visualization for community participation rates in Gasabo district (July 2017-Dec 2019)



At a glance, the results in Figure 2 shows that the year 2018 recorded a higher community participation rate of 91.83 percent while 2017 registered the lowest percentage of 89.78 percent.

Monetary value of community engagement activities (Umuganda)

This section presents a monthly analysis of the monetary value of community engagement activities, a graphical representation and GIS visualization map for the monetary value of community engagement activities in Gasabo district for the period July 2017-Dec 2019.

Table 3: Monetary value of community engagement activities (Umuganda) in Gasabo district (July 2017-Dec 2019)

Period	Cycles (Six months)	Umuganda value % (Six months averages)
July 2017-Dec 2017	Cycle 1	17.80%
Jan 2018-June 2018	Cycle 2	21.76%
July 2018-Dec 2018	Cycle 3	21.39%
Jan 2019-June 2019	Cycle 4	16.30%
July 2019-Dec 2019	Cycle 5	22.75%

Source: Field Data (2022)

Table 3 shows the monetary value of community engagement activities (Umuganda Value) in Gasabo district for a period of 30 months (July 2017-Dec 2019) which represented five cycles during the study period. The six months average shows that the monetary value of community engagement activities (Umuganda) increased steadily from cycle 1 (17.80%), July-Dec 2017 to cycle 2(21.76), Jan-June 2018, then slowed down in cycle 3(21.39%), July-Dec 2018 and cycle

4(16.30%), Jan-June 2019 and rose to a peak in cycle 5 (22.75%), July-Dec 2019. The data shows that cycle 5 (July -Dec 2019) was the peak period for monetary value of community engagement activities (Umuganda) in Gasabo district.

Figure 3: Graphical representation of the monetary value of community engagement activities (Umuganda) in Gasabo district (July 2017-Dec 2019)

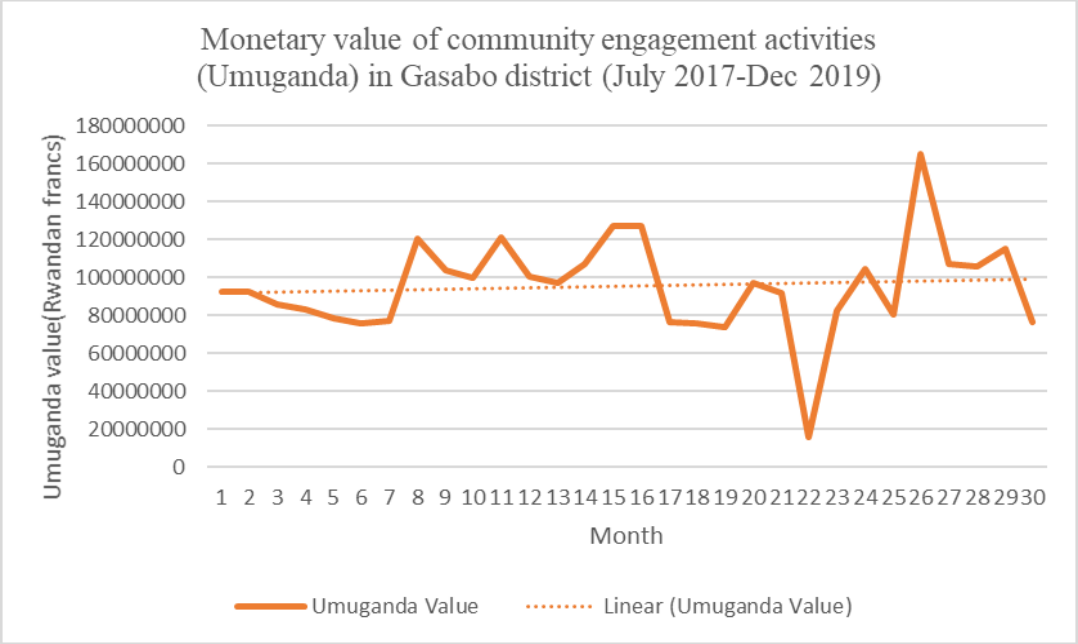
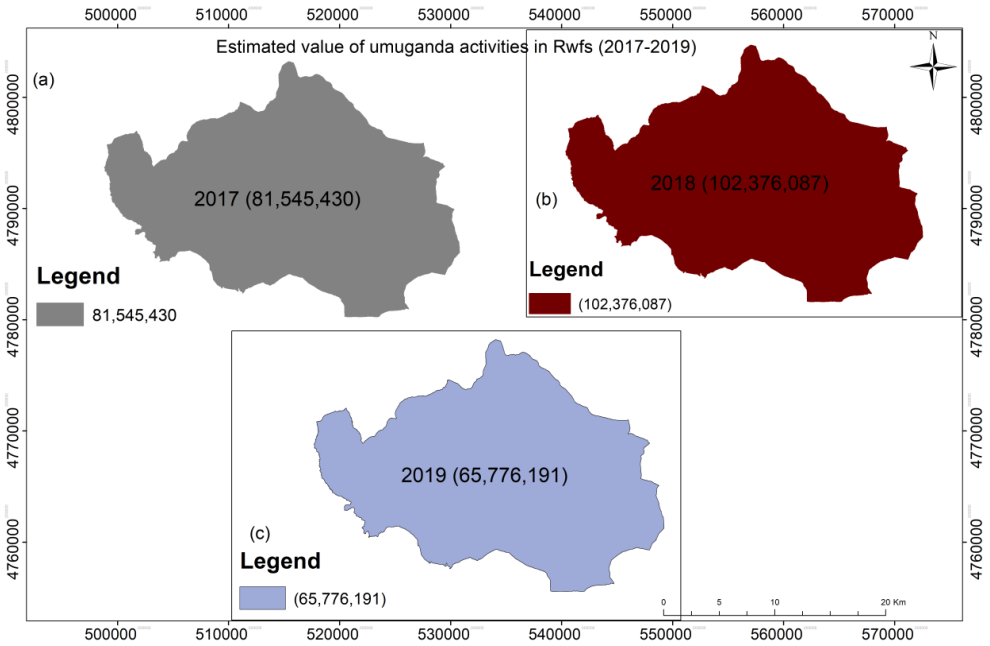


Figure 3 clearly shows that month 22 (April 2019) recorded the lowest monetary value of community engagement activities, while month 26(August 2019) recorded the highest monetary value of community engagement activities during the whole study period. It can also be observed from the Figure 4.4 that there was a steady rise in the monetary value of community engagement activities between April 2019 and August 2019. The monthly variations in the monetary value of community engagement activities were less in the first 16 months (July 2017-October 2018). After October 2018 there was a steady decrease in the monetary valuation of community engagement activities until April 2019. Again, the same downward trend is noticed in the last four months of the study (August -Dec 2019).

Figure 4: GIS visualization for Value of Community Engagement Activities in Gasabo district (July 2017-Dec 2019)



Once again at glance from the above GIS pictorials it can easily be seen that the value of activities in 2018 was higher (102,376,087 Rwfs) compared to other years (2017 and 2019) considered by this research. Moreover, the analysis in Figure 3 revealed that the value of the Umuganda activities corresponded with the participation rate (see Figure 1).

Environmental related disasters in Gasabo district

This section presents an analysis of the environmental related disasters, type of the recorded disaster per year, the total losses per year, graphical presentation, GIS visualization for environmental related disasters in Gasabo district. The total losses per year were calculated by determining the average after summing up the monthly disasters in Gasabo district.

Table 4: Environmental related disasters effects in Gasabo district (July 2017-Dec 2019)

Period	Cycles (Six months)	Disaster Effects (Six-month totals)	Disaster Effects (Yearly totals)
July 2017-Dec 2017	Cycle 1	128	128
Jan 2018-June 2018	Cycle 2	921	
July 2018-Dec 2018	Cycle 3	65	986
Jan 2019-June 2019	Cycle 4	85	
July 2019-Dec 2019	Cycle 5	137	222

Source: Field Data (2022)

Table 4 shows the environmental related disaster effects in Gasabo district for a period of 30 months (July 2017-Dec 2019) which represented five cycles during the study period. The six months average shows that cycle 2(Jan-June 2018) registered the highest counts of disaster effects in Gasabo district (921). Cycle 3 (July-Dec 2018) registered the list number of disaster effects (65). The year 2018 registered the highest number of disaster effects (986) compared to 222 disaster effects in 2019 and 128 disaster effects 2017. It is important to note that the month of April 2018

registered the highest disasters of 851 which accounted for 63.7% of all the disaster effects that were considered during the study period (July 2017-Dec 2019).

Figure 5: Graphical representation of the disaster effects in Gasabo district (July 2017-Dec 2019)

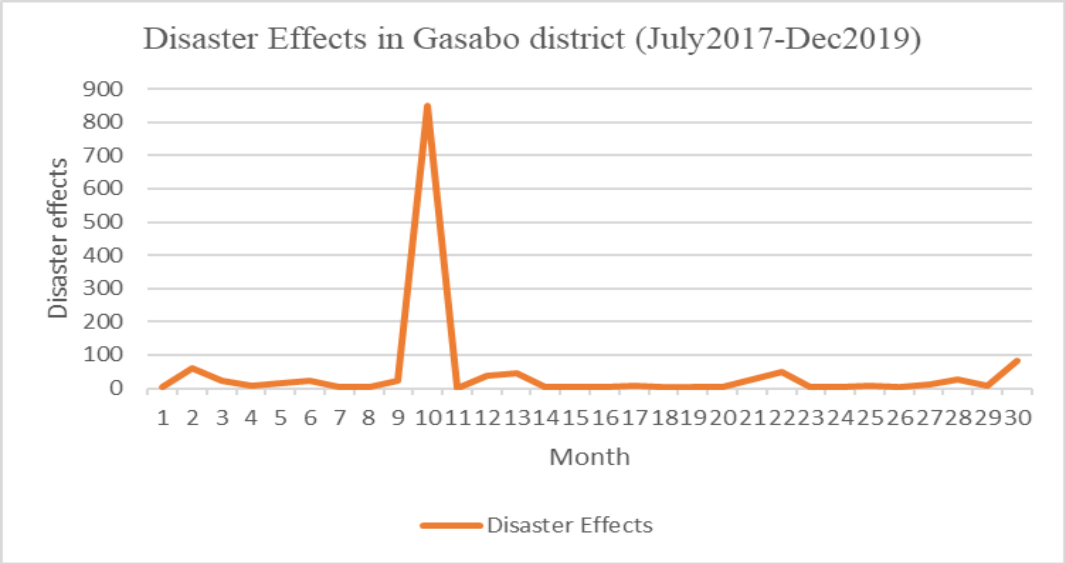


Figure 5 shows that the district experienced disaster effects of not more than 100 counts in any particular month during the study period apart from April 2018 when it was the highest (851). 17 out of the 30 months during the study experienced counts below 10 disasters effects in in any particular month. The disaster effects also show a cyclical nature of occurrences. March, April, September and October 2017, 2018 and 2019 experienced higher peaks of disasters compared to the other months of the year.

Distribution of annual rainfall (mm) in Gasabo district

This section presents the average monthly rainfall, graphical representation and GIS visualization for Spatial distribution of annual rainfall (mm) in Gasabo district.

Table 4.5: Distribution of annual rainfall (mm) in Gasabo district July 2017_Dec 2019

Period	Cycles (Six months)	Rainfall (Six months totals) (mm)	Rainfall (Six months averages) (mm)
July 2017-Dec 2017	Cycle 1	**15.56**	**2.26**
Jan 2018-June 2018	Cycle 2	**16.45**	**2.74**
July 2018-Dec 2018	Cycle 3	**16.65**	**2.76**
Jan 2019-June 2019	Cycle 4	**19.88**	**3.31**
July 2019-Dec 2019	Cycle 5	**11.31**	**1.89**

Table 4.8 shows the spatial distribution of annual rainfall (mm) in Gasabo district for a period of 30 months (July 2017-Dec 2019) which represented five cycles during the study period. The six months average shows a steady increase in the amount of rainfall from cycle one to four; cycle 1 (July-Dec 2017), 2.26 mm, cycle 2(Jan-June 2018), 2.74 mm, cycle 3 (July-Dec 2018), 2.76 mm and cycle 4 (Jan-June 2019), 3. The last cycle of 2019 recorded the lowest six months average of 1.89mm. The data shows that cycle 4 (Jan-June 2019) recorded a peak amount of rainfall during

the study (3.31mm). The year 2018 registered the highest amount of rainfall (33.1mm) compared to 2019 (31.19mm).

Figure 4.6: Average monthly rainfall (mm) in Gasabo district (July 2017-Dec 2019)

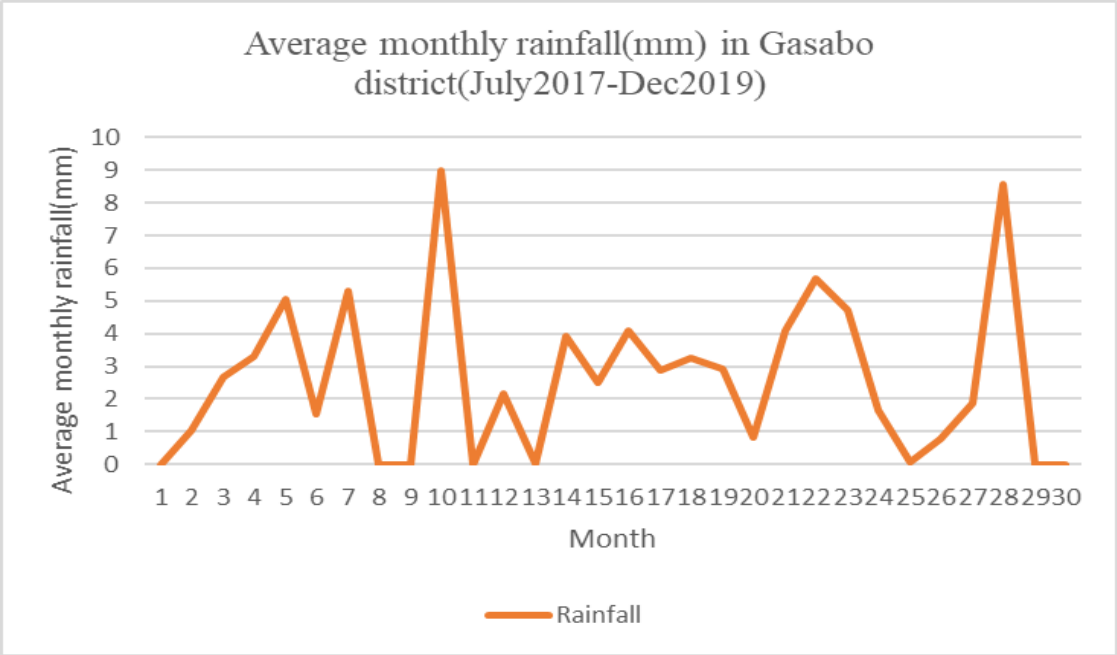
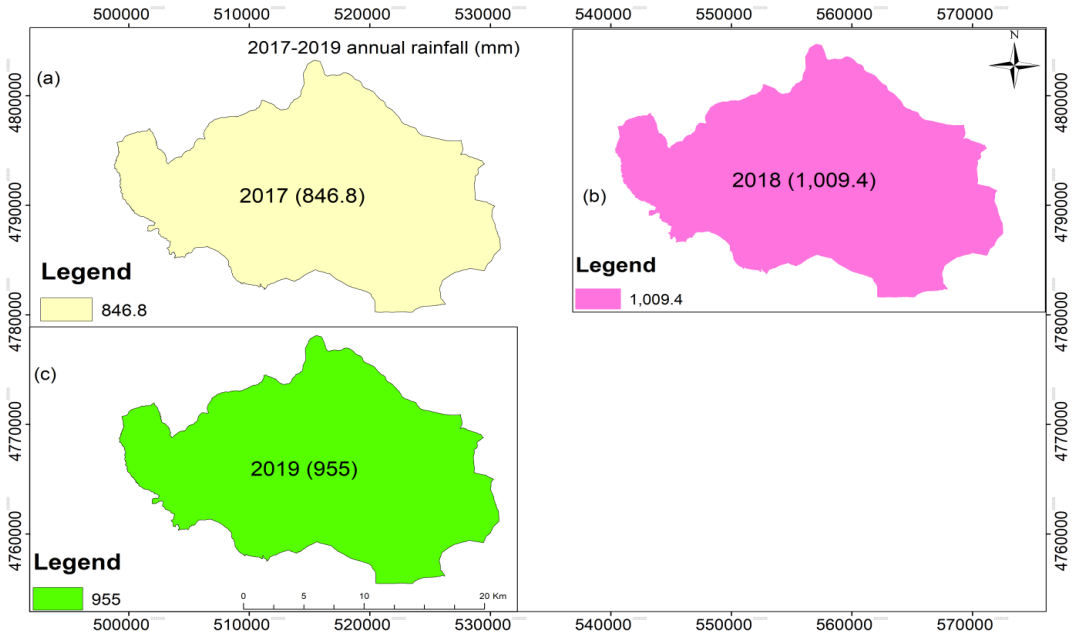


Figure 4.7 shows the cyclical nature of rainfall in Gasabo district for the period July 2017 to Dec 2019. Gasabo district received the highest amount of rainfall during the 10th month (April 2018) of 8.99 mm and 28th month (October 2019) of 8.58 mm. Also, the graph shows an increase of rainfall received in a particular month is preceded by a decrease in the following month. It is also notable that during the 30 months study period, six months had zero rainfall recorded; 2017(July), 2018 (February, March, May) and 2019 (November and December). Lastly the amount of rainfall received in Gasabo district ranged between 0-8.99 mm.

Figure 4.7: GIS visualization for special distribution of annual rainfall (mm) in Gasabo district (July 2017-Dec 2019)



The GIS results in Figure 4 shows that, aggregately for Gasabo District, in 2018, high rainfall was recorded at 1,009.4 mm, and 2017 registered low annual rainfall of 846.8 mm.

Based on the results of this research, it can be noted that the year 2018 recorded a high number of rainfalls which likely caused disaster occurrence and their associated losses to increase. However, the results in Figures 4.3 (Participation rate) and Figure 4.5(Umuganda Value) indicated that the same year (2018) recorded a high participation rate and Umuganda value, which would ordinarily have contributed to a reduction disaster occurrence, and hence a reduction of losses as well. Perhaps a different picture would have emerged if the periods used had been shorter than one year for cycle.

Correlation Analysis

To determine the degree and direction of link between each predictor variable and the response variable, correlation analysis was carried out. The correlation findings in Table 4.11 display correlation nature between the research variables in relation to magnitude and direction.

Table 7: Correlation Analysis

		Disaster effects	Community engagement (%)	Umuganda Value (Rwf)
Pearson Correlation	Disaster effects	1.000	-.294	-.016
	Community participation rates (%)	-.294	1.000	.493
	Umuganda Value (Rwf)	-.116	.493	1.000
Sig. (1-tailed)	Disaster effects	.	.047	.049
	Community participation rates (%)	.047	.	.003
	Umuganda Value (Rwf)	.049	.003	.
N	Disaster effects	30	30	30
	Community participation rates (%)	30	30	30
	Umuganda Value (Rwf)	30	30	30

The findings in Table 7 shows that community participation rates and disaster effects have a weak negative and significant relationship ($r = –0.294$, $p = 0.047$) at 5% significance level. The

relationship between the monetary value of community engagement activities (Umuganda) and disaster effects is also seen to be a weak negative significant relationship ($r = -0.116, p = 0.049$) at 5% significance level. The monetary value of community engagement activities and community engagement have a moderate positive relationship ($r = 0.493, p = 0.003$) at 5% significance level. These findings suggest that all the independent variables [(Community participation rate, The monetary value of community engagement activities (Umuganda value)] have a relationship with environmental related disaster risks reduction in Gasabo district, Rwanda.

Regression Analysis

Regression analysis is used to determine the influence of the independent variable and the dependent variable. The study computed multiple regression analysis to test the study hypothesis. For $p < 0.05$, H_0 will be rejected; and H_1 accepted.

Table 8: Model Summary for Rainfall, Community participation rates, Monetary value of community engagement activities (Umuganda value) and Disaster effects

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.478[a]	.229	.201	137.317	
2	.580[b]	.337	.288	129.671	
3	.675[c]	.456	.393	119.691	1.749

a. Predictors: (Constant), Rainfall(mm)
b. Predictors: (Constant), Rainfall(mm), Community participation rates (%)
c. Predictors: (Constant), Rainfall(mm), Community participation rates (%), Umuganda Value (Rwf)
d. Dependent Variable: Disaster effects

Source: Research Findings (2022)

Adjusted R^2 shows the variation in the dependent variable due to changes in the independent variable. Table 8 shows that adjusted R squared for our model (3) was 0.393; this is an indication that at 95% confidence interval, up to 39.3% of variability in environmental related disaster risks reduction in Gasabo district in Rwanda can be explained by the variability in the explanatory variables. This implies that 60.7% of the environmental related disaster risks reduction in Gasabo district, Rwanda is accounted for by other factors not considered in the model. The findings also show that the d-value was 1.749; since the value is sufficiently close to $d = 2$, then we conclude that there is insignificant autocorrelation in the explanatory variables, and therefore considered alongside other diagnostic tests as given in this document, regression analysis computed is reliable.

Table 9: Analysis of Variance for Rainfall, Community participation rates, Monetary value of community engagement activities (Umuganda value) and Disaster effects

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	156439.139	1	156439.139	8.297	.008[b]
	Residual	527968.327	28	18856.012		
	Total	684407.467	29			
2	Regression	230411.972	2	115205.986	6.852	.004[c]
	Residual	453995.495	27	16814.648		
	Total	684407.467	29			
3	Regression	311933.056	3	103977.685	7.258	.001[d]
	Residual	372474.410	26	14325.939		
	Total	684407.467	29			

a. Dependent Variable: Disaster effects
b. Predictors: (Constant), Rainfall(mm)

c. Predictors: (Constant), Rainfall(mm), Community participation rates (%)
d. Predictors: (Constant), Rainfall(mm), Community participation rates (%), Umuganda Value (Rwf)

The data had a 0.001 significance level, according to ANOVA results as captured in Table 9. This suggests that the model is the best choice for drawing conclusions about the variables.
The F calculated value was greater than the critical value (7.258> 1.697), an indication that community engagement significantly influences environmental related disaster risks reduction in Gasabo district, Rwanda. And with $p = 0.001 < 0.05$ it indicates that the model was significant.

Table 4.6: Regression Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2727.747	893.135		3.054	.005
	Community participation rates (%)	-33.286	10.420	-.548	-3.194	.004
	Umuganda Value (Rwf)	-2.566	1.240	.024	-.385	.025

Source: Research Findings (2022)

From Table 10, the regression model becomes:

$$Y = 2727.747 - 33.286X_1 - 2.566X_2 + 39.274X_3$$

Where:

Y – Disaster effects; X_1 – Participation rates; X_2 – Umuganda value;

Conclusions

The first objective of the study was to analyze the extent to which community participation rates influences environmental-related disaster risks reduction in Gasabo district, Rwanda. The study found that community participation rates is statistically significant in explaining environmental related disaster risks. This indicates that community participation negatively and significantly relates with environmental-related disaster risks reduction in Gasabo district, Rwanda. The findings also suggest that an increase in environmental related disaster risks leads to a decrease in community participation rates in Gasabo district, Rwanda. Realistically, the result should be a direct proportional relationship. That is, as environmental related disaster risks increase there should an increase in the community participation rates. This is a clear indication that though based on the findings, community participation rates influence environmental related disaster risks reduction in Gasabo district, Rwanda it represents a leverage point to the community. The governance office should examine why with increase in disaster effects the community participation does not increase proportionately.

The second objective of the study was to assess the extent to which the monetary value of community engagement activities (Umuganda) influences environmental-related disaster risks reduction in Gasabo district, Rwanda. This indicates that the monetary value of community engagement activities (Umuganda) negatively and significantly relates with environmental-related disaster risks reduction in Gasabo district, Rwanda. The findings also suggest that an increase in

environmental related disaster risks leads to a decrease in the monetary value of community engagement activities (Umuganda) in Gasabo district, Rwanda. Ideally, the result should be a direct proportional relationship. That is, as environmental related disaster risks increase there should an increase the monetary value of community engagement activities (Umuganda). This is a clear indication that though based on the findings, the monetary value of community engagement activities (Umuganda) influences environmental related disaster risks reduction in Gasabo district, Rwanda it represents an opportunity point to the community. The governance office should examine why with increase in disaster effects the monetary value of community engagement activities (Umuganda) does not increase proportionately. It is important to note that the relationship between the monetary value of community engagement activities (Umuganda) and community participation rates is positive and statistically significant. It presents a true picture of what should be happening in the community. It implies that community participation rates directly influence the monetary value of community engagement activities.

The third objective was to explore the effect of rainfall on environmental-related disaster risks reduction in Gasabo district, Rwanda. The study found that rainfall is statistically significant in explaining environmental related disaster risks reduction. The study also found that rainfall positively and significantly relates with environmental related disaster risks reduction. This implied that a unit increase in rainfall would lead to an increase in environmental-related disaster risks reduction in Gasabo district, Rwanda. Therefore, based on the findings, the study concludes that rainfall significantly influences environmental-related disaster risks reduction in Gasabo district, Rwanda.

Recommendations

Community participation rates

From the study, it was found that community participation rates have a weak negative relationship with disaster effects, which represents an opportunity for the administrative authority. Ideally the higher the community participation rates the more the community engages environmental disaster risk reduction efforts. The study therefore recommends that concerned government departments, ministries and relevant agencies focus on improving mobilization strategies within communities to increase the level or participation of community members in disaster risk reduction efforts.

Part of the strategy to improve the level of participation in the community may be to require that every family be unconditionally represented during engagement activities. Penalties should be higher to discourage members from paying dues and be exempted from participating in planned engagement activities. Community members can also be organized in terms of skills depending on the specific activities taking place to avoid redundancy during activities. The plan should also incorporate a clear strategy for mitigating the various effects of disasters to avoid reactive activities, because the more changes in the plan, the more difficult it is for members to consistently know and plan their time effectively.

Monetary value of community engagement activities (Umuganda)

The monetary value of community engagement activities (Umuganda) was also found to have a weak negative relationship with disaster effects, which represents another opportunity for the relevant government department, ministries and other agencies in Gasabo District, Rwanda. Ideally, the more environmental disaster risk reduction efforts are made, the more monetary value community engagement (Umuganda) activities should generate. But in this study, monetary value had a negative relationship with risks related to environmental disasters. It is important to note that this study found that the level of community participation had a positive relationship with the monetary value of community engagement activities (Umuganda). This means that an

improvement in the level of community involvement ideally leads to an improvement in the monetary value of community involvement activities (Umuganda). The study revealed that one of the biggest challenges was to effectively measure community engagement activities (Umuganda).

This could be solved by creating extended criteria for measuring each activity that are environmental disaster related. However, for the criteria to work effectively, a clear procedure must be established from the district to the sector as to how the process will be carried out. This can be achieved by empowering all community members with measurement skills and also designating an officer from the sector office to be present during the activities to assist community members with accurate measurements using a specific criterion. The government can also create an incentive structure for the community throughout the year, i.e., reward dedicated community members, allocate more resources to communities that have demonstrated better value creation in their activities, among other things.

It should be noted that unless we measure financial value, we will continue to make decisions at the expense of our social, environmental and personal well-being. To measure progress, we need to measure financial value and social value. Without both, we can increase one at the expense of the other. Just like longitude is latitude, we need social value and financial value to know we're on the right track. There is more focus on the value of output activities in the current criteria for measuring community engagement activities (Umuganda). Community effort and time should be factored into the criteria, which form a large part of the community's motivation to participate in community activities (Umuganda).

Rainfall

In order to deal with the problem of seasonal rainfall, it is recommended that the administration in Gasabo District, Rwanda should focus not only on emergency response measures but also on preventive measures aimed at reducing the risks of environmental disasters. A detailed analysis should be done during a particular year and activities with clear results should be recorded for that year. They should then be carefully matched with qualified community members to be completed within a specified time period. Reactive responses to disasters lead to further exposure of communities when the same disasters recur.

Suggestions for Further Studies

The study recommends that a consideration be made to substantively include an investigation of the effect of government legislative policy framework on the environment-related disaster risk reduction efforts. In addition, the same study could be undertaken, assessing the same effects against a narrower band of time, instead of monthly cycles over such a long duration of time. Finally, perhaps more variables could be added and their direct interaction on disaster effects be checked through a non-linear regression process. This study can be replicated in other community engagement projects.

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