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Impact of Climate Change on Public Health in Rwanda

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Abstract

Rwanda is a small Central African country. A land with thousands of hills and mountains. It is a low-income country and one of Africa's fastest-growing economies. It is home to a variety of ecosystems, such as mountainous rainforests, gallery forests, savanna woodlands, wetlands, aquatic forests, and agroecosystems. From rising temperatures to changing rainfall patterns, the hidden dangers of climate change are unmasking themselves in the form of various health risks. Every year, many deaths, bodily injuries, and house collapses, among other repercussions, are documented as detrimental effects of climate change events on public health. This article delves into the intricate relationship between climate change and public health in Rwanda, exploring the adverse effects it has on vulnerable communities. By shedding light on this pressing issue, we can better understand the urgency of taking action to mitigate the impact of climate change on public health as well as potential solutions to the current predicament. The authors researched several literatures to develop their perspectives on the subject and explored potential solutions to protect the well-being of Rwandans in the face of this global crisis.

Introduction

The term "climate change" is a shift from weather conditions to extreme weather events. [1] and it is brought on by the release of greenhouse gases into the atmosphere as a result of utilising fossil fuels, deforestation, and other natural human-made activities. [2], [3] Climate change can produce a variety of catastrophic events such as landslides, floods, earthquakes, heat waves,

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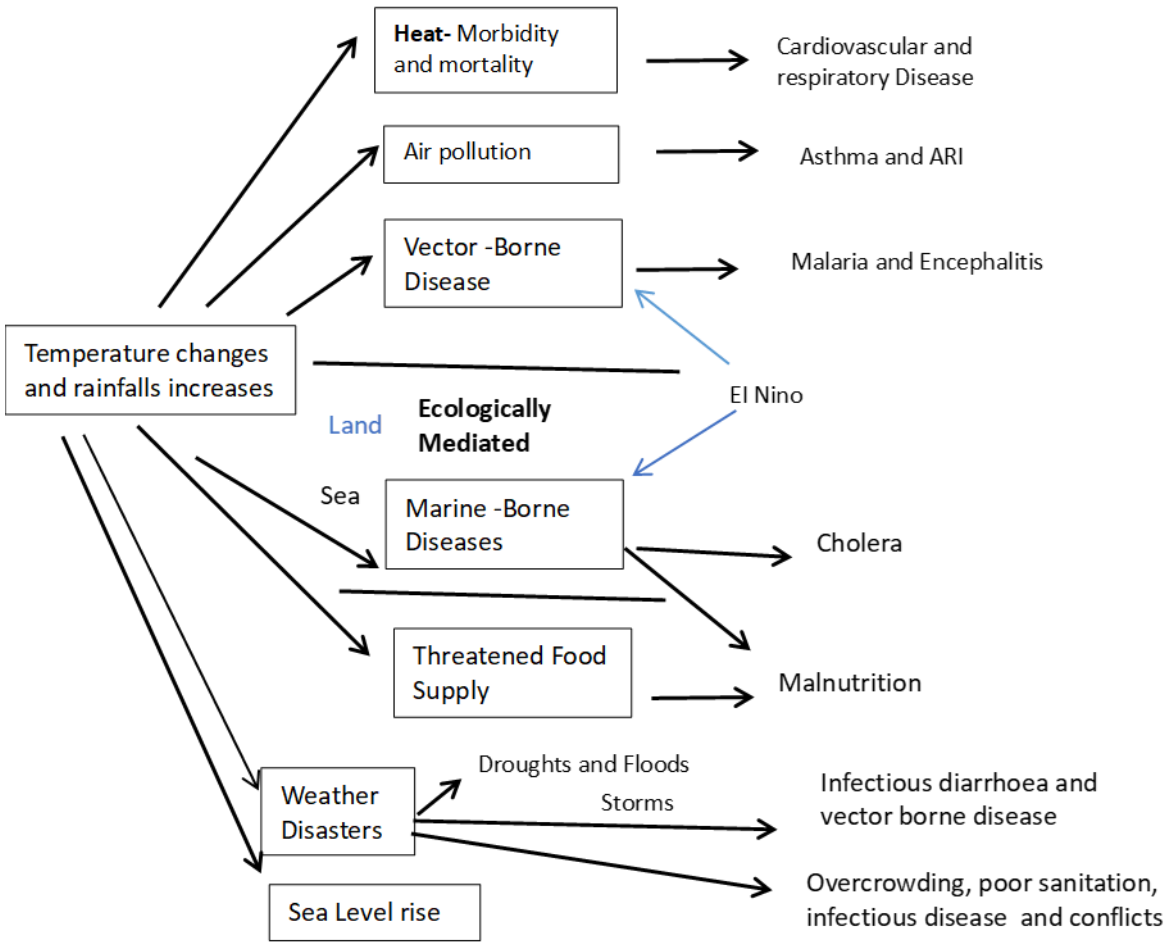
rainstorms, and wildfires, all of which have caused significant effects on human health. Those negative effects can contribute to incidence of new cases of diseases, infections, and epidemics [4] and are anticipated to cause physical injuries, infectious diseases, water- related conditions, and mental health problems. Climate change remain a worldwide important issues which is a major concern to human health threat [5], for example, Ballester et al. (2023) founds that in summer 2022, more than 61000 people died across the Europe countries due to searing heat [6].

In Africa, excessive weather events have harmed approximately 19 million individuals and killed 4,000 people since 2022 [7]. Additionally, evidences recorded 134 droughts since 2000 to 2019, with the majority of them 70 occurred in East Africa [7]. Moreover, droughts and famine killed 2.500 people in Uganda and affected 8 million people in Ethiopia [7].

According to world health organization, between 2030 and 2050, climate change is expected to cause approximately 250 000 additional deaths per year [8]. The shifts in temperature and rainfall that characterize climate change impose health consequences, especially on the vulnerable population [2]. Climate change is not just a distant threat; its impact on our health is becoming increasingly evident.

The figure presented above illustrates the intricate relationships between the various pathways of climate change and the consequent impacts on public health, particularly in relation to specific diseases that can affect the broader population. One of the primary causative agents of climate change is the

Causative mechanisms of climate change effects on public health



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alteration in temperature and precipitation patterns, leading to a cascade of effects including extreme weather events, heightened sea levels, increased morbidity and mortality from heat-related conditions, amplified air pollution, the proliferation of vector-borne diseases, the degradation of marine ecosystems, and the destabilization of food supply chains.

While the general population's health is imperilled by a range of ailments stemming from climate fluctuations, some notable examples include an elevated risk of cardiovascular and respiratory disorders, heightened susceptibility to infectious diseases like Malaria and Cholera, malnutrition, and an increased incidence of diseases that are communicable or noncommunicable.

Impacts of climate change on malaria vector control in Africa

Numerous studies have demonstrated that malaria transmission is highly sensitive to climate (e.g. [10], [11], [12], [13], [14]). This dependency arises because the survival, reproduction and behaviour of the major African malaria vectors (Anopheles arabiensis, An. coluzzii, An. gambiae and An. funestus) are highly sensitive to environmental conditions such temperature, humidity and rainfall [15], [16]. Also, malaria parasite development within vectors is temperature dependent [17]. Notably, temperature influences almost all mosquito life-history [18], [19] and demographic processes [20]. The sporogonic success (development of infectious stages) of malaria parasites within vectors is also temperature

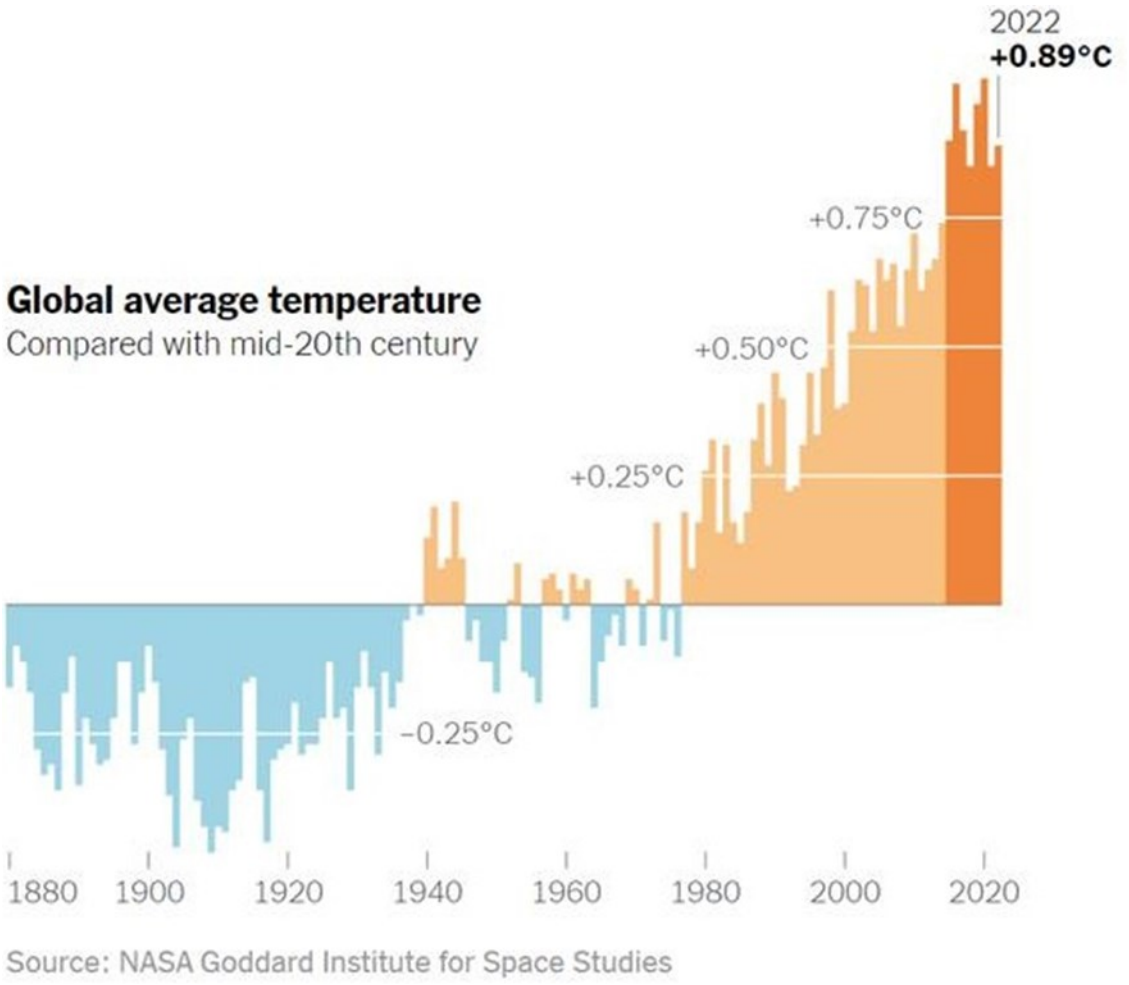

Figure 1. Impact of climate change on public health in Rwanda

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dependent; with the length of the extrinsic incubation period decreasing with temperature up to a maximum threshold beyond which sporogony fails [21], [22]. The environmental dependencies of these key mosquito vector and parasite processes make malaria transmission highly likely to change with climate.

While the potential impacts of climate change on malaria have received much attention [23], there is another crucial question that has been largely overlooked: how effective will malaria vector control and elimination strategies be under modified climates? Here we hypothesize that the efficacy and ability to implement core vector control interventions for malaria could be significantly reduced by climate change due to direct and indirect impacts on mosquito vectors and interventions. If confirmed, such climate-mediated impacts could slow or even reverse progress towards malaria elimination even as the geographical area suitable for transmission in Africa may fall.

Predicted impacts of climate change are more variable across the East African region. Specifically, predictions of the magnitude and direction of climate impacts vary somewhat between different Global Circulation Models and Representative Concentration Pathways scenarios. Many East African countries are already classified as 'water stressed', and are expected to become increasingly so as climate changes. For example, per capita water availability is expected to fall below scarcity levels in Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Uganda, Tanzania and Zambia by the end of the century. This is based on predictions of temperature rises between 0.9–3.4 °C by the 2060s, and 1.3–5.5 °C by 2090s [24]. However, there is some discrepancy between predictions depending on the modelling approach, focal area and scale applied. One study of future rainfall over the Lake Victoria region of East Africa predicted no significant change in mean monthly rainfall by the 2040s, and only a slight increase by 2075. While changes to precipitation across East Africa may be locally variable, there is consensus that temperatures will rise [25].

Public health is gravely threatened by climate change, which is universally acknowledged. In Rwanda, a country Approximately 52% of the country's total land area is arable and the total cultivated area equates to 66% of the national territory, with over 93,000 hectares of marshland under cultivation [26]. With much small plot cultivation occurring on hills or mountain areas, increased runoff and landslides have been experienced, increasing the country's vulnerability to climate change impacts [26]. In addition, the country gas emissions are very little and insignificant comparatively to many other countries.

However, due to country's rapid economic growth, eighty percent of people rely on wood fuel to meet their energy demands [4], the use of indigenous fuels in businesses and for electricity generation, use of coal in cement industries and increase of livestock farming, emissions are constantly rising at 67% from 2006-2018 [27], [28]. Which play an important role to increase of temperature and changing in rainfall keep the country to be susceptible to climate change, which Climate change's consequences will increase exposure to various infections [29], [30]. Moreover, a study tested the farm vegetables and agriculture water, the findings confirm in all areas of the country a presence of foodborne pathogens [31], and loss of diversity due to increased human activities all put the country at higher risk and increase the incidence of novel infectious pathogens and zoonotic disease outbreaks including rift valley [32]. The climate change in Rwanda is responsible to cause six different types of zoonotic disease which include viral haemorrhagic fevers, highly pathogenic avian influenza, Rift Valley fever, brucellosis, human African trypanosomiasis (sleeping sickness) and rabies, are strongly linked to climate that increase the risk to Rwandans, the country developed a strategic plan (2021-2026)- aiming to control and minimize risk that pose serious risks to human health [33]. However, it is not clear if

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health facilities has capacity to diagnose those conditions, capacity of health care workers on managing those conditions from primary health care settings [33]. In addition, the Nyungwe rainforest possibly is likely to host harbours pathogens that have not yet been identified and researched. Furthermore, it raises the danger of infectious diseases spreading to Rwandan as a result of climate change-related phenomena due flooding, heat waves, and intense rain.

Fires of any type, including wildfires, has a negative impact on the environment because they emit air-polluting pollutants into the atmosphere. These pollutions may raise the dangers to human health, such as increasing the likelihood of cancer of the lung and other respiratory conditions. Although there aren't many fire events in Rwanda, the damage they do create is significant, and they keep becoming worse. For example in 2009, according to Ministry in charge of Emergency Management, two fire incidents were recorded from both Muhabura volcano national park (150 hectares burned) and Nyagatare District forests and farms (30 hectares), also in 2007, another outbreak occurred in Akagera National park [34]. Additional, according to National police statistics, 131 in 2022 and 79 fire outbreaks in occurred in different parts of the country caused more deaths and injuries [35].

Furthermore, a report from the Ministry responsible for Emergency Management states that in the past three years, wildfires had destroyed around 1,000 hectares of forest. From July to September of 2020, 458 hectares of forests were destroyed by wildfires; the districts most severely impacted were Bugesera, Gatsibo, Kayonza, Muhanga, Nyamagabe, and Nyanza. The data also shows that in 2021 and 2023, wildfires burned 160 hectares and 73 hectares, respectively. Furthermore, recent fire incidents have occurred around the nation in a number of locations including, 20 hectares of residents' forests in Karongi district [36] and Nyungwe National forest with estimated at 8 hectares burned [36], fires are further to account for harmful pathogens spreading from the burned area and losing their habitat, which causes animal and human migration, urbanization of natural spaces, and the proliferation of vectors, and such mosquitoes, tsetse flies, and other vectors that can lead to mosquitoes borne diseases such as malaria.

The diseases carried by mosquitoes that are predicted to have a growing effect on human health as a result of climate change include schistosomiasis, tick bite fever, and malaria [4]. Malaria is disease transmitted by mosquitoes, primarily anopheles commonly plasmodium falciparum and gambiae species [37]. Malaria is among the leading causes of morbidity and mortality [38] and remains a public health priority in Rwanda [39]. Between 2005 and 2011, Rwanda's scale- up of interventions successfully reduced malaria incidence by 86 percent and in-patient malaria deaths by 74 percent, with at least eight districts achieving pre-elimination (37). Although government of Rwanda has made significant achievements in recent years to lower the risk of malaria, it is widely known that variations in temperature and precipitation brought on by climate change increase the likelihood of malaria and recurrences of the disease [40]. Moreover, it is anticipated that a more humid and warmer environment (in the central, northern, and western regions) will extend malaria transmission zones into the highlands, perhaps leading to a 150% increase in incidence by 2050 [41]. To better prepare for these diseases, it is essential to understand the natural environments of diseases spread by mosquitoes and their surroundings that strive in area with high rainfall and they are limited by low temperatures and high altitudes.

The environment change in climate will keep annual temperature has been noticed over the past 40years in Rwanda, which might bring Climate change will impose additional challenges to controlling malaria and other vector disease due to the influence of high temperatures in the life cycle and shifts in mosquito behavior to earlier in the day and outdoor biting, insufficient coverage of vector control

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interventions [42]. Additional, rainfall patterns in Rwanda have changed over the previous 30 years which become more shorter and more intense which expected to increase by 5% to 10%, which may help with breeding places, increased water bodies, irrigation with increase in rice fields [43], particularly in areas with inadequate sanitation, stagnated water from flooding may also lead to a rise in malaria incidence by hosting mosquitoes and giving a location to reproduce. There is broad consensus among scenarios and climate estimates regarding schistosomiasis (also known as bilharzia), which indicates that risk of infection in Rwanda could rise by 10–30% over the next 20 years [44]. The burden for emergence and re-emergence of these diseases in the country is expected in region with wild area of the country through land use and land scarcity in future due to environmental changes. Floods, droughts, and landslides are just a few of the tragedies brought on by climate change. Every year between March and June, Rwanda experiences torrential rainfall that hits the northern, western, and southern provinces, producing floods, setting off landslides, and resulting in casualties and property damage. Nsengiyumva et al. (2018) study on the susceptibility to landslides confirms that from 2011 to 2018, landslides had an adverse effect on public health and had various negative effects on human wellbeing, resulting in the deaths of 114 people, 141 injuries, damage to 623 housing, 72 roads, 31 bridges, and 4 classrooms. In addition, Over the period of the last five years (2018–2022), Rwanda has experienced an average of 237 deaths, 7874 damaged houses, 6,864 hectares of crops destroyed, 212 schools, 67 road sections, and 59 bridges destroyed [46]. Furthermore, recent severe floods and landslides in May 2023 across several provinces, primarily in the western, northern, and southern region, resulted in the deaths of 131 people, the displacement of 5,800 families, 6,391 homes, 2 health centres, 29 bridges, a large number of national and district roads, a large number of voltage lines, as well as 5 power stations and 58 schools [47]. These incidents could cause outbreaks of illnesses, transmitted through contaminated water and poor sanitation, including typhoid fever, cholera, typhoid, bacillary dysentery, and hepatitis A and E, may occur after these incidents. Due to the severe rains brought on by climate change, outbreaks of these diseases could happen at any time.

In Rwanda, the number of cases of diarrhoea is also anticipated to rise [48]. Moreover, according to Rwanda Biomedical Center (RBC), cholera outbreak appears to be endemic in some parts of the country, especially areas located in Lac kivu like Rusizi district mainly Nkombo sector, Nyamasheke, Rubavu, Rutsiro and Musanze districts due to poor hygiene and the utilization of contaminated water from lac Kivu during the heavy rainy season with a documented 285 cases and 3 people died since 2010 [49].

The increase in heavy rainfall is expected to keep increasing in future due to climate change, which will raise the risks of floods, erosions and inundations that contaminate rivers and lacks which induce for the re-emergence of cholera. Also, a study conducted in Kigali city shows already climate change impacted the life of children, also the higher rain in the country will likely to raise respiratory diseases mortality and morbidity such as pneumonia and Acute Respiratory infections, especially for under 5 children, which increase with climate variation in raining and humidity, pneumonia cases increase by 0.29% to 0.91% for each millimeter increased in rainfall across all part of the country which pose a burden to public health [50], and aggravating Asthma and fungal infection such as athlete's foot.

The projected increases in average temperature by 2050 and 2080 range from up to 2.5°C and 4°C, respectively [51], as well as increases on length of heat waves by 7–22 days [41]. This increase serves as a warning to Rwandans about the dangers of heat exhaustion. Particularly, at risk are the Bugarama Valley and Kagitumba in Nyagatare, where greater maximum seasonal and yearly temperatures represent a serious threat to public health. For example according to Rwanda Meteorology Agency, recently

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recorded rare highest ever temperature in Kigali city. Heat waves in those areas are predicted to make respiratory disease morbidity and death worse [51], [52].

In addition, studies has evidenced that stroke is a burden in Rwanda and is third leading cause of mortality, according to the Rwanda Biomedical Centre, stroke itself count to 5.1% of total deaths [53] , [54] and it is expected to increase due to the change in temperatures and negatively impact the mortality of cardiovascular disease in the country. Furthermore, mortality due to respiratory disease may increase and also mortality due to diabetic disease is expected to raise in the country due to raise of temperature. It is also expected that, as temperature raise, people living with diabetes mellitus will more experiencing dehydration during extreme heat and causing a risk of hospital admission, may also aggravate the complications and mortality rate of diabetes especially among elderly people and young children during extreme heat [55], [56]. Despite the detrimental effects of climate change, Rwanda's population still faces social disparities that contribute to inequities in the country's vulnerability to climate change hazards. The country is becoming more exposed to and vulnerable to both rising temperatures and increased climate variability, according to the 2018 National Climate Change Vulnerability Assessment. Rwanda continues to face a very high risk that weather- or climate-related hazards may result in increasing annual losses. Four districts, Karongi, Ruhango, Huye, and Gisagara, are particularly sensitive to climate change, making the Southern and Western Provinces more vulnerable than other provinces. Conversely, nine districts—most of which are in Western Province (Nyabihu, Rutsiro, Ngororero, Karongi, and Nyamasheke), three in Southern Province (Huye, Ruhango, and Gisagara), and one in Northern Province (Gicumbi) were the most susceptible to the negative effects of a changing climate on human health, progress in social, economic and public health progress is likely to be undermined by expected climate change trends [57].

Generally, the country is strongly dependent to agriculture, which increase the risk of the vulnerability to climate Change. According to one of three indices for social susceptibility to climate change, an evaluation of social sensitivity to climate change places Rwanda on top among all African countries due to Rwanda's high population density, that significantly increases its vulnerability. Additionally, the correlation between farming activities like growing coffee, potatoes and climate change indicates the possibility of problems with food production [58], [59] and water supply may be impacted, raising the risk of food insecurity and famine which pose negative effects on the well-being and health of individuals as well as social conditions.

Furthermore, vulnerabilities Indicators of health included the number of diarrheal illnesses, and malnutrition (stunting and wasting). Rwanda's population is expected to increase, which will lead to shortage of farmland, and the most important crops for food security that are highly climate sensitive. As a result, food production is still a highly vulnerable industry that is particularly exposed to the effects of climate change, which will result in a shortage of food due to disruptions in agricultural production during extreme weather events [4]. Malnutrition was also listed by the World Health Organization (WHO) in 2018 as one of the global health problems linked to climate change globally, particularly in low-income countries like Rwanda. The percentage of children under five who suffer from stunting decreased in the nation from 44% in 2010 to 33% in 2020 [60]. Nevertheless, the country is still struggling to deal with chronic malnutrition, which affects 35% of children under the age of five, and climate change will continue to exacerbate the rates of food insecurity, which only reached over a third of Rwanda's population in 2018 [57], [61], [62]. Climate change will impact food security and reducing quality of water, which pose also concerns for increased adverse health implications for the country [63]. Under Vision 2050, Rwanda aims to eliminate chronic malnutrition by 2035, which may

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be challenged due to increasing risks of climate change [63]. Additionally, Food supply limitations will have an effect on diabetic patients as they will have to eat processed foods, which can exacerbate type 2 diabetes [64]. In order to combat the effects of climate change, the government must develop health policies and initiatives. In order to find flaws in the health systems that should shield the most vulnerable populations from the consequences of climate change.

In 2015, REMA included vulnerability and adaptation indicators into priorities, which was evaluated in 2018 with remarkable improvements, however health related indicators still need to be improved as in evaluations [65]. In addition, to infectious diseases and chronic illnesses, climate change may have a substantial impact on oral health, particularly on dental caries. Temperature increases and rainfall can lead to humidity and limit water supplies, which can worsen oral health by promoting the growth of bacteria in the mouth [66]. Furthermore, in Rwanda the prevalence of dental caries is high that affecting more people both adult and children ranging from 42.4% to 71.5% [67]. A long with that, climate change will affect also oral health following malnutrition which is linked to enamel hypoplasia, decay in the teeth, and delayed tooth eruption [68], the department of public health should also consider the effect of climate change on planning to reduce prevalence of dental caries in Rwanda as well oral health in general, more research studies are needed to explore the association of climate change and oral disease in Rwanda.

Rwanda's biodiversity conservation contributes to health benefits, including community livelihoods in terms of food, medicine, energy, shelter, and a number of social values. In 2011, the government developed biodiversity conservation policy with an aim to protect the environment but also to improve population health [69]. However some disease like Diarrhoea incidence are significant in protected area like volcanoes national park located in north-western province. In Rwanda, diarrhoea is the third leading cause of death in children under 5 years old which was responsible for 18.3% of childhood deaths in 2015 [70]. however mortality due to diarrhoea was declined at a moderating rate to shrink from 0.17 % in 2003 to 0.07 % in 2017. Evidences shows that an increase in one millimeter of rainfall was associated with decrease of 14 cases of diarrhoea while increase of one degree Celsius of temperature was associated with an increase of 17 diarrhoea cases. Most significant spatial clusters of diarrhoea were observed in the northern province and Western province, significant association between diarrhoea diseases and climate dynamics was observed [70], [71]. Literatures has also shown that diarrhoea is associated with rain fall, and increased temperature in the country, it is expected that weather changes will impact morbidity and mortality of diarrhoea disease for children under 5 which will increase hospitalization and cause a burden in health facilities, and households in the country, especially in northern province and western province [72]. Similarly, a study conducted in Rusizi district on daily health facility visit for gastroenteritis symptoms and daily precipitation data among under 5years old discovered significant association between clinically diagnosed intestinal infections and instances of intense rainfall [73]. To decrease diarrheal infections in the highly affected community, it is crucial to develop and implement health programming that promotes awareness of early interventions including rotavirus immunization. Alongside with climate change effects to infectious disease and chronic disease, climate will also affects the morbidity and incidence of dental caries which raise the demand for health services.

Although, the negative effects of climate change also have a significant influence on mental health. The most prevalent mental health conditions brought on by climate change include suicidal thoughts and behaviours, stress, nervousness , and depression [74].

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Table 1. Summary of climate change hazards recorded in Rwanda (2014-20118).

	Deaths	Injured	House damaged	Crops damaged	Lost Cattle
2018	249	323	15,777	10831 ha	809
2017	67	133	5,768	5251 ha	587
2016	168	161	4,459	2070 ha	208
2015	121	175	2,603	1759 ha	88
2014	104	251	3,595	3074 ha	245
	Class room	Health Centers	Roads	Churches	Bridges
2018	67	3	32	24	63
2017	198	3	13	37	49

Source : REMA,2018

From above table, the five categories of loss and damage reported by MINEMA. From 2017 and 2018 takes into account the number of classrooms, health centres, highways, churches, bridges, water supply, and electrical transmission lines that have suffered damage [75]. The local community was impacted by these events, which had immediate effects on their mental health by triggering losses in employment, limited access to primary healthcare services, homelessness, and shortages of food. The government of Rwanda, has in place the measures to support people with mental health from health centers to referral hospital. However, lack of awareness from those victims who are affected mentally by climate changes cannot be treated and not consult health facilities because of lack of awareness on mental health alarming signs symptoms. However, there is a need to decentralize mental health services to community level especially on health post for first aid mental health service to respond to the needs of victims after climate change incidents [76].

Current Strategies And Challenges

In order to address the risks associated with climate change for public health, the Rwandan government has put in place a number of strategies. These include bolstering Rwanda's Meteorology Agency (Meteo Rwanda), which provides an advisory and precautionary message to the entire population, updating the public with climate warning about future weather events, implementing electric mobility, Bus Rapid Transit, Green Growth Strategy and restoring and designing wetlands as green spaces and green city as well infrastructure indicators with an emphasis on environmental and ecological impact that lead to reduction of greenhouse gas emissions in Kigali city and six seconded cities and contribute to climate change [77], [78]. However, healthcare facilities, particularly newly built or renovated hospitals and clinics, must also adopt green building policies in all part of country. In addition, the government implemented climate-smart farming, which aims to reduce and adapt to climate change effects [79], and funds social assistance for those impacted by climate change as well as the presence of mental health professionals in institutions ranging from health centres to tertiary medical facilities [76]. Furthermore, the government initiated one health program aiming to improve institutional, operational, and policy coordination as well as cooperation amongst several pertinent parties; establish a collaborative

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surveillance system to respond and mitigate the risks of zoonotic infections, vector-borne and food-borne illnesses, and other public health concerns which contribute indirectly in responding to negative effects of climate change [80], usage of agricultural chemicals and techniques such as terrace construction and marshland drainage [81] and the use of in situ water harvesting approach for sustainable agriculture in Rwanda [82], these approaches implemented by government helped to increase ecosystems' and environment resilience to the effects of climate change.

Along with that, the government launched national adaptation plan (NAP) readiness project in 2017, it aimed at enhancing its capacity to respond to climate change in high-risk zones by implementing a NAP for integrated flood and landslide management in urban areas and 11 priorities sectors for adaptation were mentioned [83]. A blueprint for achieving focused and quantifiable climate action for both climate change adaptation and mitigation, Rwanda developed a National Determined Contribution (NDC) which is a plan for addressing climate change. According to both NAP and revised NDC, includes a reference to vector-based disease prevention, which is intended to strengthen preventative efforts and cultivate adaptability to disease outbreaks. Unfortunately, the plan does not cover mental health, waterborne illness, or other health risks [84].

Furthermore, the country has experienced some events that resulted in inundations and floods of different rivers. For example Nyabarongo River and its surrounding wetland which impact access to health services as well as limiting transport movements, the NAP doesn't mention any strategy to respond to road and infrastructures sanitation due to flood from rivers and inundations [85]. The Department of Public Health within the ministry of health plays a role to the preservation and conservation of the environment, and works for providing access to clean water, sanitary conditions, and good hygiene, particularly in healthcare facilities, and contribute in reducing the negative effects of climate change on the population [86]. However, it is not clear regarding readiness and ability to respond to the emerging health risks associated with climate change. It is necessary to create a dedicated national health and climate change plan that prioritises building capacity to respond to the detrimental effects of climate change on public health as well as creating programmes and policies that are explicit in addressing the negative effects between health and climate change.

Conclusion

The author of this paper highlight how climate change is affecting the Rwandan population health and exploring future area of focus to mitigate the warning of climate change. The author suggesting that the public health policies should be strengthened and creating a national health and climate change plan with clear responsibilities and interconnecting the different sectors including Rwanda Biomedical center, agriculture, MINEMA, environmental, Rwanda Meteorology Agency and private sector including international funded agencies to respond to mitigation of climate change and the author provided the outlook on relationship of climate change and Rwandan public health and strategies that have been implemented by the government including implementation of green public space in many cities of the country, strengthening Rwanda's Meteorology Agency (Meteo Rwanda), implementation of one health program, funding social assistance to victims of climate change, implementation of climate-smart farming- by using chemicals and terrace, water conservation practices . Therefore, there is a need for continuation of these strategies and consider particularity of each region in the country.

Recommendations

The author is recommending some further strategies to respond to negative effects of climate change to

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public health in Rwanda that could include : use of telemedicine services that reduce the rate of referrals and indirectly contributing on reduction of carbon emission from ambulances.

In addition, the author is highly recommending use of electric ambulances especially in health facilities located in over populated areas like Kigali city and seconded cities to prevent respiratory disease but also protecting the environment health. Also, the agricultural sector must prioritise species that can survive in climates with warmer temperatures and less precipitation, establish local strategies to reduce farming erosion, and implement a variety of soil and water conservation techniques in order to contribute to the reduction of malnutrition. Furthermore, the government need to implement effectively the environmental friendly transport systems to limit air pollution especially in Kigali city and seconded six cities.

The Rwanda Biomedical Centre, the body in charge of controlling malaria, needs to take into account future climate scenarios in order to be aware of prospective increases in infectious disease including malaria hazard, brought on by rising temperatures as well as the resources needed to prevent or treat future rises in malaria rates, malnutrition among under 5 children, mortality due to diarrhoea, oral health particularly gingivitis and dental caries and considering the particularity of region. Furthermore, department of public health in ministry of health should focus on building the capacity of health care professionals for responding to impact of climate change. This paper also recommend further studies on effects of climate change towards medicine supply and storage, mental and oral health problems in Rwanda.

Finally, in order to secure access to health care services, the author recommend that Mutuelle de Sante's enrolment be strengthened and Rwanda social security board to expand it to cover private facilities services. Additionally, mapping health insurance among residents in climate change-prone regions and ensuring that everyone has health insurance coverage are both crucial in preparing for the effects of climate change.

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