The Impact of Climate Change on Vulnerable Populations

The Impact of Climate Change on Vulnerable Populations

Social Responses to a Changing Environment

Editors

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Dedication

This book is dedicated to my sons. Thanks for your unwavering support throughout this journey, especially when there were instances of adversity and loss.

Dr. Debra D. Joseph

I dedicate my efforts on this book to both my parents who, throughout their lifetimes, have impressed upon me the importance of having courage and humility in the pursuit of my dreams.

Dr. Roshnie A. Doon

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About the Editors

Dr. Debra D. Joseph is the Coordinator and Lecturer of Social Work at the University of the West Indies, Cave Hill, Barbados. She is also an Honorary Consultant Researcher with the Ni3 Centre at the University of Huddersfield, UK, an institution that addresses domestic violence. She is developing a body of work on the social impacts of climate change for vulnerable populations. This seeks to highlight, but is not confined to, the links between gender inequalities and climate change. Dr. Joseph has undertaken work in the areas of domestic violence, HIV/AIDS, women fisher folk, environmental sustainability, disasters, and climate change. Furthermore, she has completed studies of tropical Storm Erika—Dominica; Hurricane Maria—Dominica; and undertaken a Family Case Study and discussed the impact of female-headed households post-Hurricane Maia–Dominica. She received the "Jeremy Collymore Award for Research in Humanitarian Response and Disaster Risk Management" for the year 2019.

Dr. Roshnie A. Doon is currently an independent researcher in the field of Labour Economics. She holds a PhD in Economic Development Policy, an MSc in Economics, and a BSc in Economics from the University of the West Indies St. Augustine, Trinidad. She pursued a master class in International Business from the Henley School of Business at the University of Reading, U.K., and is currently an affiliate of the Global Labor Organization (GLO), Essen, Germany, and an executive committee member of the Caribbean Academy of Sciences (CAS), Trinidad and Tobago Chapter. Her academic interests are focused on applied and empirical economics, with work in the areas of labour, gender, and education economics. She has published research on a wide range of areas, which include higher education instruction, economic implications of COVID-19, returns to schooling, educational mismatch, STEM education, wage inequality, gender wage gaps, and economic development policy.

Foreword

It is a privilege to be able to continue to contribute to the body of literature addressing vulnerability and marginality in the climate change field. As an interdisciplinary scholar in both Environmental studies and Africana and Latin American studies, my work sits at the nexus of environmental psychology, environmental justice, and natural resource management. Over the past decade and a half, the bulk of my work has been with marginalized and vulnerable communities in the Caribbean and the US as they experience climate change impacts and other environmental injustices such as food access and the impacts of oil and gas drilling. My scholarship examines the ways in which fishers in the Caribbean are disproportionately impacted by climate change and highlights the everyday strategies that are used to adapt to impacts that they experience.

This text, *The Impact of Climate Change on Vulnerable Populations: Social Responses to a Changing Environment* by Debra D. Joseph and Roshnie A. Doon, continues to center climate change and its impact on vulnerable and marginalized communities. Climate change is an existential threat to the world; if not addressed, it has the potential to cause irreparable damage to ecosystems and life. But why marginality? Multiple studies across various disciplines have highlighted that vulnerable populations have dealt with and are currently experiencing climate change impacts differentially. The book highlights these impacts and shows their widespread nature and demonstrates how they are experienced differently. The vulnerable and marginalized tend to experience the most significant impacts of climate change and are often the ones who do not receive the support that is needed to properly adapt to climate change. Even more important, the book draws on the wide range of marginality and vulnerability indicators such as race, class, gender, livelihoods, and indigeneity, centering, for example, tribal communities in India and Africa. The book addresses not only the needs of vulnerable populations to climate change but also the solutions that are needed to address these problems, e.g., the use of resilience hubs. Taking a solution-oriented approach is necessary within climate change research to show practical ways of tackling a problem that at times seems insurmountable. The breadth of areas covered by this book is compelling and will allow it to draw a wide audience that includes academics, policy makers, and practitioners across multiple sectors, e.g., social work, economics, development studies, law, government, and public policy to name a few. Further, the topics that are covered as it relates to climate change expands the discussion of climate change into new realms such as addressing general health, mental health implications, housing dynamics, ableism, and prison communities, showing the multi-faceted impact that climate change has on the society.

One of the exciting new contributions of this book is the focus on health and climate change. Elderly care, homelessness, and mental health within children

are understudied areas, and having chapters that address this issue makes a pivotal contribution. Understanding how and why these vulnerable populations lack the financial means to secure proper housing, transportation and health care services is central for addressing adaptation measures within these communities. Another pivotal contribution is the focus on ableism and how this contributes to vulnerability, with a particular focus on how these populations tend to have higher morbidity and mortality rates in emergencies, especially those related to the impacts of climate change. Two other areas that are also worth mentioning include the focus on maternal and children's health as impacted by climate change and the effort to highlight the cumulative impacts of environmental hazards and climate change effects.

This book takes a comprehensive global approach that is sorely needed. This timely contribution deepens the literature on the impacts of climatic change impacts and its associated solutions, with a focus on vulnerable and marginalized populations.

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Preface

Climate change refers to the long-term changes in the Earth's climate, including changes in temperature, precipitation, and wind patterns. It is primarily caused by human activities, such as burning fossil fuels and deforestation, that release large amounts of greenhouse gases into the atmosphere, thus trapping heat and causing the Earth's temperature to rise. The impacts of climate change include rising sea levels, more frequent and severe natural disasters, and changes in ecosystems and agriculture. Addressing climate change requires us to reduce greenhouse gas emissions and transition to cleaner energy sources, as well as to adapting to the changes that are already underway.

Being involved with the climate has been a personal journey for me. In my childhood, I didn't think much about the environment or its impact on our lives. I began to realize the urgency of the situation as I learnt more about the science of climate change and its potential consequences at school via geography. Subsequently, I trained to become a meteorological assistant and worked at the Trinidad and Tobago Meteorological Office for over twenty years. There, I was able to familiarize myself with the weather and weather events. I then decided to switch careers and became a professional social worker, another rewarding venture. In the academic world, I was finally able to bring together those two areas—climate and social work. This has become my niche area for research and publications. As I continued to educate myself and publish in the area of climate change, I became more involved in advocacy and activism efforts. Climate change is a complex issue, but I believe that every individual action can make a difference. We all must do our part to mitigate the effects of climate change and protect our planet for future generations.

Vulnerable populations around the world are being affected by climate change. These populations, which include low-income communities, children and others, are disproportionately impacted by the effects of climate change. This includes increased the frequency and intensity of natural disasters, food and water shortages, and health risks such as heat stroke and respiratory illness. Governments and organizations need to prioritize the needs of these populations in their climate change adaptation and mitigation efforts. This includes providing access to resources and support for adaptation strategies, as well as addressing the root causes of climate change such as greenhouse gas emissions. By prioritizing the needs of vulnerable populations, we can work towards a more equitable and sustainable future for all.

This book is the beginning of a journey with climate change and its impact on vulnerable populations. I hope it brings clarity, awareness and enhanced knowledge of its effects and creates an impetus for action throughout the world.

Debra D. Joseph
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The central theme of this book is the impact that climate change has on vulnerable populations around the world. It covers a wide range of key issues that diverse groups who are sensitive to changes in the climate are likely to experience before, during and after the occurrence of change. To this end, the complications arising from these events include a multitude of problems such as the displacement of the elderly; homeless and disabled communities; growth in infant mortality; the rise of major environmental hazards such as air pollution and the improper disposal of solid waste; the upsurge of mental health conditions amongst the youth and adult population, and those living in poverty; as well as the challenges experienced by persons when dependent upon the sea as a source of food and income.

The research conducted in this field is an important as, although there is great emphasis on the prominent goal of the United Nations Framework Convention on Climate Change (UNFCC), which is to bring down the concentration of greenhouse gasses in the atmosphere to a manageable level in order to reduce human interference in the environment to the point where it does not pose a risk to the earth and its 7.8 billion inhabitants, there is not enough emphasis placed on the impact that climate change and natural disasters have on the already vulnerable groups around the world. Thus, there is a need for information discussing these and more of the issues highlighted in this book, particularly as they relate to the experiences of vulnerable groups in the Global South. Indeed, this most of this book comprises research from the Caribbean region, and individual countries like South Africa and Pakistan.

Research on the impact that climate change has on vulnerable populations around the world has escalated in recent years because, as climate change events such as extreme heat, flooding, food insecurity, and air pollution, continue to worsen, there is a chain reaction, or even evolution, in how vulnerable groups such as women, children and older adults react to them. This creates an added burden on household and economic systems, as these vulnerable groups may develop low immunity, worsen pre-existing conditions like heart disease and heat-related illnesses, and enhance the need for adequate housing, thus increasing the need for public healthcare and infrastructure. Therefore, research into these areas must form the foundation of the informed policy decision making necessary at the governmental and institutional levels in order to change the ways that these bodies address the consequences of climate change events experienced by vulnerable groups.

There is a need for the kinds of research displayed in this book in order to expound on the vulnerabilities of the most defenseless segments of the world's population, who may not have the chance nor the opportunity to have their grievances heard on the world stage. What makes this book an unusual and worthwhile piece of literature is that it exemplifies the problems that vulnerable groups experience concerning climate change events from a scholarly perspective,

which makes the content integral to policy development. In this regard, the content of this book may be attractive and beneficial to not only graduate students and academics who may wish to build on the foundation provided in this book regarding climate change and human vulnerabilities, but may be of great use to government bodies in the design of climate change policies that relate to vulnerable populations.

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Introduction

Roshnie A. Doon

Climate change threatens the physical and mental health of vulnerable communities and can have a significant impact on their livelihoods. Climate change can also deepen existing social and economic inequities and contribute to the erosion of coping skills and resilience. Transformative social and economic responses based on inclusion and dialogue with members of the community are needed in such an ever-changing global environment, including investment in innovative measures to strengthen community-based assets, and the fostering of collective agreements and partnerships between communities and governments.

The unpredictable nature of climate change events often presents vulnerable communities such as farmers, fisherfolk, and indigenous groups, amongst others, with challenges that threaten the economic stability of their households, communities, and even their domestic economies. This can be especially true if the country in question relies on tourism or agriculture as a primary source of revenue. For example, Akanbi et al. (2021), found that for Nigerian farmers engaged in low-technology-based food production such as rice farming, climate change poses a significant threat as it increases their vulnerability to food poverty. For this reason, Bedeke (2022) argues that farmers need to change their style of cropping to accommodate exposure to extreme conditions such as erratic rainfall, recurrent floods and droughts, elevated temperatures, and solar radiation. In such instances, Bedeke (2022) suggests that programs that facilitate such behavior changes can lead to the propagation of drought-tolerant plants and high-yield varieties of rice and other crops (Bedeke 2022). It is important to recognize that climate change, manifest as it is in multiple ways, impacts communities differently depending upon a range of multi-layered factors.

For example, along the coastal regions of Spain and the Mediterranean, climate change has played a significant role in the regional disparities in the vulnerability of fisheries and coastal tourism, leading various communities to become more exposed than others. Aragão et al. (2021) found that based on the sensitivity of fisheries to climate change and the ability to adapt to such changes, fisherfolk in the Mediterranean were more vulnerable than those in the Atlantic. While tourist resorts on the north-western Mediterranean coast of Egypt are particularly prone to shoreline and beach erosion, the degradation of infrastructure, and the devaluation of properties, reducing the revenues earned by the tourist industry (El-Masry et al. 2022).

Countries in Sub-Saharan Africa are heavily dependent on agriculture and fishing and women play an integral role in the processing and selling of the commodities produced. However, women have little access to land, to agricultural support services or to financial resources and consequently are more vulnerable to climate change impacts on food security. Anugwa et al. (2022) find that such

inequalities arise because of traditional socio-cultural roles, inequities in access to education, and the deprivations faced geographic locations such as coastal or rural communities. Apart from the gender dynamic of climate change, Awolala et al. (2021) find that even though depressed areas may have access to basic amenities, women (and their children) and elderly populations are often income-poor, lack the necessary services to ensure their wellbeing and have insufficient support from government institutions.

Extreme weather conditions, such as elevated temperatures and prolonged droughts in the case of Africa, impacts persons' capacity for food security in a negative manner while simultaneously exacerbating social inequality. These conditions impact the health of vulnerable communities as these extreme climate change events may lead to malnutrition, cholera, and the displacement of entire communities such as nomadic tribes who may lack access to water and consequently have poor levels of sanitation and hygiene (Charnley et al. 2022). Indeed, climate change is increasingly responsible for population displacement and the creation of refugee communities.

Tribal communities in Africa and India often earn their income from engaging in agricultural practices such as cropping and working on tea plantations, making them vulnerable to high rainfall, flooding, and landslides (Deb and Mukherjee 2022; Kaur et al. 2022). For this reason, these groups are slow to adapt and are more susceptible to the effects of climate change events. Even in economically advanced countries like Australia, human-induced climate change events such as bushfires are known to harm the health of remote communities that, because of their isolated location, have limited access to transport, health care services, infrastructure, and economic resources (Hall and Crosby 2020).

International organizations such as the United Nations Framework Convention on Climate Change (UNFCCC) are tasked with designing and implementing climate change policies to address the impact that climate change has on vulnerable groups in society. However, Biesbroek et al. (2021) explain that the policy literature tends to focus more on the impact of climate change more widely, rather than on the needs of especially vulnerable groups, adaptation, or governance. In addition to focusing on the last three areas, there is a need to review how vulnerability impact assessments are undertaken by institutions around the world because vulnerability ranking determines climate change responses (Birkmann et al. 2022).

Notwithstanding these important areas of adaptation, mitigation, governance, and the design/effectiveness of climate change policy on vulnerable population, the aim of this book is to shed greater light on the experiences of various vulnerable populations within countries to the extreme changes to climate change. This is especially important as the perception of risk to vulnerable populations has increased dramatically as their healthcare, food, shelter, financial security and physiological needs are all put into jeopardy due to climate change events (either natural or

manmade) causing disproportionate imapcts on their lives and livelihoods (Akerlof et al. 2015; O'Brien and Wolf 2010).

This book provides a detailed discussion of how climate change events are linked to existing issues such as homelessness, maternal and child health, mental health, gender-based violence in the midst of the COVID-19 pandemic, farming, food insecurity, problems of gender equality, biological vector-borne diseases, temperature-related diseases, as well as ecological and climate anxiety in children. This book considers these and more pressing subject matters in relation to a wide variety of changes to the global climate, with discussions ranging from extreme heat, rising temperatures/precipitation, frequency of climate change disasters such as hurricanes, and reducing air quality, to the presence of droughts and extreme flooding. This collection of chapters is based on the perspectives of vulnerable communities not only from the Caribbean region, but from individual countries such as Trinidad and Tobago, South Africa, Dominica, Pakistan, and the United States.

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The Social and Economic Inequalities of Climate Change Events on the Elderly, Disabled and Homeless Societies in the Caribbean

Debra D. Joseph and Roshnie A. Doon

Abstract: The are several vulnerable populations experiencing climate change events around the world that continue to threaten the health and well-being of some of the most susceptible populations in our society, such as, the elderly, the disabled, and the homeless. Although there are 100 million homeless people globally, overall, 1.6 billion people live without proper housing. Such hardship implies that this population group might be unable to effectively prepare, respond, and recover from climate change events. In the Caribbean, this group of people is at risk because of the volatile nature of climate change, such as, changing temperatures and catastrophic weather events, which may not be included in the design of mitigation plans. This presents a significant gap, as there is limited information in the literature that highlights the impact that climate change may have on these vulnerable groups existing in the Caribbean. This chapter seeks to fill this gap by discussing the social and economic inequalities that climate change events pose to elderly, disabled, and homeless individuals. By implementing a secondary research methodology, this study finds that in the Caribbean, these groups tend to lack financial and physical resources to respond and recover from climate change events due to their low income and the inequitable and inefficient dissemination of information on climate change adaptation and mitigation strategies.

1. Introduction

According to Rhiney and Baptiste (2019), climate change and its accompanying threats in the Caribbean can be seen as developmental in nature. Presently, it deepens existing vulnerabilities that can prove debilitating and impact issues such as poverty and inequality. Vulnerable groups such as the homeless, elderly, and disabled could be negatively affected by climate change, especially if elderly individuals are both disabled, and homeless. Layers of inequalities can create a heavy burden for these three categories of individuals. Awareness of the consequences can lead to effective interventions to help alleviate such a burden. All human life is essential. Worth and dignity coupled with a propensity to grow should be values that are adhered to with the utmost standards. EPA (2021) states that one of the populations that are adversely affected and socially vulnerable to climate change is the elderly: a group aged 65 years and over. Bryant et al. (2022) add that people 65 and older are particularly vulnerable to the effects of climate change because of special needs and

advancing age. They reiterate that, despite their vulnerability, older people are often omitted from climate change discussions and don't have a seat at that table. Bryant et al. (2022) state that first responders, health care providers, and society, in general, tend to overlook older adults until after an extreme event or post-disaster. They add that few initiatives have focused on studying the long-term consequences of these events for the older population, preparing at-risk older adults and their families for such events, or helping this population and their families better comprehend, prevent, and mitigate the long-term debilitating effects of climate change. The issues and challenges that impact the elderly, disabled and homeless are discussed in this chapter from a physical, health, and psychological point of view. Furthermore, this chapter also strives to discuss the economic implication of climate change events on this population segment in the Caribbean. Emphasis is placed on the social and economic inequalities of climate change events on these vulnerable groups. Within the climate change literature, although there is much that has been conducted on the Caribbean's extreme vulnerability to climate change, there has been very little consideration made regarding how these events (natural or man-made disasters) impact the elderly, disabled, and homeless in Caribbean society. As a result, the needs and inequalities experienced by these groups are often inadequately captured and addressed in climate change resilience plans in the Caribbean. This presents a significant research gap in the literature, which this study seeks to fill, and in doing so, this study from a Caribbean perspective makes two important contributions.

The first is it examines in detail the social inequalities that the elderly, disabled, and homeless groups in the Caribbean are likely to experience during climate change events from the perspective of the aging process, cognitive impairment, social isolation, and other issues. Secondly, it examines the economic implications that climate change events are likely to have on the elderly, disabled, and homeless in Caribbean societies from the perspective of having limited household incomes, precarious housing and public infrastructure, health and safety, and climate change adaptation measures that are designed with these vulnerable groups in mind.

A summary of the review findings highlights that from the social perspective, the elderly, disabled, and homeless populations face a myriad of challenges because of climate change events such as storms and hurricanes. Their vulnerability increases as a consequence of these events. Each member of the population highlighted has its own set of issues that can overlap with each other. Strategies need to be put in place by those in charge to help alleviate these challenges, especially in times of crisis. Everyone is important, and no one should be left behind. This also speaks to the promotion of human rights for all.

Additionally, a review of the economic implications that climate change is likely to have on elderly, disabled, and homeless groups in the Caribbean reveals several interesting findings. Firstly, elderly women who might also be homeless and people who are rendered homeless during and after climate change events might not have sufficient household income to access basic needs. This problem

may be exacerbated during climate change events, as they may be allocated fewer resources. Second, during climate change events, the movement of both the elderly and the disabled is severely hampered by different modes of transportation, which can become inaccessible to those affected. The lack of inclusion of different modes of public transportation creates an even greater risk during these events as the elderly and disabled might use these services less. Third, it is expected that during periods of excessive rainfall, the overall health of the homeless would be lowest during this time because they may be more susceptible to foodborne, waterborne, and vector-borne diseases, with little access to secure and safe forms of housing and clean drinking water. Fourth, the destruction of green spaces during climate change events may negatively impact the health outcomes of older people, leading to a rise in chronic health conditions. Fifth, since elderly, homeless, and destitute people in the Caribbean are also known to suffer from the negative effects of extreme temperatures and, in some instances, heat waves, there is a need for risk assessment and communication studies to be undertaken to consider how climate change impacts them, and how they can respond to these events.

This chapter is organized as follows. Following the introduction in Section 1, a brief discussion in Section 2 is provided on the material and methods implemented in this study. This is followed by Section 3, which examines the social inequalities of climate change events in elderly, disabled, and homeless societies in the Caribbean, and then Section 4 explores the economic implications of climate change on the elderly, disabled, and homeless in the Caribbean. Finally, the study is concluded in Section 5.

2. Research Methodology

Given that this study is conceptual in nature, it focuses heavily on analyzing the existing literature and how climate change events impact elderly, disabled, and homeless societies in the Caribbean. Such a conceptual framework is necessary as it is built upon the existing literature, which is appropriate when discussing the social and economic implications of climate change on these specific vulnerable groups.

To build this framework, first, the topic for research, i.e., the social and economic inequalities of climate change events on elderly, disabled, and homeless societies in the Caribbean, was decided upon. Second, using a secondary research perspective, several pieces of literature which are relevant to the topic were collected. These collected works were obtained from many reliable sources such as relevant books, scientific journals, and reports from climate change and environmental institutions such as the National Oceanography Centre (NOC), the Environmental Protection Agency (EPA), and the United Nations (UN).

Third, when using the literature, emphasis was placed on the social and economic implications that elderly, disabled, and homeless groups are likely to experience resulting from climate change events. Emphasis was placed on social and economic factors as together they influence the ability of these vulnerable populations

to achieve long, healthy lives, as well as reduce long-term inequalities in society. Fourth and finally, using the relevant literature available, a research framework was developed. To this effect, in this study, two frameworks were developed. The first examined the social inequalities of climate change on the elderly, disabled, and homeless in the Caribbean. To perform this, the physiological and psychological reasons why these vulnerable segments are more susceptible to the effects of climate change were examined. The second framework examined the economic implications of climate change on the elderly, disabled, and homeless in the Caribbean. To conduct this, economic factors, which included but were not limited to household income and public sector provisions, were examined in the context of climate change events in the Caribbean.

In the case of this study, a conceptual research methodology was appropriate because it was cost-effective, used fewer resources, it was likely to assist in generating new research ideas, as this study can be a foundation upon which climate change data are collected based on the experiences of these vulnerable groups. Using this study can help identify patterns in the literature and can improve the overall analysis of the topic.

Using this approach, the literature map used to inform a discussion on the economic implications of climate change on the elderly, homeless, and the disabled in the Caribbean in Section 4 is shown in Figure 1 below. This figure identifies the 5 major themes to be discussed, i.e., limited household funding, housing and public infrastructure, health and safety, climate change adaptation, and research and development.

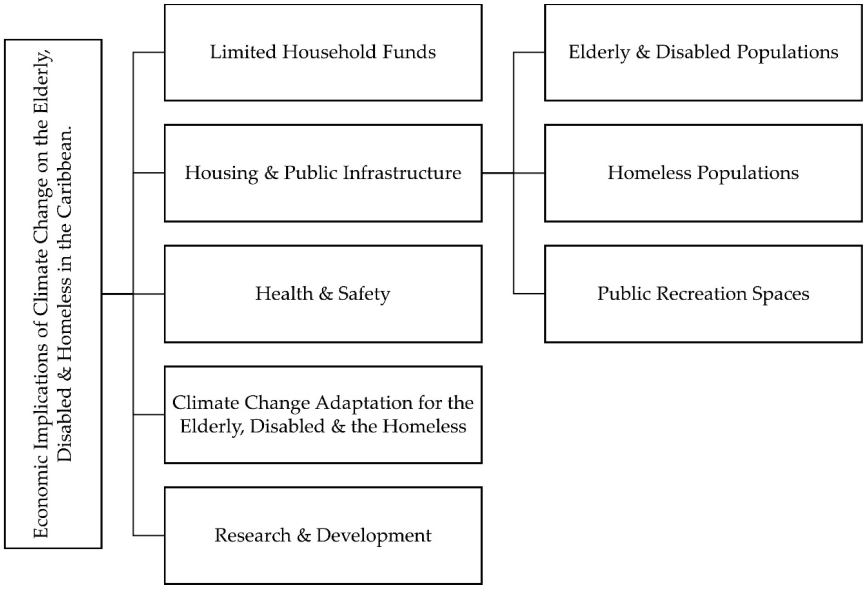

Figure 1. Literature map of the economic implications of climate change on the elderly, homeless, and disabled in the Caribbean. Source: Figure by authors.

3. Social Inequalities of Climate Change Events on Elderly, Disabled and Homeless Societies in the Caribbean

The seven major themes discussed for social aspect in this paper can be seen in the concept map in Figure 2.

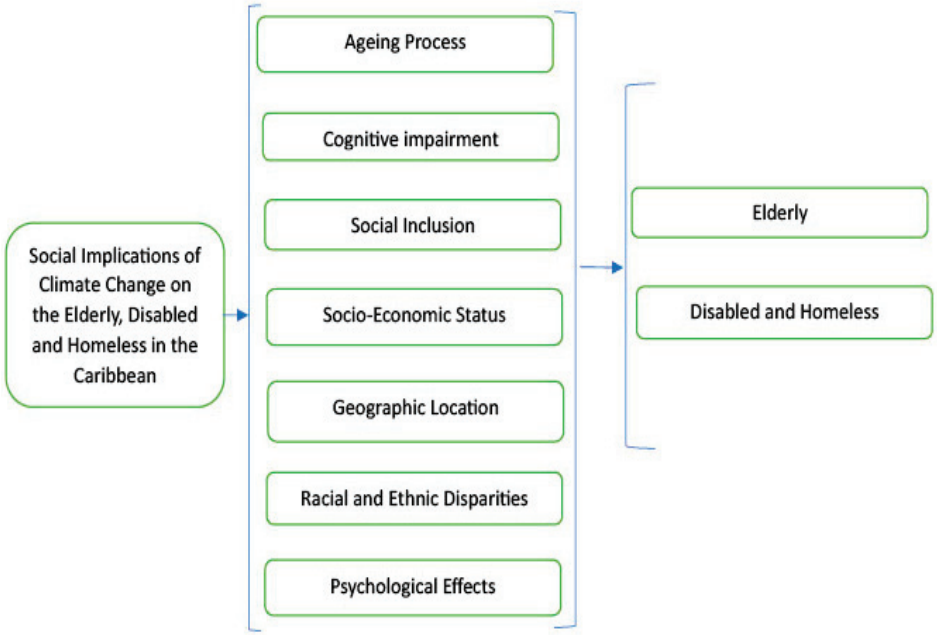

Figure 2. Literature map of the social implications of climate change on the elderly, homeless, and disabled in the Caribbean. Source: Figure by authors.

3.1. The Elderly

Bryant et al. (2022) share the physiological and psychological reasons why elderly persons are more susceptible to the effects of climate change. These included the aging process, cognitive impairment, social isolation, socio-economic status, geographic location, and racial and ethnic disparities.

3.1.1. Aging Process

Aging can increase risk factors for mobility, chronic conditions, and susceptibility to dehydration and can diminish sensory awareness (ACL 2018). These conditions can reduce the ability of these seniors to respond to climate events. Climate change events can exacerbate chronic illnesses in adults, especially when there is a lack of food or water, extreme heat or cold, stress, exposure to infections, and interruptions to access much-needed medications. Additionally, the elderly that are reliant on physical support and medical equipment may encounter disruptions in a climate change event such as a storm, hurricane, earthquake, or volcanic eruption (Balbus et al. 2016). Gamble et al. (2013) report that the most foreboding climate stressors

facing the elderly are heat waves, hurricanes, flooding, droughts, poor air quality, and infectious diseases. They might also be experiencing factors associated with advancing age, such as diabetes, cardiovascular impairments, and heat sensitivity. Bunker et al. (2016) find that a 1-degree Celsius rise in temperature can affect the mortality and morbidity of the elderly.

3.1.2. Cognitive Impairment

A study of evacuations during Hurricane Gustav in 2008 finds that nursing home residents with severe dementia had an increased mortality risk between 30 and 90 days after the evacuation (Brown et al. 2012). During a climate crisis or event, the elderly with cognitive impairments can have a limited grasp on communications, weather warnings, disaster bulletins, and offers of assistance. They might also have difficulty taking preventative measures before the event or being able to help themselves after the event. These seniors can become agitated during the crisis. Brown et al. (2012) report that, during Hurricane Gustav in 2008, residents in nursing homes had an increased mortality risk 30 to 90 days after evacuation. According to USA Today (2019), suffocating heat resulted in 12 patients dying after the passing of Hurricane Irma in September 2017. Irma caused a power outage to the nursing home's air conditioning system, and, as such, the residents experienced temperatures of nearly 100-degree temperatures for days. The workers at the facility, it was said, failed to evacuate despite the terrible heating situation at the Rehabilitation Center.

3.1.3. Social Isolation

Social isolation can create feelings of loneliness, helplessness, and hopeless feelings in the elderly. It can reduce an individual's capacity to cope with climate events. Seniors who are ill and housebound are unable to flee from harm during an emergency. They might not be able to ask for help or receive emergency information (Bryant et al. 2022). Banks (2013) adds that rescuers might not be aware of these individuals during search, rescue, and recovery efforts. This also points to the competence of emergency managers who do not recognize the specific vulnerabilities of the elderly and their inability to address these needs effectively.

3.1.4. Socio-Economic Status

Poverty tends to increase as individuals age (Li and Dalaker 2019). Elderly persons who live in sub-standard housing might be unduly affected (Gamble et al. 2013). Some elderly individuals living on fixed incomes may postpone much-needed repairs to their homes, which can be inadvertently affected by severe weather events. These weather events can expose this population to increased harm and danger with the inability to leave their homes quickly and safely.

3.1.5. Geographic Location

The Caribbean Islands are referred to as Small Island Developing States (SIDS). They might be the least responsible of all nations for climate change; however, they are the most likely to experience the worst effects of the same. In the long term, some islands may become inhabitable, and, as such, this makes them even more vulnerable. According to UNFCCC (2005), 90% of SIDS are located in the tropics and are seasonally affected by extreme weather events such as storms, hurricanes, and cyclones. These events produce flooding in coastal erosion, which affects the livelihoods of many. El Nino Southern Oscillation events also produce dramatic weather changes in rainfall, rising sea levels, and other events.

Mycoo et al.'s (2022) report states that the main areas of living are located along the coast and with their current infrastructure concerning urban development and are exposed to climate change hazards. They state that the population of many SIDSs are concentrated in the low-elevation coastal zone (LECZ), which is defined as coastal areas below a 10 m elevation. Approximately 22 million people in the Caribbean live below a 6 m elevation (Cashman and Nagdee 2017). Mycoo et al. (2022) posit that sustainable development challenges include insufficient land use planning and competition, which contributes to the vulnerability of settlements to climate change. Category 4 and 5 hurricanes severely impact settlements; for example, Hurricane Maria in 2017 destroyed nearly all of Dominica's infrastructure, and losses per unit of GDP amounted to more than 225% of the annual Gross Domestic Product (GDP) (Eckstein et al. 2018). Therefore, with respect to climate change incidences, SIDSs face several health risks that pertain to temperature change, including rainfall, climate variability, and extremes (Mycoo et al. 2022). Climate change is increasing the present burden of climate-related health risks. Health risks can arise from exposure to extreme weather events such as heatwaves, changing weather patterns, the compromised safety and security of food and water, and the creation of disruptions to health systems (Schnitter et al. 2019).

The homeless, as one of the groups most vulnerable to climate change, are exposed to especially concerning health impacts. These individuals are most exposed to weather conditions and a myriad of social and economic issues. Gamble et al. (2013) report that older adults and higher numbers of older adults with low incomes live in high-risk locations affected by global warming. These areas include coastal zones, which have experienced more frequent and severe tropical storms. Urban locations are considered a risk factor for vulnerability to climate stressors because of the 'urban heat island effect', present because of the dense concentration of pavements, buildings, and other surfaces that absorb heat. This heat effect can lead to heat-related illnesses and mortality.

3.1.6. Racial and Ethnic Disparities

Members of minority groups are susceptible to the effects of climate change as they may most likely experience situations that increase climate-related risks, such

as poverty. Poverty limits access to healthcare and proper housing for the elderly (Gamble et al. 2013).

3.1.7. Extreme Weather Events

Older adults are at risk of the impact of hurricanes; people 65 and older had the greatest mortality rate after Hurricane Maria, which descended on Puerto Rico in 2017 (Cruz-Cano and Mead 2019). The above discussion on the specifics of climate change that affect older adults can also be said about the homeless and the disabled. All three categories of vulnerable populations can be affected by social isolation, socio-economic status, geographic location, and extreme events such as hurricanes and flooding. This points to mobility issues for the elderly, disabled, and homeless. Where can they go to when such events occur? Who helps them? Additionally, are their immediate needs prioritized?

3.1.8. Psychological Effects

Older adults, according to Adeola and Picou (2014), experience higher stress levels three years after Hurricane Katrina compared to those under the age of 65. The psychological effects of experiencing a storm or hurricane had an impact on this vulnerable group. Levinson (2012) notes that while most homes for the elderly provide mental health services normally, these services are interrupted and not prioritized during disasters.

3.2. The Disabled

For the disabled, reduced adaptive capacity, according to Rhoades et al. (2016), is an issue, as traveling to a shelter in a storm can be extremely difficult for those confined to a wheelchair. These challenges can be worsened by crises. The morbidity risk is high for those with mental illnesses, disabilities, alcoholism, cognitive impairment, and other substance abuse and social isolation, increasing the risk of death (Ramin and Svoboda 2009).

3.3. The Homeless

It must be noted that homeless populations face unique vulnerabilities, and these vulnerabilities can lead to critical mental and physical health consequences, adding to which the prevalence of homelessness worldwide could be increasing due to climate change. Consequently, Kidd et al. (2021a) developed a hypothetical model that captures the risk factors and the vulnerabilities of the homeless to climate change. They looked at the types of risks in two categories: both primary and secondary. At the primary level, the risks were associated with cold, humidity, water level, rapid change, and disasters. At the secondary level, food, water, insecurity, vector-borne diseases. illness, mortality, morbidity, emergency service use, infrastructure burden, and homelessness prevalence were included.

Both levels of risk can be impacted by the following: dwelling vulnerability, chronic illness, malnourishment, mobility, education, social inequity, social service infrastructure, and response. As a consequence, the following outcomes can materialize, for example, illnesses that can lead to increased mortality and rising morbidity, exposure to violence, and emergency service use and infrastructure burden. This can have a cyclic effect and further increase the primary and secondary risks without proper interventions to mitigate these circumstances. Kidd et al. (2021b) add that there is a need for outreach and education, service adaptations, and disaster planning to assist with disaster responses. Homeless people may experience vulnerability to conditions such as heat stroke, dehydration, and respiratory illness (Osborn et al. 2019). Malnutrition is a huge issue that reduces their ability to tolerate temperature extremes (Walters and Gaillard 2014). It must also be noted that the homeless are a highly stigmatized group, and historic inequities can be exacerbated during adverse climate change events.

4. Exploring the Economic Implications of Climate Change on the Elderly, Disabled and Homeless in the Caribbean

By the year 2022, it is estimated that the population of the Latin American and Caribbean region will be 658 million (UN 2022). Even though the rate of fertility in the region has slowed by two births per female, those of the adolescent age have a rate of 53 births per thousand. This, together with the rising life expectancy of Caribbean nationals to 80.6 years by 2050, implies that by 2056, the region's population is expected to peak at 752 million (UN 2022). Such a transformation in the size of the population could undoubtedly cause significant changes in the demographic structure of the region. This implies that the vulnerable segment of these populations, such as the elderly and weaker social groups, not unlike the homeless and the disabled, are all likely to grow. According to the ECLAC-UN (2022), it is expected that by the year 2030, the proportion of people 60 years and older in the Latin American and Caribbean region will be 16.5%.

As the Caribbean region continues to grapple with the effects of climate change such as the negative fallout from natural disaster events, i.e., hydrological hazards, such as flooding, geophysical hazards such as earthquakes and landslides, and meteorological hazards such as hurricanes and tropical storms, it is expected that the number of people affected by such events will also grow. Among the wide range of areas in which these vulnerable segments could be impacted as discussed below, the one which stands out the most is housing, which could either be compromised or unavailable. Because of the immediate threats that climate change poses to the housing of the elderly, disabled and the homeless, this unavoidably creates a domino effect, with a myriad of challenges ranging from changes in household spending to individual healthcare, which these groups now face.

4.1. Limited Household Funds

Paying special attention to the economic implications that these events are likely to have on the elderly, homeless, and disabled in the Caribbean reveals that the elderly living in squalid and overcrowded conditions are susceptible to climate change events. Like elderly migrant women living in the slum areas of Dhaka City, India, and Kenya, elderly women in rural areas in the Caribbean might be one of the most vulnerable groups to climate change events because they are the poorest in their communities. It is possible that these elderly women, who may also be homeless and those who are rendered homeless due to climate change events, do not have sufficient household income to access basic needs such as food, shelter, and healthcare services (Amjad 2020).

This is an important issue because, during rising levels of inflation and cost of living in the Caribbean and given that the spending habits of the elderly and homeless people tend to yield short-term benefits, they are often allocated fewer public resources as their experience of climate risks is either ignored or oversimplified (Omolo and Mafongoya 2019). As a result, what may transpire is a reduced quality of life and standard of living, as climate change events might increase the risk of undernutrition as well as water insecurity experienced by the elderly, disabled, and homeless population; existing inequalities continue to persist because government assistance in the form of senior citizen's pensions, public assistance grants, and food cards are limited and insufficient to meet the medical and dietary requirements of such people as the cost of living continues to rise (Stein and Stein 2021). For these reasons, the elderly, homeless, and disabled in the Caribbean might not fully support climate change policies because of the lack of inclusion of their needs and experiences in climate change mitigation and adaptation plans (Andor et al. 2018).

4.2. Housing and Public Infrastructure

4.2.1. The Elderly and Disabled Population

The prevalence and intensity of climate change events often cause a significant and negative impact on household and living conditions, as well as the public infrastructure of victims around the world. In Brazil, Azevedo et al. (2021) explain that during climate change events, the movement of both the elderly and the disabled is severely hampered by different modes of transportation, which become inaccessible to them. This lack of inclusion by different modes of public transportation, such as public buses and taxis, creates an even greater risk during rainy weather, storms, and flooding events, as the elderly and disabled might use these services less, especially when residing in urban and rural areas in the Caribbean.

The lack of inclusion and social capital regarding disaster response for these groups often serves to exacerbate their current circumstances and makes them even more marginalized than before (Benevolenza and DeRigne 2018). This is especially the case, as disabled and weaker social groups in the Caribbean tend to be more

prone to impoverished conditions. As a result, they are less likely to be given priority during evacuation exercises and offered insurance to protect their assets and homes during adverse weather events. One example of such a situation occurred during the passage of Hurricane Katrina in 2005 when it was estimated that 155,000 people with visual and physical impairments were adversely affected during evacuation exercises (Kosanic et al. 2019). This is because people with disabilities as well as the elderly who are disabled, might not have access to safe housing and shelters during adverse weather conditions due to infrastructural issues such as walkways, bathrooms, and beds not being designed to meet their needs. Thus, some disabled people may be rendered homeless during and after severe weather events.

4.2.2. The Homeless Population

People who experience homelessness are generally exposed to extreme weather events because they lack the financial know-how to adapt to conditions by having their own homes. Often, these people may also be elderly and disabled and can have very little access to supportive social networks and secure supplies of food, shelter/housing, medical facilities, and medication (Anderson et al. 2021). In the Caribbean, it is expected that during the annual dry and rainy seasons, extreme temperatures and rainfall, which in the latter case lasts from June-November, means that the overall health of the homeless is lowest during this time. This is mainly because, during the rainy season, the increase in rainfall and the risk of flooding and landslides make them more susceptible to foodborne, waterborne, and vector-borne diseases, as they may have little access to secure and safe forms of housing and clean drinking water (Kidd et al. 2021a). Living in such conditions, unfortunately, contributes to the homeless in the Caribbean experiencing instances of lower emotional well-being, as well as the continued erosion of both their physical and mental health (Bezgrebelna et al. 2021).

Regrettably, in the design of climate change policies, the subject of climate change and the homeless population is often treated as two separate issues rather than looking at how they interact with one another (Greif 2021). Such a disconnect in the climate change discussion in the Caribbean implies that the vulnerability of the homeless to climate change events is not effectively addressed. This leads to the greater stigma associated with homelessness and more occurrences of environmental injustice toward the homeless (Gibson 2019). In such a situation, what is needed to combat the issue of climate change and homelessness in the Caribbean is a Human Rights-Based Approach, which addresses the housing precarity that the homeless face, providing better means of housing and urban planning with the homeless population as the main stakeholder.

One good example of a climate change response that is sensitive to the needs of the homeless, which the Caribbean region can learn from, is the measures implemented by the government of Bangladesh to deal with climate change-induced displacement. This plan, as explained by Kisinger and Matsui (2021), resettles

displaced homeless people into cluster villages on public land, providing life skills and training to help them better reintegrate into society and the workforce, as well as support through social safety nets, and financial support from all non-governmental organizations.

4.2.3. Public Recreational Spaces

Further to this, as the world's population continues to age, in most cities and communities where the elderly live, public spaces such as community gardens, parks, cafes, and barbershops are being created to encourage them to lead a more active, sociable, and healthier lifestyle. Unfortunately, as Higueras et al. (2021) explained, climate change events such as typhoons, hurricanes, and earthquakes can not only destroy these public spaces but also have a marked effect on the health outcomes of older people. Where there is a lack of green spaces, it is expected that health issues such as obesity, cardiovascular diseases, respiratory diseases, heat/cold shocks, accidents, and mental health issues, may pose an even greater risk when the elderly reside in high-density and rural areas.

In the Caribbean, even though there are many private and public sector enterprises which contribute to a thriving social atmosphere, such as waterparks, boardwalks, and parks, it is unknown whether these activities are designed for the needs of the elderly and the fluctuating climate change conditions in mind. For this reason, what is needed in the Caribbean is the design of inclusive, comfortable, and healthy green spaces, as well as communities that consider the safety, location, and health/mobility of the older population.

4.3. Health and Safety

Given that climate change influences the mortality of the elderly through elevated temperatures and air pollution, there is a need for age-specific temperatures and air pollution projection studies to be undertaken in the Caribbean to determine the predicted mortality burden of these changes within a heating climate (Chen et al. 2020). Studies have shown that in countries such as San Paulo, Brazil, as well as China and Crete, the prevalence of heat waves pose a significant threat to some of the most sensitive populations, such as the elderly, with the estimated heat-wave elderly-related mortality rate rising to 587 deaths per 100,000 residents per year in Brazil with exponential growth in the years of life lost to the elderly in China, and a strong correlation between the mortality of the elderly with both ambient temperature and humidity in Crete, Greece (Diniz et al. 2020; Huang et al. 2018; Tsekeri et al. 2020).

Notwithstanding the outcomes experienced by the elderly and other vulnerable groups in these countries, in the Caribbean, at the intuitional level, there is a need for municipalities within each town or district within their own local government office or regional cooperation office to design strategies that manage how the elderly in their respective communities' experience and manage heat-related

risks through enhancing their adaptation work. Such adaptation measures, like those implemented in Baden-Wurttemberg, Germany, could also target general practitioners and nurses who tend to the medical needs of elderly clients by providing supplementary emergency medical training to treat heat-related conditions (Herrmann and Sauerborn 2018). Such training would allow general practitioners in the Caribbean to better check for cardiovascular (ischemic heart disease) and respiratory ailments (heat stroke, exhaustion, and asthma) while monitoring how the use of certain drugs such as blood pressure medications, antihistamines, and decongestants, used to treat hypertension, asthma and allergies and changes in extreme temperatures, can cause heat intolerance.

Like the elderly, homeless and destitute people in the Caribbean are also known to suffer from the negative effects of extreme temperatures and, in some instances, heat waves. However, there remains very little empirical research, as well as adaptation and mitigation plans, documenting their experiences with climate change events such as extreme temperature, flooding, droughts, pollution, and vector-borne diseases.

Often the homeless, such as those in Australia and India, and like the Caribbean, may be more vulnerable to heat stress and other conditions resulting from changes in their living environment. For this reason, these groups are more likely to suffer from dehydration and heat stress symptoms and may even die from hunger (Every et al. 2021; Islam 2022). For this reason, what is needed in the Caribbean, in such a case, is for the state and non-governmental organizations to make available safe and clean forms of drinking water for the homeless alongside safe forms of housing, information on heat stress symptoms through outreach programs, and to provide greater access to housing units, and shelters which are aimed at the homeless population.

4.4. Climate Change Adaptation for the Elderly, Disabled and Homeless

Given that many countries may not have specific climate change adaptation and mitigation plans which are focused on the needs of the elderly, the disabled, and the homeless in society, what is needed in the Caribbean are risk assessment and communication studies which concentrate on vulnerable groups such as the elderly, disabled and the homeless, to determine how they perceive the impact that climate change is likely to have on their health and response to extreme weather conditions (Bi et al. 2020).

In this way, Caribbean environmental agencies can learn from and follow in the footsteps of countries like China and Japan, who are already ahead of most countries in ensuring that, even with the occurrence of climate change events, the most vulnerable in society can continue to lead a healthy lifestyle which is both sustainable and productive, while designing effective communication strategies to meet the needs of these groups.

For example, in the case of Tokyo, Japan, Park et al. (2021) explained that the use of more advanced mapping techniques, such as fine-scale heat mapping, is an essential component in the design of adaptation strategies when it comes to dealing with the intensity of heat exposure experienced by the elderly residing in urban areas. The use of spatial patterns of heating, if adapted to the Caribbean, would allow for not only greater comparisons to be made but help environmentalists and policymakers in the Caribbean identify where the hotspots of heat exposure by the elderly occur and how large they are expected to grow in the future.

Further to this, given that climate change impacts the livelihoods of elderly, disabled, and the homeless in a significant way, it is expected that during and after climate change events, the ability of some economically actively elderly and disabled people may be constrained either through the loss of jobs, or their reduced ability to undertake tasks at work due to financial and personal constraints. Further to this, continued joblessness, together with the loss of income and housing, are also contributing factors to people becoming homeless. Thus, it is important to develop employment programs that are targeted toward retired and unemployed elders, as well as persons who are disabled, to strengthen their earning capacity.

4.5. Research and Development

Additionally, besides the individual and institutional economic costs associated with the impacts of climate change on the elderly, disabled, and the homeless, it is noted that within the environmental research literature, there is a significant lack of country-specific studies that examine the impact of climate change events on these vulnerable groups, particularly for the Caribbean (Kwon 2020; Kinay et al. 2018). For this reason, it is not likely that the direct effects of climate change diseases and the negative outcomes caused by climate change events, such as extreme temperatures, are recorded in the Caribbean. This hinders the implementation of policy measures promoting the adaptation of vulnerable groups such as the elderly, homeless, and disabled to climate change events since few studies produced in the Caribbean empirically examine the impact that climate change has on these communities (Kosanic et al. 2022).

Such insufficient research is likely to have a negative influence on the design, practice, and implementation of climate change policies concerning this segment of vulnerable people, as the research undertaken may not be either supportive or inclusive of the needs of these people. Furthermore, the exclusion of these vulnerable persons in the design of climate change policies could create an unstable policy environment, reducing the dissemination and uptake of research. This issue, together with issues of limited grant funding and limited engagement with policymakers, practitioners, and intermediaries, could, unfortunately, discourage researchers from undertaking good quality climate change research focusing on vulnerable populations that are robust and ethical and can inform policymaking. For this reason, there is a dearth of case studies that examine these issues in the Caribbean.

What is needed, in this instance, is greater investment in conducting empirical research studies and a case study approach, which examines the health effects of climate change on the homeless, elderly, and disabled in the Caribbean. The findings of such studies could be integrated and used in the policy implementation process of adaptation and mitigation plans. The collection of relevant data, and the production of empirical research studies, are imperative to the successful implementation of these policies because their lack of evidence is often highlighted as the main barrier to undertaking such studies. Should greater data be collected and analyses be undertaken, it would illustrate how climate change events influence the ability of the elderly to adapt to such situations with the need for more social safety nets (Rhoades et al. 2016).

Further to this, within the literature, there is a great need for climate change research to be more compassionate in terms of its conceptualization of human vulnerability (Eriksen 2022). Instead of describing the disabled, elderly, and homeless as victims of climate change, they could be viewed as the experts on adaptation and mitigation strategies that are geared toward their specific vulnerable group. Such a reimagining of the roles and insights of the disabled and the vulnerable concerning climate change events could reduce their exclusion and promote greater inclusion in the design of environmental and climate change policies (Larrington-Spencer et al. 2021).

Moreover, the experiences and needs of vulnerable communities in response to climate change events are often clumped together and generalized within the literature. Strambo et al. (2021) explained that such a practice should be stopped in each vulnerable group, such as the disabled, homeless, and elderly, who all have multiple identities with different needs that all intersect with each other. As the systematic scoping review method implemented by Kidd et al. (2021b) revealed, in the case of the impact that climate change has on homelessness, this topic is severely under-developed, and is insufficient in its current form to adequately address or even inform mitigation and adaptation plans.

5. Conclusions

Small Island Developing States (SIDS) are vulnerable to climate change events because of their nature and geographical location. Many dwelling places are located along the coast in the direct path of adverse weather events, such as storms and hurricanes, which wreak havoc on landfall. The vulnerable populations of the elderly, homeless, and disabled are inappropriately affected because of already present health issues, social isolation, mobility, limited access to services, and psychological issues. Stakeholders and the Government of the day must recognize the social and economic implications of these vulnerable populations and seek to address these as soon as possible. Mitigation and adaptation plans are necessary and must be prioritized to ensure that the risks to these groups are minimized and that an element of safety and security ensues. The fundamental human rights of these groups are in question

concerning climate change and its events. Awareness and education are integral as a means of support and recognition of these groups. There must be action and intervention undertaken to protect the lives of these vulnerable populations.

Some of the most important economic implications that climate change is likely to have on the elderly, disabled, and homeless groups in the Caribbean include (1) the elderly and the homeless might not have a sufficient household income to put in place mitigation measures in cases of severe weather conditions, (2) the movement of the elderly and the disabled could be severely impacted by severe weather conditions as different modes of transportation become limited and inaccessible during extreme flooding and rainfall, (3) the health of the homeless population is likely to worsen during periods of excessive rainfall, as they may have limited access to safe housing and clean drinking water, (4) the destruction of green spaces during climate change events can negatively impact the health outcomes of older people, leading to a rise in chronic health conditions.

The findings from this study show that not only do climate change events have a significant and often irreversible impact on the elderly, disabled, and homeless groups in the Caribbean, but their exclusion from climate change policies, and empirical research studies, can mask greater societal problems in the Caribbean like unequal opportunities, discrimination, ableism, gentrification, and ageism. The findings of this study provide several avenues for several unique pieces of future research to be undertaken, such as examining the link between gentrification and climate change in the Caribbean, as well as looking at the role which ageism plays in climate change discussions in the aging Caribbean region.

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The Impact of Climate Change on Maternal and Child Health in the Caribbean

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Abstract: Maternal health concerns the well-being of women during pregnancy, childbirth, and the postpartum period. Climate change events often threaten maternal health because mothers and their offspring are more susceptible to environmental changes. In developing countries, 88% of children succumb to climate change-related deaths. The inherent vulnerability of mothers and their offspring to infections, illness, and malnourishment due to limited social services, healthcare, low household income, and dependency, are often to blame for the high mortality rate. Given that the literature on the impact of climate change events on maternal and child health in the Caribbean region is scarce, this chapter seeks to address this gap by using a secondary research approach. The impacts that climate change events in the Caribbean are likely to have on the maternal and child health of persons residing in flood-prone areas and coastal communities will be discussed. Like Nigeria, Ghana, and India, in the Caribbean, climate change events negatively impact the mortality of the mother and her child. The decline in the nutritional quality of food, amongst other health-related issues, also contributes to adverse pregnancy outcomes.

1. Introduction

Climate change represents one of the most significant global health threats of the 21st century, but more so for vulnerable populations, such as pregnant women and children. Extreme temperatures, airborne diseases, and the intensity of hurricanes with destructive high storm surges negatively impact some of the poorest countries in the Caribbean. Airborne diseases are caused by pathogenic microbes small enough to be discharged from an infected person via coughing, sneezing, laughing, close personal contact, or aerosolization of the microbe. The discharged microbes remain suspended in the air on dust particles, and respiratory and water droplets. Illness occurs when the microbe is inhaled or contacts mucus membranes or when secretions remaining on a surface are touched (Division of Disease Surveillance 2023). Some of these countries do not have the measures to either mitigate or adapt to these climate change events, leaving them at the mercy of climatic elements that accompany these natural disasters. Globally, approximately 1.3 billion people in low- and middle-income countries live below the poverty line, with 70% of these people being female (Sorensen et al. 2018). Climate change diminishes women's health, especially during pregnancy, where maternal health and nutrition are vital to the developing foetus and infant (Franco-Orozco and Franco-Orozco 2018; Sorensen et al. 2018).

Roos et al. (2021) assert that climate change impacts the maternal health of expectant mothers in many ways, such as pregnant women experiencing physiological changes that make it challenging to thermo-regulate. These changes include internal heat production due to foetal growth. When heat balance cannot be maintained, heat shock causes proteins are released, creating biological and physiological reactions with severe effects on maternal and perinatal health, including the neonatal period. Heat exposure can increase the risk of premature birth and rupture of membranes, low birth weight, and stillbirth (Chersich et al. 2020; Bekkar et al. 2020). Dehydration from increased sweating in pregnant women can cause the onset of early labour and prolong the duration of labour (Hnat et al. 2005).

The United Nations Children's Fund (UNICEF) (2015) posits that the dangers of climate change are more pronounced for children than for adults. Children are more vulnerable to vector-borne diseases than adults and face dangers from under-nutrition and diarrhoeal diseases. UNICEF adds that the physical dangers of extreme weather events can cause adverse effects on their young bodies and mind. Children will also experience these effects longer than adults. This chapter examines climate change's social impact and economic cost on maternal and children's health. Apart from the impacts, it calls attention to ways in which adaptation can help quell these impacts to enhance the standard of living for those affected.

The debate on the impact that climate change has on maternal health around the world has consistently focused on vulnerable populations in countries such as India, Indonesia, Nigeria, Ghana, and Uganda, as well as regions such as Sub-Saharan Africa and Asia. This focus is often the case because the populations of such countries and regions are prone to experiencing extreme forms of natural disasters. For example, in the case of the Asian Pacific region, there is a tendency for tsunamis, volcanic eruptions, earthquakes, and cyclones to occur, while in Asia, there is a frequent incidence of floods, landslides, mudflows, and extreme temperatures (UNICEF 2022; Burunciuc 2022).

Even though these countries have very little control over the prevalence of these climate change events, as they are indeed natural disasters, what countries can control is their response to these events through the timely implementation of mitigation and adaptation strategies. Unfortunately, many disastrous climate events tend to occur in low-income developing countries and small island developing states, where there are minimal resources and means of responding to such disasters.

Women and children are two of the most vulnerable groups negatively impacted by climate change events (Adebayo 2021). According to the World Population Prospectus by the United Nations (UN) (2022), the data for 2020–2021 reveal that within one year, both the Total Fertility Rate (TFR) and global births have fallen by 0.03 births per thousand and 1,158,000 births, while both the number of infant deaths and infant mortality rate have fallen. A similar trend is echoed in the Caribbean region where for the same timeframe, the number of births has fallen by 10,000, while the TFR has also fallen by 0.03 (UN 2022).

The same cannot be said for regions like Sub-Saharan Africa, which is prone to severe natural disasters, as there was an increase of 596,000 births between 2020 and 2021 (UN 2020). Although these population statistics on a global scale and for the Caribbean reveal a somewhat positive outcome regarding the mortality of babies and population demography, it is at the regional level that pregnant women living in places like Sub-Saharan Africa and Asia experience maternal and neonatal health problems. This situation is likely to be exacerbated by climate change.

2. The Social Impact of Climate Change on Maternal and Child Health in the Caribbean

Women are affected both socially and culturally by climate change. Five aspects of climate change that impact maternal health and children will be discussed based on Sorensen et al. (2018). From a social perspective, these aspects are the increasing frequency of extreme heat events and rising seasonal temperature; poor air quality from the combustion of fossil fuels; increased frequency of climate disasters such as hurricanes and flooding; food insecurity; as well as changes in temperature, precipitation, and ecology which are altering the presence of vector-borne diseases.

2.1. Increased Frequency of Extreme Heat Events and Rising Seasonal Temperatures

Van Zutphen et al. (2012) was one of the first studies to address elevated temperature and its association with congenital disabilities. Rylander et al. (2013) also examined elevated temperatures and maternal health and found that the physical exchange of heat to maintain a stable core body temperature is approximately 37.8 degrees Celsius. Heat will be added to the body if the air is hotter than the body. An individual's capacity to reduce excessive heat by sweat evaporation to regulate core body temperature is influenced by the surrounding temperature, humidity, wind, and clothing. If the core body temperature continues to rise, heat exhaustion can occur. Persons can adjust by seeking shade, drinking more water, and swimming. However, with the increasing temperatures caused by climate change, the heat shock risk increases. Pregnant women are at risk of 'over-heating' because of their hormonal situation at all stages of pregnancy (Cunningham et al. 2010). This 'overheating' increases health risks for both the mother and foetus. Kuehn and McCormick (2017) add that dehydration in pregnancy results in decreased uterine blood flow and could lead to pre-term labour. Newborns can experience a too high or too low temperature as they possess limited temperature regulation capacity (Poursafa and Kelishadi 2011). Strand et al. (2011) reviewed the literature and suggested that the impact of seasonal patterns of prenatal exposure to extreme ambient temperature may be a factor for pre-term birth and stillbirth. Sheffield and Landrigan (2011) stated that heat-related effects may affect school performance and increase pregnancy challenges and renal effects. The influence of these outcomes would vary by region and socioeconomic status, fuelling health inequalities (Sheffield and Landrigan 2011).

According to Sorensen et al. (2018), extreme heat events and their consequences for maternal health and children are exacerbated by poor access to healthcare services and cooling facilities, and lack of transportation to access these healthcare services. Lack of communication and awareness by the populace, those in authority, decision makers, and healthcare professionals to the effects of extreme heat adds to the list. There is also a paucity of gender-disaggregated heat-related health data to assist in decision making. Religious and culturally heavy clothing add to the consequences of extreme heat events (Sorensen et al. 2018)

2.2. Poor Air Quality

Poor air quality from the combustion of fossil fuels and air pollutants can cross the placenta and impact foetal growth. It can also impair maternal respiratory and cardiovascular health leading to reduced efficacy of placental function and consequently foetal development (Sorensen et al. 2018). Indoor Air Pollution (IAP) can also affect pregnant mothers. Pope et al. (2010) stated that the consistency of findings across settings and exposure to second-hand smoke and ambient air pollution point towards a causal relationship between low birth weight and IAP and begged for further studies in developing countries. It must be noted that traditional indoor stoves are used for cooking in many developing countries. This cooking method produces carbon monoxide and hydrocarbons and accounts for nearly 24% of ambient air pollution (Health Effects Institute (HEI) 2020).

2.3. The Frequency of Climate Change Disasters

There is an increasing frequency of climate disasters, such as hurricanes and flooding, in Small Island Developing States (SIDS). Mycoo et al. (2022) posited that among the 29 Caribbean Small Island Developing States (SIDS), at least 22 were affected by at least one Category 4 or 5 tropical cyclone in 2017. These climatic events highlighted these islands' high exposure and vulnerability, which can add to community vulnerability for long periods of time. Added to this, the exposure of the surface of these islands over their entire area, the high concentration of people, infrastructure, utilities, lack of services in flood-prone coastal areas, inadequate housing, limited access to food and transportation, and unpreparedness explains the widespread total devastation. This devastation affects island supply chains which depend on ports, roads, power, and communications and contributes to the complexity of rescue operations and the delay in returning to a sense of normalcy on the affected islands. Fresh water, food supplies, medications, and fuel are in short supply for several weeks or months after the climatic event. The vulnerability of healthcare systems is triggered and can become a burden to many (Shultz et al. 2018). Morbidity and physical injuries escalate. Imagine this scenario for maternal health and children. There are 29 Small Island Developing States (SIDS) in the Caribbean.

Women suffer disproportionate mortality during natural disasters. Women that are particularly vulnerable during disasters are mostly homebound, caring for

children and the elderly while waiting for relatives to return from disaster-related evacuation. Underlying inadequate literacy and education can add another layer to vulnerability as women may not have access to information. This inadequacy can affect women's ability to take steps to safeguard their lives (United Nations Division for the Advancement of Women (UNDAW) 2001). Women seem to be more calorie-deficient than men, leading to poor physical health and vulnerability to resource shortages, as suggested by studies from Bangladesh (Rahman 2013; Del Ninno et al. 2001). Pregnant women and those giving birth post-disaster have been found to have increased risks of complications such as preeclampsia, uterine bleeding, and low birth weight (Tong et al. 2011). Notably, women and girls in the aftermath of a disaster, particularly those in lower-economic situations, are at higher risk for physical, sexual, and domestic violence (International Federation of the Red Cross and Red Crescent 2007). Women suffer undesirable job loss, stagnant personal economic recovery, and poor access to obstetric care following and during disasters (Sorensen et al. 2018).

UNICEF (2015) states that floods threaten children's survival and development. The direct impact includes injuries and death by drowning. Many children lack the strength to stay on their feet against raging waters with debris. Floods compromise safe water supplies. Contaminated water can lead to diarrhoeal outbreaks. Worldwide, diarrhoea ranks among the top five causes of death for children under 5 years of age. Diarrhoea is a significant cause of death during natural disasters and other complex emergencies (UNICEF and WHO 2009). In these situations, people are further displaced, and they move into temporary, overcrowded shelters where the drinking water may be tainted and space is limited Additionally, damage to housing and lack of sufficient shelters expose children to danger and lack of food availability. Coastal flooding salinates, i.e., the reintroduction of soluble salts into arable land, destroy crops and reducing food availability and income. In such instances, breastfeeding becomes vital as preparing breastmilk alternatives can become nearly impossible.

2.4. Food Security

The vacillation of rainfall and temperature patterns negatively impacts crops, livestock, and fishery yields, adding to food insecurity. According to Sorensen et al. (2018; Jáuregui-Lobera 2014), women suffer higher rates of macro- and micronutrient deficiencies, and higher rates of anaemia which can impair cognitive functioning such as poor attention span, diminished capacity to remember things, emotional highs and lows, and impaired sensory perception. Malnutrition can cause negative impacts on neonatal outcomes, including intrauterine growth retardation and perinatal mortality (FAO 2002). Taking all these aspects into consideration, women are inherently sensitive to food insecurity and the resulting deficiencies due to increased needs during pregnancy and post-pregnancy, for example, in the feeding of the newborn. Often, culturally, women may prioritise food provision for children and adult males,

neglecting to ensure that they obtain a balanced or available meal. In low-income countries, women produce 60–80% of all food. As such, livelihoods, as well as nutrition, are negatively impacted during times of disaster (GDI 2017). Further, less than 10% of female farmers are landowners and barely 2% have proper paperwork for their land, exacerbating control over farmland and food security (GDI 2017).

According to FAO (1996), food insecurity is defined as inadequate access to healthy, affordable, and culturally appropriate food and this impacts more women than men, especially those of reproductive age. Food insecurity during pregnancy has great implications for the health of the mother and her baby, as this can lead to negative maternal and child health situations (Augusto et al. 2020). Pregnant women who do not have access to proper nutrition are at a higher risk for gestational diabetes and excess maternal weight gain (Laraia et al. 2010), low birth rate (Sahlu et al. 2020), maternal stress (Augusto et al. 2020), birth defects (Carmichael et al. 2007), and premature births and can struggle to breastfeed (Orr et al. 2018). Challenges with food insecurity during pregnancy can have detrimental effects on child growth and development (Augusto et al. 2020). Moafi et al. (2018) posited that food insecurity is linked to poor quality of life for pregnant women and Maynard et al. (2018) added that it is also linked to prenatal and postpartum depression. McKay et al. (2022) supported this by stating that the burdens imposed by food insecurity worsen the mental health of pregnant woman. McKay et al. added that it is important to screen very early for food insecurity in pregnancy and to identify 'at risk' women. This would benefit the provision of mental health support. Most often, food insecurity initiatives, with respect to pregnant women, do not consider income and poverty, employment status, education level, location, ethnicity, and access to food and nutrition programmes (Costa et al. 2017).

2.5. Changes in Temperature, Precipitation, and Ecology Are Altering the Presence of Vector-Borne Diseases

Exposure to mosquito-borne illnesses poses health issues to pregnant women. Dengue virus, present in the Caribbean, leads to an increased risk of caesarean delivery, eclampsia, and growth restriction (Pouliot et al. 2010). It is the most rapidly spreading mosquito-borne viral disease in the world. Sorensen et al. (2018) found that pregnant women are susceptible to mosquito-borne diseases due to their higher CO_2 production and increased peripheral blood flow. Mosquitoes are attracted to CO_2. Consequently, this helps them to locate their hosts quickly. Sorensen et al. explains that women spend more time around the home performing domestic tasks, which places them close to standing water with mosquito breeding sites. They add that lack of access to proper prenatal care and supported deliveries puts women at risk for postpartum haemorrhage and poor maternal outcomes.

The issues highlighted in Sections 2.1–2.5 look at the situation where pregnant women and children are affected by the social conditions that increase their vulnerability to climatic events. Pregnant women, babies, and children deserve

to live and exist in a world free of the debilitating effects of climate change. As such, issues impacting these populations must be put on the agenda of Caribbean governments to safeguard maternal and children's health. Some interventions can include:

- Reducing greenhouse gas emissions to limit temperature rise. The focus should be on sustainable development.
- Prioritizing the needs of pregnant women and children and making them central to climate change adaptation. While we acknowledge that all people deserve protection from the vagaries of climate change, the effects will rebound more to those with the least say on climate change.
- Provisioning the most substantial protection from the government and civil organisations to pregnant women and children to reduce the inequity.
- Enhancing healthcare systems. Robust and reliable healthcare systems are critical for healthy children and mothers.
- Listening to women's and children's voices on climate change. Their participation is integral for effective interventions in their lives.
- Educating and building awareness training in climate change are critical ingredients of support. This training can help foster women's and children's capacity to adapt to change. It can also promote community resilience by imparting knowledge, skills, and engagement. People will feel a part of and be stakeholders in their own lives. Inclusion and stakeholder commitment are two tools that provide a buffer against climate change. Environmental sustainability should be put on the curriculum of primary and secondary schools to enhance the understanding of the mitigation and adaptation strategies for climate change.

Apart from the social issues, the economic costs of climate change events on maternal and child health of low-income and single-parent households were alluded to in addition to the social perspective; these socioeconomic aspects are highlighted below.

3. The Socioeconomic Aspects of Climate Change Impacts on Maternal and Child Health in Low-Income and Single-Parent Households in the Caribbean

The emphasis will be placed on briefly discussing the possible economic implications that climate change events are likely to have on the health of pregnant women and their babies residing in low-income and single-parent households in the Caribbean. This discussion is from the perspective of changes in temperature, air pollution, drought, flooding, structural racism, and eco/climate anxiety.

Such a meaningful discussion is essential, as the climate change events discussed below will likely hurt both the mother and baby's pre- and post-natal healthcare. Moreover, such a dialogue is indeed crucial at this stage in the climate change discussion as all the issues highlighted below may prevent the Caribbean from achieving goal 3 of the Sustainable Development Goals (SDGs) which focuses on

ensuring healthy lives and promotes well-being for all ages with particular reference to maternal health. This dialogue is necessary because climate change tends to impact maternal and childhood health in a myriad of ways, as discussed below, and the low-income status of many pregnant mothers in the Caribbean. This situation may prevent them from coping with the problems of food insecurity and accessing proper healthcare services and housing infrastructure (Homer et al. 2009).

3.1. Temperature-Related Impacts

According to Molina and Saldarriaga (2016), there are five ways in which temperature can influence the growth and development of an unborn foetus in pregnant women. These are discussed briefly below and include the accessibility of food, maternal mental health, biological infectious diseases, extreme temperatures, and temperature-related diseases.

3.1.1. Inadequate Access to Food Supplies at the Household Level

In the first case, severe malnutrition in pregnant women can occur because of climate change events such as droughts, flooding, and landslides. This malnutrition is because, under such severe weather conditions, the quantity and quality of food produced become constrained. The limited availability of nutritious food due to changes in agricultural production and low household income often creates an unpredictable environment for the foetus to grow and develop.

To cope with extreme cases of hunger, pregnant women in the Caribbean who are part of low-income households may change their consumption of foods to one which may be high in calories, but low in nutrients, also known as nutrient-poor foods because of their cheaper cost (Bloem et al. 2010; Darnton-Hill and Cogill 2010). Such an unexpected change in the quality of pregnant women's diet can lead to micronutrient deficiencies, which are associated with higher birthweight/large gestational age, maternal obesity, and gestational diabetes (Zhu et al. 2019).

The unpredictable nature of changes in the weather was also noted to affect pregnant women in rural Uganda, for example, who are part of indigenous communities. Even though there was a marked improvement in their access to antenatal healthcare, the overall maternal and child health amongst their people declined and worsened as food insecurity persisted when compared to non-indigenous women (Bryson et al. 2021). Nevertheless, regardless of the origin, such food insecurity will likely result in less diet diversity in the long run and a rise in maternal health disorders in the Caribbean, which are associated with poor diet and nutrition (Niles et al. 2021).

3.1.2. Maternal Mental Health (MMH) Costs

In the second case, according to Engle (2009, p. 963S), maternal mental health is "a state of well-being in which a mother realises her abilities, can cope with the normal stresses of life, can work productively and fruitfully, and can

make a contribution to her community." Often conditions associated with extreme temperatures, such as heat stroke and dehydration, can exacerbate pre-existing mental health conditions experienced by some pregnant women, such as postpartum depression, maternal dysthymia, pregnancy, and postpartum anxiety and obsessive compulsive disorder (OCD), as well as birth- related Post-Traumatic Stress Disorder (PTSD) (Waqas et al. 2022).

In cases where such conditions exist, they can affect the developmental outcomes of the foetus in many direct ways, such as interrupting the bonding process between mother and baby, breastfeeding, and changes in the cognitive ability of the baby (Smith et al. 2022; Juvrud et al. 2021). Notwithstanding these factors, pregnant women and single parents from low-income households in the Caribbean may suffer from higher rates of MMH disorders. Pregnant women and single parents in the Caribbean reside in low-income households with more than one dependent relative and children. Household resources may be diverted from accessing additional forms of care, such as counselling and social services, to satisfy primary needs, such as paying utility bills and buying groceries.

In addition, pregnant women who suffer from MMH conditions may access less treatment because the topic of mental health in the Caribbean carries a great deal of stigma. Consequently, even though healthcare institutions in the Caribbean provide such services, and while it may be essential to maintaining the health of some pregnant women, these services may not be used due to fears of discrimination by family, peers, and community members. The internalisation of shame by pregnant women brought on by MMH disorders and the associated stigma can worsen these conditions, making the condition more prevalent in the Caribbean.

3.1.3. Biological Infectious Diseases

In the third case, there is a class of diseases transmitted by biological vectors, which can also be transmitted from mother to baby. The World Health Organization (WHO) (2020) has listed nine vectors, that is, mosquitoes, aquatic nails, fleas, ticks, lice, blackflies, sandflies, tsetse flies, and triatome bugs, as being the primary cause of 27 diseases which can be manifested as either viral, bacterial, parasitic, or ectoparasitic diseases. According to Brand and Keeling (2017), temperature changes influence the life cycle of biting insects, including those listed above, which may cause these insects to bite more on warm days, leading to greater transmission of diseases.

Vector-borne diseases are known to cause distress amongst pregnant women, as the timing of such infections can be in utero like congenital Zika syndrome, leishmaniasis, and Chagas disease. These diseases can have adverse outcomes during pregnancy, such as low foetal birth weight, congenital deformities, and even pre-term labour, as they can be passed on congenitally (O'Kelly and Lambert 2020). In terms of child health, vector-borne diseases, along with water- and airborne diseases, some of which are caused by climate change events, are known to negatively affect

young children's health outcomes, causing conditions such as asthma and pneumonia (Akachi et al. 2009).

The emergence of vector-borne diseases such as the Zika syndrome in the Caribbean can pose a significant risk to pregnant women, even though the WHO (2022) indicates that the region had the lowest report of such diseases in 2020. This is because there has been a lack of reporting and sensitisation of the public by the health institutions of Caribbean countries. As a result, the extent to which this vector-borne disease impacts the foetuses of pregnant women in the Caribbean may not be known. Although it is not known, it is possible that women from low-income households may not be able to access the necessary medical attention or take precautions to safeguard the foetus's life, which makes them particularly vulnerable.

3.1.4. Extreme Temperatures and Temperature-Related Diseases

In extreme temperatures such as heat waves, pregnant women in the Caribbean may become vulnerable to heat exhaustion, heat cramps, heat stroke, and dehydration, which can lead to premature labour. Extreme temperatures also make it more likely that wildfires in the Caribbean will occur more frequently and last longer. As a result, it is expected that the contents of the smoke, which may also include harmful chemicals from plastics and toxic fumes from waste materials, can also contribute to pre-term labour. This an important problem, as low-income households in the Caribbean may not be able to manage periods of hot weather in a resilient manner because their houses may not be designed with cooling measures such as air conditioning units, thermostats, ceiling fans, and attic and garage insulation (Flores-Larsen and Filippin 2021).

The smoke contents can reduce the blood volume, which causes the level of oxytocin to become more concentrated, thus leading to Braxton Hicks contractions, better known as false labour pains (Raines and Cooper 2022). Such contractions, while expected, can potentially cause distress to the foetus. Furthermore, extreme heat waves, which are known to cause pre-term deaths, neonatal deaths, and miscarriages, were also found to be associated with seasonal variations in the use of caesarean delivery for high-risk pregnancies. One example of such an occurrence is in Ghana, where high ambient heat and extreme temperatures led to a higher incidence of both caesarean deliveries and spontaneous abortions.

Under such circumstances, as the maternal heat exposure level rises, so too does pregnant women's likelihood of experiencing an abortion (Asamoah et al. 2018). In cases where a caesarean delivery and spontaneous abortions may become a reality for some pregnant women in low-income situations, this may become a financial and legal burden. These procedures are expensive but having an abortion in many Caribbean countries like Trinidad and Tobago in its Offences against the Person Act is currently illegal (Trinidad and Tobago 2016). Therefore, while some of these procedures may not be accessible through public health institutions, in instances where such procedures are necessary to preserve the mother's life, they can be

inaccessible to pregnant women and single parents from low-income households, which may lead to a rise in illegal abortions and maternal deaths amongst this population segment.

Apart from foetuses, young children under five years old are also vulnerable to high temperatures associated with extreme heat as they have little ability to thermoregulate, i.e., to regulate their body temperature. Studies such as Hu et al. (2019) have found that short-term changes in the outdoor temperature were strongly linked with high blood pressure in children, especially if the patient is female and has a low body mass index. In countries like the Caribbean, with a distinct dry weather season, the exponential growth in heat-related child mortality is likely to outweigh any improvements made to reduce child death from these conditions. This can be due to changes in population growth and the continued rise in global emissions (Chapman et al. 2022).

3.2. Ambient Air Pollution

During the different stages of pregnancy, the immune system of pregnant women tends to change to ensure that the foetus which grows within the maternal uterus is not rejected by the mother's immune system (Förger and Villiger 2020). During this period, the mother's immune system becomes more sensitive to toxins and chemicals deposited in the environment through exhaust discharges, air congestion, and factory emissions. Inhaled toxins can influence the outcome of her current pregnancy via pre-term birth, low birth weight, and neurological disorders, and also future pregnancies due to adverse effects on her fertility.

Notwithstanding these experiences of pregnant women in the Caribbean, the reproductive health of all women, regardless of if she is pregnant or not, can be adversely affected by several climate change variables such as humidity, precipitation, and temperature of the environment, as well as changes in gonadal function and neuroendocrine regulation due to changes in health and socioeconomic status (Choudhari 2022; Jegasothy et al. 2020).

In addition to the health of pregnant women, ambient air pollution in the form of exhaust fumes, forest fires, and agricultural production exacerbates climate change. It is also widely hazardous to children's health (Brumberg and Karr 2021). These fumes worsen respiratory diseases in children and babies sensitive to changes in air quality. In the case of the Caribbean, the major contributors to air pollution in the region are produced by the areas of manufacturing, oil refinery, electrical power generators, transportation, and lead production.

In the Caribbean, the average exposure to ambient air pollution remains high, about 18.3 $\mu g/m^3$ with a household air pollution exposure of 0.413 $\mu g/m^3$ in 2019 (Health Effects Institute (HEI) 2020). In both cases, the concentration of air pollution poses a threat to pregnant women, young children, and Caribbean economies. If sources of pollution are left unchecked, this can lead to not only public health crises in terms of a surge in the maternal problems mentioned earlier and respiratory illnesses,

but it can put a significant strain on all sectors. Financial resources would be diverted away from health, education, and infrastructure to the environmental sector to treat the problems of air pollution.

3.3. Droughts

In the Caribbean, with a defined wet and dry season, droughts can be caused by a failed rainy season with a dwindling of freshwater resources. Climate change events such as droughts tend to significantly impact pregnant women's health because the threat of famine implies that the risk of hunger and malnutrition is great.

In the Asia-Pacific and Caribbean regions, such a threat impacts not only the dietary needs of women but also their overall health and sanitary needs because droughts often cause the price of food, water, and basic amenities to increase at an alarming rate (Algur et al. 2021). As a result, during periods of drought, inadequate access to water is further complicated by poor sanitation, which in turn, can contaminate water sources, leading to a recurrence of childhood respiratory, fever, and gastroenterological illnesses in pregnant women and children (Singh et al. 2006).

The lack of a frequent, accessible, and clean supply of water poses a great risk to the foetus, as pregnant women from low-income households may not have easy access to bathroom facilities (i.e., toilet, shower, bathtub, or sink for washing) with running water, as well as clean cooking facilities (Patel et al. 2019). As a result, economically poor pregnant women may experience adverse pregnancy outcomes under drought conditions, increasing the maternal mortality ratio of women in the Caribbean. As economic resources become constrained in developing countries and regions like the Caribbean, it is also possible that fewer pregnant women may access antenatal care, and more will become malnourished. This malnourishment leads to medical conditions such as anaemia, premature birth, obstructed labour, postpartum haemorrhages, and underdeveloped organs (Parrotte 2015).

3.4. Flooding

At the other extreme of weather conditions, like drought, are the temperature changes, which create excess rainfall and a high probability of flooding. In the Caribbean, flooding has become an annual problem because the number of intense rainfall occurrences has increased due to climate change events such as extreme temperatures and meteorological events such as hurricanes and tropical storms (Fontes de Meira and Phillips 2019). These events, as expected, can cause significant socioeconomic disruption to the lives of many, as some households may be ill-prepared to deal with such events due to the rising cost of resources such as personal protective equipment.

From the perspective of maternal and child health, during these events, pregnant women, small children, and several other vulnerable groups like the elderly are likely to become victims of flooding, landslides, and high winds accompanying extreme rainfall (Bartlett 2008). In the Caribbean and other low-income developing countries

like Nepal where most citizens from low-income households have an uncertain and sometimes precarious source of income, the probability of experiencing adverse outcomes such as the loss of life is shockingly high for women and young children, especially girls, during flood events. For example, in Nepal, preschool girls are five times more likely to die from a flood-related death (Pradhan et al. 2007).

Oddly enough, during heavy periods of rainfall, the flooding of outdoor toilets can also increase the spread of water-borne diseases such as cholera and enteric viruses. With little access to piped water and rotavirus vaccines, these viruses can also impact the mortality of babies and young children in the Caribbean (Delahoy et al. 2021). As the risk of such water-borne diseases rises, this can become a burden to pregnant women living in low-income households as they may not have sufficient funds to access healthcare as needed. In this instance, public health facilities will need to be outfitted with the necessary resources and made available to pregnant women who may not be able to access private healthcare.

3.5. Structural Racism

Apart from the climate change events highlighted above, it has also been noted in the literature that pregnant women who are women of colour and those living in overpopulated rural and urban or less affluent communities are more vulnerable to climate change events. This is primarily the case because members of these communities in the Caribbean may experience discrimination during the distribution of resources needed to mitigate the effects climate change events. Thus, it forces many persons, including pregnant women, living in low-income households with less access to heat reducing resources such as air-conditioning, indoor fans, and proper housing infrastructure to address extreme temperatures.

Further to this, the problems experienced by pregnant women, people of colour, and impoverished communities may not be included in the discussion of climate change concerning climate justice, social and environmental justice for women of colour, social and economic equality, gender equality, and the inequitable distribution of resources to mitigate the effects of such events in the Caribbean. These issues contribute to the higher rates of pre-term labour in women of colour, and as a result, they are more likely to be hospitalised during their pregnancy.

Furthermore, apart from pregnant women, women of colour, and impoverished communities, structural racism and discrimination often exacerbate these community members' trauma and mental health needs in response to climate change events such as flooding and heat risks. They are frequently neglected by healthcare providers and governmental institutions responsible for dealing with these problems within these communities (Gutschow et al. 2021).

3.6. Eco-Anxiety and Climate Anxiety in Children

Exposure to such vector-borne and infectious diseases and climate change events often has more far-reaching effects than just the physical health of pregnant women

and children in the Caribbean. One of the most under-studied areas in which climate change events have impacted maternal and child health is that which deals with their mental health.

Climate change is likely to have a significant impact on the psychological health of children in that they may develop anxiety, phobias, PTSD, and attachment disorders, which leads to abnormal development in their emotional responses, cognition, and language skills (Burke et al. 2018). Consequently, as these children become young adults, they will continue to show signs of mental health distress in response to climate change events in complex ways, such as eco-anxiety and climate anxiety (Gislason et al. 2021).

In countries like India and the Philippines, the continued exposure to extreme weather events such as cyclonic storms, monsoons, and typhoons, have led to significant behavioural changes in children and young adults. Feelings of extreme worry, powerlessness, helplessness, anxiousness, guilt, and betrayal can ensue due to their perceptions/beliefs that their respective government's policy response to climate change is inadequate (Hickman et al. 2021). Young children in the Caribbean from low-income households who exhibit signs of eco-anxiety and climate anxiety may not have access to the resources needed to help them cope with these problems. This anxiety can be due to the high cost of mental health resources and the stigma attached to conditions such as anxiety. In this case, the relevant authorities must help parents and children through free counselling and therapy at health institutions to ensure that the children experiencing anxiety have a safe space to speak and treat their concerns.

4. Conclusions

Climate change and the social and economic challenges to maternal and children's health have been discussed. One aspect almost always impacts the other. Socially, pregnant women and children are affected by extreme heat events, increasing frequency of climate-related disasters including hurricanes and flooding, food insecurity, and risks of waterborne diseases. These stated aspects impact and exacerbate gender inequality in vulnerable groups, especially in developing countries. Climate change and the occurrence of hurricanes, flooding and storm surges create havoc on SIDS, rendering destruction to infrastructure and disrupting water supplies, transportation, and electricity. Consequently, financial burdens are incurred by the government. The economic fallout can cause limited access to necessary resources and services for pregnant women and children. Governments must put the needs of this population high on their agenda to ensure that better living conditions are available.

Notwithstanding the importance of the discussion on maternal and child health in the Caribbean in terms of climate change, it must be noted that there are several specific challenges faced in collecting health data in the Caribbean, which, if available, would have added a greater depth to the argument put forward in this

manuscript. In particular, the inability of health and data collection institutions in the Caribbean to collect health data is often the result of such institutions lacking the basic infrastructure to collect such data, which ranges from limited physical and human resources to underdeveloped institutional frameworks to guide its collection. The inability to put effective structures in place often results in the inaccurate collection of health data, which in the Caribbean, can be either incorrect or faulty. The use of such faulty data can lead to a poor representation of national health statistics. Further to this, apart from data collection issues, there is also limited access to public health data from institutions for researchers in the Caribbean due to a lack of funding, high costs, and privacy concerns. As a result of this, there is very little empirical and applied research being undertaken in the Caribbean concerning maternal and child health. To address this issue, first there should be data collection measures in place to capture the impact that climatic events are likely to have on women and children in the Caribbean through ministerial bodies in the areas of health, education, and housing. Second, there should be greater inclusion of the views of women and children in regard to the design of climate change mitigation measures at the household, community, and institutional level. Finally, there should be greater institutional investment in terms of the provisions of grants and funding for researchers to conduct research in this specific area of study.

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Conserve What Our Children Deserve: Environmental Hazards and Their Impacts on the Inhabitants of Rawalpindi, Pakistan

Shafia Azam, Uzma Imtiaz and Dure Najaf

Abstract: Climate change is one of the gravest issues encountered by humanity today, resulting from serious environmental hazards that are acutely poisoning the natural ecosystem. This study endeavored to pinpoint the causes of environmental hazards and explain their detrimental effects on the climate. Using a qualitative approach, we investigated the attitudes of the local community and analyzed their practices through the thematic analysis method, hoping to provide a refined idea about the risks and community tactics involved in discerning the menace of environmental degradation. In-depth interviews were conducted in the local languages, with 60 respondents of Rawalpindi who hailed from different walks of life alongside local inhabitants, which were later transcribed into English. The findings revealed that the major environmental hazards, air pollution, waste disposal, and scarcity of clean water caused by factories and vehicles; poor waste disposal management; rapid urban population growth; the contamination of water; and poor sewerage systems, have negative effects on the physical and psychological health of people. This study shows that there is a dire need for the continuous process of planning and management to be enacted by educationists and government officials to create awareness and mitigate the existing environmental hazards.

1. Introduction

Mother Earth provides bliss to its inhabitants through its natural resources. These resources are the real treasures of the world in which we sustain our lives. The innate selfishness of humans has even impacted these treasures. Human activities have resulted in the degradation of natural bliss. These resources, which are a gift for humankind, are depleting one by one and are becoming a curse for humankind. It is because of the continuous degradation of the natural resources of this planet that our environment is gradually eroding with the rust of human actions. With the continuous degradation of environmental resources, adverse substances impacting the natural balance of the Earth are turning out to be the environmental hazards (Liverman 2001) with which the Earth is currently battling. These environmental hazards are impacting the natural balance of the environment, thus having detrimental effects on individuals.

South Asia is one of the most affected regions in terms of environmental problems. The rise in temperature, glacier melting, food issues, and water security are some of the issues that have multiplied the environmental hazards that have

caused a national political issue. Pakistan is one of the countries around the world that is affected by environmental changes and has the most polluted cities. Lahore, the second-largest city in Pakistan, is currently ranked as the world's most polluted metropolis, forcing authorities to scramble to combat this environmental disaster (Al Jazeera 2021). Multiple reasons are responsible for environmental degradation. Environmental hazards have emerged in the form of pollution. Pollution of varying kinds is acting as a monster and engulfing the lives of many every single day. Air pollution, land pollution, and water pollution are the three different forms of pollution that are taking hold of the health of hundreds and making individuals pay a price as high as their lives in the battle with this chaos. The indoor or outdoor contamination of the environment in which an individual sustains life is considered air pollution (World Health Organization 2022), which is slowly creating this unseen haze of danger around humans. Mother Earth is not even safe from the atrocities of humans and is now facing the worst kind of land pollution ever recorded in history. With industrialization, land pollution has become a major concern for many governments. Even water is not safe from this hazard, and improper sewage treatment is reflected in the form of impure drinking water, which is impacting two-thirds of the global population, as 2 billion people in the world today do not have the access to clean drinking water because of the constantly increasing levels of pollution (CDC n.d.). Drinking water is especially becoming a poison in the lives of children. Rai et al. (2020) indicate that water pollution is linked to a range of adverse conditions, including infections and diarrhea, and it can lead to stunted growth in children in South Asia. Akhtar et al. (2018) revealed that in urban areas of Lahore, drinking water contains heavy concentrations of lead and chromium, which are becoming a major reason for hindered development and congenital disabilities among children.

Pollution in its varying forms is destroying the natural rhythm in underdeveloped countries where the issues are enormous, and managing these issues takes a lot of wealth and many strategies. In underdeveloped countries, where economic and political issues are enormous, climatic concerns are at the bottom of the priority list, and this is exactly why the environmental hazards in Pakistan are enormous and increasing gradually due to a lack of effective strategies.

Environmental hazards have emerged as a perplexing concern today. It is important to explore whether we can provide our children with a healthy life or not as they are directly impacted by environmental hazards, especially air pollution. Children living in areas where the air quality is unsafe and the air has a higher concentration of pollutants frequently develop respiratory and cardiovascular disorders (Colbeck et al. 2010). Exposure to air that is blackened with pollution leads to reduced lung function among children, who thus develop a risk of permanent lung damage (Zaidi et al. 2019). Sabzwari and Qureshi (2019) assert that when children have to sustain lives in areas where pollution concentrations are at a peak, it impacts their cognitive and neurological development as well.

In Pakistan, especially in the metropolitan city of Rawalpindi, the amount of pollution has doubled over time, which has had varying causes and impacts on the lives of people hailing from every walk of life. This study aims to understand the basic causes behind the growing environmental hazards in the metropolitan city of Rawalpindi. In addition, it explores the impacts of growing environmental hazards upon the lives of people residing in the suburbs.

Environmental hazards are enormous, and so is their impact on the global world. The current study was based in Pakistan, and the sample was limited to Rawalpindi city in light of selective sampling. The different causes of pollutants and their impacts on the lives of people were analyzed. In addition, measures were then recommended based on the experiences of the local population of Rawalpindi, which was divided into various categories based on the participants' professional and personal lives. Against the backdrop of this discussion, this study addresses the following research questions:

1.1. Research Questions

- How do environmental hazards impact the physical and psychological health of the local community in Rawalpindi?
- What are the attitudes of varying groups of people in Rawalpindi considering the impending menace of environmental hazards?

1.2. Significance of the Study

This study reveals the extent of environmental hazards prevalent in varying localities of Rawalpindi. It will further help to pinpoint the types of hazards, their chief sources, and the risks associated with them. This study is also significant as it explores the attitudes and perspectives considering the chief hazards prevalent in the environment. This study will help to un-layer the public opinions of individuals and their approaches concerning the impending hazards.

This study provides a better understanding of the environmental issues in overpopulated areas, their causes, and their impacts on urban communities. In addition, it is also a crucial study in terms of devising policies against pollution control, as it involves the opinions of the general public. Hence, in light of the current study, the phenomenon of policy-making and implementation can be facilitated on the governmental level.

2. Methodology

The ethnographic research method was employed to conduct this study. Researchers can observe study participants in their natural environments and interact with them using the qualitative research method known as ethnography. (Sharma and Sarkar 2018). While employing the ethnographic research method, in-depth interviews are conducted to collect the perspectives of the respondents on the chosen phenomenon. In-depth interviews are utilized as a research strategy in which the

researcher gently guides the participants' dialogue across a long discussion to learn about their unique perspectives on one or more narrowly defined subjects (Rubin and Rubin 2011, p. 4). In order to conduct interviews, in this study, an interview guide was constructed after an extensive literature review to cover all the aspects of the main research questions which are focused on exploring the perspectives and practices of people regarding the causes and effects of environmental hazards. An interview can be frequently guided by a list of semi-structured questions that the researcher develops and asks each interviewee. Each in-depth interview takes a different turn and travels down its own meandering road depending on the interviewee's responses. It is crucial for the researcher to have the freedom to explore any relevant subjects that the interviewees themselves bring up (Brounéus 2011).

The interview guide was tested in a pilot study before starting the fieldwork and was revised by incorporating essential changes and omitting unnecessary questions. The pilot study was conducted outside the actual locale of the study, and data were collected from 5 participants including 3 males (1 janitor, 1 transporter, and 1 restaurateur) and 2 females (1 healthcare professional and 1 housewife from the local population). After modifying the interview guide, actual fieldwork started in July 2021 and ended on 15 September 2021.

The locale of the fieldwork was Rawalpindi City and its suburbs (Figures 1–3). The metropolitan city of Rawalpindi has undergone substantial urbanization over the past three decades, as residents of rural areas moved there in search of jobs, education, and other necessities. The exponential growth of urbanization has disrupted the local climate (Mannan et al. 2021).

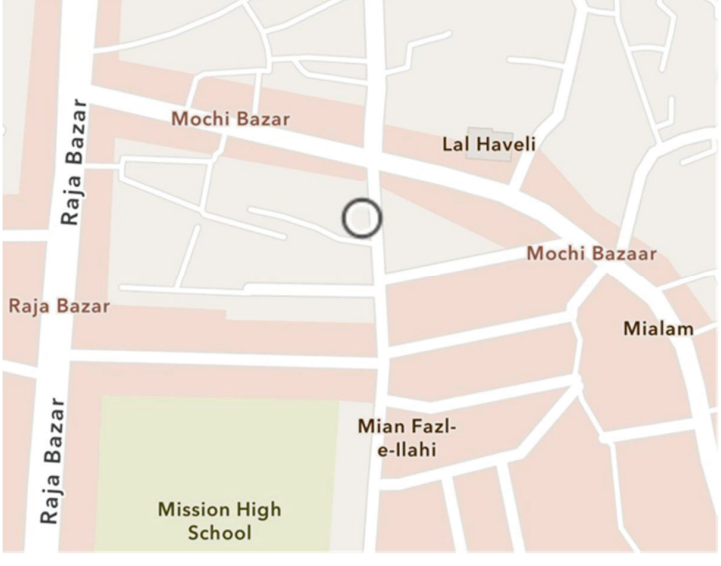

Figure 1. Study Area of Raja Bazar. Source: Adapted from ARCGIS (2022).

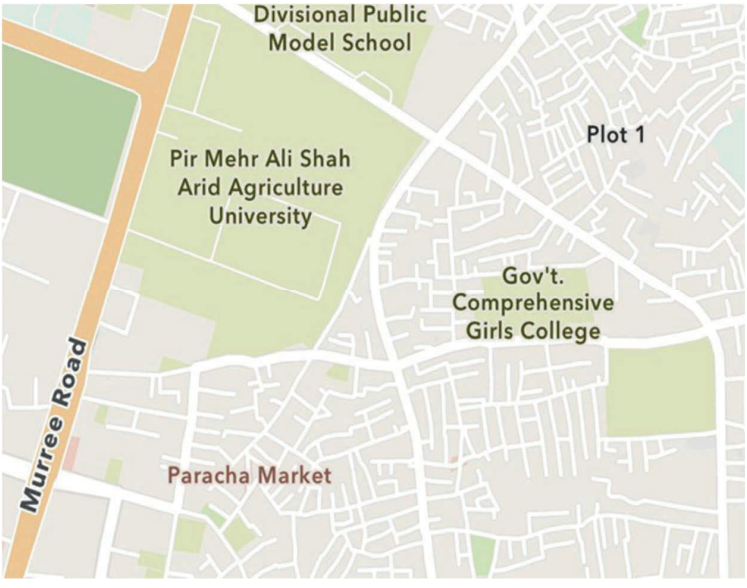

Figure 2. Study Area of Murree Road. Source: Adapted from ARCGIS (2022).

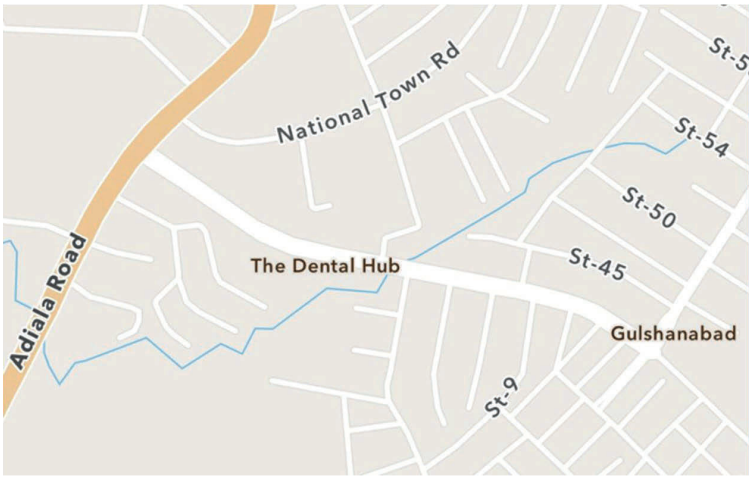

Figure 3. Study Area of Adiala Road. Source: Adapted from ARCGIS (2022).

Using the purposive sampling technique, in-depth interviews were conducted with 60 respondents of Rawalpindi: healthcare professionals (10), janitors (10), transporters (10), restaurateurs (10), and the local population (20), which were later transcribed into English. The heterogeneous sample was selected in terms of their demographics, belonging to different age ranges, educational levels, and socio-economic backgrounds, to collect a variety of perspectives of the people from the chosen locale.

Before starting the interview, rapport was developed with each participant of the study. The goal of building a relationship with participants was to collect rich

data while preserving mutual respect (Guillemin and Heggen 2009). Due to the mutual trust and understanding that are fostered by a positive relationship between a researcher and a participant, having a good rapport with participants may result in researchers having better access to information and data (Leach 2005). During the interviews, field notes and jottings were taken. The interviews were conducted in the local languages, i.e., Punjabi, Pothwari, or Urdu, which were later transcribed into the English language, taking the issues of translation into consideration.

The transcribed data were further sorted and coded to develop initial themes. After developing initial themes, similar coded themes were formed into more focused themes. The analytical byproducts of data analysis include categories, themes, subcategories, and subthemes (Vaismoradi and Snelgrove 2019). The subsequent analysis section of this study is based on these themes generated after a rigorous process of sorting and coding.

3. Results and Discussion

3.1. Major Environmental Hazards

Environmental dangers, the most pressing concern of our time, are brought on by several factors that this study has explored. It also discussed the impacts of major environmental toxins on people's lives.

No doubt our environment today is going through its worst phase as industrialization prevails around the world. This industrialization might be a blessing for people seeking ease in every single affair of life but is developing itself into a curse for the environment. With growing industrialization and unplanned development, pollution has emerged as the chief issue around the world. Pollution in its various forms keeps on leaving its imprints on the mental and physical state of its direct victims, i.e., humans. The contamination of the atmosphere of land which leaves an adverse impact on humans is categorized as a constituent of environmental pollution. Landrigan et al. (2018) state that exposure to the contaminants of the environment, particularly lead, air pollution, and pesticides, leads to 9 million deaths worldwide each year. This contamination might exist in the air, land, or water. Due to pollution, natural elements are not only contaminated but become insufficient to meet the growing needs of the population, especially in underdeveloped states where the graph of growth is considerably lower compared to the developed countries of the world. Grandjean and Landrigan (2014) found that the toxins present in the environment are threatening to cognitive and behavioral development among children, especially during the early years of their growth. One of the most powerful environmental hazards exists in the form of air pollution. Over the years, the quality of air has significantly worsened because of growing human activities. In fact, the WHO reports that 99% of the air pollution in the world today contains exceeding levels of air pollutants. A total of 92% of people worldwide reside in areas where the levels of particulate matter are exceedingly higher than the standards imposed by the WHO (Cohen et al. 2017).

Though it is a universal dilemma, Pakistan has seen dangerous levels of increment in the amount of pollution in its atmosphere over the span of the last five years. According to the Air Quality Life Index, Pakistan holds the status of the fourth most polluted country on a global scale, with an alarming rate of 44% pollutants in its air according to the latest statistics. The intensity of the particulate matter in the air becomes so high in the winter months in some of the major cities of Pakistan that it starts acting as a life-threatening phenomenon. In fact, metropolitan cities such as Lahore and Rawalpindi face the curse of smog every year, and the death rate has become as high as 128,000 people on an annual basis all over the country. These victims are all engulfed by the monsters of air pollution (Junaidi 2019). The major culprits behind this high rate of smog in Pakistan are industrial emission of chemicals, smoke coming from brick kilns, and unchecked engines of automobiles which are pacing at a faster rate on the roads every day (Al Jazeera 2021).

There has been a rapid increase in the number of vehicles in Pakistan, which is responsible for carbon emissions. Smog is produced by vehicles. Interviews with several transporters from Rawalpindi were conducted to ascertain the true reason behind the increasing levels of smog and pollution, especially in the winter months in Rawalpindi. One-third of the transporters believed that the "growing influx of population in this city" has become a chief reason for air pollution and smog in the past few years. According to them, it is because of the increased number of vehicles in Rawalpindi which has made the situation hard to battle, since the authorities cannot control the fast-paced growth of automobiles. Ramanathan and Feng (2009) state that the black carbon emission from automobiles is the second most lethal contributor after carbon dioxide, leading to global warming. Most of the transporters thought that in crowded areas such as Murree Road and Katcheri Chowk, where the peak hours result in hours of traffic jams, the engines of the automobiles are usually creating a mess in the atmosphere for many hours. Another interesting fact was revealed as some of the drivers believed that the initiation of the metro bus project has increased the amount of pollution twofold as the smog levels have become increasingly high in areas where the bus system as well as local transportation work in collaboration. Almost all the transporters agreed that they have seen the amount of smog increasing in the past few years, and most of this is because of the unchecked car engines which have become old over time. When they were further questioned, the transporters revealed that the growing economic burden is in some ways responsible for the amount of pollution in the air which they breathe because they are unable to take their vehicles for regular maintenance as the petrol price keeps on hiking and the potential profit is lower as compared to the past.

One of them reported that smog irritates our airways when we breathe it in. He shared a case where one of his family members died because of lung disease. Some of the locals also complained about the burning of their eyes and throat. They stated that their eyes and throat may burn on a day with a high ozone alert, and they may cough and wheeze as well.

Air pollution is not only a concern for transporters as it hinders the possible range in winter, but it is also becoming a burning issue for commuters. These commuters have been organized into various categories. Students, professionals, and daily wagers were questioned about their perspectives. Many of the youth who hailed from the student category believed that air pollution in the city is increasing to dangerous levels. Certain students believed that the amount of carbon monoxide in the atmosphere is becoming a major reason behind long-term respiratory problems. Three students complained that their asthma worsens due to smog, and this impacts their academic life as well. Among the professionals, we interviewed three doctors who were of the view that air pollution has become a major reason behind the increased number of respiratory ailments. Meanwhile, some commuters believed that transporters are not careful in terms of protecting the atmosphere despite repeated warnings. Daily wagers considered that the burden on transporters has intensified due to the bulk of the population traveling on an everyday basis and the number of automobiles that have increased at a higher rate to meet these needs.

Industrialization also plays a vital role in spreading pollutants in the air. The use of furnace oil in factories causes great destruction. The unplanned growth of factories is not only responsible for creating havoc in the form of air pollution but is one of the leading factors behind the production of industrial waste. Ukaogo et al. (2020) suggest that industrialization not only leads to air pollution but enhances the concentration of solid particulate matter on land, impacting public health. Not only industrial waste but also household waste is another dangerous threat to humankind since the silent dumping of waste is a time bomb that will take the lives of many with it when it explodes. The European Environment Agency considers that the linkage between human activities and waste material is close enough since the waste is directly dependent on human consumption, which, of course, is growing due to the growing needs of the global population. The rapid expansion of heavy industry to meet the needs of a growing population leaves the concentration of toxins on the land unchecked as contamination begins to impact healthy lives (Binkley and Miao 2015). In countries where population growth is left unchecked and there are no strict policies implemented for the effective management of human growth, the problem of waste contamination follows. Pakistan faces a severe problem of land pollution due to unchecked population growth and a careless attitude towards Mother Nature.

WWF (2021) has come up with a very intriguing kind of pollution that has existed for the last ten years in Pakistan. Its plastic pollution has increased over time due to the high level of consumption of the population in major cities as well as villages all across Pakistan. Even the capital of Pakistan, Islamabad, faces a grave situation regarding plastic bag pollution, where burning plastic not only pollutes the land but it once again devastates the atmosphere. According to the statistics recorded, 65% of the waste in Pakistan is composed entirely of plastic in its various forms. Sometimes, the waste is shopping bags, while other times, bottles and boxes of plastic contribute their due share in adding more pollution to the already bleak

picture. With every approaching year, the share of plastic increases by 15%, which is enough to destroy the planet, making individuals concerned about their health on a large scale (Mukheed and Khan 2020, pp. 1–7). When combined with the rainy seasons, this unchecked increase in waste means that epidemics have become a common tale in every household.

3.2. Impact of Environmental Toxins: Natives' Perspective

Several janitors in Rawalpindi were questioned about this chaotic scenario. A 27-year-old janitor held people accountable for creating this chaos and blamed their carelessness. According to him, it is the sheer carelessness of people that they display by openly disposing of waste in the streets every single day and not contributing a lot to clean up the mess, which makes the situation worse in the end. Two other janitors who have been in the cleaning profession for the last ten years believed that the number of cleaning people is fewer and the waste level is significantly higher, which is why it has become very problematic for a few people to collect garbage that has been left for a long time. Almost all the janitors believed that one reason behind improper waste disposal is the lower wages that are paid to them. A 45-year-old janitor expressed that sustenance on meager figures and cleaning every single day seems difficult for most, and that is why many young janitors these days are finding alternative jobs instead of cleaning, which enables them to clean only at weekends or on special days. Another 30-year-old janitor stated:

> A number of times while we are cleaning the roads and drains, the passersby, especially young boys start ridiculing us and calling us names. This sometimes leads to occasional rows as well. The young janitors who are taking up the job are hot-headed. Frequently, we have faced a situation where one of our men stops coming to work and this leaves the heaps lying on the roads for days. People also need to understand that when we are not doing this of free will, it's our job and they need to respect this opinion if they want their roads clean.

This suggests that the inability of janitors to continue working due to the attitudes of people makes the waste twofold, and it becomes impossible in the end to clean huge dumpsters.

Interviews were conducted in various suburbs of Rawalpindi, including Murree Road, Adiala Road, and Raja Bazaar. The locals reported that the implemented system of the government to collect the waste is a total failure. There is no individual appointed by the union council who comes to check on the garbage dumpsters on a daily basis. A 40-year-old female homemaker said that she has appointed some Afghani kids to collect the daily garbage who later throw the garbage in Nala Lai. An old man living in the vicinity of Raja Bazaar told us that there are open dumpsters in the nooks and crannies of every Mohallah/street, which are then dumped in Nala Lai (a rainwater-fed natural stream that runs through the city of Rawalpindi) by

the mutual efforts of the people of the locality as they collect money for arranging for individuals to clean up the dumpsters. This reveals that the system of cleaning garbage in common areas is not properly managed. Five men from the area said that the dumpsters have become the reason for increased epidemics in the area, especially in the monsoon seasons when there is increased vector growth. Diseases such as dengue, Malaria, and diarrhea have become common phenomena. Some locals blame restaurant establishments that are totally unhygienic and are established just by the side of the road, which creates a very unhealthy atmosphere. A man from Murree Road revealed that it is a rare occurrence for restaurant owners to properly dispose of the waste; usually, they dispose of it quickly on the roads. The same behavior from the owner of a meat shop was noticed, who was described as not caring about the hygiene of their shop, and an unpleasant impact was noticed. A 29-year-old man from Murree Road revealed:

> The restaurant owners are quite careless in dumping their waste. You will find the neighborhood all tacky and pungent because of the actions of a few. There is no one who checks on them or holds them accountable.

In order to find the opinions of restaurant owners, five different restaurant owners were interviewed, who revealed that a lack of a proper government setup prevents them from disposing of waste in safe spaces. One of the owners said that the economy has much to do with this. As the inflation graph is on a rise, it is hard for them to create safe spaces which ensure hygiene because they have been there in the locality for a while, and increasing prices beyond a certain range could lead to public outrage. A 50-year-old restaurant owner told us that:

> We do not have enough money to manage waste disposal on a daily basis. In all honesty, it's not even our responsibility but the government needs to send the garbage trucks daily. When they don't pay heed to the situation and keep on raising prices, how can you expect us to manage another extra expenditure on our own?

Therefore, it becomes extremely hard for them to manage hygiene and their businesses side by side. Several owners were of the view that it is because of the lack of government care towards local businesses which prevents them from maintaining proper standards, unlike posh restaurants.

Within the locality, doctors from three different hospitals were interviewed. They had quite similar values about the health impacts of dumpsters in the area. One female doctor asserted that over the years, with the growing numbers of dumpsters, gastric problems have elevated at a much higher rate. She stated that much of it has to do with the vectors which feed on those dumpsters and then impact masses. Another doctor stated that he finds 90% of patients with diarrhea and gastroenteritis on a daily basis are infected because of unhealthy standards. Another 47-year-old physician stated:

> Quite often, the attitudes of locals are also to be blamed when we talk about the negative impacts of pollution. Whenever there is an epidemic on the run, most people are reluctant to accept that it's because of their activities. Even when I suggest they use boiled water or practice basic hygiene, they are usually overlooked after the initial two days of following. People here only want to get relief from an ailment but they don't want to look at the reasons which have made them ill.

A local doctor stated that during monsoons, most of the people he treats suffer from dengue, which is an outcome of the open dumpsters. One of the doctors from the Holy Family hospital also showed great concern about waste management. He asserted that the infectious waste from the hospital needs to be properly disposed of since it is creating great havoc in spreading infectious and some fatal diseases. All four doctors believed that the government needs to be highly active about the issue of pollution and waste management and needs to take prompt measures in the area.

When every natural bliss is corrupted at a gradual pace, the most significant elixir of life is not even safe from the harsh consequences of human activities. Water, which gives life and acts as a harbinger of health and natural bliss, is now becoming a major cause of death throughout the globe as its soul is corrupted by the hands of the monster of pollution. This not only leaves a big question mark on the quality of the drinking water which is available but also closes all paths for the availability of fresh and pure water at a time when the environment is battling the issue of pollution. Eventually, there will be a lack of freshwater resources for the population all around the globe, since most of the water reservoirs have already been destroyed and are no longer suitable for drinking. Azizullah et al. (2011, pp. 479–97) note that just like other forms of environmental hazards, Pakistan faces a major issue in the supply of clean drinking water, and this makes it the 80th country among the 122 countries listed as providing fresh and clean drinking water to its people. Almost two-thirds of the drinking water, whether it is underground or appears in the form of streams or lakes, is highly polluted by the activities of humans and industries on a collaborative level. The level of toxins present in water is so high that the mortality rate is elevated particularly in this part of the South Asian region.

The locals from Adiala Road, Murree Road, and Raja Bazaar were interviewed about this issue. Nearly all the locals believed that the drinking water which is available to them is not clean at all but contaminated. Two-thirds of the locals asserted that they boil the water which they use because it helps them to elevate its quality. A 30-year-old woman, who is also a mother, believed that she can never rely on supplying unboiled water to her children as she knows that it is highly poisonous and has seen people suffering from dysentery within the locality. Locals of Adiala Road were of another opinion. They stated that their area suffers from the scarcity of drinking water most days, which is why they are forced to arrange private tankers to meet their needs. One man said that almost half of his hard-earned money is spent

arranging for tankers, which seems very problematic for those belonging to the lower middle class. A 51-year-old shopkeeper shared his views:

> Most of us are not affluent enough to afford mineral water or water filtration units. I have been running this grocery shop for the last twenty-five years, and throughout these years, I have seen the customers buying mineral water bottles only when they lack water bottles with them while traveling and suddenly a pang of thirst strikes.

Certain locals from the Raja Bazaar stated that the scarcity of water in their areas is a reason that they never bother about the quality of the water which is available to them. A mother from Murree Road stated that she becomes highly anxious every time her children are down with fever and diarrhea because she knows that it is because of the water, and that is why even after repeated boiling, the water quality is becoming troublesome and the chief cause of major infections.

A 43-year-old doctor who works in a government hospital said that every single day, new cases come to the hospital who are suffering from chronic diarrhea to an extent that sometimes it becomes life-threatening. In his view, the ineffectiveness of active government policies is contributing to a higher rate of infection in the suburbs. Another colleague of his believed that it is the booming level of population in these suburbs that has made it quite difficult for the hospitals as well as government organizations to provide active facilities all the time. While interviewing a general physician, it was revealed that the lack of proper planning in terms of urban development as well as active waste and sewage management in the suburbs was the prime cause of the elevation of severe health infections in these areas.

4. Conclusions

In overpopulated cities such as Rawalpindi, pollution has become a major cause of concern among other issues. This study takes the opinions of the general public into account and serves to locate the prime factors due to which these environmental hazards are deteriorating the natural balance of the environment. By shedding light on the attitudes of the public, the study defines pollutants destroying the environment from the lens of the general public, as Nixon (2011) suggests:

> The environment is not a passive backdrop for human action, but rather a central player in shaping human destinies. The world we inhabit, and the ways in which we interact with it, profoundly influence the outcomes of our lives and the quality of our experiences.

Keeping in view the above discussion, based on the findings, we conclude that overpopulation is the main cause of environmental hazards. Fast population development can cause environmental deterioration and habitat loss, as well as a rise in the demand for resources such as water and electricity. Promoting family planning, funding healthcare and education, and enacting laws that support

sustainable development are all examples of appropriate overpopulation planning. According to different respondents, the responsible attitude of the public regarding waste management in the form of recycling products and the minimal use of plastic can help us to improve our environment. Health workers were also very much concerned about the infectious wastes/chemicals that need to be properly disposed of. Pollution, greenhouse gas emissions, and the spread of disease can result from improper waste management. Promoting recycling and composting, putting trash reduction plans into action, and investing in new waste-reduction technology are all examples of appropriate waste management planning. Water security was also mentioned by a few respondents since Pakistan is a facing critical water shortage. Pipe leaks, ineffective irrigation techniques, and excessive water use can all result in water wastage. Planning effectively for water waste might include actions such as encouraging water conservation, making investments in cutting-edge technologies, and putting laws in place that support sustainable water management. Water sources can become contaminated and waterborne diseases might spread as a result of improper wastewater management. Planning effectively for sewerage systems might entail actions such as making sure wastewater is treated to strict standards, making investments in cutting-edge treatment technologies, and encouraging water conservation. High temperature, air pollution, and bad sanitation systems are all responsible for respiratory, skin, and gastro diseases. Hence, this study discovered that the main environmental threats—air pollution, inadequate waste management, the shortage of fresh water caused by businesses and automobiles, growing urbanization, water waste, and inadequate sewage systems—have a significant negative influence on people's physical and mental health. Therefore, proper planning and management need to be enacted by government officials and educators to continuously plan and manage efforts to conserve a healthy environment for our future generations.

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Resilience Hubs: A Climate Change Resource for Vulnerable Populations in the United States

Mary Strawderman and Laura Herrmann

Abstract: The threat of climate change disproportionately impacts racial and ethnic minority communities in the United States. Communities experiencing environmental racism are more sensitive to the effects of social stressors, such as lack of access to adequate and appropriate healthcare, education, and economic stability. As a result, these communities often have fewer social resources with which to both protect themselves and recover from as well as adapt to extreme weather events, such as flooding, wildfires, hurricanes, poor air quality, and temperature extremes. Climate change exacerbates the historic, systemic oppression of vulnerable communities and worsens existing disparities resulting from cumulative environmental hazard exposure. Traditional approaches have historically failed to prioritize the needs of marginalized communities. Community-driven resilience has the capacity to drive transformative resilience through the disruption of traditional power structures by centering resilience around the site-specific needs of communities. Community resilience can be increased through Resilience Hubs, physical structures where residents can gather for shelter, support, resources, and community connections. Resilience Hubs strengthen community solidarity and offer aid to community members suffering from the effects of climate change and climate disasters. This chapter discusses community-based Resilience Hubs as a method of addressing the disproportionate impact of climate change on vulnerable racial and ethnic minorities.

1. Vignette

Resilience Hubs are community-sponsored spaces that serve to strengthen social cohesion and offer aid to community members facing the effects of chronic climate change and acute climate disasters. Hubs can serve communities during a disaster by providing shelter, power, food, and medical supplies. Hubs can also be sources of disaster-preparedness education and information on resources necessary to prepare for as well as recover from disasters. Where emergency shelters address temporary needs during a disaster, Resilience Hubs are intended to be spaces for before, during, and after a climate emergency. Hubs are one way of addressing the disproportionate impact of climate change on vulnerable racial and ethnic marginalized neighborhoods by helping such communities adapt to chronic climate change and acute climate disasters. As a transformational resilience tool, hubs not only link to other essential needs but also enhance the economic and social capital of immediate communities. In Petersburg, Virginia, the Virginia Environmental Justice Collaborative (VEJC)

worked with the community to create a Resiliency Hub in the city. The Resiliency Hub, through centering their resilience work on the needs of the community, utilizes the knowledge of the community for transformation and innovation. The following vignette, as told by Queen Shabazz, a hub founder, tells their story.

> I became involved in environmental justice work 26 years ago when my son was poisoned by lead. This prompted me to found United Parents Against Lead and eventually become the CEO for the Virginia Environmental Justice Collaborative. The collaborative advocates for clean air, water, and soil. We were participants in the halting of the Atlantic Coast Pipeline and we are now working to do the same with the Mountain Valley Pipeline. Central to our efforts is the objective to support and protect the environmental justice communities that we serve and work with. The cumulative impacts of climate change are steadily hitting frontline and fence line communities and we want to lend support to those voices in those communities that are fighting to protect their safety and health.
>
> One of our major initiatives is the Resiliency Hub in Petersburg, Virginia. This was a joint effort of United Parents Against Lead and the 45 member organizations of the Virginia Environmental Justice Collaborative. The Petersburg Resiliency Hub is the first of its kind in the state. Built in 1941, the building has historic significance as a United Service Organization (USO) facility for Colored Army troops during military segregation in World War II. Because of the building's age, it was in poor condition structurally and was about to be demolished. We are happy that we were able to preserve it and save that history and use it for something similar to its original intended purpose.
>
> Petersburg had been very distressed once the economy collapsed and many of the major businesses employing people pulled out. There are several blocks that are abandoned, just vacant lots or abandoned buildings that have been there for years. The community where the hub is located was once known as the "Delectable Heights" and was a community of working class, Black professionals. Once we started work on the hub, other people started buying up some of those vacant properties. We like the fact that we are instrumental in revitalizing the community back to where it once was. Strengthening the workforce, so that community residents will be able to provide for their families is also a key component to this revitalization that the hub will address.
>
> To start the process of turning this historic building into a functional Resilience Hub for the community, we received a planning grant through the Partnering for Resilient Communities from the Institute for the Sustainable Communities. After we finished the planning grant, we got implementation funds to start restoring the structure of the building and

getting solar panels. The solar panels were donated by the Honnold Foundation. The Clean Energy Group also funded us to have a feasibility study conducted. The hub was a perfect fit for those who were looking to fund projects that promote clean energy and support historically economically disadvantaged communities. Other funders just started approaching us, wanting to support the Resiliency Hub.

When extreme weather events occur, the Resiliency Hub serves the immediate community as a place to shelter, a place to stay warm when the weather is cold, or as a cooling center in the summertime during extreme heat. It is also a place for food and fellowship. This is a place for community members to power up their electronic and medical devices, store their medication and baby food. The Hub will be of service, not only during a climate crisis, but every day, for educational workshops, training, and certifications. We offer 1st Aid CPR AED certifications, lead and mold inspection and remediation, Healthy Homes certification, and Solar PV Installation certification. Children can come and do their homework after school. For some community members, the Hub serves as a food pantry for people to come and get food. We are even talking about getting electric vehicle charging stations across the street in the parking lot.

Our idea is to be a central point where people can come for information, not just in times of distress, but to be there every day to disseminate information and resources and a meeting place for community members to host various activities. It is a place where people can come and voice their concerns. We bring in the mayor and other elected officials and people in the city administration that they need to speak to. It would be a central space, for all the concerns of the city to know that they have a safe haven to come and speak freely, and to make the connections that they need to make to get what they want done.

The use and design of our Resiliency Hub are intended to be responsive to the needs of the community. We talked to different people in the community about what this could be if this building was converted into a Resiliency Hub and we got an overwhelming response in favor of bringing it there. We wanted to be multi-generational so we brought in youth and elders of the community. We found the "unelected mayor" and he directed us to who we should talk to. We created a Community Advisory Board so that we would have church members, parents, grandparents. The board guides the activities and the direction that we'll go in. We are advocates for community-controlled funds, because we know that a lot of the expertise is right there in the community.

We're hoping that Petersburg will be an example of a successful Hub that can be replicated, though there is no one size fits all, no template.

Each Resiliency Hub will be different according to the needs of that community. I'd advise others interested in Resiliency Hubs to get with your stakeholders, talk to community members, talk with the elected officials, see what funding is available. Allow the community to dictate what they would like to see in that space. In terms of resiliency, it may be a source of food, a place for informal meetings and networking, or a youth center. It's going to depend on what that community says it needs. Be prepared to have hours and hours of conversation, because you might hear different things from different people.

To ensure that the focus of Resiliency Hub services remains on the needs of the immediate community, create a Community Advisory Board. This ensures that the Hub will stay locally focused and that it won't become a situation where someone from the government starts imposing their will on how the hub should function. Leave that space for trial and error. Allow the community and Hub to self-correct. Have the openness of communication for everybody to come together and for everyone to be heard and bring those people to the table. Respect their voices. Because each community is different, the first step is to identify what residents might need. Think of possible challenges and hazards, and then start planning for those.

We can't deny that climate change is happening and that our communities are distressed. Some are far less equipped to deal with it, whatever may happen. I would encourage communities to start thinking along those lines that we need to have a blueprint. People need to know where they'll be able to go in the event of a crisis. So, let's just try to be prepared. We can't wait until the water is coming up over the sidewalk to start saying, "Where can we go for shelter and safety?" (Queen Shabazz, CEO, Virginia Environmental Justice Collaborative—Practitioner view, 12 January 2023)

2. Introduction

The effects of climate change are altering the environmental and social realities of communities around the world. How communities prepare for and respond to environmental changes will likely depend upon both the social structures of communities and environmental infrastructure (Thomas et al. 2018). Not all communities are equally positioned to prepare for the changes to come and those that are already occurring. In the United States, racial and ethnic minority communities, primarily Black and Hispanic neighborhoods, disproportionately experience the effects of climate change, compared with majority-White communities. The discrepancy between these communities will be exacerbated by climate change in the coming decades, and communities within the United States need to actively work towards an equitable climate change resiliency strategy (Berberian et al. 2022;

Thomas et al. 2018). Resilience Hubs have the potential to be transformational spaces for marginalized communities facing climate change through the promotion and support of community-driven self-reliance.

The systematic marginalization and social disenfranchisement of minority communities across America has created patterns of unequal access to the resources needed to combat climate change (Thomas et al. 2018). Climate resource needs are not limited to tangible climate-based infrastructure projects or engineering feats of design, such as disaster warning systems and flood walls; communities also need social infrastructure resources, such as accurate information communicated in native languages (Davies et al. 2018), access to liquid capital before and after hazard events, and functional connections with community support networks (Thomas et al. 2018). The critical role of social networks and social capital has been generally shown to contribute to community resilience, especially in marginalized communities made vulnerable to environmental disasters due to historic patterns of environmental racism situated within larger social systems of oppression. Resilience Hubs are community spaces intended to support the social infrastructure of communities and aid in the equitable distribution of resources before, during, and after climate-induced emergency hazard events (Baja 2018).

In this chapter, we argue that community-created Resilience Hubs can provide critical social infrastructure with which to address the disproportionate impact of climate change on environmentally vulnerable communities. The community-driven development of Resilience Hubs can circumvent reliance on traditional governmental power structures for resource provision. Investment in these community-based resources is a way to develop the social and physical infrastructure support needed by environmentally vulnerable communities to confront the threats of climate change. This paper helps to inform and support the community-driven development of these spaces.

3. Background

Black and Hispanic citizens across the United States are more likely to live in areas that will experience greater temperature extremes, a higher risk of flooding, and air pollution (Environmental Protection Agency 2021; Marlow et al. 2022). The studied impact of increasing temperatures across the United States has focused on the concept of "heat island" effects in urban areas, specifically urban areas lacking in green space and tree canopy combined with a high concentration of impervious surfaces. A study by Jesdale et al. (2013) examined these heat islands across the United States and found decreased tree canopy as well as increased impervious surfaces to be associated with residential areas historically segregated by race and currently populated by marginalized communities. This pattern of disproportionate impacts on marginalized communities was again demonstrated in 2017 in Houston, Texas, during the extreme flooding caused by Hurricane Harvey. Chakraborty et al. (2019) documented the extent of flood waters across Black, Hispanic, and

socioeconomically deprived neighborhoods as significantly increased as compared to White, affluent neighborhoods. Historic U.S. federal and state government redlining policies relegated minority communities across the country to areas adjacent to industrial facilities and high-intensity development, disproportionately exposing many to a lifetime of industrial air pollution (Boone et al. 2009).

The health and wellbeing of residents in minority neighborhoods are at higher risk than residents in White neighborhoods partly because of the physical environment in which they live (Bullard 2005). Many marginalized communities that have been subjected to a multitude of environmental injustices for decades are now also vulnerable to experiencing the brunt of climate change. The scope of the environmental justice movement has focused historically on the ongoing threats and risks posed by already-polluted and -damaged environments in which marginalized people live, work, and play; more recently, the movement has expanded to include climate change injustice. The implications of climate change may be global, but the consequences are experienced locally. The compounding of environmental injustices with climate injustices poses an increasing threat to both the physical and social wellbeing of marginalized communities.

As climate change worsens, the growing physical and social vulnerability of environmentally marginalized communities are inevitable. Social vulnerability is the susceptibility of a social group or community to environmental hazards or stressors in addition to the corresponding ability of said group or community to prepare, manage, and recover from the impacts of these hazards and stressors (Otto et al. 2017). The social impact of heat island effects, for example, is especially taxing on marginalized communities. Patterns of heat exposure have been shown to delineate along lines of social inequity (Renteria et al. 2022). The literature has documented that neighborhoods with greater heat exposure are negatively correlated with lower incomes and education (Otto et al. 2017). During heat waves and periods of extreme rainfall, marginalized communities are more likely to experience violent crime and increased rates of aggressive citizen behavior, leaving residents exposed to negative changes in social behavior (Otto et al. 2017). Madrigano et al. (2018) found, in New York City, that a lack of access to in-home air conditioning during heat waves was also indicative of limited access to services, resources, and social mobility within Black communities.

Often cities and local governments will open or establish cooling shelters as a resource for a community to ameliorate the impact of extreme heat. These cooling shelters are set up in public spaces and are available for residents who otherwise would not have access to a cooled space; however, these spaces are often inadequate and only address the physical needs of a community, while failing to understand or address the social needs. In Los Angeles, Shonkoff et al. (2011) explained that the lack of transportation options for many minority and ethnic communities precludes many residents from gaining access to cooling shelters; the residents with the greatest need could not travel to shelter locations. Meanwhile, in New York City, Madrigano

et al. (2018) found that when cooling shelters were opened and readily accessible by public transportation, many residents still chose to stay home in the heat rather than go to the shelter because they feared the unknown or did not want to be around strangers (Madrigano et al. 2018). The residents preferentially chose to isolate at home and suffer the heat because they were not connected meaningfully to the people in their community.

These studies point to the need for sweepingly different climate change adaptation measures rather than policy incrementalism and focusing climate inequity efforts along the margins of environmental injustice; the cooling shelters discussed above will fail climate-vulnerable communities if the barriers present are not concurrently addressed. Policies that exclusively address the physical impacts of climate change do not address the resource gap between climate mitigation, environmental racism, and social justice. Going forward, marginalized communities will need both accessible physical resources and social resources to ensure the adaptability of individuals and whole communities to the changes caused by climate events.

Social vulnerability within a community is often reflected in the availability of real alternatives and resources to community members in the face of an environmental hazard. In the vignette above, Ms. Shabazz points out that residents in Petersburg, VA, are beginning to experience the impacts of climate change but lack real alternatives or the resources necessary to respond to the city's environmental changes. Instead of working within the political or bureaucratic governmental systems, community organizations came together to establish a Resilience Hub. In Petersburg, social connectivity is driving community resilience rather than government planning and spending. The VEJC was mobilized to action partly due to a lack of alternative options offered by the city. The VEJC, by acting outside of the standard policy process, has created real alternatives and opportunities for community climate resilience. Other communities can learn from Petersburg that climate action is not dependent upon a planned government response, but can be a grassroots effort. Cities and local governments can, in turn, learn to support as well as encourage community-driven resiliency work and incorporate community leadership in formal climate action policy and planning.

Social vulnerability is not a static condition; it is dynamic and worsens or improves in response to changes in community preparedness for and resilience to dealing with environmental hazards. Adepoju et al. (2022) studied the adaptations made in four minority communities in Houston, Texas, in response to the successive events of Hurricane Harvey and Winter Storm Uri. They found that "social connectedness was key to disaster resiliency; previous disasters reinforced the importance of staying connected to family and friends" (Adepoju et al. 2022, p. 9). Residents were able to use their experiences during Hurricane Harvey to improve their outcomes following Winter Storm Uri, demonstrating a decrease in their social vulnerability through increased community connections. Communities unable to

adopt new strategies to prepare for, manage, and recover from environmental disasters and hazards become even more vulnerable to climate change. Community resilience is a critical deciding factor in community success in the face of ongoing climate change.

4. Definition and Context

4.1. Community Resilience

Resilience can be understood as the preparation for and adaptation to change and disruptions (NIST 2018). Community resilience, in the framework of climate change, is the collective capacity of a community to adjust to post-disaster conditions and protect itself from the cumulative impact of climate change. Pre-disaster mitigation strategies that enhance community resilience, such as the Resiliency Hub in Petersburg, Virginia, are being implemented in many areas of the United States. The Resiliency Hub functions to create alternatives to neoliberal society through community-driven approaches to environmental and economic problems (Cretney 2014).

Varying degrees of transient post-disaster stress can be expected before recovery or adaptation, even in the most resilient communities (Norris et al. 2007). Over-exposed communities, however, can experience persistent post-disaster dysfunction because they have lower levels of community resilience (Bergstrand et al. 2015). This persistent dysfunction is partially due to a lack of political connections, depressed socioeconomic status, and stunted social capital, all of which are necessary to secure adequate support and resources, such as shelter, electricity, food, and medical supplies, following a disaster (Kaniasty and Norris 2004). The goal of enhancing community resilience can seem superficial in that it does not redress the systemic and structural racism that created the lack of political connections, depressed socioeconomic status, and stunted social capital of at-risk communities. Resilience is not necessarily a positive outcome, especially if the current state of a system or community is in a state of stress or dysfunction (Béné et al. 2012).

Resilience does have the potential to exist as a conduit of transformation (Nelson 2014). This can occur through a disruption that causes a shift in the state of a system or community to one with more favorable conditions (Walker et al. 2004). While there has been a shift in the federal government's climate disaster focus from infrastructure-only approaches toward community-resilience-focused approaches (FEMA 2021), transformative approaches to resilience are not likely to originate from the federal or state government. The existing dominant political power structures that created community climate and social vulnerability through policies and practices are often not capable of disrupting their own power structures. In the absence of systemic changes that create more equitable systems through reforms in regulations and policies, government-originated resilience, while aiming to avoid persistent post-disaster dysfunction, is more likely to uphold the "status quo" of dominant

political structures (MacKinnon and Derickson 2013). Federal and state governments' "lack of acknowledgement of politics, power, inequality and agency provides fertile ground for those wishing to perpetuate neoliberal ideology to engage resilience as a tool" (Cretney 2014, p. 637).

Community use of resilience is transformational when it challenges the values of neoliberal subjectivities (Cretney 2014). The Resiliency Hub in Petersburg, Virginia, co-created with community members, echoes the needs of the community. This means that the hub serves as a place-based source of investment into economic and social capital for the local community. The creation of the Hub has already sparked a revitalization of the local area. Properties that were vacant are being rehabilitated, and local economic capital will be stimulated through educational workshops, training, and certifications. Investing in the development of the skills and resources of a community in addition to strengthening the local workforce, so that community residents can provide for their families, are vital to the revitalization and resilience of local communities. The Hub enhances social capital by serving as a place of fellowship where members can convene and use the space for their needs. It is imperative that the co-creators of community resilience acknowledge the ways that dominant social structures created conditions of vulnerability in the first place (Banzhaf and McCormick 2012).

Within the community resilience framework, social capital is a primary conduit by which resiliency is created, established, and nurtured. Targeted resources that encourage connections with family, friends, neighbors, and other community members are essential in gaining access to disaster support and resources (Norris et al. 2007). Social networks often serve as initial first responders after an adverse event, with neighbors checking on one another and providing critical aid as well as support (Aldrich and Meyer 2015). The Petersburg Resiliency Hub is not just a resource during a climate disaster, but a transformational space of revitalization. It disrupts the economic and social inequalities produced by structural and systemic racism as well as neoliberal subjectivities by co-creation with the community. The Hub remains aligned with the community's goals and priorities through collaborative decision making. The co-creation process also empowers communities and builds community ownership of and trust in the Hub. This allows for a focus on the immediate needs of the community, disrupting the dominant structures' use of resilience as a tool of hegemony.

4.2. Social Capital

Social capital is fundamental to the development of community resilience. Building ties within and across social networks enhances access to the resources most essential to communities in the face of disaster. Social networks allow access to financial and non-financial resources, such as loans, gifts, information, emotional support, shelter, childcare, rescue, and aid (Kaniasty and Norris 1993; Hurlbert et al. 2000; Elliott et al. 2010). During a disaster, not only do government and

nonprofit organizations provide financial and non-financial resources to community members; the provision of resources also occurs through other community members, community-based organizations, and faith-based organizations. The conceptualization of social capital by Bourdieu (1979) denoted the ties within one's social network as a collective resource of potential economic and cultural capital.

Ties within and across social networks can increase social capital in the form of bonding, bridging, or linking. Bonding occurs horizontally between socially cohesive homogeneous groups, or individuals with shared identities, and is important for forming social cohesion and support (Szreter and Woolcock 2004; Granovetter 1973; McPherson et al. 2001). Bonding also happens via relationships with family and friends. Bridging occurs horizontally across groups of loosely connected heterogenous individuals that do not have shared identities and is important for generating solidarity and respect (Szreter and Woolcock 2004; McPherson et al. 2001). Bridging happens through membership in organizations such as religious groups, sports and other clubs, and parent–teacher associations (Small 2009). Linking occurs vertically among groups or individuals of different levels of political mobility and socioeconomic status, which often provides greater access to social power and vertical mobility (Szreter and Woolcock 2004). Linking happens via interaction with local leaders, community-based organizations, and local governments.

Communities and individuals can have different levels of bonding, bridging, and linking social capital. Strong social ties among homogeneous groups that occur within bonding social capital can inhibit the transmission of information because of the homophily that limits a broader outlook of the world (McPherson et al. 2001). A lack of bridging social capital can impair resilience due to the inability to secure resources and information across heterogeneous groups (Hawkins and Maurer 2010). Resilience Hubs can serve as a physical location where social connection links can be fostered. While there has been little focus on the vertical structuring of organizations and societies within the context of social capital (Kwon and Adler 2014), Resilience Hubs that are co-created with communities create bridging and linking ties in the community. Frameworks of social capital often fail to acknowledge the economic and political factors that create social capital (Mohan and Mohan and Mohan 2002); however, social capital not only explains the creation and sustainment of dominant structures but also addresses the persistence of these power relations (Woolcock 2001). The social capital framework "recognizes that exclusion from economic and political institutions is created and maintained by powerful vested interests, but that marginalized groups themselves possess unique social resources that can be used as a basis for overcoming that exclusion, and as a mechanism for helping forge access to these institutions" (Woolcock 2001, p. 16). The co-creators of community resilience can play a role in overcoming the exclusion of these institutions through staying locally focused and actively informed by communities.

Resilience Hubs amplify community resilience through the building of social capital. Resilience Hubs are the physical structures that facilitate social interactions

by gathering residents to work together, engage in community decision making, and build the needed bonding, bridging, and linking social capital (Baja 2018). Hubs can provide the most vulnerable marginalized communities with the tools with which to protect themselves from increasing climate change burden, as well as the ability to adapt post-disaster. Practitioners and co-creators of community resilience must navigate the complex power dynamics that shape social capital. This is because "power differentials are a result of systemic racism, and they are reified and perpetuated in the built world. Part of the creative act for practitioners working in vulnerable communities is to find ways to use their problem-solving skills to actively refute those systems of oppression, and then also know when it is time to get out of the way and let the community drive the project" (Walsh 2018, p. 184).

The Petersburg Resiliency Hub navigated these complex dynamics by recognizing the expertise of the community. Connecting with the "unelected mayor" allowed for an entry point into the community so that they would not be met with hostility as "outsiders". The creation of a Community Advisory Board that guides the direction of the Hub taps into existing resources and knowledge in the community to support the community. The Hub can also serve as a place at which to access political institutions and political leaders in the community. Bringing the mayor and other elected officials to the Hub gives community members a way to voice their needs and concerns, while building connections to dominant systems. The Petersburg Resiliency Hub is actively using this transformative approach to navigate and contribute to bonding, bridging, and linking social capital, which addresses the persistence of these power relationships.

5. Resilience Hubs as a Transformational Resilience Tool in the United States

A one-size fits all approach does not apply in the case of Resilience Hubs, as they are intended to be flexible and responsive to community needs (Murray and Poland 2020). This is reflected by the Urban Sustainability Directors Network (USDN), which states the following: "Resilience Hubs, defined and led in partnership with members of the community, should meet the unique needs of residents and organizations in that neighborhood. This means that no two Resilience Hubs are likely to be identical" (Baja 2018, p. 4). Resilience Hubs are most effective when partnerships are developed with and between community members. An authentic partnership respects local expertise that can lead to systemic change, and "this is especially true when they [partnerships] are conducted with awareness of larger systems, and in collaboration with other coalitions working to resist systems of oppression, as well as to create new structures supporting a just transition to a regenerative economy" (Walsh 2018, p. 182).

Hubs should provide opportunities for social capital bridging and linking within communities through engaging with local private businesses, faith-based organizations, and agencies that have an established level of rapport with the community. Partnerships should be led by the community and include vulnerable

and marginalized community members to enhance equitable outcomes (Murray and Poland 2020). Hubs increase bridging and linking social capital through the sharing of community information, providing access to political mobility, and increasing the ability of citizens to communicate directly with local governments about their specific needs. Resilience Hubs advocate for communities and provide resources in alignment with community needs. Hubs cannot exist without the trust and support of community members. Involving communities in the decision-making process is essential in the creation and design of a Resilience Hub. This centers the perspectives and voices of communities in the design, implementation, and evaluation of Hubs. Resilience Hub development can serve communities by strengthening bridging and linking social capital, which catalyzes cooperation between local governments and community-based organizations. Social connections, a sense of belonging, and access to resources are strengthened through these Hubs. It is notable that using known and trusted spaces in communities for disaster relief increases their utilization during disasters (Mazereeuw and Yarina 2017). Resilience Hubs are often community-managed facilities, such as civic centers, convention centers, libraries, or churches. Regardless of the primary function of a Hub, the location should be familiar, trusted, and accepted by residents. The Resiliency Hub in Petersburg is unique in that it utilized an existing structure with historical significance as a United Service Organization (USO) facility for African American troops during military segregation in World War II. The location is known to the community and the restoration of the building is leading to a revitalization of the area, in part through an increased interest in the purchasing of nearby abandoned properties. Resilience Hubs often serve multiple functions for disaster relief: community engagement centers, relief stations, and/or disaster shelters. Some Hubs may serve only one of these functions, and others may serve as all three. The Resiliency Hub in Petersburg functions as a place of fellowship, education, and resources, as well as a shelter from heat and climate events.

Because vulnerability is not static, damage sustained to Hubs during a disaster reduces community resilience. Redundancy of resources can serve as a stalwart against declines in community resilience, particularly in the face of repeat disasters. If there is no redundancy, then the community will remain vulnerable and could suffer from persistent post-disaster dysfunction (Norris et al. 2007). Therefore, the Resilience Hub itself must be prepared for single- and chain-event vulnerabilities to disasters such as flooding, extreme heat or cold, and wildfires. The Hub should be equipped with backup power systems so that electricity is available during outages (de Roode and Martinac 2020). The Urban Sustainability Directors Network, the USDN (Baja 2018), recommends a hybrid system that includes a mix of power generation and storage, such as a Hybrid Resilience System (HyRS).

Communities should be assessed for the threats that they face and their ability to withstand these threats (Ribeiro and Bailey 2017). The condition of and current use of a proposed physical Resilience Hub site, as well as the size, its accessibility to

elderly and disabled individuals, and its vulnerability to climate disasters should be taken into consideration when assessing the suitability of a Hub location (Baja 2018). This means assessing a community's overall vulnerability by evaluating if the community is urban, suburban, or rural, vertically mobile or not, its socioeconomic status, and the availability of transportation to the Hub. Understanding the complex power dynamics and how they intersect to impact a community allow for the identification of specific points (Meadows 1997) of focus that, when addressed, impact the connected systems (Walsh 2018).

The mitigation of the effects of climate change and climate change disaster cannot be addressed through physical infrastructure approaches alone. Transformational community resilience is essential in the implementation of social and political strategies to address climate change. Black and other marginalized communities that have historically been displaced into high-risk climate disaster areas, such as floodplains and urban heat islands, may also have unequal access to support and resources. Their collective capacity to protect themselves from cumulative climate change burden and their ability to adapt after a disaster rely on a joint effort among community members. A transformational approach through the use of Resilience Hubs, such as the Hub in Petersburg, is not only responsive to the effects of local climate disasters but also promotes ongoing systemic change and neighborhood revitalization, such that a community is not in a state of perpetual hypervigilance against potential disasters. Local actions can have long-term and significant impacts (Walsh 2018).

The VEJC took purposeful steps in the creation of the Petersburg Resiliency Hub. The VEJC's efforts were unique, in order to meet Petersburg's needs, but may serve as guidelines for others to incorporate into their own community-driven processes. Communities interested in developing resilience solutions can use the Petersburg Resiliency Hub and other existing Hubs as prototypes. The VEJC connected with stakeholders and community members. Community members and community representatives were engaged early on to ensure community support of a Hub. A Community Advisory Board was put into place to guide the activities and direction of the Hub. An advisory board dictates the use of a Hub based on the needs and perspectives of a community. The VEJC worked to leverage resources and secure external funding to restore the building and install solar panels. They planned for the possible hazards that the community might face so that they can be prepared to support the community. The creation of each Hub is unique and often one of trial and error. Additionally, there are resources beyond the Petersburg Hub; for example, there are organizations such as the USDN that offer support and guidance to communities developing their own Resilience Hubs.

6. Conclusions

There is little debate that climate change poses a real and escalating threat to the planet and its inhabitants. All communities must address current climate events

and prepare for impending challenges; however, decades of environmental injustices in the United States have created significant disparities between marginalized neighborhoods and majority-White neighborhoods. This means that some of these neighborhoods, especially those most susceptible to climate impacts (e.g., coastal regions of the country exposed to increasingly severe hurricane and flooding events), are already disadvantaged in facing such an overwhelming challenge. Residents of the most environmentally vulnerable neighborhoods often struggle for adequate funding and support to navigate social, political, and environmental solutions at a local level.

One of the most important characteristics of communities that successfully coalesce and advocate for change is resilience. Can resilience within at-risk communities be developed, nurtured, and sustained? Creating lasting resilience is realizable through community-driven initiatives that bring a transformative power to countervail traditional political power structures. Resilience Hub development is one transformative approach that can build community strength and capacity in the face of climate change. The responsibility to prepare for and respond to climate change is incumbent upon federal and local governments, while nonprofit organizations and local businesses can assist in identifying climate change threats to communities, developing feasible solutions, and implementing local climate disaster mitigation plans. Traditional power systems have historically failed to prioritize the environmental conditions of marginalized communities. The paucity of changes in dominant systems to promulgate equity through policy and regulation reforms means that a top-down approach cannot result in significant transformational resilience. Resiliency created by communities for communities has a stronger likelihood of creating the transformative change that a community needs to combat climate impacts.

Human resilience, both individually and as groups, is critical for citizens to effectively address negative climate events at all levels of society. As a foundational component of community resilience, bridging and linking social capital, built through interactions across heterogeneous groups, is invaluable to climate change resilience. This paper stipulates that Resilience Hubs are an accessible and flexible tool that can be developed within vulnerable marginalized communities to meet the challenge of inevitable climate disasters. In working to co-create transformational community resilience through Resilience Hubs, it is crucial to address systemic power imbalances, foster community ownership, promote intersectoral collaboration, and advocate for equity and inclusion. The co-creation of Hubs with local residents also guarantees that Hubs are centered on the needs of communities and their buy-in of Hubs in addition to their functions and activities. Collaboration with stakeholders and the utilization of available resources and grant funding can help the long-term sustainability of Hubs. Finally, addressing the socioeconomic, cultural, and political forces that created the vulnerability and marginalization of communities ensures that Hubs are equitable and inclusive, leading to truly transformational resilience.

The authors encourage formal research on the effectiveness of the Resilience Hub model in building community resilience to more effectively address inevitable climate change problems.

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A Crisis within a Crisis: Climate Change and Gender-Based Violence (GBV) during the COVID-19 Pandemic in Trinidad and Tobago: A Narrative Review

Roshnie A. Doon and Debra D. Joseph

Abstract: Across the world, Stay at Home (SAH) and State of Emergencies (SOE) have been executed at various levels of intensity to preserve the lives and livelihoods of men, women, and their families against the COVID-19 pandemic. However, while these policies were implemented to protect lives, they also became a barrier to the security of men and women who are victims of domestic violence. Indeed, the literature has highlighted a worrying trend, in that there appears to not only be a rise in the various forms of domestic violence against victims resulting directly from the SAH measures, but also in the context of climate change, issues of lack of safety, food insecurity and economic insecurity in a COVID-19 environment have all served to intensify the experiences of victims. Using a secondary research methodology, the primary focus of this chapter is to explore the prevalence of non-extreme forms of domestic violence offences in Trinidad and Tobago occurring during the COVID-19 pandemic, its connection to climate change events, and how these changes are likely to fuel domestic violence.

1. Introduction

The Sustainable Development Goals (SDGs), better known as the Global Goals, are a collective call to action towards the resolution of many social, economic, and environmental ills that plague our world, in the hope that future generations may live a sustainable life. Of the 17 goals established by the United Nations (UN), the goal on Climate Action, i.e., goal 13, is the one that is the most critical to the survival of the human race, as it focuses on the need to take urgent action to transform the industrial activities of the leading producers of greenhouse gasses (GHG), which are having irreversible and long-lasting effects on poorer nations across the world (United Nations Environment Programme (UNEP) 2022). The losses accumulated from climate change-related disasters pose not only a significantly large financial cost to global economies through recovery and resilience efforts, but also have a notable impact on the lives and livelihoods of many persons around the world (United Nations Development Programme (UNDP) 2022a).

It is for this reason that if Goal 13, the Call to Climate Action, is not achieved, then this can worsen the ability of the world to achieve many of the other SDGs by 2030, especially when it comes to Goals 5 and 10, which focus on gender equality, and reduced inequalities (United Nations Development Programme (UNDP) 2022b;

United Nations Development Programme (UNDP) 2022c). It is therefore essential to understand how the drivers of gender inequality such as climate change have contributed to the prevalence of gender-based violence in Trinidad and Tobago, as climate change events may act as a trigger for violent incidents (United Nations Development Programme (UNDP) 2022d).

The prolonged presence of the COVID-19 pandemic has unfortunately worsened the situation of many victims of domestic violence (Adibelli et al. 2021). In that, not only have SAH measures trapped victims with their abusers, but the disruption in the functions in many sectors, such as healthcare, education, transportation, etc., have reduced their access to essential health services needed during instances of intense abuse, which may lead to severe wounds, such as traumatic brain injuries, hemorrhages, vision impairments, contusions, lacerations, and strangulation marks, as well as broken bones and fractures.

Bearing in mind that climate change and the COVID-19 pandemic when combined may have created the perfect breeding ground for domestic violence to occur in Trinidad and Tobago (Akel et al. 2021; Berniell and Facchini 2021; Glazebrook et al. 2020). This chapter will examine in great detail using a secondary research methodology not only how domestic violence manifested itself during the pandemic around the world, but also analyze the prevalence of non-extreme forms of domestic violence offences in Trinidad and Tobago, the link between climate change and domestic violence in Trinidad and Tobago, and how climate change has contributed to the occurrence of domestic violence, before examining the challenges and future perspectives of the issue for Trinidad and Tobago.

Notwithstanding the significance and importance of GBV in relation to the issue of climate change, there are several limitations of the work performed in this study. These limitations mostly concern the availability of data, and the statistical coverage of domestic violence incidents in Trinidad and Tobago, which if available may have allowed for greater empirical and applied research to be carried out. In particular, there is very little historical domestic violence data collected, and as a result it is not possible to determine if the patterns of domestic violence have intergenerational effects. Furthermore, the data collected on domestic violence in Trinidad and Tobago are limited in scope, in that only basic information concerning the victims such as age, sex, and marital status is collected, which also limits the level of analysis. Should this information be expanded to include information such as their level of education, previous instances of abuse, and presence of children in the household, it would have made for a much richer analysis of domestic violence in Trinidad and Tobago. That being said, one particular line of future research may possibly be to examine the impact that climate change has on the men who are victims of domestic violence in the Caribbean in relation to climate change. This is likely to add a great dimension to the literature as domestic violence amongst men is not at the forefront of the climate change and domestic violence discussion.

2. Global Manifestations of Domestic Violence during the COVID-19 Pandemic

The COVID-19 pandemic is an event that has forced the world to face many of its insecurities. From issues surrounding the equitable distribution of food and health care to that of political and economic instability, it appears that no one has been spared from the turmoil that the pandemic has unearthed. One such area that has received great attention during the COVID-19 pandemic is that of violence within the home environment, and its many linkages to topics such as Intimate Partner Violence (IPV), Gender Based Violence (GBV), Mental Health, Poverty, and Income Insecurity.

During the pandemic era, domestic violence in its many variations has raised its head to reveal some devastating outcomes, such as the prevalence of mental health disorders amongst pregnant women who are victims of domestic violence. Abrahams et al. (2021) explain that in a COVID-19 environment, the psychological distress that pregnant South African women experienced alongside severe food insecurity, sexual abuse, and marital distress, made many of them even more pre-disposed to common mental health disorders such as anxiety, depression, and post-traumatic stress disorder (PTSD) than in the pre-pandemic period. Similar to pregnant women, married women who were homemakers in India, as illustrated by Indu et al. (2021), exhibited depressive, anxiety, and perceived stress symptoms, which were strongly associated with domestic violence offences. Sleeping disorders were also highlighted by Peraud et al. (2021) as another contributing factor associated with domestic violence against women in France.

A similar outcome was observed for Lebanese women who were not pregnant during quarantine periods, where victims suffered from higher levels of anxiety and stress during extremely abusive situations (Akel et al. 2021). In most instances, forced cohabitation between victims and perpetrators of domestic violence was often one of the main causes of such abuse to persist during quarantine, as the possibility of conflicts and instances of interpersonal violence increased (De Berardis et al. 2021). For example, in the case of Italy, women were found to have less control over their movement, especially during stressful conditions, and were less likely to report the incident (Barchielli et al. 2021). Despite the lack of formal reporting, it was found that in the case of Italy and other European countries such as France, Germany and Spain, 5 weeks after the March 2020 lockdown, the intensity to which domestic violence searches were carried out via Google mobility data for these countries was at its highest, i.e., 20% (Berniell and Facchini 2021).

In contrast to that of European women, in the Portuguese context, even though the telephone remained the primary means of communication, many victims of domestic violence never used either social media platforms such as Facebook or videoconferencing applications such as Zoom, Microsoft teams, etc., during quarantine, and as a result, these victims received less remote support (Caridade et al. 2021b). Thus, victims of domestic violence such as those in Belgium reported greater dissatisfaction with healthcare services, and social support, and higher levels of emotional loneliness and vulnerability (Drieskens et al. 2022). Such

factors in many instances influenced the ability of victims such as women in Turkey, reducing their ability to effectively cope with stress (Evcili and Demirel 2022). This causes the victims' perception of stress to increase, which in turn increases their likelihood of worsening health and mental health outcomes.

Another manifestation of such psychological abuse is emotional abuse. Turkish women during the pandemic were found to suffer from stronger intensities of emotional and verbal abuse even if they were literate. This problem was worsened further if the woman and her partner were both unemployed during periods of lockdown (Adibelli et al. 2021). This consequence was also mirrored by married Saudi Arabian women, who endured multiple forms of domestic violence during quarantine, i.e., violent abuse (87.7%), emotional abuse (37.9%), and sexual abuse (39.9%), especially if they had many children (Alharbi et al. 2021). El-Nimir et al. (2021) explain that in the case of Arab women, 50% of victims were exposed to psychological violence during periods of lockdown at least one to three times per month, and sometimes daily if their partner lost his job during quarantine.

Apart from the social implications of the pandemic on domestic violence, the economic consequences of the virus also influenced the rate and intensity of domestic violence cases. As illustrated by Arenas-Arroyo et al. (2021), even though the economic impact of the pandemic was found to be significantly larger than the stints of lockdown, it was found that if the economic situation of the man in the household was to worsen during this period, his partner was more likely to experience the backlash from the loss of his job. In India, it was found that the type of marriage (Sikh, Parsi, Muslim, Buddhist, and Jain marriages, just to name a few), the area of residence, the husbands' age and education, and the employment status of the women were all variables (Rayhan and Akter 2021).

Given that women were more likely to have become unemployed between March 2020 to September 2021, this also increased the risk of their children dropping out of school permanently, neglecting the care of their children and dependent family members, and suffering from GBV as their level of uncertainty and job loss increased (Flor et al. 2022). Such economic instability at the household level, together with a marked decline in education amongst girls, was also noted to have led to a rise in early marriages in Bangladeshi girls originating from rural communities (Gautam et al. 2021).

Apart from the marked increase in violence against women during the pandemic, countries such as Ethiopia have noted the rise in cases against young girls. According to Kassie et al. (2022), 40.05% of Ethiopian girls have experienced some sort of violence, with psychological abuse being its primary form during the pandemic period. This statistic was positively associated with the use of social media, viewing of explicit content and substance abuse. Similar to young girls in Ethiopia, 27.6% of young adolescent girls in Kenya experienced IPV during the pandemic, and its occurrence is associated with poor support mechanisms in the home and community, and their partner's age difference (Decker et al. 2022). Further to this, as school closures continued after the initial lockdowns from March 2020, the state of Florida in

the United States also continued to record high cases of juvenile arrests for domestic violence, predominantly amongst Black and Hispanic youths (Baglivio et al. 2022).

Notwithstanding the overall impact that domestic violence has had on victims around the world, Drotning et al. (2022) find that the victims' sexual orientation also played a crucial role in their risk of violence. Sexual minorities in the United States were noted to have suffered a greater incidence of domestic violence than victims who were heterosexuals. In addition to this, other minority groups such as Refugees were noted by Mutambara et al. (2021) to have suffered from the negative effects of violence, by having their needs for safety during the pandemic ignored by state officials and excluded from mitigation measures.

In most cases of IPV and GVB cases, victims reportedly suffered from many forms of abuse cited in the literature such as physical, verbal, emotional, economic, and sexual manipulation; however, during the pandemic, new types of violence against women emerged. For Nigerian women, such violence manifested itself as threats to be thrown out of their homes by offenders, and threats concerning losing custody of their children, which in both instances hinder their ability to protect themselves and their children from becoming exposed to the COVID-19 virus (Fawole et al. 2021). In many instances, as discussed by Leigh et al. (2022), the virus was used by the perpetrators of domestic violence as a tool to control their victims and make them more submissive. This is an important issue, as McLay (2020) explains, that even in Chicago, United States, when Stay at Home Orders were issued, not only were domestic violence incidents more likely to occur, but offenders were less likely to have been arrested.

3. Research Methodology

For the purposes of this chapter, a secondary research methodology will be implemented to investigate the linkage between climate change and gender-based violence in Trinidad and Tobago during the COVID-19 pandemic. The main type of research conducted is that of secondary research or desk research as the data used in this chapter was retrieved from the TTPS and the Metrological Office of Trinidad and Tobago, while drawing on articles, journals and reports as discussed below. This type of research was chosen for this study because of its cost effectiveness, and it is largely based on existing research that aids in achieving the objectives of this chapter.

First, to examine how domestic violence cases manifested themselves around the world, several sources of scholarly literature are used to investigate the experience of victims around the world. Second, to study both the prevalence of non-extreme forms of domestic violence offences and its relationship to climate change in Trinidad and Tobago, domestic violence and climate change data were sourced from the Meteorological office of Trinidad and Tobago, and the Crime and Problem Analysis (CAPA) unit of the Trinidad and Tobago Police Service (TTPS).

The data which were collected during the period of 2020–2021 were compiled by the Crime and Problem Analysis (CAPA) unit of the Trinidad and Tobago Police

Service (TTPS). This registry is notably limited in nature due to a lack of resources by the Trinidad and Tobago Police Service (TTPS) to put together a comprehensive domestic violence database, and as a result the database only gathers information on the date of the incident, month and year when the incident occurred, the division and station where the incident was reported, the type of offence, the marital status of the victim, the victims' citizenship, ethnicity, occupation, sex, date of birth and age. It is well-known, however, that issues surrounding the non-collection and incomplete gathering of domestic violence data are cited throughout the literature as being a common limitation to carrying out empirical-type analyses that can aid policy development in this area.

Third and finally, to understand how climate change is likely to fuel domestic violence in the Caribbean, and the challenges that it poses to the region, a host of scholarly literature, reports, and discussion papers are used. The use of the secondary research methodology is paramount to the success of this chapter, as it enables one to not only identify and fill current research gaps in the literature that concern the Caribbean perspective that climate change has concerning gender-based violence, but to also serve as a starting point to understanding how climate change adaptation and mitigation plans influence the environmental linkages of violence.

4. The Prevalence of Non-Extreme Forms of Domestic Violence Offences in Trinidad and Tobago during the COVID-19 Pandemic

Before investigating the connection that climate change events are likely to have on domestic violence in Trinidad and Tobago, it is important to examine the overall prevalence of non-extreme forms of domestic violence offences occurring during the COVID-19 pandemic. Using a sample of 2372 men and women who are victims of domestic violence and are between the ages 18–65, a summary of some of the characteristic features of the victims shown in Table 1 below reveals that for the period of 2020–2021, most victims of domestic violence are between the ages of 25–34 (36.4%), married (34.7%), employed (72.2%), and considered to be non-essential workers (48.5%).

Table 1. Descriptive statistics (2020–2021).

Variable	All Victims (%)			
	All Offences	**Physical Offence**	**Verbal Offence**	**Legal Offence**
Age Group				
Age 18–24	11.40	13.60	7.40	6.50
Age 25–34	36.40	38.90	33.80	24.50
Age 35–44	31.30	31.00	32.00	31.00
Age 45–53	13.10	11.30	14.90	21.50
Age 54+	7.90	5.20	12.00	16.50
Marital Status				
Common Law Relationship	28.30	31.40	24.80	15.50
Divorced	1.60	1.00	2.30	4.00
Married	34.70	34.10	36.10	35.50
Separated	4.10	3.30	4.80	8.50
Single	30.10	29.80	30.50	30.50
Widowed	1.10	0.30	1.60	6.00
Time of Assault				
Weekday	73.50	72.40	75.40	76.50
Weekend	26.50	27.60	24.60	23.50
Employment Status				
Employed	72.20	72.20	74.10	66.50
Essential Worker	23.70	23.80	23.90	21.50
Non-Essential Worker	48.50	48.30	50.20	45.00
Unemployed	27.80	27.80	25.90	33.50
Observations	2372	1562	610	200

Source: Table by authors.

In addition to this, most of these offences, i.e., 73.5%, appear to occur on a weekday (Monday–Friday). For the purposes of this chapter, the three main types of non-extreme forms of domestic violence offences considered will be those that reflect physical, verbal, and legal abuse, as these types of abuse were most widespread during the COVID-19 pandemic. Briefly defined according to Living Without Abuse (LWA) (2022),

- Physical abuse includes behaviors such as biting, beating, burning, slapping and other similar actions that can lead to permanent injuries.
- Verbal abuse includes behaviors such as the frequent use of name-calling, obscene language, demoralizing and discounting the feelings of others, as well as the use of silence to exert control.
- Legal/financial abuse includes behaviors such as withholding money from their partner, making them accountable for everything spent, and either taking out loans or creating debts in their partner's name.

Based on the sample data taken, in the case of Trinidad and Tobago, most of the domestic violence victims appear to suffer from physical abuse (65.9%) and to a lesser extent verbal (25.7%) and legal (8.4%) abuse during the COVID-19 pandemic. In the case of physical abuse, many victims are between the ages of 25–44 and 35–44, in either a common-law relationship or married, while being employed and a non-essential worker. A similar outcome was also found for victims of verbal abuse; however, victims of legal abuse were slightly older, falling in the 35–44 age category.

A further look at the overall occurrences of each type of domestic violence offence shown in Figure 1 reveals that for the period of 2020–2021, all offences appear to peak in the months of March and July, after which offences tapered off and declined during August–December. A similar trend is observed for victims of physical abuse; however, while cases declined considerably between April–May, there was a steady rise in cases in the May–July period. When compared to victims of verbal abuse, the number of cases peaked in the month of May, declining thereafter, while the number of legal abuse cases remained small and relatively stable regardless of the month.

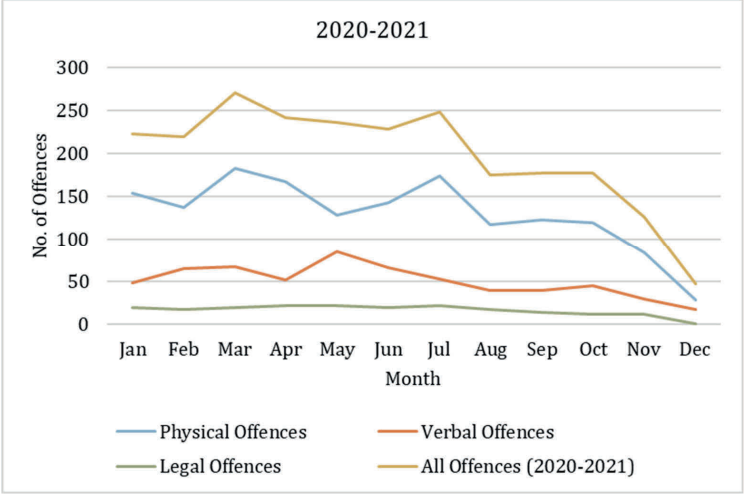


Figure 1. Domestic violence offences (2020–2021). Source: Figure by authors.

When the occupational status of the worker is considered as reflected by Figure 2a most essential workers tend to experience physical abuse, which peaks in the months of March, May, and October, when compared to verbal abuse, which seems to be consistently high during the months of March–July. In terms of Figure 2b, non-essential workers tend to experience higher rates of domestic violence in the months of March and July; however, when the type of offence is considered, non-essential workers tend to suffer from higher rates of physical abuse in the months of March, April, July, and September. A somewhat similar trend is observed for victims of verbal abuse, but there is a greater fluctuation in cases after July. Finally, Figure 2c shows that unemployed victims of domestic violence tend to consistently experience high levels of domestic violence during the months of February–May,

which peaked in July and declined thereafter. A similar pattern is exhibited by unemployed victims who experienced physical abuse, but there was a visible decline in cases during May. The opposite was observed for verbal abuse, which was at its highest in May, and relatively low for the remaining months. Regardless of occupational status, the cases of legal abuse tend to be small and stable over time.

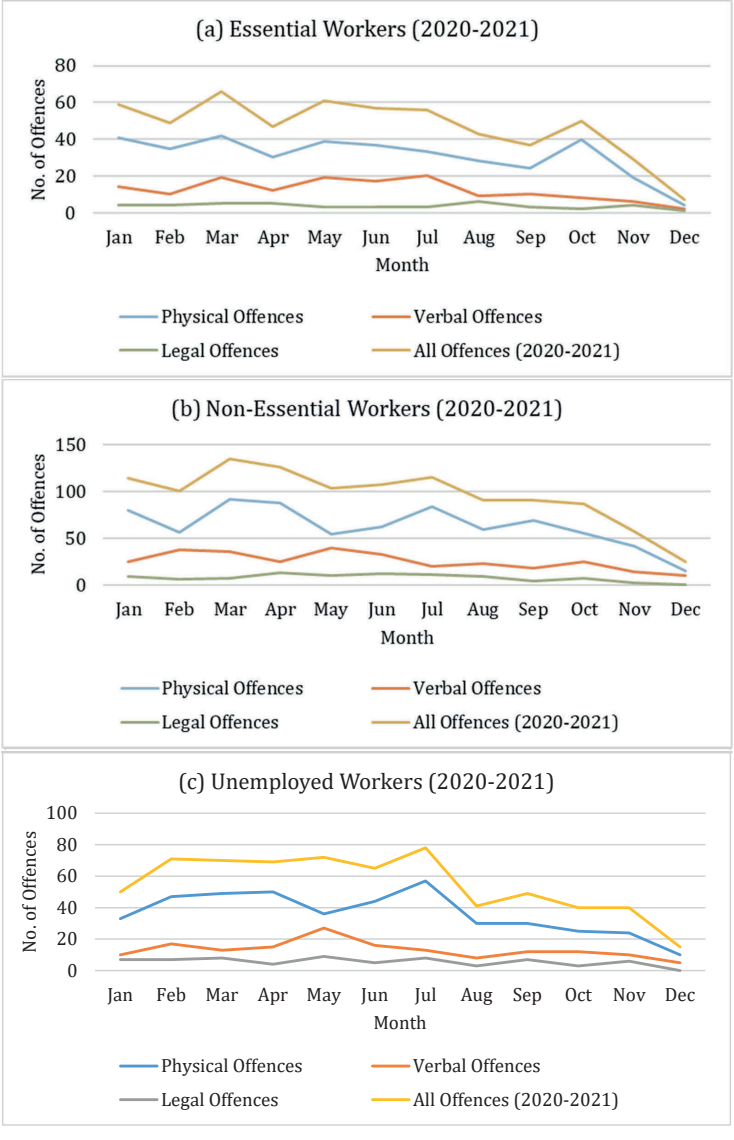


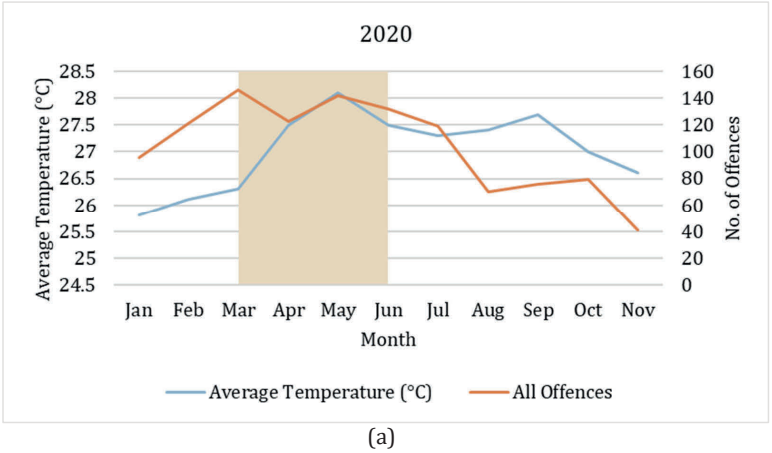
Figure 2. Employment status of domestic violence victims (2020–2021). (**a**) Shows the incidence of domestic violence experienced by essential workers; (**b**) shows the incidence of domestic violence experienced by non-essential workers; (**c**) shows the incidence of domestic violence experienced by unemployed persons. Source: Figure by authors.

5. Climate Change and Domestic Violence in Trinidad and Tobago

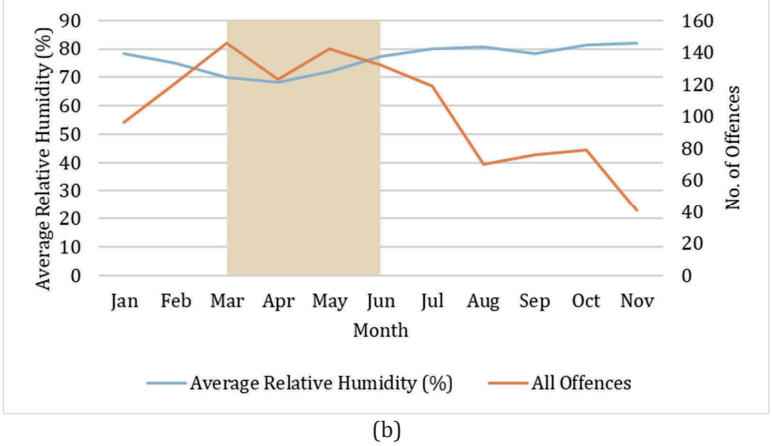
The negative implications of extreme climate change events are not a problem that can be dealt with in the future. It is a current ongoing problem that is taking place in real-time and is having an irreversible impact on the lives and livelihoods of those vulnerable to these events, particularly when originating from Small Island Developing States (SIDS) such as Trinidad and Tobago. The current effects of global climate change are likely to have widespread effects on the environment, as the occurrence and intensity of climatological (extreme temperatures, droughts, and wildfires), geophysical (earthquakes, landslides, volcanic activity, and tsunamis), hydrological (avalanches, floods), and meteorological (cyclones, hurricanes, tropical storms, tropical waves, typhoons), events have all grown in magnitude (Federal Emergency Management Agency (FEMA) n.d.).

These climate change events have all contributed to the breakdown of the protective mechanisms of the household by intensifying the problems of insecurity related to relationships, social interactions, jobs, and employment, as well as the provision of basic needs such as food, housing, and healthcare. Such disruptions to the safety and well-being of the household are also linked to the collective occurrence of violence within the home and communities, as their lives and livelihoods are now threatened more perceptibly, which can make worse the level of poverty and socioeconomic inequalities that women and victims of domestic violence in Trinidad and Tobago may experience (Belsey-Priebe et al. 2021). Thus, leading to a higher incidence of violence and violent crime. Climate change events such as famine and drought have led to periods of war as the social mechanisms put in place to protect people erode. One example of such a breakdown can be seen from the relationship that the presence of domestic violence cases may have with changes in the climate (Caridade et al. 2021a).

In the case of Trinidad and Tobago, according to Figure 3, during the 2020 SAH orders, which lasted during the months of March–June, the number of non-extreme forms of domestic violence was at its highest. In 2020, as the average temperature increased from 25.8 °C in January to a high of 28.1 °C in May, so too did the occurrence of domestic violence cases, which increased from 96 to 142 cases. These cases peaked at 146 in March just at the onset of the SAH Orders. Following the relaxation of the SAH Orders, as the average temperature declined to 26.6 °C in December, the number of cases also declined to 41 in December. Interestingly enough, during periods of high temperature when the prevalence of domestic violence cases was elevated, the average relative humidity as expected was low, i.e., 70.1 mm to 71.8 mm between March–May 2020. Under these conditions, on these uncomfortably hot days, it is noted that warmer temperatures are likely to increase feelings of anger, hostility, and aggression, resulting in higher levels of domestic violence (Mahendran et al. 2021).



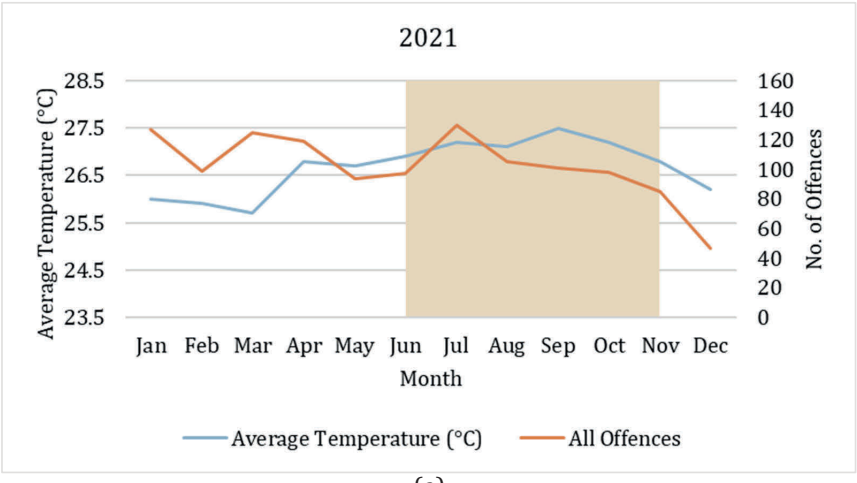
(a)



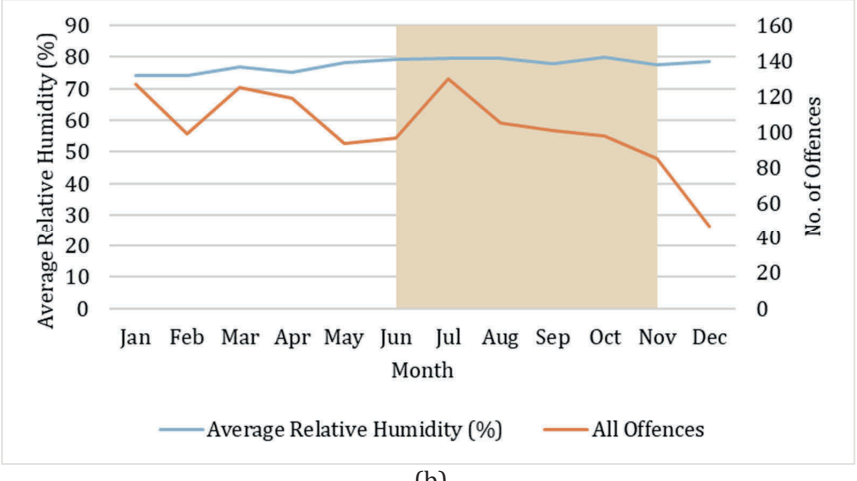
(b)

Figure 3. Average temperature (**a**), relative humidity (**b**) and DV offences during Trinidad and Tobago's 2020 SAH orders. Source: Figure by authors.

In 2021, as the COVID-19 pandemic persisted, Trinidad and Tobago also introduced an SOE during the months of June–November to assist in the management of the virus. During this time, according to Figure 4, although the number of overall cases of domestic violence remained high, between June to November the cases of non-extreme forms of domestic violence dropped slightly from 97 to 75 cases. However, one month into the SOE, the number of offences peaked at 130 cases in July 2021. In Trinidad and Tobago, some of the warmest months occur during the June/July–October period, averaging at around 27 °C, and coincidentally throughout this timeframe the cases of domestic violence were again high, with at least 100 cases per month.



(a)



(b)

Figure 4. Average temperature (**a**), relative humidity (**b**) and DV offences during Trinidad and Tobago's 2021 SOE orders. Source: Figure by authors.

From June/July–October, when the average temperatures were elevated, the average relative humidity was observed to also be quite high, 79.2 mm to 77.5 mm. The presence of both high levels of temperature and humidity are known to cause physical and behavioral changes in persons such as mood swings, depression, anxiety, drowsiness, fatigue, heat strokes, and sleep disturbances, as the human body struggles to cool itself, where again such a distortion in the behaviors of perpetrators and victims of domestic violence can lead to intense bursts of aggression and extreme violence (Otrachshenko et al. 2021). However, as the temperature declines and becomes more comfortable, and with the lifting of SAH in 2020 and the SOE orders in 2021 after July 2020 and December 2021, as more people are now outdoors, the incidence of domestic violence is likely to decline.

6. Climate Change Fuels Violence Against Victims

In the case of Trinidad and Tobago, as with many regions around the world such as Sub-Saharan Africa and East Asia, which are vulnerable to experiencing disastrous climate change events, the arrival and departure of tropical storms, hurricanes, flooding, and extreme temperature and rainfall, together with the impact of the COVID-19 pandemic, have all threatened the livelihoods of those most vulnerable in society. This is especially the case as it relates to gender-based violence since the twin island state continues to experience adverse climate events, which according to Thurston et al. (2021) can open three main pathways for gender-based violence to occur. The first is that climate change can be a stressor that triggers gender-based violence; second, climate change enables environments in which gender-based violence can strive; and third, climate change often exacerbates the underlying drivers of gender-based violence.

6.1. Patriarchal Societies and Fragile Communities

The vulnerability of domestic violence victims to climate change events is often linked to the traditional values and cultural norms regarding the role of women in the household and the community, where men traditionally have power over women, which implies that the security of women may be hampered during weather-related events such as tropical cyclones in countries such as Fiji, as men may have more control over the use and allocation of resources needed during and after the occurrence of natural disasters, while women have extraordinarily little influence during the adaptation, mitigation, and recovery process (Kopf et al. 2020).

For this reason, it is expected that climate change events may worsen the living situation of victims of domestic violence, particularly those residing in fragile communities such as coastal communities in countries such as Nigeria, as well as low-income urban and rural areas in Trinidad and Tobago (Akinemolu and Obafemi 2019). These areas are often considered to be vulnerable to climate change events because there is little investment made to develop and maintain the infrastructure of communities (housing, roads, drainage pathways), and to provide basic services such as healthcare, frequent waste collection, clean drinking water and electricity (Fraser 2021).

Consequently, the victims living in these communities may not be able to put in place adaptation and mitigation plans at the community level to deal with the adverse effects of climate change events such as flooding and landslides. This unfortunately leaves communities in Trinidad and Tobago more vulnerable to experiencing higher levels of discord in their communities such as crime, civil disobedience, and displacement during the post-disaster period (Memon 2020). Such heightened tensions, created by flood events in other countries such as Kenya, Pakistan, and Sri Lanka, have been observed to be followed by a growth in gender-based violence and may serve as an example of what is likely to happen in Trinidad and Tobago if climate-related violence of the poor is left unchecked (Bonds 2016).

In an environment where both climate change and domestic violence are rampant, it may also strengthen feelings of vulnerability, hopelessness, and despondency, within the community. This is likely to make victims of domestic violence from these living areas in Trinidad and Tobago more predisposed to experiencing higher levels of exploitation, as their living situation is now insecure. This heightened feeling of vulnerability is unfortunately made worse by the slow process to access grants and financial assistance from government bodies to undertake recovery efforts, which may be fraught with unnecessary bureaucratic red tape (Cameron et al. 2022; Parkinson 2022).

6.2. Access, Use and Control of Resources

In the aftermath of a climate change event, men and women tend to experience and react to these challenges in diverse ways depending on their access to resources. Given that women and domestic violence victims in Trinidad and Tobago may have a higher social disadvantage, given that they have less ownership of land, they are more dependent on local natural resources for food, water, and energy supply used in cooking and heating, and have less access to environmental goods and services. It is also possible that victims may also have less access to education and training on how to deal with the effects of extreme weather events, which may all contribute to creating the perfect conditions for violence to thrive in their homes (Caridade et al. 2021a; Chersich et al. 2019). The growing scarcity of fertile croplands and other essential environmental resources, together with climate extremes such as temperature and precipitation, all contribute to the development of collective forms of violence such as riots, protesting, and youth gangs within communities (Levy et al. 2017).

6.3. Extreme Temperatures and Employment

Violence in hot weather is not a new phenomenon, as with the case of Trinidad and Tobago, other countries such as South Africa have found that temperature changes can have a profound effect on the psychology and behavior of perpetrators and their victims. Where extreme weather may bring about a sense of discomfort, emotional instability, mood disturbances, eroding well-being, irritability, confusion, anger, and aggression, which together may increase the likelihood of violence against one's partner or family members (Chersich et al. 2019). For this reason, when related to variations in temperature, this type of abuse, according to Henke and Hsu (2020), reduces to a form of expressive violence, which is aggression that occurs as an emotional response to frustration. This is further supported by the fact that countries in warmer regions of the world are more likely to exhibit higher rates of violence and dangerous crime during hotter weather. Such conditions have led to higher rates of physical and sexual violence and even cases of femicide.

Interestingly enough, Henke and Hsu (2020) explain that if the victim of domestic violence is employed and has job opportunities regardless of the industry of employment, then this often protects them from experiencing temperature-based

violence, as the victim has greater bargaining power. It is noted, however, that while the victims of domestic violence can be employed in any industry, some sectors are more labor intensive such as in the areas of agricultural/farming and garment construction such as in the case of Bangladesh and Ghana, and victims may be more exposed to heat stress and extreme weather events, which could lead to higher instances of extreme violence (Anderson Hoffner et al. 2021; Glazebrook et al. 2020).

6.4. Sexual Gender-Based Violence (SGBV)

As climate change events restrict access to resources, when conflict arises, so too does the incidence of sexual and gender-based violence. This is because the environmental conditions created by natural disasters as well as the COVID-19 pandemic not only worsen the inequalities that victims in Trinidad and Tobago may also experience but may provide the perfect disguise for the perpetrators of sexual gender-based violence to target victims (Clark et al. 2022). Given that legal restraints, social protective measures, social networks, and health care services may be weakened during the occurrence of natural disasters, perpetrators may use these conditions as an intentional tactic to intimidate their victims. This effectively displaces victims, as well as migrant and refugee victims of abuse, who are now more than before vulnerable to entering into the sex-trade industry, as well as child marriages in response to their desperation for necessities, food insecurity, mental stress, mental trauma, post-traumatic stress disorders, as well as privacy and protection (Ovenden and Daalen 2022; Desai and Mandal 2021).

Even though climate change plays an important role in the spread of sexual gender-based violence during climate change disasters, victims continue to be victimized because there is not only an international legal instrument that adequately addresses such violence, but several major United Nations (UN) Climate Negotiations such as the United Nations Framework Convention on Climate Change (UNFCCC)—1992, Kyoto Protocol—1997, and the Paris Agreement—1995, and several earlier Conference of the Parties (COP), barely addressed SGBV in great detail (United Nations (UN) 1992; United Nations Climate Change (UNCC) 2022; Environmental and Energy Study Institute (EESI) 2022). As a result, women and victims of domestic violence will continue to experience verbal, physical, and sexual violence in their communities.

6.5. Environmental Degradation

Apart from climate change events, natural and fabricated environmental degradation influences the intensity of domestic violence and violence against women. From a legislative and climate change policy perspective, not only is there little inclusion and representation of women, but the rights of Indigenous communities in countries such as Indonesia, who are also disproportionately affected by environmental degradation caused by problems such as deforestation, land disturbances, pollution, landfills, and overpopulation, are hardly considered

(Csevar 2021). As a result, this often serves to worsen their current vulnerabilities inclusive of gender-based domestic violence, as well as the marginalization and social exclusion of these Indigenous communities and communities in low- and middle-income countries.

One example where environmental degradation through water insecurity has fueled violence occurred in Sub-Saharan Africa, Latin America, and South Asia, where prolonged periods of drought forced women to not only venture far distances outside of their communities to search for water, but also put themselves at risk to verbal, physical and sexual violence, as well as being raped and abducted by strangers such as armed groups (Médecins Sans Frontières (MSF) 2005), not to mention the risk of intimate partner violence dealt with by their partners when they fail to secure water and food resources to meet the needs of the household (Tallman et al. 2022).

7. Challenges and Future Perspectives for Trinidad and Tobago

Based on the recommendations put forward by United Nations Women (UN Women) (2017), one must ensure that service providers and survivors realize that not only physical violence is violence but there is also psychological abuse, verbal abuse, financial abuse, and emotional abuse as well. Education on the domestic violence act and what constitutes abuse is crucial for building awareness of abuse. This can go towards recognizing, preventing, and addressing abuse. Schools, as part of their social education, should incorporate this in their curricula. Domestic violence is too pervasive for society to do anything. It must also be noted that domestic violence can ensue from as early as the beginning of a relationship. Observing red flags concerning the types of abuse can auger well for prevention and leaving a relationship early.

Many women experience victim blame from persons in society, for example, the police, family members and random persons. This can prevent the reporting of the violence for months. Women may be embarrassed and shamed, leading to non-seeking help behavior for counselling, community programs, clinics and other supportive interventions that are available. Domestic violence can create both intrapersonal and interpersonal conflicts. Understanding abuse can help women build their self-esteem, develop healthy self-concepts, and realize that they are worthy of their place in society.

Resources need to be strengthened. Non-Governmental Organizations (NGOs) are fund deficient and struggle to employ staff, finance staff training and enhance existing programs. More funding is needed to hire social workers and counsellors. When social workers and counsellors are stretched, the interventions could be compromised, and clients may not feel that their needs are being met. This is an added burden that they do not need. Shelters may need the presence of child psychologists as children could be particularly affected by domestic violence and may wake up screaming in the night and or have behavioral challenges. Shelters can neither address mental illness nor suicide attempts. Women who fall into this category can become invisible to services and have greater difficulty accessing shelter

and support. Further to this, state resources are also too limited and inadequate to address domestic violence. Although this issue is dealt with in ministries and units, there is a need for greater coordination. Relationship factors such as patriarchy, economic stress, men's multiple partners and substance abuse to name a few exacerbate women's vulnerability to domestic violence. The sexual violence of rape in marriages or with partners needs greater attention, as it is under-discussed in forums. Economic insecurity is likely to increase because of COVID-19 and with-it women's and men's dependence on each other.

Women must be able to negotiate safely for finances to support themselves and their children in households, especially those who are dependent on partners for financial support. Women may feel alone and do not know where to turn despite the range of services available by both the State and NGOs. They remain at risk, especially when they leave violent relationships. There are inadequate provisions for their immediate and sustained protection. Interventions must be fast, immediate and consistent. The protection system is not effective enough. Holistic support is sorely needed.

8. Conclusions

Many women have experienced domestic violence throughout their lifetimes and continue to do so presently. New layers of challenges tend to exacerbate this violence, such as COVID-19 and climate change. These added layers tend to perpetuate inequality and inequity concerning women and their needs. If mechanisms are not put in place to alleviate this scourge in society now, women are going to continue to suffer the consequences. These consequences can lead to death, with increasing homicidal figures in the country. The challenges faced have been highlighted and provide a way forward for the provision of adequate and holistic support for women in such circumstances. Those in authority must take notice and act immediately.

The empirical evidence provided within the scholarly literature, and actual research highlights and interprets the voices of women who have experienced domestic violence. The findings cannot be generalized to the population of Trinidad and Tobago, as such, further scientific studies or a systematic literature review with meta-analysis are necessary to confirm this hypothesis.

This issue should be placed high up on the agenda of policies and programs to be initiated or supplemented by the state. Awareness programs, whether they be via social media, press or television, should be developed and distributed accordingly. Education is a key component to understanding the elements of domestic abuse. The impacts of climate change on women should also be a part of this campaign as it adds another layer to the plight of women and can be a factor in domestic abuse. The links should be delineated to inform the public. Hopefully, persons in the public will take notice and join the advocacy for additional resources and services for women who experience domestic violence in our society.

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Examining the Psychosocial Issues that Impact Female-Headed Households Post-Hurricane Maria in Dominica

Debra D. Joseph

Abstract: Hurricane Maria made landfall on the southwest coast of Dominica on the 18th September 2017 as a category 5 hurricane with up to 160 mph wind speed. This left 31 people dead and 37 missing. Around 65,000, or approximately 80% of the population, were directly affected and more than 90% of roofs were damaged or destroyed. Power and water supplies were disrupted and entire crops destroyed. With an estimate of USD 930.9 million damages, most were sustained in the housing sector (38%), followed by transport (20%) and education (8%). Four months after the hurricane, Dominica was severely affected. Around 450 people resided in collective shelters. Over 80% of houses still had inadequate roofing. This research examined the psychosocial issues that faced the Dominican population of female-headed households after Hurricane Maria. It also examined the current physical state of homes of these women as they struggled to find some form of normalcy in living. Its focus will support community resilience, one of the four priority areas of the Regional Comprehensive Disaster Management Strategy. The results can hopefully motivate people and/or organisations to become more involved in comprehensive disaster management and have long term changes which can have positive national, regional and international implications for strengthening disaster resilience. Pre-existing, structural gender inequalities mean that disasters affect women and girls in different ways than they affect boys and men. The vulnerability of females increases when they are in a lower socioeconomic group, particularly in the Global South. This vulnerability impacts preparedness, evacuation, response, number of deaths and recovery. The reasons for this vulnerability can often be traced to the roles females hold in society and existing gender and cultural norms where they live. Research in this area can help the understanding of women and how they cope in such disasters. The aims were: to examine the living conditions of persons immediately after Hurricane Maria and four years later; to find out what issues are impacting their quality of life; and to expose the gaps in their current needs. The chapter examines the issues faced by female-headed households, with respect to the aims, methodology, methods, major findings and implications. Major findings showed that not much changed post-Hurricane Maria and four years later. The COVID-19 pandemic created more challenges and hampered infrastructure and other progress due to the Hurricane.

1. Introduction

McKinnon and Alston (2016) posit that social workers now view the physical environment as a means by which social inequalities present in an environmental crisis. There has been an increase and re-evaluation of the physical environment by social workers over the past decade. This provides the basis for intense scrutiny of environmental policies, social inequalities and economic frameworks that form the source for engagement with the Earth and its inhabitants. In general, social work practice takes part in the micro, mezzo and macro spheres. In the micro sphere, social work works with individuals via case management and examines the issues that may impact on that person with respect to environmental policies, social inequalities and economic challenges. In the mezzo sphere, social work addresses challenges in said area with families and groups, and in the macro sphere social work looks at these areas mentioned in relation to communities and society. The practice of social work is all-encompassing through all three spheres put together.

The environment is relevant in all three categories and embraces casework with case management (micro sphere), group work and work with the family (mezzo sphere) and community work (macro sphere). Social policy is critical with respect to environmental concerns, as it leads to relevant programmes and practices in all three spheres. Social work education is the main thread that connects all three spheres as based on evidence-based practice and theories, both support interventions in all three spheres. In all these categories, it behoves social work to recognize relevant environmental issues and to advocate for environmental awareness and improvements. The importance of social justice emerges. The aspects of human rights, child's rights and recognition of the United Nations Sustainable Developmental Goals (SDGs) form part of the tapestry for intervention at the three levels of social work practice concerning the environment. Any pedagogical approach in the eco-social work paradigm must promote the eco-social lens and critically examine the anthropocentric lens (Rinkel and Mataira 2018).

Tropical cyclones frequent the Caribbean during the months of June to November. All records show that changes in tropical cyclone frequency and magnitude due to climate change have significant implications on the vulnerabilities of Caribbean populations. According to the UNDRR (2023), for the past ten years, disasters have caused a heavy toll on communities and the well-being and safety of countless individuals, with current focus on islands in the Caribbean. According to the Intergovernmental Panel on Climate Change (IPCC 2021), Tropical Cyclone intensification rates on a global scale have increased in the past 40 years. These intense hurricanes include categories 4 and 5, which have destroyed buildings and infrastructure and threatened human lives in the Caribbean.

According to Dulal et al. (2009), climate change is a social equity issue because the poor and disadvantaged are the persons vulnerable to most of the impacts. They add that climate change may impact socio-economic systems, but not all communities will be affected in the same way or degree. Policies must promote fairness, justice

and equity with respect to social policies. All societal groups must benefit from climate adaptation policies and equity must account for the main overlapping and vulnerable groups, such as the poor, the indigenous, women and children.

In this research, women, particularly female-headed households, were the main individuals used because of their vulnerability in climate change crises. Dulal et al. state that from a psychosocial point of view, climate change can exacerbate social disruption and undermine social sustainability for different groups in differing ways.

Dominica is the most northerly island of the Windward Islands. The country is located at 15° 25′ North latitude by 61° 21′ West longitude, north of Martinique with an approximate population of 77,629 (est. 2022) (CIA 2022). It is a mountainous volcanic island with steep terrain. Most of Dominica's centre is dominated by steeply dissected terrain. Consequently, much of the population, 90%, is in settlements along the coastal areas of the island (The World Bank 2012a). This island experiences some of the highest annual rainfall amounts in the region. In August 2015, Dominica experienced severe damage due to Tropical Storm Erika. High winds and heavy rains caused flooding and landslides, destroying buildings and killing more than two dozen people. Several communities were devastated (Encyclopaedia Britannica 2015; Rock et al. 2018). Since 1950, this island has been exposed to thirteen named tropical storm systems passing within 40 km of the island, and since 1979, the island inhabitants have been impacted by fifteen tropical systems, including eleven hurricanes (The World Bank 2012a). The latest was Hurricane Maria, a category five hurricane, in September 2017.

2. Background Literature

Drolet et al. (2016) state that countries and communities that are unprepared for natural disasters and are unaware of the risks have reduced capacities and suffer the impact of disasters more severely (UNDP 2014). They add that social development forms the basis of the principles of social justice, respect and integrity of people and working for vulnerable populations, like the values of social work. What is needed is a more focused look at integrating environmental concerns with sustainable development from a social work perspective and the integration of the same in the curriculum for social work programmes. Rock et al. (2018) asserts that social workers in the Caribbean can incorporate Green Social Work (GSW) practices in their interventions to help people and communities function better in their living spaces pre- and post-disaster and plan accordingly. Dominelli (2012) agrees and further states that social workers should focus on the interplay between residents' lives and the natural environments.

Hurricane Maria impacted Dominica as an extremely strong hurricane with speeds of up to 155 mph (CEDEMA 2017). This hurricane resulted in intense storm surges, torrential downpours, raging rivers and extremely high winds that left a lot of devastation in its wake, with 90% of roofs being damaged or destroyed. There was about USD 930.9 million in damages, and most were sustained in the housing

sector. Overall damages and losses were estimated to be around USD 1.3 billion (Assessment Capacities Project (ACP 2018); PDNA 2017).

2.1. Female-Headed Households

According to the IPCC (2014), in considering climate change and its impacts, persons who are marginalised socially, economically, culturally, politically and institutionally are particularly vulnerable to these changes. Female-headed households can be considered one of the most vulnerable groups due to limited access to land, formal employment, credit and insurance resources (The World Bank 2012b). Rosenhouse (1989) examined household headship, stating that a decade of research on women and development shows that households headed by women are over-represented among the world's poor and have increased worldwide in the past two decades. Poverty is not restricted to this group, but the sheer numbers in this group deserve additional attention in social adjustment programmes. The World Bank (2012b) supports this view, as does the ILO (2018).

2.2. Gender Gaps in Social Protection—Disaster Impacts

The International Labour Organisation (ILO 2018) states that women have less access to social security during their working lives compared to men because of the gendered labour division in the world and, for the purposes of this study, particularly in the Caribbean. Women are less covered by pensions in Dominica and other Caribbean countries and tend to hold vulnerable employment. According to ECLAC et al. (2005), the gendered labour division and limited access to productive resources exacerbate disaster situations. They add that women's higher unemployment rates post-disaster can be linked to new economic opportunities that favour the historically male-dominated construction sector and infrastructure rebuilding. Furthermore, female-headed households tend to be more vulnerable to the impact of disasters as they tend to be poorer, especially in rural areas (ILO 2018). Poverty puts the female-headed households at a severe disadvantage as it reduces their capacity to decrease the shocks. Caribbean women have less access to land, productive resources and credit compared to men (CDB 2015).

3. Literature: Effects on Mental Health Post-Disaster and Women in Disasters

The following literature looks at the mental health effects immediately after a disaster and years later.

Roque (2022) examined the psychological effects on persons during and after the passing of Hurricane Maria in Puerto Rico. She reports that in terms of mental health, the greatest impact came months after the hurricane. There were feelings of despair at seeing nothing return to normal, for example, the availability of drinking water, electricity and food. Many had not recovered mentally or psychologically and needed psychological intervention. She adds that seeking such help is taboo. Maria led to persons being separated from their families and other support systems. There was an

increased number of calls to suicide hotlines as opposed to the year before in 2016, from 91,333 to 113,830. Some of the mental health problems included post-traumatic stress disorder (PTSD), loneliness, the sense of loss and isolation, to name a few. PTSD seems to be most common among Puerto Ricans since the hurricane. This may appear immediately, weeks or years after the event (Roque 2022).

According to Martin (2015), Hurricane Sandy affected millions in 2012. It was found that depression levels increased by 25% post-storm and doctor's visits also increased by a significant number. She adds that large-scale disasters have a great effect on the physical and emotional health of disaster survivors. Understanding of these mental issues can improve future disaster relief programs and policies. This can assist government and non-government organisations to assist communities in the aftermath of such disasters.

Ruggiero et al. (2012) add to the studies of the effects of hurricanes and found that after a storm, 15% of individuals reported anxiety and stress related to the storm. They suggest that issues emanating from the aftermath of a hurricane, such as lack of electricity, food, money and/or transportation significantly correlated with mental health problems.

In the aftermath of Hurricane Sandy, many experienced despair, hopelessness, anger and anxiety, and instead of acknowledging anxiety or depression, some complained of a headache, stomach ache or some other physical ailment (Graham 2012).

Unequal opportunities with respect to education and health care means that in times of disaster women are more vulnerable than men. The socio-economic status of women and gender-specific factors increase women's disaster vulnerabilities (Kashyap and Mahanta 2018). Armaș and Gavriș (2013) add that gender-based inequality can increase women's vulnerabilities in disasters. They argue that gender inequality has greatly contributed to the vulnerability of women to floods and other disasters. Gender exclusion is also reflected in all levels of the disaster process, for example, exposure to risk, preparedness, response, physical impact, psychological impact, recovery and reconstruction. Exclusion can contribute to the vulnerability of women during and after disasters (Armaș and Gavriș 2013). This was supported by Chanty and Samchan (2014), who state that women's vulnerability to disasters is rooted in their traditional gender roles, such as reproductive, productive and social, inclusive of childcare responsibilities.

The theoretical framework utilised concepts from social support theory. According to Leahy-Warren (2014), social support is seen as a middle-range theory that focuses on relationships and the interactions within those relationships. Drageset (2021) asserts that social support has proven to have a significant impact on psychological distress, quality of life, loneliness, burden of care, anxiety and depression. As a result, this research sought to examine the psychosocial issues that impacted the women, what support they received, how they perceived that support and what needs they deemed unmet.

The objectives of the study were:

1. To examine the living conditions of persons after Hurricane Maria, immediately and four years afterwards.
2. To find out what issues and challenges were impacting their quality of life.
3. To find and expose the gaps in their current needs.

There is distress from a mental health perspective immediately after a hurricane or natural disaster. Manifestations may include anxiety, depression and PTSD. This study fits into the existing studies and contributes to existing knowledge by providing direct feedback on the psychosocial issues that impacted a purposive sample of female-headed households post-disaster in a Caribbean country, namely, Dominica. Presently, there is a dearth of research that examines female-headed households in the Caribbean post-disaster.

4. Methodology

An exploratory qualitative methodology was used. Methods included a semi-structured interview protocol used to solicit feedback from participants and Photovoice. The research was carried out in four (4) phases between 2020 and 2021:

Phase 1: An audio taped interview lasting approximately one and a half hours if permitted.

Phase 2. Provision of three representations of the subject's life presently in pictures which they deemed very important in their livelihood for the newsletter. This was to facilitate the Photovoice aspect of the research.

Phase 3: Head picture portraits were taken for the newsletter, and three simple questions regarding the subject's current life and what they thought was needed were asked. This is to be highlighted in a glossy magazine as a research output.

Phase 4: Publication of newsletter.

All four (4) phases were completed.

Photovoice is a participatory method articulated by Wang and Burris (1997), in which the participants use cameras to capture visual representations of their everyday lives so that the researcher working with the individuals can gain insight into practices that may otherwise be only described in words. This additional method can help communities to better engage in critical dialogue around the problems and issues they face in the aftermath of a disaster. The participants were active researchers using cameras, which identified and captured important areas of their lives. These images were collated as part of the research to provide visual highlights of the feedback from the women. The pictures from each participant were collated and placed in a newsletter under the participants' responses to gaps in their needs. Five

of the seven women agreed to be highlighted in this newsletter. The newsletter was published for dissemination.

The interviews were carried out by two (2) social work students, who had graduated with their BSc. in Social Work form the University of the West Indies, Cave Hill, Barbados. Both students live and work in Dominica. Meetings and training were held via Zoom. Students were also given written instructions as to how to conduct the interviews. Each interview took approximately one hour and all were conducted in 2021–2022. The women were not compensated for the interviews; they volunteered to be part of the research and to share their experiences. An eighth participant was identified, but due to difficulties in meeting with the research assistant, she could not participate in the interview. The research was structured to interview at least ten (10) individuals; however, this research was carried out during the heights of the COVID-19 pandemic, and as such many challenges were encountered. This chapter highlighted the results of the semi-structured interviews with the seven (7) women. Interviews were audio-taped and transcribed verbatim for analysis.

4.1. Inclusion Criteria

Participants were chosen based on the inclusion criteria: women who were single and in charge of their households at the time of Hurricane Maria in 2017 and four (4) years later in 2021.

4.2. Method—Semi-Structured Interview Protocol

Participants were given an information sheet which described the research, a consent form to sign once they agreed to do the research and a demographic form was also completed for each. They were assured of confidentiality.

There were eleven (11) questions in total. A sample of questions asked is below:

1. What has changed for you in the following areas post Hurricane Maria in 2017 and four years later in 2021?

    a. Physical
    b. Social
    c. Economical
    d. Educational
    e. Psychological

2. Were you employed pre-Maria? If yes, what was the nature of your employment.

    a. Are you employed presently or any time after Maria? If so, what is the nature of your employment? Is the renumeration less If so by how much? Is it more, If so by how much? Is it adequate for living? If not why, If yes, why?

3. Are you residing at the same location post-Maria?

If yes, give account of damages if any and cost of repairs if any.
If no, give account of what happened to your place of abode post-Maria.
Give area once lived and area now lived. How many miles away?

4. Did you move to different places to live post-Maria? If yes, how many and by whom.
5. What type of support did you receive post-Maria?

    a. Informal Support from family and friends?
    b. Formal support from Community, Government, NGOs and Civil Society?

4.3. Data Analysis

Data collected from audio taped interviews were transcribed verbatim and analysed by using Template Analysis. This involves the development of a coding template where themes are identified and summarised (University of Huddersfield 2023).

Hierarchical coding was emphasised, using broad themes such as responses to Hurricane Maria immediately after its passing in 2017 and four years later in 2021. Themes were narrowed and included social, spiritual, economical, psychological and educational experiences.

5. Sample Description

Altogether, seven (7) females participated in this study, all of whom were single mothers. They ranged between the ages of 34–56 (M = 41.6), and resided in the parish of St. David, except for one, who lived in St. Andrews. Their professions ranged from teaching and agro-processing to farming and hairdressing.

All seven women reported participating in some form of training post-Hurricane Maria by the government. Some of the training undertaken included Return to Happiness, Hazard Vulnerability & Capacity Training, Ham Radio training, Cassava Field School Training, training from UNDP in strengthening the disaster management capacity of women, Child-Friendly Spaces, Counselling in Gender-based violence, Early Childhood Care and Development, Child Protection Services and Child Assault Prevention (CAP). Some of the skills possessed by the respondents included farming, agro-processing, hairdressing, leadership, CPR, cooking, Spanish and computer skills, and one individual indicated that she was Community Emergency Response Team (CERT)-certified.

In addition, six of the women were never married, with one being divorced. Three had tertiary education and two had secondary education. Five were employed, one self-employed and one unemployed. Each had lived in their parish for over thirty years. Six out of seven women were employed; the fact that all seven had training speaks to the tenacity and resilience of these women. The determination to retain employment in the aftermath of the hurricane and to avail themselves of available and necessary training despite the mounting challenges add to this resilience and determination and the quest for survival. The sample size was chosen with a cap of ten (10) persons because of the COVID-19 pandemic and the challenges this presented

in terms of access to participants, periodic lockdowns and other COVID-19 protocols. The research was time-specific based on guidelines given by the donor. Even though seven (7) women were interviewed, saturation of responses was seen from their feedback to the research questions asked.

6. Findings

6.1. Living Conditions of Dominicans

6.1.1. Immediate Living Conditions

As a result of Hurricane Maria, the participants reported experiencing a significant amount of loss and damage. Specifically, two individuals reported losing their homes as Maria demolished the entire structure, while the others provided an account of the considerable loss and damages they endured, inclusive of the complete loss of their roof which in turn led to water-damaged flooring, walls, doors, furniture, cupboards, appliances and electronics, as well as compromised electrical systems. Participants also reported losing windows and water tanks, and in the case of those who were self-employed, losing their source of income because Hurricane Maria destroyed their place of work.

As expected, these losses and damages disrupted the lives of the participants and in most cases caused significant displacement. In the days and weeks following Maria, most of the participants found themselves needing a place to stay and reported their struggles with finding one that was safe and secure. Consistent with their accounts, some found themselves having to move from place to place, either because of safety issues, family issues, lack of funds, lack of food for the children, over-crowdedness or simply to avoid having to deal with the wreckage caused to the home by the hurricane. Altogether, the women reported being forced to stay with family members or at a hurricane shelter, to live in their car or in a tent or to rent a room, with most of them reporting having moved as many as three to five times before they were able to settle.

6.1.2. Living Conditions Four Years Later

Despite it being four years since Hurricane Maria impacted Dominica, Dominicans were still struggling to recover from the damages and losses they endured in 2017. This was highlighted by two of the interviewees, who stated the following:

> "… there are still people who live in shacks, on dirt floors with just barely any shelter. They have the galvanize but there are holes in there. And they have tarps over it."—Female, 56, St. David, 3 children.

> "… there are people who have it worse than me. Because there are people who still have tarpaulin over their homes, and they have nowhere else to go because they have no job so they can pay rent. Nobody to help them."—Female, 38, St. David, 2 children.

Similarly, the interviewees highlighted their current struggles in recovering from Hurricane Maria, noting that they were either living in a home with cracks, water-damaged walls or partially restored roofs, or one which needed to be demolished. Additionally, some of the respondents were forced to relocate, with one respondent noting that she was currently renting and had just started the foundation for her new home, and another stating that she lived in a small structure built by her father and teenage son and was unsure as to when she will be able to return to her former home. According to most of the women, their inability to recover from the damages caused by Hurricane Maria was due to financial constraints and were currently being exacerbated by the COVID-19 pandemic and the increasingly excessive cost of living. Social workers can be available in communities to be the first point of call for intervention. Again, knowledge of systems that provide formal support is integral to helping the populace to better function post-disaster.

6.2. Issues and Challenges Impacting Dominicans' Quality of Life

6.2.1. Immediate Issues and Challenges

In their attempt to recover from the effects of Hurricane Maria, Dominicans encountered several challenges which in turn impacted and are still impacting their quality of life. The following section highlights these psychosocial challenges, inclusive of physical, social, educational, economic and psychological issues.

Psychological

Given the devastation left behind by Maria after its passing in 2017, it is no surprise that Dominicans were affected by it psychologically. In recounting their experience during and post-Hurricane Maria, many interviewees reported exhibiting signs of psychological trauma, inclusive of anxiety, and potentially Post-Traumatic Stress Disorder (PTSD) in accordance with the criteria in the DSM-IV (American Psychiatric Association 1994). One of the women noted that she had her first anxiety attack the night of Maria, causing her to feel vulnerable, which was a foreign feeling to her because she always felt she was "superwoman". Another indicated that in trying to come to terms with all she needed to do to recover from the damages of the hurricane and simultaneously care for her family, she had a nervous breakdown, which caused her to be hospitalized for months.

Similarly, another respondent acknowledged that she felt overwhelmed by the added responsibility of supporting her family, inclusive of two babies, an adult female cousin, a brother, a daughter and a mother during the aftermath of Maria, and in returning her household to normal and taking care of the damages caused by Maria. Additionally, one of the women reported experiencing PTSD-like behaviour, such as hyper-vigilance and difficulty falling or staying asleep according to the DSM-IV (American Psychiatric Association 1994), whenever it rained or was windy. She stated that after the passing of Hurricane Maria, regardless of how lightly or heavily the rain fell, it "bothered" her. Reporting on the impact of the hurricane on

their family members, one of the women voiced that she believes that her grandfather passed away months after the passing of Hurricane Maria because he was unable to cope with its repercussions.

Social

As is often the case after a hurricane has ravaged a country, Dominica experienced nationwide electricity and internet outages. Naturally, this situation made it difficult for Dominicans to stay connected with their friends and family members, especially those living overseas. Aside from the effects of these service outages, however, one respondent specifically noted that she avoided socializing to avoid discussions about her painful Hurricane Maria experience with others. Individuals were separated from their families both physically and socially because of damages to property. This situation created anxiety and worry as many did not know if their family members were safe or not.

Economic

After the passing of Hurricane Maria, many families in Dominica encountered economic challenges. As per the feedback provided by the interviewees, some of these challenges were a result of loss of, or a considerable decrease in, income; having to financially support other family members; and/or the exponential costs of addressing the damages caused by Hurricane Maria. Relative to their loss or reduction of income, two self-employed respondents noted that their place of work was destroyed by the hurricane which in turn impeded their ability to conduct their daily tasks, e.g., farming, agro-processing and hairdressing. Consequently, while one reported losing their entire income, another reported a reduction of approximately 60% in her income.

Furthermore, three (3) respondents indicated that their mothers lost their source of income, which in turn made them financially dependent on the family. In two of these cases, this resulted in the respondents becoming the sole provider for the household, both of which included two (2) others in addition to their mother. Although everyone reported experiencing significant loss and damages to their home, one respondent reported losing Eastern Caribbean Dollar (XCD) 100,000 in damages. As a result of these financial challenges, one respondent noted that they had to postpone the building of their new home, while another admitted to experiencing grave difficulty in sending her four (4) children back to school, so much so that she was forced to seek assistance outside of the family to do so.

Educational

In addition to the above issues, Dominicans also had to endure some educational challenges. Specifically, because of the damages caused by Hurricane Maria, one respondent noted that her daughter had to attend school on a shift basis while another reported that transportation became problematic, which forced her son to

leave home to reside with a family member to continue his college education. This situation was further exacerbated by their lack of access to the internet, which made it challenging for youngsters to complete their school assignments. Moreover, one of the women reported that after Hurricane Maria, her professional development was hindered due to a lack of funds on the part of the government and damages sustained by the building in which the training occurred.

Spiritual

Altogether, the respondents did not report experiencing many spiritual challenges after Hurricane Maria. While one interviewee indicated that her mother's ability to attend church was impeded, the other admitted that she withdrew from the church due to the lack of assistance offered to her in the aftermath of Hurricane Maria. She also experienced a decreased faith in God, given the negative impact which she thinks God allowed the hurricane to have on her life. However, her faith in God has since been restored.

Other challenges—Infrastructural Impacts and Immediate Aftermath

In addition to the above, the participants highlighted several other noteworthy challenges endured by Dominicans in the immediate aftermath of Hurricane Maria. These challenges emerged from their lack of access to electricity and the uneven distribution of disaster relief goods. According to two of the respondents, they had to remain without electricity for approximately eleven (11) months as they did not have the funds necessary to fix the compromised electrical system. Consequently, some of them relied on generators, which were quite costly to maintain and thereby caused even greater financial strain. The lack of electricity also caused food storage issues according to one respondent.

Concerning the distribution of disaster relief goods, some respondents reported that it was initially challenging to source food and tarpaulin, and then later to source financial support and building materials. They acknowledged that while the people of Dominica did indeed receive a lot of support either from the government or non-governmental organizations (NGOs), the distribution of these items was, to a considerable extent, inequitable and unfair. Speaking on this issue, the respondents stated that many persons did not get the help needed and that the distribution of help was not equitable. Sourcing supplies for babies and food for the elderly were also a challenge. According to one respondent who had two babies in the house, it was especially difficult to source Pampers and milk after Hurricane Maria. Similarly, sourcing food items for the elderly was difficult. Given that the elderly do not like eating the dry foods that are given in relief packages, other types of food had to be sourced. As such, one respondent noted that she had to find ways to source "hard food" (ground provisions) for her elderly stepfather, which was initially a challenge as the path to go to the gardens was destroyed by the hurricane.

6.2.2. Issues and Challenges Experienced Four Years Later

As of the year 2021, Dominicans are still experiencing remnants of psychological trauma. This was evident in the interviewees' account of how the rain, wind and news of impending weather systems were still affecting them to this day. According to some of the women, on days or nights when it is rainy or windy, they tended to experience feelings of anxiety. Another participant reported that whereas her mother has difficulty sleeping when it rained heavily at night, she herself cannot sleep when she is informed of impending weather systems. In addition to feeling anxious about the weather, one respondent acknowledged that she avoids hearing others' accounts of their experience with Hurricane Maria to avoid reliving her trauma. Moreover, in recounting how she felt recently when there was another hurricane scare, one of the interviewees indicated that she felt angry and expressed doubts about her future in Dominica.

Social

Despite it being four years since Hurricane Maria compromised the country's phone, internet, and television services, persons residing in various communities across the nation were still encountering difficulties accessing these services. Accordingly, staying connected with friends and family members remains a challenge for some in Dominica. Consistent with one of the respondents, many of them now must rely on expensive and limited data plans to gain internet access, which thereby forces them to limit their social interactions due to a lack of funds. Additionally, she noted that, unlike pre-Hurricane Maria days, they are now unable to host social events, such as birthday parties and home barbecues, due to financial constraints imposed by Hurricane Maria, which are further compounded by the COVID-19 pandemic.

Economic

Economically, women are still experiencing a myriad of challenges ranging from the excessive cost of living and meeting basic daily expenses to addressing personal health challenges and supporting dependents such as children and sick, elderly parents. Speaking specifically on the issue of the cost of living, one respondent noted that the rate of inflation has decreased her purchasing power and is making it impossible to save and prepare for future disasters. Another respondent, whose home was demolished, explained that because of having to start over, that is, paying rent, purchasing clothing and food for herself and her children, she is so financially drained that despite experiencing a physical illness that commenced after Maria, she has thus far been unable to seek medical care for it.

Moreover, two of the respondents highlighted the struggles they undergo daily trying to survive on their reduced income. According to one respondent, she is living on 40% of the income she was generating pre-Hurricane Maria. As such, she is so financially strained that she has been unable to sustain her practice of depositing

money in her children's accounts for emergencies since Hurricane Maria and is often unable to meet her personal needs as she must prioritize the needs of her children. In addition, another respondent voiced her current struggles with meeting her daily expenses, noting that her recent transfer from a pensionable position to a non-pensionable position had made it difficult for her to support her son and his college education, pay off her loan, care for her elderly parents and pursue further professional development. Increased insurance premiums and the closure of international borders which restrict the exportation of products were also noted to be contributing to their current economic strain.

Women head 39% of households in Dominica. When Hurricane Maria hit, many women, especially the older heads of households, did not have home insurance as they were living in family homes built by their parents. These older heads of households shared that they were unable to move out of shelters because they had no access to housing materials. Their main concern was sourcing finances to rebuild (PDNA 2017).

Spiritual

While not many persons noted any spiritual challenges currently being experienced, one individual admitted that she had been drawn closer to God post-Hurricane Maria and thus ensures that she prays to Him for the protection of her home, children, and country whenever the hurricane season approaches.

Other Challenges

Aside from the above, discussions with the women revealed two other noteworthy challenges that they have recently encountered or are currently experiencing. Recounting her experience at the onset of the COVID-19 pandemic in Dominica, one respondent noted that she was forced to leave her children behind for two months to avoid losing her job. On the other hand, one respondent reported that there is a discrepancy between the type of training provided, and the job opportunities available, to women. Explaining the issue, she noted that despite taking advantage of the skills and training opportunities available to them, some women are unable to access certain opportunities simply because of their gender.

6.3. The Unmet Needs of Dominicans Post-Hurricane Maria

6.3.1. Immediate Unmet Needs

In dealing with the aftermath of Hurricane Maria, Dominicans needed a lot of support to recover from the destruction and trauma they endured, which they did receive. Nevertheless, there were several areas in which their needs were unmet. Based on the respondents' accounts of their experience, there appeared to have been a need for training, education and psychological support among Dominicans to help them cope more effectively with the ramifications of the hurricane. Psychological

support was needed to help the respondents deal with the anxiety, fear, anger, despair and other overwhelming emotions they felt after the passing of the hurricane. Education was needed by the public regarding their use of water and generators following a hurricane.

Additionally, training in the provision of psychosocial support following a disaster was needed by the Rovers Team, disaster relief volunteers, social workers and other helping professionals who were required to immediately return to their duties. Moreover, similar support services offered to the public were also needed by government workers and other relief personnel as they too were significantly impacted by the hurricane. According to the respondents, however, they were either deemed ineligible or overlooked for assistance because of their civil servant status.

6.3.2. Unmet Needs Four Years Later

Psychological

Some Dominicans remain in need of psychological and financial support to aid in their recovery from the loss and trauma they suffered in 2017. As highlighted, some Dominicans are still experiencing psychological distress initially caused by their Hurricane Maria experience. Whether it is simply a windy or rainy day, a mild weather system affecting the island, the onset of the hurricane season or discussions of people's experience with Hurricane Maria, the occurrence of these stressors is still causing anxiety, fear, anger and despair among some. Psychological interventions are thereby needed to help improve their mental health.

Financial

Despite their best efforts, some Dominicans are still struggling to rebuild their homes and places of work, support their children's education and daily needs, care for their elderly parents and improve their overall quality of life. As a result of their inadequate salary and the increasingly inflated cost of living which has been exacerbated by the COVID-19 pandemic, many of them still find themselves living in damaged homes, unable to meet their financial obligations.

Infrastructure

Affecting Dominicans' way of life, particularly their social, professional and academic life, is their lack of access to reliable phone and internet service. Four years since their telecommunication systems were compromised, the telecommunication companies in Dominica were yet to restore services in various communities across the island. According to the respondents, this situation is impeding their ability to stay in touch with their friends and family members; limiting their children's use of the internet to complete their school assignments; and putting a further strain on their already limited finances due to their reliance on data. One respondent

is thereby calling on the government of Dominica to put more pressure on the telecommunication companies to address the issue.

Educational

The respondents highlighted the need for training and education for single, unemployed women. Consistent with their feedback, some of the areas (e.g., mechanics, tiling) in which the women are currently being trained are not beneficial to them, as employers are reluctant to hire them due to their gender. As such, there is a need for training in areas that afford women more job opportunities. Of particular interest to two of the respondents was training in nursing and hairdressing. The women also expressed interest in finding opportunities to secure additional streams of income.

See Table 1 below for a comparison of findings immediately after Hurricane Maria and four years later which provides inferences to the main themes of the findings with respect to psychological distress and unmet needs.

Table 1. Comparison between psychosocial responses immediately after Hurricane Maria and four years later.

Psychosocial Experiences	Immediate Responses After Hurricane Maria	Responses Four Years Later
Psychological	Signs of psychological trauma, inclusive anxiety, and Post-Traumatic Stress Disorder (PTSD).	- Still experiencing remnants of psychological trauma. - Feeling anxious about the weather. - Felt angry and expressed doubts about her future in Dominica. - Cannot sleep when informed of impending weather systems.
Social	Nationwide electricity and internet outages.	- Persons residing in various communities across the nation are still encountering difficulties accessing the country's phone, internet and television services. - Rely on expensive and limited data plans to gain internet access, which thereby forces them to limit their social interactions due to a lack of funds. - Unable to host social events, such as birthday parties and home barbecues, due to financial constraints imposed by Hurricane Maria, which are further compounded by the COVID-19 pandemic.

Table 1. *Cont.*

Psychosocial Experiences	Immediate Responses After Hurricane Maria	Responses Four Years Later
Economic	- Loss of, or a considerable decrease in, income. - Having to financially support other family members. - The exponential costs of addressing the damages caused by Hurricane Maria.	- Excessive cost of living and meeting basic daily expenses to addressing personal health challenges and supporting dependents such as children and sick, elderly parents. - Having to start over, i.e., paying rent, purchasing clothing and food for herself and her children—she is financially drained trying to survive on their reduced income. - According to one respondent, she is living on 40% of the income she was generating pre-Hurricane Maria.
Educational	- Children attended school on a shift basis. - Transportation became problematic. - Professional development was hindered due to a lack of funds on the part of the government and damage sustained by the building in which the training occurred.	- Discrepancy between the type of training provided, and the job opportunities available, to women. - Despite taking advantage of the skills training opportunities available to them, some women are unable to access certain opportunities simply because of their gender. - Consistent with their feedback, some of the areas (e.g., mechanics, tiling) in which the women are currently being trained are not beneficial to them, as employers are reluctant to hire them due to their gender. As such, there is a need for training in areas that affords women more job opportunities.
Spiritual	- Did not report experiencing many spiritual challenges. - Pulled away from the church due to the lack of assistance offered to her in the aftermath of Hurricane Maria.	- Drawn closer to God post-Hurricane Maria.

Table 1. *Cont.*

Psychosocial Experiences	Immediate Responses After Hurricane Maria	Responses Four Years Later
Infrastructure	- Did not have the funds necessary to fix the compromised electrical system. - The lack of electricity also caused food storage issues and it was initially challenging to source food and tarpaulin, and then later to source financial support and building materials. - The distribution of these items was, to a considerable extent, inequitable and unfair. - Difficult to source Pampers and milk after Hurricane Maria. Similarly, sourcing food items for the elderly was difficult.	- As a result of their inadequate salary and the increasingly inflated cost of living which has been exacerbated by the COVID-19 pandemic, many of them still find themselves living in damaged homes, unable to meet their financial obligations. - Lack of access to reliable phone and internet service. Although it has been four years since their telecommunication systems have been compromised, the telecommunication companies in Dominica are yet to restore services in various communities across the island.
Unmet Needs	- Need for training, education and psychological support among Dominicans to help them cope more effectively with the ramifications of the hurricane. - Psychological support was needed to help the respondents deal with the anxiety, fear, anger, despair and other overwhelming emotions they felt after the passing of the hurricane. - Education was needed by the public regarding their use of water and generators following a hurricane.	- Remain in need of psychological and financial support to aid in their recovery from the loss and trauma they suffered in 2017. - Some Dominicans are still experiencing psychological distress initially caused by their Hurricane Maria experience. Whether it is simply a windy or rainy day, a mild weather system affecting the island, the onset of the hurricane season or discussions of people's experience with Hurricane Maria, the occurrence of these stressors is still causing anxiety, fear, anger and despair among some. - Psychological interventions are thereby needed to help improve their mental health.

Source: Table by author.

The findings show that there were not many differences immediately after the passing of Hurricane Maria and four years later. Table 1 shows that the women were able to speak more about their situation four years later as opposed to immediately after the hurricane. It seems as if they had the time, despite their challenges, to process and assess their current situation more effectively and articulate their needs. The findings also showed the impact of the COVID-19 pandemic with respect to the setbacks in the social, economic and infrastructural spheres. One of the main themes

was unmet needs. Training is available, but not in the area for the most wanted skills. Another theme is the impact of the COVID-19 pandemic, which created challenges and setbacks for recovery, both psychologically, socially, economically and educationally. Persons had to be isolated in their homes because of COVID lockdowns and protocols and were unable to socialise or see their loved ones. This seems to have negatively contributed to the categories mentioned.

The psychological stress issue remained immediately and four years later, in line with Martin (2015), Graham (2012) and Goodman (2012) in the literature. They posit that psychological distress affects persons immediately after a disaster and a long time after in many ways.

Our findings are in keeping with the following authors. Roque (2022) posits that most aid provided post-Hurricane Maria in Puerto Rico was mostly as a response to physical and material damage. She believes that efforts to support the mental health of persons after a natural disaster should be comparable. She continues that it should be seen as just as important as the direct response to physical damage. Psychological issues should be given priority and addressed. As such, awareness of mental health issues should be given the necessary attention by government. Awareness campaigns on the maintenance of mental health and its contribution to well-being and health should be provided by the media. The creation of support groups in communities can greatly improve mental health challenges in all locations on the island.

Graham (2012) states that many medical offices remained closed for weeks after the passing of Hurricane Sandy, leaving persons without access to prescription medications. The power outage left many feeling frightened and emotions experienced were that of despair, hopelessness and anxiety. Goodman (2012) adds that a lot of medical problems left many persons in poor health.

Female-headed households are viewed as a vulnerable population according to Kashyap and Mahanta (2018), Armaș and Gavriș (2013) and Chanty and Samchan (2014) as mentioned in the literature, and our findings support their work. They all report that women are vulnerable because of present gender inequalities, low socio-economic status and the gender norms that pervade societies.

7. Discussion and Recommendations

The Role of Social Work Practitioners

Social work practice has always had a relationship with the environment at the micro, mezzo and macro levels of work. It is concerned with the social, economic, political and spiritual aspects of individuals. Social workers, with their skills and experience, are positioned for disaster work in terms of pre-disaster preparation, initial response, post-recovery and follow-up, which encompass crisis intervention. Human rights and the welfare of vulnerable populations are values that guide practice. Being part of an interdisciplinary team forms part of the work of social workers, as their input can help with assessments and intervention in disasters.

Social workers' knowledge of resources concerning temporary housing will assist in helping displaced individuals locate shelter as soon as possible.

Social workers, especially community social workers, can meet with members of the community to assess the unmet needs of individuals. Needs assessments are encouraged along with the building of relationships with communities. Social workers intervene at the micro, mezzo and macro levels. This puts workers in good stead to intervene at the community level. The worker possesses a wealth of knowledge concerning available services and resources for assisting persons with unmet needs. The presence of social workers is critical for effective interventions in communities. Most of the time they are untapped resources. More recognition of their roles in society should be encouraged. Continuous training in disaster preparedness and post-disaster intervention is important for social workers. One must remember that social workers can be affected by disasters and may not be able to function to the best of their abilities in the aftermath of such events. Hence, the Association of Caribbean Social Work Educators (ACSWE) can play an integral part. They can assist with the coordination of efforts throughout the region when a disaster event occurs. Relationships can be built with entities that are responsible for interventions after such an event as part of social support. Social workers can also sign up to be part of intervention services in their countries.

As such, they will be part of the pool of human resources considered to assist any Caribbean country, when necessary, be it 24 hours post-disaster, 1-week post-disaster and so on. Training in crisis intervention can assist social workers in sharpening their skills to immediately intervene in the lives of others after disasters. People need to know that help is available, and this can alleviate their anxieties and fears and present some comfort. Efforts must be coordinated with the necessary authorities so that resources are not duplicated but are provided seamlessly for all affected.

The results have implications for the provision of psychological services for those affected, immediately after and continuing. These issues must be given priority as psychological trauma and distress can impact negatively on the lives of women and reduce their quality of life. It can hinder effective work and parenting and permeate other areas of their lives.

8. Limitations

Sourcing of participants was a challenge as the COVID-19 pandemic led to many lockdowns and protocols for living on the island. It prevented access to participants for intermittent periods. As such, it delayed the interviews with participants for lengths of time. Some participants made appointments but due to the precarious COVID-19 conditions could not keep the appointments. Ten participants were to be interviewed; however, only seven were able to take part in the research. At one time, one research assistant contracted COVID and her interviews had to be delayed by two to three weeks because of existing protocols.

The research assistants used were culturally aligned to the participants as both are citizens of the country, presently reside there and are aware of the distances and where the participants lived. The researcher was also aware of the terrain and the people as she was part of the psychosocial team that travelled to the country after the devastation caused by Tropical Storm Erika in 2015.

9. Conclusions

Hurricane Maria left a lot of damage in its wake. Female-headed households were impacted from psychological, social, educational and spiritual points of view. This study aimed to find out what happened immediately after the passing of the hurricane and four years later. There were improvements; however, COVID-19 impacted the trajectory of improvements in a negative manner. Female-headed households are still grappling with the after-effects in those four spheres and require the intervention of the government at the macro level. Unmet needs and psychological distress were main themes that emerged from the findings. Interventions entail ensuring that households are more resilient to disasters, an expanded safety net to help households move above the poverty line, higher income earning capacity, focus on climate resilience livelihoods, improved telecommunication systems and education and training for single and unemployed women. Emphasis on psychosocial support to assist with anxiety, fear and other distressing emotions linked to Hurricane Maria is needed today.

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The Challenging Climate for Women in Caribbean Fisheries—From Seaweed to Seafood, and Practice to Policy

Maria Pena, Patrick McConney, Bertha Simmons and Katherine Blackman

Abstract: While scholars agree that Caribbean small-scale fisheries should be managed as social–ecological systems, the domination of natural science over social science is staggering. This inequity is reflected in gender analysis of impacts of climate change and variability on women in fisheries. There is little information on how climate impacts women's livelihoods and leadership in Caribbean fisheries. Most data concern the marine environment and male-dominated harvest sector. We set out to learn more about climate impacts on, and climate adaptation by, women in fisheries, including how fisheries climate science could incorporate gender mainstreaming. Over the past three years, a transdisciplinary team has assembled sets of mainly qualitative data to address these issues, mainly through interviews and interactive workshops with women and men in the fishing industries and organizations of Caribbean countries. The challenges women face due to climate are diverse and include influxes of sargassum seaweed that change species composition and abundance in catches of seafood. Women not only deal with challenges in their livelihoods and households, but also in becoming fisherfolk leaders who influence and engage policy. This chapter examines such challenges and offers ideas for improvement in the context of gender mainstreaming.

1. Introduction

Many scientists agree that climate change is the most pervasive and urgent global threat of our time, contributing to complex environmental, socioeconomic, and governance issues that impact developed and developing countries. However,

> a much smaller community of scholars and practitioners has documented the linkages between climate change and gender inequality showing differentiated impacts on men and women because of gender division of labour and differences in use, control and ownership of assets and natural resources. (Tovar-Restrepo 2017, p. 412)

This is the situation in the Caribbean, where limited information exists on gender in fisheries and their nexus with climate change. Diverse gendered impacts of climate change burden women in Caribbean fisheries, both directly and indirectly (Morrow 2017). Excluding gender from applied research to conceptualize, examine, and address climate change impacts on fisheries means that an inadequate understanding and inappropriate solutions could intensify maladaptation (Sturgeon 2017). As argued by

feminist authors in the collection assembled by Frangoudes et al. (2019), there is an urgent need to transform gender relations in fisheries, including climate aspects.

Attention must be paid to both women (Solano et al. 2021) and men (Salguero-Velázquez et al. 2022) to understand gender relations. In the Caribbean fisheries harvest sector, few women fish, and a small but unknown number own or co-own fishing vessels. Most work in postharvest, with a few in ancillary services. The Caribbean Regional Fisheries Mechanism (CRFM) is the authoritative regional fisheries body and source of statistics. It estimates that about 470,000 persons have fisheries sector livelihoods in its 17 CRFM member states, with a third of these (mostly men) in harvest (CRFM 2021). This leaves about 320,000 persons employed in fish processing, marketing, distribution, and ancillary services (e.g., ice production, gear supply, boat repair, research, development, and management). CRFM does not provide gender disaggregated data for any country, and lists collection and analysis of gender-disaggregated data as its first priority (CRFM 2020a).

There are few women in the Caribbean fisheries harvest sector, but extreme weather events increase hazards at sea and reduce the number of fishing days for the harvest sector dominated by men. This in turn limits the fish landings to be sold by the women who dominate postharvest. Fishery households tend to be poorer and female-headed, further increasing the burden on women (IDB 2020). As women work harder and longer to secure supplementary income for their households, less time is available for training and education, and for participation in fisherfolk organization leadership. Limited access to assets needed to cope with and adapt to climate impacts may translate into women fisherfolk having less power to engage and influence climate-related decisions in fisheries governance and wider society. Women's voices at all levels of governance and all forums for decision making are likely to lead to empowerment, with more equitable and sustainable development (IDB 2020; Kabeer 1999; Morrow 2017).

Women have been recognized as key actors in climate change adaptation and mitigation, given their diverse roles in fisheries as scientists, managers, civil society trailblazers, and resource users. Women are change agents who catalyze the transformation necessary to achieve climate-smart resilience in the supply of Caribbean seafood (CRFM 2020a). Yet, women's ability to adapt to climate change is often limited by entrenched societal gender norms, roles, and inequalities that "result in women being the most disadvantaged by the impacts of climate change and least well placed socially, legally and economically to respond to them" (Morrow 2017, p. 402). These challenges motivate women's empowerment and gender mainstreaming (FAO 2017; IDB 2020). Women must engage in climate change discourses, given the disproportionate impact on the vulnerable in society (Morrow 2017). Documenting the climate challenges faced by women in fisheries and how they deal with them in livelihoods and organizational leadership can inform gender mainstreaming (GIFT 2018).

In this chapter, we examine challenges in women's livelihoods and leadership in Caribbean small-scale fisheries and suggest gender mainstreaming at the

fisheries–climate nexus. The next section sets out the methods followed by results and discussion of women's adaptive capacity in two specific cases. We conclude with a perspective on the way forward.

2. Materials and Methods

We use three analytical frameworks to understand fisheries' social–ecological systems: adaptive capacity, livelihoods analysis, and institutional analysis (GIFT 2018). This chapter first sets the context for adaptive capacity, followed by summary analysis of two cases of women in Caribbean small-scale fisheries that illustrate some challenges and adaptations.

A review of the literature provides a practical perspective on the scope for women's adaptive capacity to climate in Caribbean small-scale fisheries. The review employs a heuristic version of the framework from McClanahan and Cinner (2012) that uses five dimensions of adaptive capacity: assets, flexibility, learning, social organization, and agency. The framework has been applied to fisheries in Africa (Cinner et al. 2015), the Pacific (Cohen et al. 2016), and the Caribbean (Turner et al. 2020). Due to the paucity of Caribbean fisheries' gender data and information, we focus on broadly thematic capacities and enablers encompassing the dimensions rather than addressing them individually. The two case studies facilitate deeper exploration using more specific analytical frameworks.

Livelihood analyses have long been used in gender studies of fisheries, and a sustainable livelihoods approach (Allison and Ellis 2001) is applied to the sargassum case (Figure 1). Climate is a particularly strong factor in the vulnerability context, but it pervades the entire framework. Slow climate change trends (e.g., sea level rise), more rapid climate variability or chronic seasonality (e.g., extreme weather events), and outright environmental surprises or shocks (e.g., sargassum seaweed influxes) all impact social, ecological, and economic conditions in the fisheries sector. Next are the livelihood capital assets (physical, financial, human, social, and natural). The third as interactions consists of institutional structures (e.g., agencies) and processes (e.g., policies). These exhibit complex interactions with climate, gender, and livelihood variables to determine feasible livelihood strategies (e.g., multi-occupationality) and outcomes (e.g., reliable income). Each provides feedback to all prior components.

Institutional analysis (Ostrom 2011) is applied in the second case. Similar to livelihoods, the first component is context. This includes ecological (e.g., marine resources), socio-economic (e.g., livelihoods), and institutional (e.g., decision making) factors. The second component is an arena comprising patterns of interactions among institutional actors (e.g., fisherfolk and fisheries authorities). Outcomes provide feedback to evolving institutional arrangements (Figure 2).

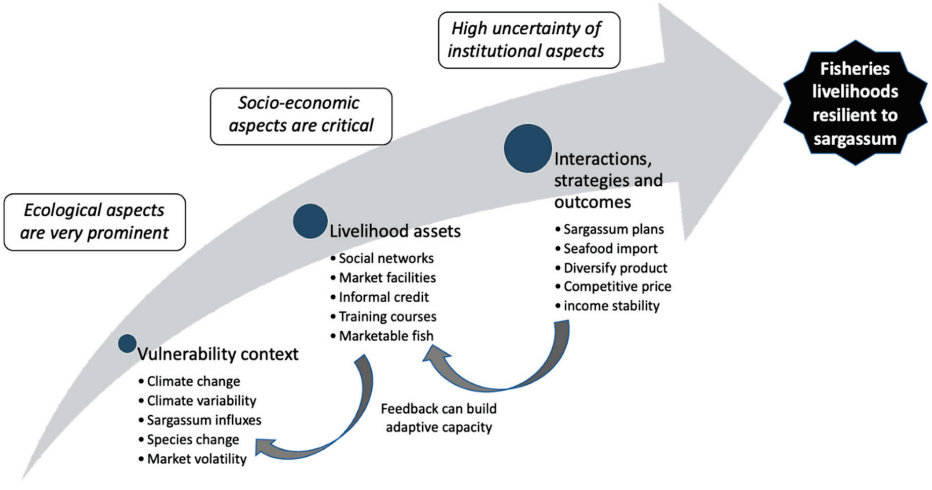

Figure 1. Simplified fisheries livelihoods analysis of sargassum seaweed influx impacts. Source: Figure by authors.

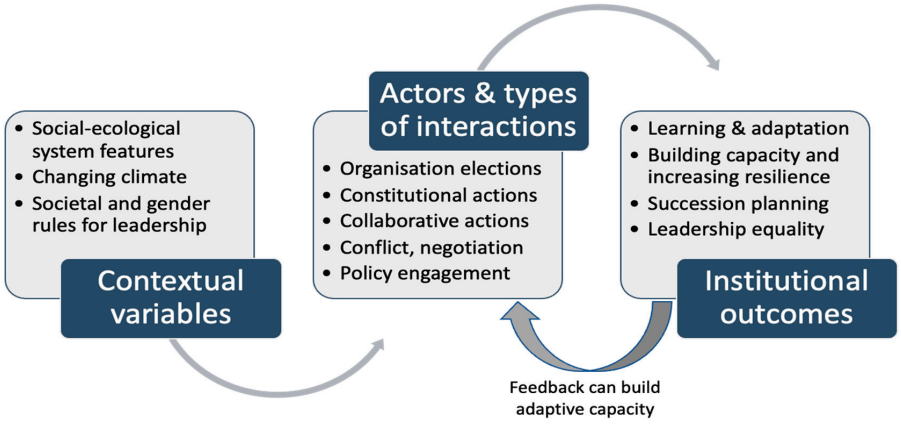

Figure 2. Simplified institutional analysis applied to fisherfolk organization leadership. Source: Figure by authors.

The figures show case-based features of the components as examples. The livelihoods case focuses on how women dealt with sargassum seaweed influxes as climate surprises. The institutional case focuses on women leaders in fisherfolk organizations that must influence policy for climate adaptation in fisheries. Both cases were constructed from several fisheries projects comprising 37 informal interviews, 6 focus groups, and 11 workshops and field observations involving approximately 100 women and the authors. For secondary data, the cases draw upon the unpublished outputs of these projects. The cases illustrate the utility of investigating how women in fisheries cope with climate change and variability. They do not claim to be representative, but they aid understanding. Lessons learned from

the cases on how women in fisheries cope with and adapt to these climate challenges can inform gender mainstreaming.

3. Results and Discussion

The general contextual review is followed by the two specific cases of women's livelihoods and leadership in Caribbean small-scale fisheries.

3.1. Gendered Adaptive Capacity to Climate in Fisheries

In available documents, the five dimensions of adaptive capacity: assets, flexibility, learning, social organization, and agency (McClanahan and Cinner 2012) were not easily separable. So, the analysis took a broad approach to ensure that all were covered, but not independently, within major themes. In reality, the dimensions are closely interwoven and, consistent with the concept of intersectionality, a reductionist approach to isolate them defeats better understanding.

Ideally, the climate challenges facing women in Caribbean fisheries should be addressed in development, implementation, monitoring and evaluation of adaptation policies, plans and practices within all levels (local, national and regional), and pillars (environmental, economic and social). This should enable women to make progress equal to men, improving resilience to climate change and variability. A close look at what is currently available to build adaptive capacity involves first understanding the gendered impacts of climate change (Figure 3).

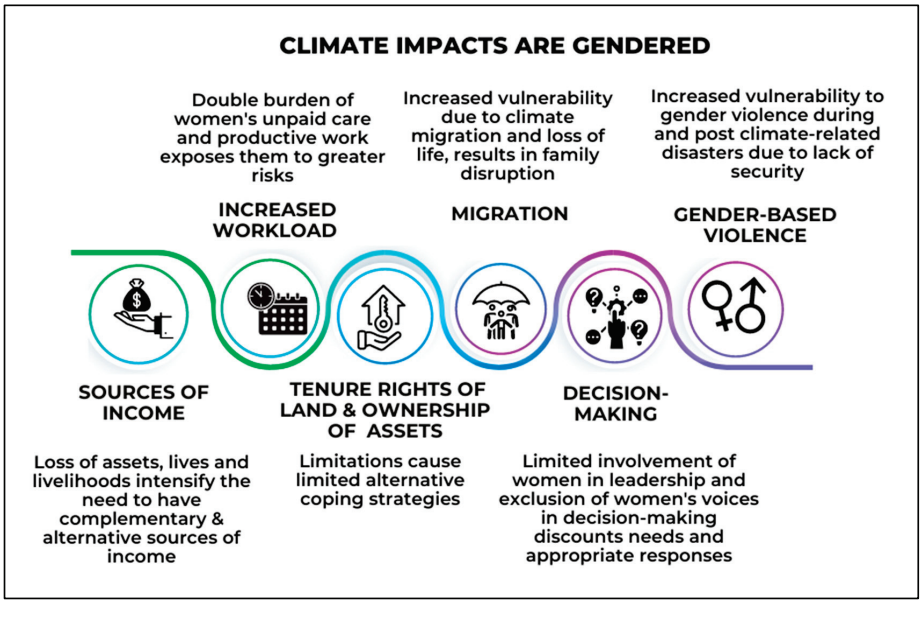

Figure 3. Climate change impacts are gendered. Source: Figure by authors.

Diversity is key to adaptive capacity. Most roles in fisheries are established by the activities, rights, and responsibilities of men (Kleiber et al. 2014). Women's roles are diverse in Caribbean fisheries as actors in the value chain and as leaders (GIFT 2018). Gender-disaggregated data are scarce and seldom capture all of women's contributions. Where such data exist, they are not incorporated into fisheries management planning, but diversity is known (GIFT 2018). In recent years, women have reported interest in diversifying their financial assets derived from within the industry.

Although present throughout fisheries' value chains, women dominate postharvest (Figure 4), participating in value-added processing, marketing, distribution, and food service (Pena et al. 2019; Romeo and McConney 2022). Caribbean women report being little constrained by their formal education, which is usually on par with or superior to men, for any work in the fishing industry (Pena et al. 2019). However, women in Barbados who take up male harvest sector roles say violating gender norms comes at a social cost. Women fishers are ridiculed, particularly by other women, for what is seen to be delinquency in household care-giving responsibilities, as fishing may keep a woman at sea for prolonged periods. Social sanctions endured by women fishers include reputation damage from being falsely accused by other women fisherfolk of intimate relations with male fishers (Pena et al. 2019). Women reinforce gender norms that constrain their own agency and flexibility.

Figure 4. Some roles of women in Caribbean small-scale fisheries Source: Figure by authors.

Regarding social organization and agency, women fisherfolk tend to be underrepresented in state-led fisheries' decision-making processes, but informally, they have been at the forefront of sustainable fisheries (e.g., refusing to buy undersized fish) and climate adaptation (e.g., promoting social security and livelihoods diversification to cope with sargassum influxes). Though less so than men, women are becoming involved in fisherfolk associations and cooperatives across the region. Increasing numbers of women occupy leadership positions, are accepted as leaders, and manage fishing industry organizations at all levels (CERMES 2020a). The extent to which they shape fisheries' policies to champion women's issues by mobilizing fisherfolk to collective action is an undocumented aspect of agency. Caribbean fishing industry women have held posts potentially strategically positioned in governance to assist women (and men) to influence policy decision making. These include positions as a senator in Saint Lucia, a chairperson of the Caribbean Network of Fisherfolk Organizations, and a co-chair of the World Forum of Fisher Peoples.

Regarding learning, within the region, progress is being made to co-develop strategies, plans, and policies integrating a gender perspective (CRFM 2020a). However, a gender-sensitive rather than a gender-responsive approach is still being applied; acknowledging gendered impacts of climate change but not establishing strategies or actions to address them (ECLAC 2019, p. 26). The situation of women and gender inequalities that are reproduced and strengthened by this deficiency continue to be treated as a side issue (Revelo 2021). Integrating a gender perspective and identifying concrete, evidence-based strategies tailored for the specific needs of women and girls will empower them to act as change agents contributing to evidence-based solutions for climate change challenges (GIFT 2018). Where plans and policies exist, limited interlinkages are made between gender, climate change, and disaster risk reduction, "demonstrating a siloed approach to policy-making and a need to renew gender mainstreaming efforts across ministries, departments and agencies responsible for climate change adaptation and disaster management" (ECLAC 2019, p. 25) to build women's resilience to climate-change impacts.

There has, however, been recent headway in regional gender mainstreaming with the development of the unpublished Caribbean Community Regional Gender Equality Strategy (CRGES) that emphasizes commitment to strengthening gender equality and empowerment of women and girls. Recent fisheries initiatives such as the Caribbean Community Common Fisheries Policy (CCCFP) (CRFM 2020b) and Caribbean Regional Fisheries Mechanism (CRFM) Gender Analysis Strategy and Action Plan (Gender ASAP) (CRFM 2020a) can contribute to gender mainstreaming in Caribbean small-scale fisheries. Gender equality, equity, and human rights-based approaches are incorporated through a CCCFP protocol on Securing Sustainable Small-scale Fisheries for Caribbean Community Fisherfolk and their Societies (SSF Protocol), which has not yet been widely implemented. The five-year Gender ASAP supports,

> gender mainstreaming in fisheries through gender-responsive approaches to address, overcome and remove inequalities, contributing to the realisation of human rights for all people in all their diversity … and ensuring their full, equal and effective participation in fostering transformative solutions in Caribbean fisheries. (CRFM 2020a, p. ix)

The implementation of the comprehensive Gender ASAP promises transformative outcomes in Caribbean fisheries, as does the CCCFP protocol on Climate Change Adaptation and Disaster Risk Management in Fisheries and Aquaculture. This protocol looks to "ensure development of a regional Fishery Sector that is resilient to climate change and ocean acidification, and enhanced through comprehensive disaster management, and sustainable use of marine and other aquatic living resources and ecosystems" (CRFM 2020b, p. 21).

3.2. Case 1: Sargassum Seaweed and Fisheries' Livelihoods

The massive influxes of floating sargassum seaweed that have impacted countries in and bordering the Caribbean Sea since 2011 have been an unpleasant surprise not only to women in fisheries, but to everyone else in the region as well (Johnson et al. 2020). Extending at its peak over 8000 km and containing up to 20 million tons wet weight of seaweed, the "Great Atlantic sargassum belt" has no precedent in recorded history (Wang et al. 2019). After a decade of applied research, uncertainty surrounds both the complex climate drivers of the influxes (Skliris et al. 2022) and finding practical solutions to the many challenges posed by sargassum influxes (Oxenford et al. 2021).

In this case, we are particularly concerned with the challenges faced by women working in and supporting the small-scale fisheries value chains of Caribbean small island developing states (SIDS). Women fisherfolk are especially concentrated in the postharvest stages of the value chains for several species of pelagic fishes (GIFT 2018; McConney et al. 2019). They buy the fish from boats and then process, market, and distribute the seafood. Few harvest fish at sea, but some are boat owners. Others supply goods and services such as fishing gear, fuel, and ice, while a growing number prepare seafood for locals and tourists at seaside eating establishments or stalls. Several female fisheries officers and marine scientists also participate in sargassum science and management. However, in this livelihood analysis, the women involved in postharvest take center stage, drawing mainly on document analysis, field observation, and informal interviews by the authors.

3.2.1. Vulnerability Context

For everyone dealing with sargassum, the vulnerability context is dominated by marine environmental and ecological uncertainty (Johnson et al. 2020). For women in fisheries postharvest, much of this is mediated through men (mainly boat owners and fishers) working in the harvest sector. The harvest sector's ability to cope with the timing, frequency, spatial extent, and severity (amount) of sargassum determines

the initial flow of fish into the value chain and all subsequent stages. Not only does this concern the quantity and seasonality of fish, but also the species composition of catches and the size of fish of various species. There are major commercial pelagic fisheries in the eastern Caribbean for four-wing flyingfish (*Hirundicthys affinis*) and the common dolphinfish (*Coryphaena hippurus*). Gender aspects of their value chains are described in Pena et al. (2020a) and Simmons and McConney (2022), respectively. These fisheries have been among the most severely negatively impacted by sargassum influxes.

Other vulnerabilities include economic (such as intersectoral) links with tourism, which is impacted by sargassum reducing visitor numbers and closing hotel properties, thereby reducing the pool of buyers for women who market seafood. Governance vulnerabilities are also a factor, as much uncertainty surrounds how fisheries and other state authorities do or do not manage sargassum influxes once they inundate coasts. The accumulations of seaweed hamper harvest as well as postharvest coastal infrastructure, perhaps directly affecting men more than women in fisheries. An exception is in coastal communities where sargassum inundation release of hydrogen sulfide and other noxious gases during decay becomes a health hazard in which women bear the brunt of family care, especially for young children. There is also early evidence that sargassum can be a direct threat to women's health (de Lanlay et al. 2022).

3.2.2. Livelihood Assets

Women in fisheries postharvest use their livelihood assets to deal with sargassum as well as other climate hazards that threaten both their fisheries and household work. The latter must be factored in, as the additional domestic duties of women often cause their livelihood assets, interactions, and strategies to differ from those of men. Regarding natural capital, the impacts of sargassum are mostly negative, and highlight vulnerabilities. However, a positive impact has been the sargassum-associated increase in catches of the formerly scarce almaco jack (*Seriola rivoliana*), which has proven highly marketable at a good price. Human capital comes into play here, as women vendors have received practical training in fish handling, processing, and marketing that assists their ability to deal with changes in catch seasonality, quantity, and species composition. Social capital is also relevant, as women collaborate in fisherfolk associations and cooperatives to act collectively. They also use social capital to acquire financial capital through kinship and institutions such as rotating credit associations (e.g., meeting turn, susu, box) which are common at landing sites among women. Their access to physical capital is primarily dependent on the state at medium-to-large fish landing sites that provide buildings with water and electricity for low or no fees. However, women fish vendors also invest in domestic refrigeration to store fish at their homes and reduce sargassum-induced variability.

3.2.3. Interactions, Strategies, and Outcomes

Livelihood interactions with various governance and commercial structures and processes such as state agencies, private firms, legislation, policies, management practices, and transactions do not differ much by gender in the case of sargassum issues. This is largely because there are still very few initiatives that directly address sargassum. Similar to men, women are mostly left on their own to devise strategies for dealing with sargassum. Very few institutions have been built by fisherfolk around adapting or coping with sargassum through collective action, but it is a concern of at least one group comprising women postharvest (Pena et al. 2020b). The main livelihood strategies involve reducing the uncertainty and fluctuations in revenue due to sargassum. This can be attempted through social networking, multi-occupationality, and generally becoming more innovative and adaptive in outlook. Resorting to selling imported fish is a short-term strategy that women postharvest can employ, but which cannot be employed by men in the harvest sub-sector. Despite reduced supplies of some fish, it is also important that the women maintain their seafood prices within a window of market competitiveness against other foods, both local and imported. The livelihood outcomes in relation to sargassum are not yet easy to determine, as they vary due to the experimentation with no clear solutions to the wicked problem of sargassum.

3.2.4. Lessons Learned

While most attention in sargassum science and management has been paid to the male-dominated harvest sector of fishers and ecology, there are clearly impacts on the livelihoods of women along pelagic fisheries value chains, particularly concerning postharvest livelihood socioeconomics. The wicked problem of sargassum influxes features uncertainties about both causes and solutions. Communication among regional actors about sargassum has improved, but much more is needed to support adaptation (McConney and Oxenford 2020). Well-informed adaptation innovation is required from within the industry, as well as from the state. Gender mainstreaming is necessary to engage all actors along entire fisheries value chains, including the women engaged in postharvest (FAO 2017). The women are vulnerable to climate change and variability due to their dependence on natural ecosystems and the male-dominated harvest sub-sector. They have demonstrated their capacity to cope without extensive support, but longer-term adaptation for resilience to sargassum remains elusive.

3.3. Case 2: Organizational Leadership and Resilience

Although leadership has been studied extensively across disciplines, it is a recent fisheries research topic. Globally, research on women's leadership of fisherfolk organizations is growing (Alonso-Población and Siar 2018; Dasig 2020; Galappaththi et al. 2022; Torre et al. 2019). In the Caribbean, the limited data on gender and leadership in fisheries were recently addressed through fisherfolk organization leader

assessments to assist in understanding capacities and gaps for informing Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (SSF Guidelines) implementation (FAO 2015, 2017). These fisherfolk organization leadership profiles contribute to knowledge on leaders useful for coping with and adapting to the impacts of climate change. With these data and information, we analyze institutions in women's leadership of fisheries challenged by adaptation to climate change.

3.3.1. Contextual Variables

The Caribbean is on the front line of climate change. Fisherfolk have been observing and are coping with increased intensity and frequency of storms and hurricanes; less predictable weather; changes in species distribution, availability, catch composition and yield; increased coastal erosion; rising sea levels; and influxes of invasive species (Oxenford and Monnereau 2017). These effects are threatening Caribbean fisherfolks' livelihoods, and the well-being of their households and communities. The differences between women and men in exposure to risk and vulnerability in the face of climate change—due to the intersection of gender with characteristics of power and social identity (IDB 2020; Intergovernmental Panel on Climate Change (IPCC) 2007; Tovar-Restrepo 2017)—create a complex challenge for fisherfolk organization leaders in the region.

Addressing climate change in Caribbean fisheries requires committed and sustained collective action guided by strong leadership. Usually, however, leaders arise to mobilize temporary collective action based on crises. This fleeting cohesion for informal collective action among men and women in the fishing industry is only useful for coping with impacts in the short term, but it is ineffective for long-term adaptation (McConney 2007; Pena et al. 2021a). Women leaders complain about low cohesion and the individualistic nature of fisherfolk within the region (Pena et al. 2020b). They, however, believe in the value of organizations and are eager to take on leadership roles to assist in further strengthening to improve governance and the contribution to fisheries policy and decision making (Pena et al. 2020a, 2020b). Commitment from women in the fishing industry to promote collective action and cohesion augurs well for the industry's responses to climate change.

Societal and gender rules for leadership are parts of the social structure of organizations. While there appear, on the surface, to be few systemic barriers to fisherfolk organization leadership by women, and men say that they would support women, the growing gender in fisheries literature on collective action implores researchers to dig deeper. This is critical for exploring fisherfolk leadership at the climate change nexus. Issues of representation and inclusivity of women in taking up leadership positions or joining organizations are attributed to traditional male dominance in the fishing industry, societal stigma associated with fishing, distrust of fisherfolk organizations that have historically been mismanaged, conditionalities or prerequisites for membership (e.g., boat ownership), and cultural norms (e.g., in

Guyana, men prefer that women not be involved in these positions). These constrain participation of women as members or leaders of organizations. However, without exception, board and executive members of fisherfolk organizations said they wanted to see more women in leadership roles and as members of these organizations, contributing to their adaptive capacity. Men know that mechanisms must be created to increase and improve inclusivity of women and for gender responsiveness to be realized (Pena et al. 2021a).

Leaders (i.e., presidents or chairs) are expected to guide decision making irrespective of gender but established hierarchies shape decision making in fisherfolk organizations. Most leaders are men, but a participative approach to leadership and decision making tends to be attempted in fisherfolk organizations, whether led by women or men (Pena et al. 2021a). Such an approach is likely to give a voice to women's climate change challenges and can strengthen gendered outcomes when women are empowered to be effective stewards of fisheries for climate resilience.

3.3.2. Actors and Types of Interactions

There are many more men than women in Caribbean fishing industry leadership roles. Women tend to occupy the posts supporting leaders, such as secretarial positions, but some serve in the top leadership posts of president and vice president across all levels (local, national, and regional) of fisherfolk organizations (CERMES 2020a). Leaders tend to be mature women and men between the ages of 50–59 years old. Both women and men first take up leadership positions in their mid- to late forties, but women assume top posts sooner than men, after being in the fishing industry for under ten years. On average, men spend twice as long in leadership posts than women. Shorter leadership durations for women could be attributed to their need to balance domestic work and caregiving responsibilities with leadership commitments, but this needs to be further investigated (CERMES 2020a). With succession planning, more women could eventually secure a greater share of leadership posts in the future, contributing more to climate decision making in the sector at all levels (CERMES 2020a). Women's participation in climate change adaptation, mitigation, and resilience building can lead to extensive conservation impacts, improved community responsiveness, and successful advocacy for and implementation of climate-related policies.

Fisherfolk organization leaders cannot achieve adaptation and resilience to climate change in silos. Collaborative and coordinated action is needed to tackle the multi-dimensional problem of climate change. Some view this as a role fit for women. Collaboration provides beneficial climate change adaptation outcomes through stakeholder participation and buy-in; climate financing; knowledge generation; and information sharing. Limited collaboration may result in maladaptation (Burton 2016). Networking to include more civil society and private sector support for the fishing industry can diversify organizations to build resilience.

The Caribbean Network of Fisherfolk Organizations (CNFO) has a mandate to sustain leaders in the region by strengthening and facilitating networks (McConney and Medeiros 2014). From its inception in 2016 until recently, it was headed by a woman. Gatherings of women in fisheries, particularly the Belize Women in Fisheries Forum (WIFF), help to foster collaboration among women fisherfolk, managers, and policy makers to understand gender and climate change links. This informs gender mainstreaming in fisheries and climate policy.

Over the past 20 years, female and male fisherfolk leaders have pursued policy engagement on the SSF Guidelines, CCCFP, and its protocols (Pena et al. 2021b). Strengths of fisherfolk organization policy engagement are associated mainly with the leadership of the CNFO administrator and former chairperson, both women. Fisherfolk leadership encompasses fisherfolk understanding the link and interactions between policy and livelihoods and their need and willingness to be engaged in the policy discourse; capacity; and skills building (Pena et al. 2021b). Opportunities for women to lead fisherfolk policy engagement are diverse and include projects and programs that address capacity and resource gaps for addressing climate (Pena et al. 2021b). Given the pervasiveness of climate change impacts in fisheries, women will need to take on new roles of negotiating and advocating for a space in which attention is paid to the intersecting climate issues across the value chain.

Women fisherfolk leaders in various high posts, as well as women floor members, need to press for acknowledgement of their climate challenged situations and accompanying responses. This is already happening in Barbados, for example, where a core group of women leaders and members of an all-women fisherfolk organization is using Popular Theater as a technique to identify the issues they face in the industry, raising awareness about them through poetry, song, and role play to solve their problems and transform the industry. A shortened 2021–2022 flyingfish season due to influxes of sargassum, with its significant impact on their small-scale processing livelihoods, is one such issue that has been highlighted by the women for climate action.

3.3.3. Institutional Outcomes

There is a diverse range of capacity amongst women fisherfolk leaders in the Caribbean. Most capacity lies in general fisheries training in areas of navigation and safety at sea, fish handling, gear building, and types of fishing, as well as first aid training. Leaders would have been exposed to this training in their fisheries' livelihoods. Most of this training is geared towards men in the harvest sector, but more women now seize training opportunities, irrespective of topic, whenever available (CERMES 2020a). Leadership deficiencies exist in fisheries governance, business operations, proposal or grant development, administrative and financial management, computer use and information technology, climate change knowledge, and climate-smart ecosystem approaches. All need to be addressed by women and

men to strengthen leadership for improved fisheries viability, sustainability, and overall resilience to climate change (CERMES 2020a).

Women fisherfolk leaders have benefited from training in gender mainstreaming and digital technological innovation (Cox et al. 2021; Cox and Nembhard 2021). This training, however, needs to be ongoing to promote climate-smart fisheries practices. As they are affected by climate change, women fisherfolk leaders should also play a role in implementing climate-smart fisheries practices. Being primary caretakers of many households, women also have critically valuable views on sustainable management of natural resources (UNDP 2018).

The newly formed CNFO Leadership Institute is well positioned to develop capacity building opportunities for women leaders. The Institute's online delivery has been well accepted by fisherfolk (a large proportion being women and potential leaders) since its launch in April 2020 (CERMES 2020b). The Institute should develop leadership competencies for fisherfolk on how to integrate climate-smart approaches and practices. "Building capacity is essential in developing fisherfolk organizations and preparing them for playing a more meaningful role in fisheries governance" (McConney 2007, p. 14). A woman is the administrative head of the Institute.

Succession planning is uncommon in fisherfolk organizations in the region. Leaders believe there are no promising individuals to fill the roles; fisherfolk are thought to be unmotivated to lead; there is no capacity development for potential leaders; and current leaders are not making way for new leaders (CERMES 2020a). Given the vulnerability of fisheries to climate change, fisherfolk leaders cannot afford to take a laissez-faire approach to organizational culture. They need to be "leaderful", where each organization member gains experience in being a leader concurrently and collectively regardless of gender (CERMES 2020a). This is one of the primary ways women leaders will be able to help fisherfolk communities adapt to and cope with climate changes in the industry. There are women who view themselves as fishing industry leaders and who could benefit from mentoring to lead (Pena et al. 2020b).

Small-scale fisheries must attract ambitious, innovative, and entrepreneurial women to support sustainable resource use. The limited involvement of girls and young women in leadership threatens the intergenerational sustainability of fisherfolk organizations and Caribbean fisheries. Youth are creative, innovative, energetic, and more inclined to adopt new technologies and techniques. Their involvement in fisheries can promote development. Youth can stimulate and lead improvements in digital literacy across fisheries value chains that will, among other things, improve fisherfolks' access to climate information, improve the use of early warning systems, and aid in the implementation of climate-smart technologies (CERMES 2020a). Most fisherfolk leaders identify a successor based on their leadership qualities; loyalty to the organization and expressed interest (CERMES 2020a). Women and youth must be among emergent leaders for climate change adaptation.

3.3.4. Lessons Learned

Gender influences leadership in fisherfolk organizations, but overall, there is still insufficient information for understanding gender dynamics. Further investigation is needed. The situation is complex and intersects, in some cases, with pervasive governance issues. Leadership is perceived as personalized and is indicative of different roles and expectations for men and women (Pena et al. 2021a).

Organizational leadership is one of the most important roles for both women and men in the fishing industry. The future of fisherfolk organizations with core groups of women as leaders and members appears to be bright, as many successful current leaders possess a range of attributes that afford them their leader role. The variety of skills leaders have brought to fisherfolk organizations in the region includes administrative and management capacity/skills; business/financial acumen; communication skills; research and project/grant development expertise; and technical expertise. These, in addition to leadership skills (e.g., professionalism, open-mindedness, accountability, patience, willingness to listen, etc.) are what fisherfolk organizations need to cope with the changing climate in small-scale fisheries (McConney et al. 2003). The vested interests women fisherfolk leaders have in guiding their organizations can be capitalized on to strengthen fisherfolk participation in climate planning and decision-making for the industry.

Perch et al. (2020) show that gender in Caribbean fisheries is more complex than it first appears, differing by fishery and country. Comparing fisheries to other natural resource industries could be informative once gender-disaggregated data become more available. Key goals for small-scale fisheries can be better achieved when women "are engaged as constituents and leaders for sustainable fisheries management; are empowered as effective stewards of fisheries and their associated ecosystems; and are engaged to become drivers towards sustainable fisheries markets" Siles et al. (2019, p. 27). The main barriers to some women taking on the role of leadership are structural (e.g., preconditions for membership), attributed to stigma attached to deficient fisherfolk organizations and related to disregard for governance processes and procedures (with respect to term limits, organization elections, etc.) rather than systemic (intrinsic). Eliciting and explaining gender patterns in Caribbean fisherfolk leadership based on our exploratory research into fisherfolk organization leadership is difficult given the limited amount of data and intersectional information available on women fisherfolk leaders. The data on gender in fisherfolk organization leadership are currently insufficient. More robust investigation is required based upon exploratory qualitative research, such as in this case.

4. Conclusions

The situational analysis and two cases confirm the utility of the GIFT research framework that addresses livelihoods (in the sargassum case) and institutional analyses (in the organization leadership case). The notion of adaptive capacity, the third area of the research framework is useful for synthesizing the other two.

Adaptive capacity relies on building institutions with diversity, resources, and a reasonable level of productivity through mechanisms such as social networking, collective action, and enabling interactive governance (Pena et al. 2020a, 2020b).

Barriers against and opportunities for women's leadership of Caribbean fisherfolk organizations need further investigation. A major inequality is that women's household work is not factored in by them or others as an explicit constraint that men seldom face. Equality in leadership, irrespective of who is leading, is important for gender mainstreaming and the incorporation of women's and men's interests, needs, and priorities are taken into account in climate change policy and practice.

Gender mainstreaming supports women's participation in policy and decision-making processes. The current and future impacts of climate change require women in Caribbean fisheries to be considered in strategies and policies that will assist their adaptation and resilience across the fisheries value chain. Deeper analysis of women's livelihoods, coping strategies, power, and gender relations, among other things will inform gender-responsive and transformative climate policy across the region, ensuring that women in fisheries are no longer sidelined in the response to this harsh phenomenon.

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Factors Influencing Climate Change Adaptation Decision Making among Farmers: Case Studies and Lessons Learnt in Trinidad and Tobago

Christian Casey-Lee Virgil and Kit Fai Pun

Abstract: The agriculture sector is integral to fulfilling the human biological need to consume nutritious food. The industry depends significantly on climate-sensitive assets. Because of this dependency, the need to implement climate change adaptation measures has become increasingly necessary for the sector's survival, growth, and development. Farmers are engaged in the most fundamental steps to safeguard healthy food production. This typically involves activities necessary to grow crops and rear livestock. They make critical decisions on the use of various agricultural resources, such as land, labour, capital, water, and chemicals, that impact food production and security. This study aims to determine the measures that farmers are implementing to adapt to climate change and identify the drivers of these measures. This chapter describes a qualitative study examining the climate adaptation measures in Trinidad and Tobago's farming community. It examines factors influencing adaptation choices and the extent to which desired outcomes are achieved. Climate and food production data are used to contextualise critical issues. The study revealed that most farmers implemented measures to adapt to extreme weather conditions, specifically periods of low rainfall and flooding. It was reported that the implemented measures were successful and that their choices were driven by the availability of resources. Based upon empirical findings, the chapter sheds light on lessons and discusses cases of adaptation that would inform policy decisions and provide farmers with knowledge of various adaptation measures. Moreover, a combination of policy and improved agricultural knowledge would guide farmers in building resilience to climate change.

1. Introduction

The twin-island state of Trinidad and Tobago is a highly industrialised nation in the Caribbean archipelago (Mohammed et al. 2019). The utilisation of hydrocarbon resources has resulted in the country having one of the region's highest Gross Domestic Products (GDPs) (World Bank 2020). Although the agriculture sector is responsible for only 0.5% of the GDP, it provides employment (4%) (Shik et al. 2018) for citizens who depend on the sector for their livelihoods. The relatively low agricultural activity in the country, however, contributes to the country's dependency on food imports (Eitzinger et al. 2015). Securing the stability of the agriculture sector is therefore essential for ensuring food security and protecting vulnerable

members of society, regardless of overall economic contribution. The ability of the agriculture sector to contribute towards local food security and socioeconomic stability is becoming increasingly threatened by climate risks.

Understanding the potential impacts of climate hazards on farming practices requires understanding the local climate state and the extent to which location-specific farming practices can be affected. The primary activities in the crop cultivation process include soil preparation, sowing, adding manure and fertilisers, irrigation, weeding, harvesting and storage (Ministry of Planning and Development 2022). By utilising these activities, farmers can produce various crops to fulfil the human biological need to consume nutritious food. The total annual quantity of food crops grown in Trinidad and Tobago over the last few years have remained relatively consistent, with a noticeable decrease between 2017 and 2019, followed by an increase in 2020 and a subsequent decline in 2021 (Figure 1). The primary type of crop grown (based on weight) in Trinidad and Tobago in 2021 was green vegetables (113,211 kg), followed by root crops (28,919 kg), and then other pulses, such as corn and pigeon peas (11,091 kg) (Central Statistical Office 2022).

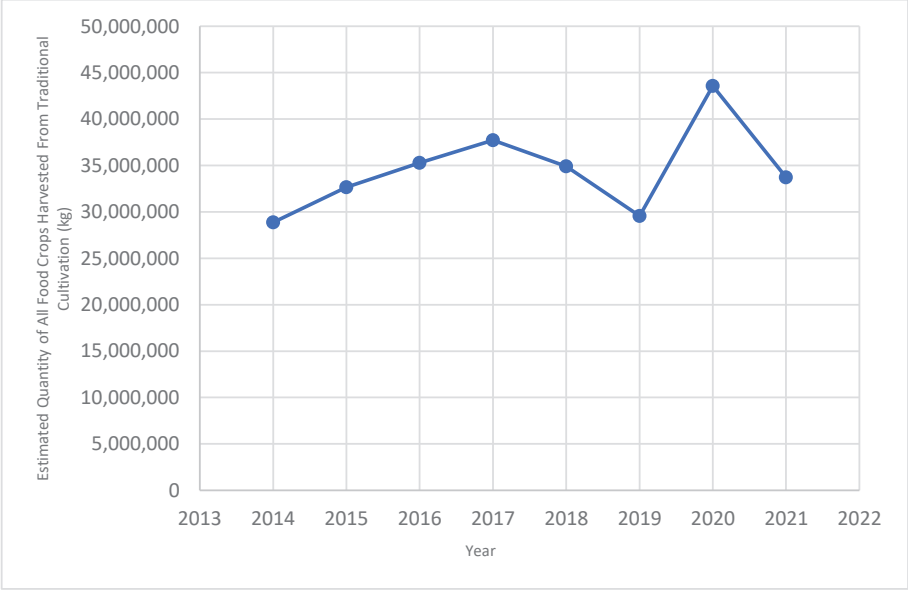

Figure 1. Estimated Quantity of All Food Crops Harvested from Traditional Cultivation in Trinidad between 2014 and 2022. Source: Authors' compilation based on data from Central Statistical Office (2022).

The agriculture sector is highly dependent on climate-sensitive assets (Linnenluecke et al. 2013) and would therefore be sensitive to climate change. The burden of climate change is disproportionately borne by low-income earners and the most vulnerable in society (Dodman and Mitlin 2013), including farmers. Climate change is expected to disproportionately affect farmers' livelihoods,

especially in rural areas (Hutchinson 2011). Farmers are susceptible to climate risks because of exposure to various climate hazards, limited adaptive capacity, and multiple vulnerabilities.

Increased ambient temperatures and droughts are climate hazards that can directly reduce crop yield. Changes in these meteorological conditions can impact crop yield by disrupting the environmental conditions needed for survivability and growth. For example, lower rainfall and higher temperatures are expected to disproportionately affect Trinidad and Tobago's root crops (Ministry of Planning and Development 2019). This effect can have far-reaching consequences, given that root crops were the second most cultivated crop (by weight) in Tobago (Central Statistical Office 2022).

Meteorological conditions can also lead to other changes that can affect crop yield. For example, changes in rainfall and temperature patterns can increase the proliferation of pests and crop-related diseases. Climate change is not only expected to affect crop yield but also the areas where certain crops can grow (Eitzinger et al. 2015). Farmers will be forced to abandon or relocate farms if existing areas become unsuitable for growing crops. This adaptation to climate change can have socioeconomic consequences that far exceed those associated with disruptions to crop yield. Generally, climate change is expected to disproportionately affect the livelihoods of farmers, especially in more rural areas (Hutchinson 2011).

It is also essential to consider the impact of climate change on farmers. Temperature increases can lead to health and safety issues among farmers. For example, high ambient temperatures are linked to chronic disease among agricultural workers in tropical regions (Nerbass et al. 2017). Moreover, high ambient temperatures are known to lead to increased physical injuries (Tawatsupa et al. 2013) mental health issues, chronic diseases, and acute heat-related illnesses such as heat exhaustion and heat stroke (Levy and Roelofs 2019). Vector-borne diseases are also expected to increase as ambient temperature rises (Moore et al. 2017). The increased use of pesticides to combat these vectors also increases the risk of farmers being exposed to pesticides (Gatto et al. 2016). Long-term pesticide exposure increases the risk of chronic diseases (Abdollahzadeh and Sharifzadeh 2021). Moreover, high ambient temperatures can increase the extent to which xenobiotics such as pesticides are absorbed via skin and lung exposure (Gatto et al. 2016).

The health and safety issues affecting farmers have direct social consequences, reduce farm productivity, and diminish income. The negative effects of poor workplace health and safety practices on productivity have been observed in several industries (Shikdar and Sawaqed 2003).

Because of the direct or indirect consequences of climate change, a reduction in crop yield can lead to reduced income, affecting the quality of life of farmers and their households (Cammarano et al. 2020). However, this cascading impact of climate change on crop yield and the resultant social impact on the livelihood of farmers and their dependents is not inevitable. As defined by IPCC (2014),

implementing adaptation measures is the "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities". This can help farmers mitigate or exploit opportunities related to climate change. Farmers possessing the necessary resources would have better adaptive capacity that enables them to maintain or improve their livelihoods by adjusting to the impacts of these climate risks and reducing vulnerabilities that climate hazards can exploit. Adaptation measures are barriers that prevent the impact of climate change and resultant effects on farmers from being inevitable.

Several studies have examined climate adaptation among farmers. For example, Belay et al. (2017) investigated the determinants of adaptation decisions made by farmers in Ethiopia. Studies by Ghanian et al. (2020) and Zobeidi et al. (2022) examined determinants of adaptation decisions among farmers in Iran.

Arising out of many studies, typical adaptation measures can be organised into general categories. However, there is room for innovation within this arena. Means of adapting to climate change can arise from cultural practices that are unique to the Caribbean. Determining unique measures can provide a means of expanding the adaptation tools available for farmers to meet the prevailing threat of climate change. However, to the best of the authors' knowledge, no study has been reported to examine adaptation decision making in Trinidad and Tobago.

Agricultural activity is concentrated mainly in the western Trinidad areas vulnerable to coastal erosion, coastal flooding, and sea level rises. These coastal issues can exacerbate the adverse effects of meteorological conditions on crop yield.

Building adaptive capacity requires accessing and utilising various resources needed for adaptation. For farmers, these resources include land, labour, capital and knowledge. However, understanding the complex impact of climate change on farmers is necessary before developing appropriate measures to use these and other resources to improve adaptive capacity.

A qualitative approach was used to examine adaptation challenges among farmers in Trinidad and Tobago. A qualitative approach is ideal for exploring the experiences, perceptions and behaviours associated with responding to real-world problems (Tenny et al. 2021). This approach allows for the deep exploration of the nature and ensuing challenges of the adaptation activities that farmers in Trinidad and Tobago were implementing. Questionnaires mainly comprising open-ended questions were distributed to 31 farmers in Trinidad and Tobago to assess adaptation activities. Questionnaires were distributed to farmers conducting farming activities mainly in the eastern areas of Tobago and the northern area of Trinidad. The study was mainly conducted in the Tunapuna–Piarco area of Trinidad and in the Roxborough area of Tobago (Figure 2).

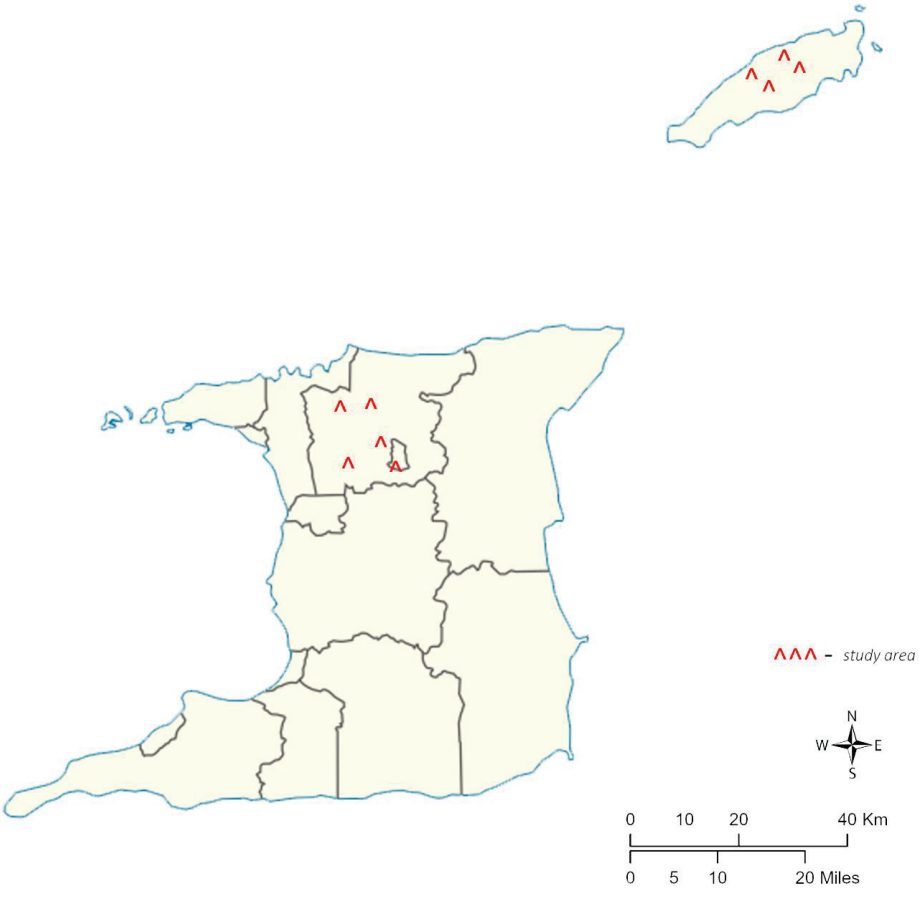

Figure 2. Study Area. Source: Adapted from Google Maps (2023).

2. Climate Change Impacts on Farming in Trinidad and Tobago

Approximately 18,951 farms (covering a total land space of 84,990 hectares) in Trinidad and Tobago grow various crops, with more than half being managed by individuals, households, and sole proprietors (Ministry of Planning and Development 2022). Therefore, reducing the impact of climate risk on farming activity in the country primarily depends on the decisions and adaptive capacity of individuals and social units rather than large-scale organisations. However, these small-scale operations often have limited resources, making adjusting to climate impact more difficult.

Farmers in this study earned approximately between 3000 and 7000 United States Dollars (USD) in annual revenue. The average farmer spent 5.6 h per day farming (or approximately, 5 days per week), resulting in an hourly income range of roughly USD 2 to USD 5. These values place the income range just below and above the country's national minimum wage, which changed from USD 2 to USD 2.60 in 2019 (Ministry of Labour 2021). Some farmers may be more capable of living

on a minimum wage than others, depending on their living situation, the number of dependents, household size, and other factors. However, living on a minimum wage can be difficult because it may not cover the costs of acquiring basic needs such as food, transportation, and medical care. Additionally, farmers who earn a minimum wage may have difficulty saving money, investing, or planning for their future. Certainly, disruptions to income-earning capacity because of climate risks can push some farmers below the poverty line. It is, therefore, essential to characterise local climate risks to safeguard the livelihood of farmers. Understanding climate risks is necessary for developing appropriate measures to improve the adaptive capacity of farmers.

As reported by the Ministry of Planning and Development (2019), the twin-island state of Trinidad and Tobago is vulnerable to climate changes, such as rises in temperature, changes in rainfall, increases in atmospheric carbon dioxide, saltwater intrusion, extreme weather events and sea level rise. According to Mohammed et al. (2019), the mean annual temperature in Trinidad and Tobago has increased by approximately 0.6 °C since 1960, and the total yearly rainfall has increased by 37% over the past four decades. However, annual rainfall data do not provide insight into rainfall distribution throughout the year, particularly during dry seasons when precipitation levels are lower than in the wet season. The dry season is when farming activities are most likely to be compromised by water scarcity. Another study by Stone (2021) determined that precipitation levels during the dry seasons in Trinidad and Tobago have been statistically consistent.

Given that overall precipitation levels are increasing and dry seasons remain unchanged, it is expected that prevalent water scarcity issues in Trinidad and Tobago should be consistent or reduced over the years. Indirectly, however, other non-climate-related factors (such as poor land development and drainage) can exacerbate the effects of rainfall, leading to flooding events. The far-reaching effects of flooding events in Trinidad include damage to infrastructure, farm equipment, and machinery (Dixon 2018). Farmer demotivation, productivity reduction, and crop destruction were also identified as negative effects of flooding events in Trinidad. Flood-related issues can affect the profitability of farming operations.

Recent studies found that the farmers' choice of crop grown has been impacted by climate change. For example, certain species of corn and beans are more tolerant to drought than other crops (Peyster 2016). Whenever access to water is limited, farmers who choose to grow these drought-tolerant species of crops would be more capable of maintaining crop yield and profitability. Several crops are monitored by the Ministry of Planning and Development (2022) (Table 1). Data are unavailable on the extent to which a crop species is vulnerable to climate change. This information can inform farmers on alternative crop options that would be more resilient to future climate states.

Table 1. Food Crops Grown and Monitored in Trinidad and Tobago (Ministry of Planning and Development 2022).

Green Vegetables	Root Crops	Other Pulses
Tomato	Cassava	Green Corn
Cabbage	Dasheen	Pigeon Peas
Cucumber	Yam	
Melongene	Tannia	
Bodi	Ginger	
String Beans	Sweet Potato	
Okra		
Lettuce		
Pak Choi		
Watermelon		
Sweet Pepper		
Celery		
Pumkin		
Dasheen Bush		
Squash		
Cauliflower		
Pimento		
Chive		
Thyme		
Hot Pepper		
Herbs		
Sorrel		

Source: Authors' compilation based on data from Ministry of Planning and Development (2022).

3. Climate Change Adaptation

It is recognised that adaptation activities can be specific to locations and context because of variability in the social and natural environment, climatic impacts, and socioeconomic and cultural conditions (Füssel and Klein 2006). For example, the spatial heterogeneity of climate change vulnerability and effects (IPCC 2022) is expected to lead to variation in adaptation activities. Different regions will have to adapt to the specific climate vulnerabilities and challenges that exist in that area. Climate change is expected to lead to varying degrees of precipitation across the African continent, with some areas projected to have more intense rainfall and others, less rainfall (Dunning et al. 2018). Additionally, within a specific geographical location, there may be variations in adaptation activity owing to differences in perception (Berkhout 2012). Farmers are sometimes challenged to develop novel means of adaptation. Moreover, non-traditional cultural measures may have been developed to adapt to climate change. The type and extent to which various adaptation measures are implemented, the underlying factors driving adaptation decision making, the lessons learnt, and the success achieved can

provide policymakers with information on the practical experiences of the farming community.

The Ministry of Planning and Development (2019) recommends farmers in Trinidad and Tobago implement adaptation measures such as water management, land distribution and management, research and development, climate-sensitive farming systems, increased awareness, and communication. Based on the cost–benefit ratio, suggested high-priority adaptation measures include on-farm water storage, mainstreaming climate change issues into agricultural management and drip irrigation. In addition, crop diversification was recognised as a suitable adaptation measure (Hutchinson 2011). Eitzinger et al. (2015) also identified cassava, sweet potato, and yam as alternative crops that might be more resilient to the changing environmental conditions in Trinidad and Tobago. Climate monitoring was also suggested as a suitable adaptation measure. Climate monitoring can inform farmers of optimal planting times to maximise the possibility of having the best possible crop yield. Climate monitoring can also ensure farmers are not overexposed to harmful weather conditions that threaten their health and safety.

4. Methodology—Data Collation and Analysis

A convenience sampling approach was used to distribute questionnaires to farmers selling crops at agricultural markets in Trinidad and Tobago. Questionnaires were distributed to farmers attending meetings held by agricultural organisations. Referrals from farmers who participated in the study were contacted and invited to fill out the questionnaire over the phone or using an online version of the questionnaire. In addition, discussions were held with farmers based on their responses to the questions included in the questionnaire. Overall, 31 farmers participated in the study. Responses from the farmers were analysed for themes and descriptions of farming adaptation activities and challenges.

5. Findings on Farmer Experiences and Adaptation Considerations

Most farmers were not members of agricultural societies (77.4%) or registered with the Ministry of Agriculture, Land and Fisheries (58.1%). In addition, most (76%) farmers indicated that they grew crops for domestic and commercial purposes. However, these factors did not appear to influence the adaptation decisions made by farmers.

Farmers in the study grew a wide variety of vegetable and fruit crops of which the most widely grown crop was plantain (Table 2). Most of the crops grown by farmers were short-term crops (crops with a harvesting time less than 365 days). The long-term crops (harvest times greater than 365 days) grown by farmers include avocado, lime, orange and mango. Short-term crops such can be harvested in as little as 4 to 5 weeks (lettuce, pak choi, chive, and celery), and as long as 10 weeks (melongene, tomatoes, and hot peppers) (Ministry of Agriculture, Land and Fisheries n.d.).

Table 2. Frequency of Crops Grown by Farmers.

Crops	Frequency	Crops	Frequency
Plantain	12	Paw Paw	3
Dasheen	10	Pumpkin	3
Bananas	9	Shadow Beni	3
Pimento	9	Cashew	2
Cassava	8	Cucumbers	2
Coconut	7	Ginger	2
Pak choi	6	Grapefruit	2
Tomatoes	6	Sapodilla	2
Avocado	5	Yam	2
Lemon	5	Bhagi	1
Lime	5	Broccoli	1
Orange	5	Cane	1
Corn	4	Cauliflower	1
Hot Pepper	4	Celery	1
Lettuce	4	Chive	1
Mango	4	French Thyme	1
Melon	3	Kale	1
Tanaya	1	Melongene	1

Source: Authors' compilation based on data from Ministry of Agriculture, Land and Fisheries (n.d.).

The main climate concern expressed by farmers in the study was related to precipitation patterns. However, there was no consensus on the overall trend. Some farmers perceived that the dry seasons were becoming dryer and the rainy seasons wetter. Others reported that the rainy season appeared to be dryer. Farmers stated they would adapt to rainy seasons and flooding by changing farming operations. These changes include land development and changing the location where crops are planted. Farmers stated they would plant crops on hillsides to facilitate drainage by gravity. This measure can be easily implemented if the land utilised by the farmer has slopes. Although less costly than alternatives, planting on hillsides is more labour-intensive. Other farmers stated they would opt to implement more expensive measures, such as constructing drainage systems alongside growing crops on hillsides. The combination of drainage construction and planting on slopes appears to be successful, as one respondent indicated that excess water is drained from the land because of proper drainage, land development, and topography when there is heavy rainfall during the rainy season.

Some farmers opted to grow plants in pots instead of in the ground. This is an economical option and should be successful, provided that farmers place the pots at elevations above flood waters.

In circumstances where farmers had challenges obtaining water, installing systems to provide water during prolonged periods of little rainfall was a common adaptation approach. Farmers installed drip irrigation equipment, rainwater harvesting, and storage systems and used artificial ponds to ensure timely water

delivery to crops. Many indicated that they unsuccessfully sought government assistance to provide equipment and improve the water supply. In addition, some farmers utilised innovative methods to reduce the costs associated with preventing crops from suffering from water stress. This method involved a farmer attempting to incorporate water conservation, capturing, and storage practices to create a self-contained farming system that mimicked the conditions of a tropical rainforest. The approach involved the farmer covering coconut and fruit trees with bags and placing coconut mulch at the tree's roots to reduce water loss by evaporation and evapotranspiration. Rainwater was also harvested and used to provide water to the crops. This approach reduced the demands on the irrigation systems that deliver stored rainwater to crops, thereby enabling the system to be self-sustainable.

Coupling water conservation practices with water collection and storage methods is effective for managing prolonged periods of low rainfall. The efficient use of limited water resources would increase the probability that crop yield can be maintained under extreme circumstances. The ability to provide and conserve the water needed by crops will become more important if precipitation levels continue to fall and other means of sourcing water are not readily available. Water conservation measures (such as using mulching or other low methods) could reduce the evaporation of water from soils and covering plants and create a microclimate environment. The effectiveness of these measures facilitates the recycling of water that crops use for evapotranspiration.

There appear to be significant consequences of changing weather patterns. A respondent indicated that the quality of the plants has changed since the climate has started to change. Changes include low crop yield and the need to introduce several types of chemicals to improve crop quality.

5.1. Farming Cycle and Workday

The time spent working on the farm can affect the frequency and duration of exposure to environmental conditions. However, on average, most farmers spend 5.6 ± 3.2 h working on their farms. Many factors were responsible for the variability in the average length of time on farming, including the availability of personnel (family and employees), the stage of the farming cycle (i.e., planting, growing, and harvesting), weather conditions, farming technique, and crop selection. Generally, most farmers worked alone. However, some reported that family members or temporary employees assisted them during the more strenuous phases of farming (planting and harvesting). Having assistance reduced the overall time farmers would spend on the farm. The choice of crop, however, was also a primary factor determining the length of time farming, with some crops requiring more attention than others. Long-term crops such as citrus (e.g., lemon, lime, and orange) require less maintenance than short-term crops such as lettuce. Generally, citrus crops are sold at a higher price than others; however, the price is less stable (Figure 3).

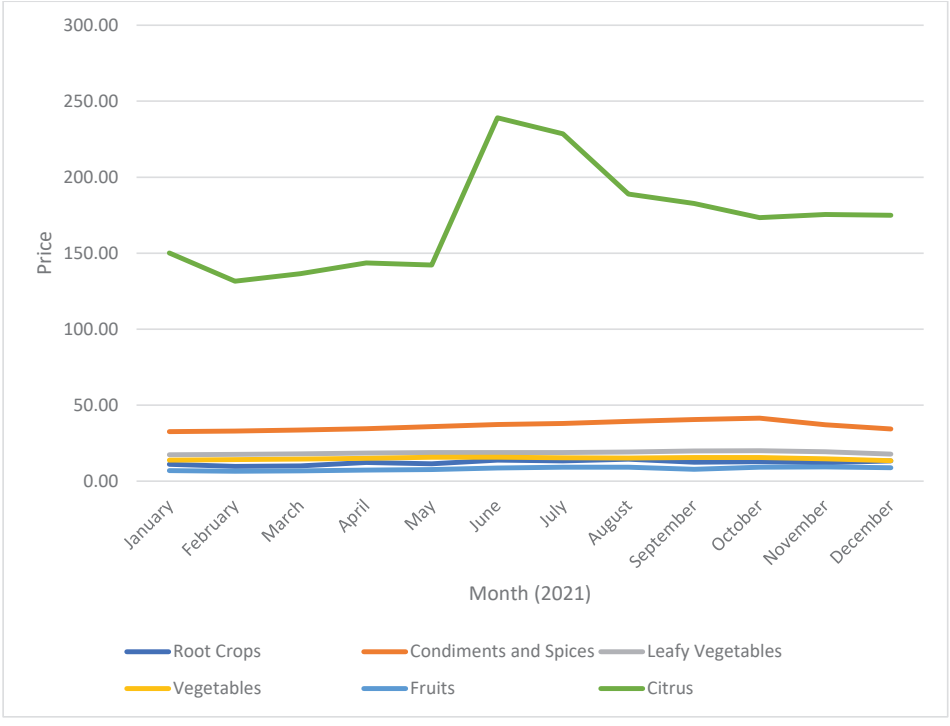

Figure 3. Price of Crops in Trinidad in the Year 2021. Prices: root crops (per kg) include carrots, cassava, yam, dasheen, eddoes, sweet potatoes, and ginger; condiments and spices (per 100) include hot peppers, shadon beni, and pimento; leafy vegetables (per kg) include cabbage and cauliflower; vegetables (per kg) include seim beans, pigeon peas, cucumber, melongene, plantain, pumpkin, sweet pepper, tomato, caraille, squash, and christophene; fruits (per kg) include banana, paw paw, pineapple, watermelon, sorrel and sorrel; citrus (per 100) include lime, grapefruit, oranges, and Portugal. Source: Authors' compilation based on data from National Agricultural Marketing and Development Corporation (2022).

5.2. Adaptation Measures by Farmers

Table 3 shows the categories of adaptation measures utilised by farmers in this study. As the climate continues to change, there may be hotter days. Adjusting the time spent working outdoors is among the measures that farmers should utilise to safeguard against heat-related illnesses. Overall, the techniques used by farmers to reduce time spent working outdoors include selecting low-maintenance crops, hiring workers (or seeking the assistance of family members), and adjusting farming practices to minimise the need for extensive manual operations. Farmers sometimes avoid working during mid-day when ambient temperatures are usually the highest. Although the health and safety of farmers are essential, it is equally critical that they can adjust working practices in a manner that has minimal to no impact on

profitability. This balance is given importance when the socioeconomic vulnerability of some farming community members is considered.

Table 3. Emerging Themes and Summary of Practices.

Themes	Summary of Practices
Crop Selection and Diversification	• Farmers opted to grow crops, such as citrus, that require less water.
Land Use Management and Infrastructural Adaptation	• Crops were planted on hillsides to avoid floodwaters. • Drainage systems were constructed to prevent lands from being flooded. • Farmers grew crops in pots to avoid floodwaters.
Disease and Pest Management	• Farmers increased the use of pesticides.
Human Resource and Labour Management	• Farmers conducted farming activities during the times of the day when the environment was cooler. • Additional workers were hired during labour-intensive phases of the crop production cycle to reduce the overall time farmers were exposed to a hot environment.
Water Management and Irrigation	• Farmers covered crops with plastic bags to recycle water lost by evapotranspiration processes. • Farmers developed rainwater harvesting systems. • Farmers utilised mulching to reduce rate at which water evaporates from soil.
Business Model Transformation	• Farmers chose to rear animals instead of growing crops.

Source: Table by authors.

Hiring workers or selecting low-maintenance crops can potentially disrupt the profitability of farming operations. For example, hiring workers can be costly, and cultivating low-maintenance crops such as leafy vegetables may not be the most profitable choice. Adjusting farming practices to minimise exposure may be the most economical option to reduce exposure to hot ambient temperatures. However, a farmer reported that they could reduce the time spent on farming by using chickens and mulching to reduce the frequency of clearing weeds from the land. Another farmer developed a job schedule to avoid working on the farm during the hottest times of the day. He opted to start working before the sun rises, take a break in the middle of the day, and resume working in the evening.

Under extreme circumstances, some farmers chose to grow different crops or switch to livestock, most switching to long-term crops. While growing these crops requires less water and maintenance and they can be sold at high prices, they often create cash-flow issues as the crops require a long period before they can be sold. However, such an approach is not desirable for vulnerable farmers who depend on a more consistent income.

Some farmers reported using more chemicals to treat pests and improve crop yield. In some instances, farmers have changed the crops that they are growing, specifically switching from short-term to long-term crops. Some farmers have shifted from crops to solely rearing livestock. These farmers reported that switching to raising livestock was a profitable decision.

Generally, respondents indicated that the adaptation measures they implemented achieved the desired result. Most respondents (90%) reported that their adaptations were successful because there was less crop loss or an increase in yield. All the farmers who installed drainage and irrigation systems reported that the measure was successful. Adaptation co-benefits were also reported. For example, farmers reported that farm management is less stressful and mental health was improved when they switched to long-term crops.

Although some adaptation measures were successful, there were notable challenges. For example, farmers who reported changing to long-term crops as an adaptation measure indicated that although the yield is good, the timeframe to make a return on investment is much longer. Another farmer stated that the increased use of chemicals did not help much because of increased rainfall. Farmers reported effects on production delivery times when the chemicals were effective against the pests. However, there were delays in ensuring that no chemical residues remained on the crops before selling to customers.

Low-cost solutions to climate change challenges are required if vulnerable farmers are to be self-empowered to adapt to climate change, and policymakers must consider the adaptive capacity of farmers. The study identified potential low-cost water conservation measures, but farmers still utilised typical cost-prohibitive water storage and distribution measures. However, some level of government intervention may still be required to equip farmers with irrigation systems.

6. Discussion

Building Adaptive Capacity

Agricultural adaptations to climate change depend on local conditions including socioeconomic status (Reidsma et al. 2010). Generally, agricultural adaptation involves adjusting farm production activities, managing finances, and introducing new technology or government assistance (Smit and Skinner 2002). Diversifying crops and altering planting dates were also identified as important adaptation strategies (Fosu-Mensah et al. 2012).

Fundamentally, the adaption of farmers to climate change initially depends on the perception of the changes and associated risks and then on the availability of resources to adapt (Tripathi and Mishra 2017). The age of the farmer, length of time farming, and education level may have affected their perception of climate change but not the choice of adaptation measures for many reasons, including the unavailability of resources to pursue high-cost or innovative measures. In this regard, a lack of financial resources may have been the main factor limiting adaptation diversity.

Maddison (2007) determined that education and access to financial services are factors that affect adaptation measures implemented by farmers. Farmers willing to implement high-cost measures may be restricted by a lack of finances. One respondent indicated that they required government intervention to implement a complex and potentially costly adaptation system. If most farmers had access to financial resources, the implementation of high-cost measures might have been more prevalent. However, most measures were low-cost measures involving minor changes to current agricultural practices.

It is also possible that the choice of adaptation measures was limited to those that were proven to be effective, and there was no further need to innovate or implement alternatives. Most of the respondents indicated that the implemented measure was effective. There is no stimulus for adaptation diversity if easily implemented, and common types of adaptation measures are effective. However, farmers had perceptions of climate change that can potentially affect adaptation effectiveness.

There were differences between the actual changes in climate and changes perceived by farmers in this study. This aligned with a study by Banerjee (2015) that determined that a farmer's perception of climate change tends to be different from actual climate change. This disparity exists because most farmers equate normal weather variability with long-term changes in weather patterns (Mertz et al. 2009). The difference between real and perceived climate change has led some farmers to mischaracterise adaptation to weather patterns as adaptations to climate change. It is important that farmers fully grasp the principles and risks associated with climate change. This will ensure that they are adequately prepared to meet the real challenges of climate change.

Therefore, there is an urgent need to improve climate change awareness among farmers. There is room for associations and government services to provide this service to farmers. Only 23% and 42% of the respondents in this study are members of agricultural societies and registered with the Ministry of Agriculture, respectively. Both entities are ideal for disseminating climate change information. Climate change issues can be discussed at society meetings, and registration with government agencies can facilitate outreach from extension officers to discuss climate-related matters. These agencies should take steps to actively improve membership (and registration).

The objective of adapting to climate change is to maintain or exceed a predefined or standard state. For farmers and organisations in general, this predefined state

is often defined by income and profitability metrics rather than characteristics of organisational operations and the services or products provided. That is, normal is not defined by the operations of the company and the product or services offered but by performance metrics such as income and profitability. Adaptation can include all measures a farmer implements to secure an income sufficient to maintain their livelihoods. This includes abandoning farming to obtain income from other ventures if necessary. Building adaptive capacity would therefore include providing and utilising resources to support farming operations or transition farmers to other economic opportunities needed to secure their livelihood. This may also include the consideration of non-climate-related factors, given that the impact of climate is one of the factors that affects the capacity of farming households to secure a livelihood (Eakin 2003).

The President of the Agricultural Society of Trinidad and Tobago indicated in an article written by Mahase (2022) that there has been a quadrupling of the cost of essential farming commodities, including seeds and fertilisers (including locally produced urea). These non-climate factors also affect the operations of farms and can exacerbate the effects of climate change. The study, however, identified low-cost solutions to climate-related challenges. However, the combination of climate and non-climate stressors can overwhelm the financial resources of the farming community regardless of the implementation of suitable adaptation measures. However, reducing climate risk can be part of an overall strategy for maintaining the financial stability of farmers. In this regard, there is a need to improve the extent to which farmers join and participate in farming organisations. These social groups are necessary for establishing knowledge networks to share and disseminate information on adaptation and exploiting opportunities that can lead to more efficient and profitable farming operations. Most of the farms in Trinidad and Tobago are small-scale individual farms. Farmers can utilise these groups to collaborate and purchase farming material at a lower cost to maximise profits. Improving or maintaining profitability will provide farmers with the capacity to finance adaptation measures if conditions continue to deteriorate or at least build up financial reserves to buffer against market changes.

There is also a need to develop government–farmer partnerships to build adaptive capacity. Government agencies can provide the resources and training needed to adapt or improve productivity. Additionally, social programs can be delivered to members of farming households to facilitate an overall improvement in the adaptive capacity of the home rather than just the individual farmer. These social programs can incentivise education and training in non-agricultural disciplines. In instances where income from farming operations is reduced, the household will be stable if members can secure employment in other industries.

It is important to note that the relatively small number of participants interviewed in this study limits the extent to which broad generalisations can be made regarding the interpretation of the findings. However, the findings provide a

foundation for future in-depth studies on the adaptation practices among farmers in Trinidad and Tobago.

7. Chapter Reflection Exercises

The social dimension of climate change often goes understated in many examinations of the impact of the phenomenon. This chapter explores adaptation measures implemented by the farming community in Trinidad and Tobago to maintain a livelihood in an increasingly threatening economic and biophysical environment. As a chapter reflection exercise, readers are asked to consider the systemic impact of climate-related reduced income from the social perspective. Consider how a reduction in household income can lead to other social consequences. This reflection will help further emphasise the impact of developing the adaptive capacity of vulnerable groups to avoid systemic social implications. Utilise the following questions as a starting point for reflection:

1. What are the social dimensions and critical factors affecting farmers' food production operations in Tobago?
2. What are the main considerations and decision areas among farmers in safeguarding farmers' food production and operations in Tobago?
3. How would farmers respond to climate change and associated threats impacting their food production in Tobago?

8. Recommendations

It appears a pressing need for government agencies to develop a policy that encourages farmers to grow climate-resistant crops. This holistic policy should provide support for acquiring, growing, and selling these crops. Acquiring and distributing climate-resilient species of crops to famers is crucial. It is important that farmers are educated on the types and species of crops that are less vulnerable to the local effects of climate change as part of this policy. However, in instances where farmers switch to crops, such as citrus, that are naturally resilient to climate change but have long growth periods, government agencies can provide support to assist in crop sales. Other mechanisms for supporting farmer growing long-term crops should also be considered. The revenue obtained from selling long term crops would have to sustain farming activities and general expenditure for a long period. Government agencies can assist farmers in acquiring larger farms that can help generate income that is more sustainable.

Moreover, it is recommended that the government and/or authorities could initiate launching adaptation measures and associated programmes to educate and enforce climate-sensitive farming practices. An expansion of this study should be carried out to examine various adaptation techniques currently used by farmers. Useful information and relevant publications on adaptation techniques should be distributed to farmers.

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Responding to Concurrent Disasters: Lessons Learnt by Social Work Academics Engaging with Flood Survivors during a COVID-19 Pandemic, in South African Townships

Nolwazi Ngcobo, Bongane Mzinyane and Sibonsile Zibane

Abstract: The devastating effects of the recent floods in several townships in the KwaZulu-Natal province of South Africa demanded an urgent humanitarian response. The extent of the flood disaster prompted both practicing social workers and social work academics to plan and provide psychosocial services for affected communities. The COVID-19 pandemic further compounded the situation in the process of engaging communities which were affected by the floods. Services that were rendered, due to necessity, included, although not limited to; trauma debriefing, grief and bereavement counselling, securing safe shelters for displaced individuals, social relief, and social security referrals. Framed within autoethnography, in this chapter we share our experiences in preparing for and responding to the needs of the communities compromised by pre-existing socio-economic and health vulnerabilities. Moreover, we report on how trauma-informed social work principles were challenged by unconducive settings common during disasters. These yielded significant lessons, particularly for social work academics. The experience of working with flood survivors forced us to rethink and redefine community engagement in academia that challenges the "ivory towers" approach to education. The field work asserted the importance of integrating indigenous knowledge systems in social work interventions alongside "flexible ethical" practice. The field work required us to center the peoples' interests, cultures and values in their intervention strategies. Furthermore, it unveiled that social work services are ineffective without strong participation and partnerships between social workers, community leaders, caretakers, and members and without inter-stakeholder collaborations. Lastly, we argue that for social workers to be relevant and effective, their intervention should be community-centered and context relevant.

1. Introduction

The Global Agenda for social workers continues to be driven by the priority needs of individuals, families, groups, and communities. "Social workers and social development practitioners are in the frontline to alleviate the hardships and challenges that people, communities, and societies face" (Lombard 2015, p. 482). With the rapid, widespread and intensifying climate change in every region and

across the whole climate system, Dominelli (2012) established the green social work (GSW) framework in 2012. This framework prioritizes social work interventions in the context of global disasters, climate change, and other crises. It calls for social workers to respond to needs, especially of disadvantaged populations, before, during, and after disasters.

On 11 April 2022, the flash floods severely damaged South Africa's KwaZulu-Natal (KZN) Province, destroyed thousands of homes and infrastructure and claimed hundreds of lives. As of 22 April 2022, at least 435 fatalities had been confirmed around the province, and there were still others missing. It is one of the deadliest natural disasters to strike the country in the twenty-first century and the deadliest since the floods of 1987, with a single day's worth of rain totaling 300 millimeters (Bouchard et al. 2022). Subsequently, the floods were declared by the then premier of KZN as a Provincial State of Emergency. Notable, the floods happened when South Africa was still under the National State of Disaster as declared by the government because of Coronavirus (COVID-19) pandemic,

In this chapter, as the authors, who are social work academics, we use collaborative autoethnography to reflect on our interactions with flood survivors from five South African townships during the (COVID-19) pandemic. The townships in which we are basing our reflections include Inanda, Ntuzuma, Marianhill, Tshelimnyama, and Nazareth. Floods and landslides hard hit these communities, and most resided in areas with pre-existing socioeconomic challenges. While this chapter focuses on social work during and post flood disasters, we also recognize the role of social workers in the prevention and management of disasters (Dominelli 2013; Shokane 2019; Willett 2019; Wu 2021).

The main functions of social workers during a disaster are the provision of relief and support, restoration, resettlement, and enhancing resilience. According to Van Breda (2018), building or enhancing resilience becomes a priority in less-resourced communities, such as in South African townships. At the heart of resilience building are "multilevel mediating processes that systems engage in to obtain better-than-expected outcomes in the face or wake of adversity" (Van Breda 2018, p. 2). Makhanya and Zibane (2020); Mkhize et al. (2014) emphasized that for African communities, the mediating processes should be rooted in indigenous, context-relevant knowledge and practices. Such assertions are stimulating current debates and an increase in research that focuses on the local knowledge and practices that enhance resilience in the face of adversity (Smith and Nguyen 2021; Van Breda 2018; Vo 2015). Against this backdrop, in this chapter, we embraced purposeful learning and affirmation of African indigenous knowledge and practices throughout our interactions with flood survivors, resulting in unique findings discussed in this chapter. This chapter begins with an introduction that briefly describes the context of our chapter. It is followed by literature on flood disasters and COVID-19, as well as a brief history of South African townships and social work practice during disasters. Furthermore, we explore the methods that framed our reflections. The

majority of the chapter focuses on the lessons learned throughout our intervention. The lessons include the manner in which trauma-informed social work principles were challenged by unconducive settings common during disasters, rethinking and redefining community engagement by academics, the importance of integrating African indigenous knowledge systems (AIKS) in social work interventions, and lastly, the value of partnerships and inter-stakeholder collaborations. *Ilima*, *ukugida*, and *Ubuntu* are some of the indigenous African practices that were incorporated during social work interventions. The analysis and discussion sections specifically clarify and elaborate on these indigenous terms. As authors, we contend in the conclusion that social workers' responses to disasters should be community-centered and context relevant.

2. Literature Review

2.1. Flood Disaster and COVID-19

According to the United Nations International Strategy for Disaster (UNISD) (United Nations International Strategy on Disaster Reduction 2019), disasters can be either (terrorist attacks, mass shootings, racial/ethnic riots, etc.) or natural (hurricanes, earthquakes, tornadoes, floods, volcanoes, etc.) and are all sudden, destructive, and a significant cause of loss of life and livelihood. Although this chapter gives the aforementioned UN definition that classifies floods as natural disasters, this presentation is in no way intended to disregard the rising views, such as those that consider floods as being man-made. Floods are thus accepted in this chapter as both a natural and man-made disaster. This position is our way of expressing their intention for the Green Social Work's preventative elements.

The effects of disaster exposure on mental health are far too frequently disregarded. In a quantitative study conducted in South Korea in 2005, Chae et al. (2005) compared respondents who had experienced a disaster with those in the control group who had not; those who had experienced the flood disaster indicated harmful impacts in their mental health. Their results confirm that the residents in the disaster-exposed group would experience higher levels of stress, and other psychosocial challenges compared to those who were not exposed to disaster.

Natural disasters in the sub-Saharan region are now more regular, and calamities related to climate change that were once considered to occur only once every century are now happening more frequently and with more disastrous effects (Bouchard et al. 2022). Increasing temperatures, more frequent and severe droughts, floods, and tropical cyclones are some of the destructive repercussions of climate change that are the subject of the 13th Sustainable Development Goal (SDG) (Zhenmin and Espinosa 2019). The aforementioned authors indicate how the World Bank had issued a warning that, if not prioritized, climate change would continue to disproportionately have a detrimental impact on developing countries. As predicted, Cyclone Idai in 2019 killed nearly three million people in Malawi,

Mozambique, and Zimbabwe, serving as a stark reminder of the impact that extreme weather occurrences are already causing on people's lives and livelihoods (ibid). Fundamentally, climate change prevents us from achieving other SDGs because it has the ability to compromise communities with inadequate resources, which worsens mental and emotional health, food insecurity, and water scarcities. The situation will worsen until all global partners commit to "fulfil their obligations to help developing countries get the support they need to address climate change" (Zhenmin and Espinosa 2019, p. 496).

In African countries, climate change is becoming a development impediment, worsening water management issues, decreasing agricultural production and food security, raising health risks, damaging critical infrastructure, and disrupting the delivery of basic amenities like water and sanitation, education, energy, and transportation (Zhenmin and Espinosa 2019). Climate change remains an ever-present global risk. However, the number of people dying from exposure to natural hazards, such as tsunamis, earthquakes, and floods, has greatly dropped, particularly in developed countries. This is due to advancements in disaster detection and monitoring systems, which confirms Dominelli's (2013) argument that disasters do not discriminate but highlight the prevailing societal injustices.

Floods are the most common natural hazard on the African continent, frequently leading to both property damage and fatalities. Their occurrence simultaneously as a calamity like COVID-19 would undoubtedly provide many difficulties, especially for underprivileged people. Likewise, COVID-19 has had a significant impact on all nations, undoing the progress made towards achieving some global goals, such as the 1990s treatment for all—to make HIV testing and treatment widely available to persons with HIV by the end of 2020, and stop the further transmission of the virus (UNAIDS 2020). In several of the recorded cases, inadequate treatment supplies were lacking during the prolonged country lockdowns, and some patients chose to forgo their treatments because they ran out of food (UNAIDS 2020). Consequently, due to infrastructural damage, which may potentially hinder the delivery of medical services and access to them, flooding can cause more widespread disease outbreaks (Suk et al. 2020).

The simultaneous occurrence of disasters in diverse locations across the continent has caused researchers' attention to change from studying single hazards to studying multiple hazards and disasters. For instance, Kassegn and Endris (2021) looked into the socioeconomic effects of COVID-19, desert locusts, and floods in East Africa and found that the three threats worsened already-existing food shortages and weakened livelihoods and development gains that had taken years to achieve. Communities experience disasters when hazard exposure occurs in the absence of sufficient material or non-material capabilities, thus increasing risk.

Living in urban areas has become a daily risk for many in Sub-Saharan Africa. Satterthwaite et al. (2019) refer to poor urban planning, inadequate infrastructure, poverty, illiteracy, limited access to water, health care, and proper sanitation as daily

hazards. Satterthwaite et al. (2019, p. 113) note that "the boundary separating extensive disasters and everyday risks can be fuzzy" and argue that essentially "disasters waiting to happen". Therefore, addressing these disasters separately is necessary to reduce cumulative exposure. Essentially, climate-related disasters intersect not only with co-occurring disasters, such as the COVID-19 pandemic, but the political and governance structure, the socioeconomic circumstances of individuals, and their capacity for adaptation (Bouchard et al. 2022). The historical and political context of townships in South Africa highlights these intersections.

2.2. The Historical Context of South African Townships

In South Africa, "the term 'township' has no formal definition but is commonly understood to refer to the underdeveloped, usually (but not only) urban, residential areas that during apartheid were reserved for non-whites (Africans, Coloureds and Indians) who lived near or worked in areas that were designated white only" (Permegger and Godehart in Zibane 2017, p. 43). For African residents, townships were areas of exclusion, oppression, control, and containment of all aspects of the life of the residents (ibid). In spite of the demise of apartheid, townships continue to be an architectural remnant of the Apartheid government, whose racial segregation policies were regulated by the Group Areas Act.

The Reconstruction and Development Programme (RDP) was established in 1994 after the democratically elected government came into power with the intention of minimizing the negative socio-spatial, economic, and political effects of apartheid by addressing socioeconomic disparities and reducing poverty in formerly oppressed and disadvantaged groups. One of its requirements was to restructure housing policies to offer free accommodation to families that past administrations had shut out. However, the development of new townships and the growth of existing ones have largely replicated historical spatial dynamics when the poor resided farther away from the city (Zibane 2017). Our responses to the flood disaster considered how socio-spatial inequalities and variations in wealth, age, education, and resource availability affect communities' ability to respond to disasters.

2.3. Social Work Practice during and Post Disasters

Social work scholarship on disasters in developing countries is growing (Koketso et al. 2021; Shokane 2019; Machimbidza et al. 2022), with implications for practice (Kreitzer 2012; Ng 2012), education (Wu 2021), policy (Mangubhai et al. 2021) and research (Maglajlic 2019). Like Ray (1999) we do not consider social work practice, education, policy and research as separate categories and similarly reject the bourgeois "universities as ivory towers" mindset, which leads to detachment from communities, even during times of disasters. Inspired by Ray (1999, p. 25), we appeal for "fresh thinking . . . [and] willingness to abandon the traditional categories that drive our thinking about who does what in the economy". Similarly, Watermeyer

(2019, p. 332) posited that for occupational relevance, community engagement for academics "is increasingly less an optional, more a mandatory".

In non-disaster settings, social workers perform a variety of roles within their micro/mezzo/macro scope of competence. Notably, Levenson (2017, p. 1) argued that "trauma-informed social work incorporates core principles of safety, trust, collaboration, choice, and empowerment". The additional tasks that social workers have to perform following disaster-related trauma can quickly become overwhelming, despite their expert knowledge of stress and trauma therapy as well as experience in public health systems, hospitals, schools, and social welfare systems (Dominelli 2013). According to Harms and Alston (2018), disasters may cause a variety of losses, including those connected to death and the attendant grieving, as well as losses unrelated to death, such as lost relatives, property, belongings, and jobs.

In a recent Zimbabwean qualitative study, Machimbidza et al. (2022) highlighted the various roles of the social worker during different disaster phases. These included the educational role for disaster preparedness, counseling, social aid, and protection available during disaster responses, and last but not least, the provision of advocacy and follow-up care during disaster recovery. However, they mentioned some social workers' reluctance to engage in disaster work. Sim and He (2022) stress the importance of reflecting on the practice process and less on the outcome, echoing Vo's (2015) conclusion that the method of service delivery is just as crucial as its results. Despite their micro-level and non-indigenous focus, Maglajlic's (2019) reviewed studies summarize critical elements of good practice for social service practitioners during disasters.

As the first best practice, responding to the genuine needs of the populace in a disaster-affected area is essential, with emphasis on bottom-up approaches to assessing survivor needs and responding fairly, with immediacy. The majority of locals were pleased with the assistance provided in the wake of the tsunami, while others remarked that those with connections in the proper places received it more quickly (Dominelli and Ioakimidis 2015). Second, service providers must have comprehensive knowledge of the current resources and capacities of neighborhood social service agencies and other partners, as well as knowledge of the sustainability of such support, whether it comes from local, national, international, governmental, or non-governmental sources (Drolet et al. 2021). Third, in order to provide relevant and timely support, social service providers in emergency situations must take the time to coordinate and collaborate with one another, regardless of their level or type (Alaniz 2012).

The fourth is that, in order to provide disaster social services that are organized and pertinent locally, the community that has been affected by the calamity needs strong local leadership that is community oriented (Tosone 2019). Importantly, services must have a degree of flexibility and responsiveness at the local level. Fifth, it is important to ensure that accurate and timely information is available and exchanged and that such communication is available through various channels

(Wang et al. 2019). The ability of practitioners to assist clients and avoid or lessen their own secondary stress is significantly impacted by their level of emotional readiness, which is a critical component of social work practice, more so during disasters (Rosenberg et al. 2022).

3. Methodology

We adopted collaborative autoethnography (Chang et al. 2013) as our methodological framework in this chapter. Collaborative autoethnography is a qualitative research method that is simultaneously collaborative, autobiographical, and ethnographic (ibid). Autoethnography, without the term "collaborative", is a combination of autobiography—the study of self-experiences and ethnography—a study of habits and culture. Autoethnography is an intriguing method that is increasingly utilized to study social phenomena through the lens of the author/researcher's personal experience (Wall 2016), although it is criticized for being self-indulgent, narcissistic, introspective, and individualized (Atkinson 2006; Wall 2016).

Chang et al. (2013) added the element of "collaboration" to the concept of autoethnography. Roy and Uekusa (2020, p. 384) argued that this method is convenient and ideal for qualitative researchers during "unprecedented times", in which conventional methods of collecting data are either disturbed by disasters or other limitations. Likewise, we selected this method in order to journal our professional and personal lessons, as social work academics, during the floods response that was compounded by COVID-19 in South African townships. This method was also chosen as it is aligned with the approach and processes adopted by a team of academics, interns, and students who organized themselves into a flood response team. We, the chapter's authors, are also members of a larger response team that reports to the Institute (MA'AT).[1]

As authors, we collaborated beginning with the identification of the flood-affected communities and continuing through the MA'AT's planning of the flood responses. This comprised the procedure for requesting entry permission from the appropriate ward councilors, "*izinduna*" (traditional headmen), and other crucial role players.

Collaborative autoethnography afforded us an unconventional opportunity to become researcher–practitioners. A crucial component of our flood response journey as reflective professional social workers was taking notes and keeping journals about

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[1] Inspired by working with vulnerable communities in more than 10 African countries, the MA'AT Institute was established within the School of Applied Human Sciences within the College of Humanities of the University of KwaZulu-Natal, South Africa, to specifically advance Afrocentric thoughts and the provision of African-centered psychosocial services to communities experiencing adversities. The services of MA'AT are multidisciplinary and often involve social work academics, social work interns, social workers, educational and clinical psychologists and psychology interns.

our intervention methods. Notably, as part of our own debriefing sessions, after contact with the community, we comparatively journaled our experiences through a self-reflexive method. Authors such as Chang et al. (2013) and Roy and Uekusa (2020) have critically discussed collaboration's advantages and adverse dynamics during autoethnography. Specifically, Chang et al. (2013) argued that self-reflection methods such as autoethnography are popular due to their individualized approach, which is also likely to expose the author's vulnerabilities. The comparative reflections allowed for the multiple voices and perspectives to be included in the research, and this increased the source of data and information from a single researcher to multiple researchers (Roy and Uekusa 2020). As a result, the comparative perspectives this heightened the rigor of the information we recorded in our journals. Unlike single-authored autoethnographies, as collaborative auto-ethnographers, we combined our energy and data to create a richer pool of data from multiple sources (ibid).

Adapting work by Chang et al. (2013), we designed Figure 1 below in order to highlight the circular steps of research design and the importance of collaboration during the process of this research method:

Based on Figure 1, we followed a similar pattern to journal our reflections, as the main source of data, systematically and collaboratively. We needed to employ collaborative autoethnography due to its postmodernist lens, which rejects the generally accepted intellectual assumptions of knowledge generation and makes room for nontraditional ways of knowing and knowledge generation (Wall 2016). Using this method, we could critically journal our collective experiences of responding to concurrent disasters, COVID-19 and floods, with indigenous communities in townships.

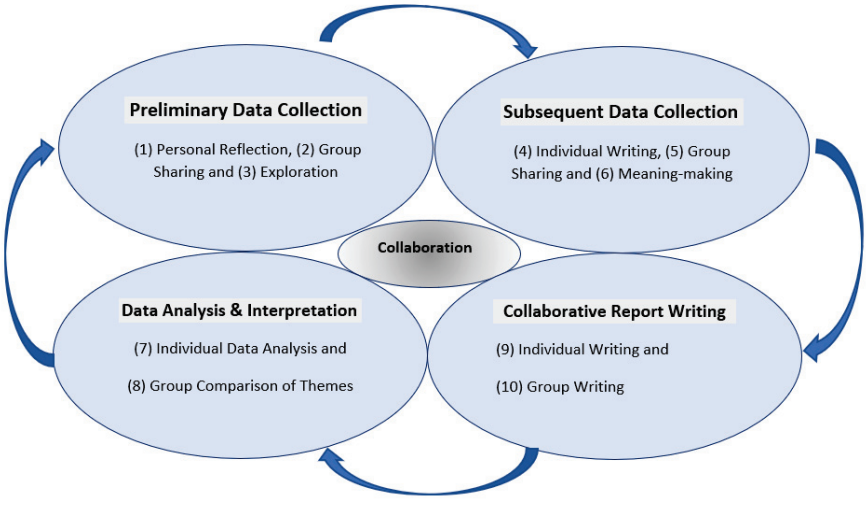

Figure 1. The Circular Iterative Process of Collaborative Autoethnography. Source: Adapted from Chang et al. (2013, p. 24).

The comparative journaling that we performed after each intervention was carried out concurrently with the examination of our reflections. In order to collaboratively create meaning, we used the model from McPhail-Bell and Redman-Maclaren (2019) to categorize similar sentences into groups, produce codes on an individual basis, and then work together in person during meetings. We had sections for, among other things, reflections on our own vulnerabilities, reflections on the current condition of the community members, reflections on newly formed partnerships and alliances, reflections on collaborations, reflections on the community's reaction to our intervention, and so forth. This categorization of our reflections enabled us to learn lessons from each other and, lastly, to provide the below narrative accounts of our collective experiences. Moreover, the collaborative analysis of our reflection ensured the trustworthiness of our findings.

4. Lessons Learnt

In this section, we present our reflections as per the above methodology. Specifically, we provide reflective discussions on rethinking and redefining community engagement; trauma-informed social work principles in unconducive settings of concurrent disasters; integration of Indigenous knowledge systems in social work interventions; and lastly a reflection on the importance of strong partnerships and inter-stakeholder collaborations.

4.1. Rethinking and Redefining Community Engagement during Disasters

Community involvement with townships is nothing new for us. Since 1996, students at the University of KwaZulu-Natal (UKZN) have worked with the Bhambayi residents through the non-profit organization UKZNCORE (UKZN Community Outreach and Research). Using African-centred psychological interventions, MA'AT Institute was most recently founded to address COVID-19 and any other related psychosocial difficulties. We can attest that providing psychosocial services to communities during a global pandemic provided us with some expertise in dealing with disasters such as floods. However, we did not anticipate that disasters of this magnitude would occur simultaneously.

4.1.1. Continuous Engagements with Communities to Build a Reputation

As a result of media updates, warnings spread quickly, and regular activities such as school were suspended. It became impossible to respond sooner on the ground, since several roads were flooded, and some bridges collapsed or were in danger of collapsing. In particular, after seeing broadcasts of displaced residents, we all experienced panic that was tinged with guilt. Even if some of us experienced water shortages from busted pipes and electricity outages, it did not compare to what was being experienced by flood survivors. However, we did continue to communicate over the phone with community workers, initially in Inanda, which was one of the affected communities.

4.1.2. Engaging Communities Proactively

On 19 April, we learned that 10 families from Inanda had reported the deaths of family members, with 1 family allegedly losing 3 members in a single instant. Two toddlers and four other people had not been located. Over 300 people were impacted, over 70 households had their homes washed away, and other people reported losing belongings and having property damaged. Despite our initial sense of confidence, this was overwhelming given our COVID-19 experience. We agreed to move forward as a group without receiving any financial assistance.

4.1.3. Flexibility and Acknowledgment of Historical Context

We chose to attend the memorial ceremony that had been planned for the grieving community members as our point of entry. The Chairperson of the memorial service officially announced our attendance at the memorial ceremony. This announcement came as a big surprise to other participants, including social work practitioners, since they were not accustomed to "academics" being at the forefront of the emergency response. The tent was crowded with government representatives, as well as representatives from non-governmental and religious organizations. Given the generally somber atmosphere, it was initially difficult to identify the families who had lost a loved one.

4.1.4. Engaging Communities with Cultural Sensitivity and Humility

We met the relatives toward the end of the memorial service. They were ostensibly still in shock, and some were still in denial. We consoled them, and out of respect for some of the survivors who could not even walk without help from family members, we had to kneel down to be at their level. All of their names and mobile numbers were written down. Some took our private cell phone numbers, since they had misplaced theirs and it was impossible for us to contact them. As uncomfortable as it was to share private cell phone numbers, the nature and extent of the disaster made it impossible for us to be aloof. The situation was critical, and some people yearned for closure because their loved ones' whereabouts were still undetermined. One woman came up to us and begged us to assist in finding her son, who had been missing for nine days. She mentioned how she wanted to mourn the loss of her son, "like the others", and retrieving his remains was important to her.

4.1.5. Engaging to Empower

Due to our mobility, we were also contacted by a leader of one temporary shelter that housed a lady who was expected to graduate with a Bachelor of Education degree. The request was for us to help make her day special. We then lobbied using social media and our connections. Many people came forward, some offering to dress her up, while someone offered to buy a cake for the graduation party, and more came forward to arrange decorations, catering, etc. As social work academics, we agreed

that we would coordinate the program and use the opportunity to restore cohesion and inspire in the midst of adversity. Unfortunately, the graduation ceremony was canceled due to a protected strike, which was a huge disappointment for all of us, but more so for the young lady.

4.1.6. Engaging with Leadership Participation and Support

One of the highlights of our engagement was to be on the ground with our deputy vice-chancellor. He participated in planning our interventions, was present in the communities, and provided us with the funds required for our response. His involvement is inconsistent with the sentiments of Watermeyer's (2019, p. 332) respondents, who "spoke of a lack of institutional interest [and] acknowledgment".

4.2. Integration of Indigenous Knowledge Systems in Social Work Interventions

Our fieldwork revealed the importance of integrating indigenous knowledge systems in social work interventions alongside "flexible ethical" practice. Upon our entry, in some of the community halls, we were met with apprehension, with some individuals unwilling to work with us, alleging to have been used for publicity stunts. Therefore, we had to be clear about our role and the importance of our engagement. Offering social work services in the aftermath of a disaster and to individuals who have lost everything meant that they were placed in a position of vulnerability. As a result, they were often visited by different philanthropists, some who were genuine and some who were not offering anything but were tokenistic for the sake of being seen as doing something. Consequently, the overexposure of displaced community members to different stakeholders, whose promises were often not fulfilled, made them cautious and reluctant to receive people who came into their shelters offering assistance.

As we provided "non-tangible" disaster relief (trauma debriefing) to people with tangible needs such as blankets, food, and homes, we had to sensibly negotiate our entry and employ emic strategies to win their hearts. Our competency and fluency in the IsiZulu language and Zulu cultural practices were instrumental in breaking the ice, facilitating communication, providing stress relief, and building and enhancing community resilience. Inspired by the work of Zibane (2017) and other Afrocentric writers (Asante 2003; Mbiti 1990), some of the strategies that were employed were the use of "*ingoma*" (traditional and religious song/chants) and *ukugida* (traditional Zulu dance) which we used to uplift their spirits and to allow for the expression of feelings.

Biko (1987, p. 42) states that "nothing dramatizes the eagerness of the Africans to communicate with each other more than their love for song and rhythm". In song lies Africans' rare ability to find humor and creativity in impossible conditions (Ibid). Zibane (2017), who reflected on her experience of growing up in the township during apartheid, discussed how music and rhythm were important tools to overcome the hardships brought by apartheid. She discussed how music was everywhere,

featuring in all their emotional states, experiences, occasions, and aspirations (ibid). "Any suffering experienced in the township was made much more real by song and rhythm" (Biko 1987, p. 42). Similarly, Flandreau (2016) confirms that traditional African songs are spiritual.

Ingoma is indeed "a way through which African people learn about their social world, express emotions, and relax" (Zibane 2017, p. 31). Lebaka (2015) also confirmed that song is one of the instruments that African people have utilized to worship and make meaning of their feelings. Following the indigenous activities, we observed more receptiveness to our individual or group therapy. The experience of using IsiZulu Language, *ingoma* and *ukugida* as part of our disaster relief intervention was very insightful. It reasserted a need for social workers working with indigenous communities to employ decolonial practices and to put the African interests, values, and culture at the center of their interventions. A significant lesson is that as much as social work is a universal profession, the Africanization of interventions is crucial within indigenous settings.

4.3. "Ilima" and "Ubuntu": The Importance of Strong Partnerships and Inter-Stakeholder Collaborations

Ilima is an IsiZulu expression that refers to collaboration during a ploughing process. The etymology of this term emerges from an IsiZulu word which is *-lima*, a communal ploughing process. The reflections shared below illustrate how we, alongside other stakeholders, managed to exercise *ilima* during our flood response. We did not literally plough communally, as per the literal definition of the term *ilima*, but we managed to work with other stakeholders in order to respond collectively to the devasting effects of *floods*. The use of the term *ilima* in referring to collaborative work is common for IsiZulu-speaking social workers in the KZN province of South Africa. The collective response (*ilima*) that we employed, alongside other stakeholders, undoubtedly resonated with the principles of *Ubuntu*. *Ubuntu* Zulu expression has gained recognition in international social work federations such as the International Federation of Social Work. This term refers to "interconnectedness", and "humanity", but it is sometimes defined as I am because we are (Van Breda 2018). As argued by Afrocentric researchers, Mbiti (1990); Mboti (2015); Eze (2017); Gade (2017), African people are characterized by *Ubuntu*-.

The diverse nature of the challenges that faced the displaced community members required collaboration (*ilima*) and interventions embedded in the ethos of *ubuntu* from multiple stakeholders.

4.3.1. *Ilima* in Action: Collaborative Engagement and Coordination

There were changes every day. More fatalities were noted, and more homes had collapsed. Holistic safety, health and otherwise, was a serious concern in crowded venues, especially for women and young children. When we arrived at the halls, we discovered that there had been little coordination and that donors

were trickling in slowly, given the lack of an organized strategy. We arrived there with interns (psychologists and social workers) in one hall, but we were unable to start psychological debriefing, since the people there were starving. When we saw how desperate for food they were, we hurried to the store to obtain ingredients to make sandwiches and juice. Surprisingly, an NPO (non-profit organization) was serving food when we got back. They were ecstatic when they spotted us approaching the people who had been stationed in the hall and thought we were in charge of the operations. From then onwards, we coordinated our services with them as partners. The lack of coordination of the *ilima* process necessitated us, as social work academics, to employ our professional roles as brokers in order to connect the community members with philanthropists who were offering hot meals, water, sanitation, blankets, mattresses, etc.

4.3.2. Hierarchy of Needs in a Disaster Situation: Collaborations and Entry

Notably, we discovered that there was inconsistency in terms of food availability in different temporary shelters. Some community shelters had an abundance of donated food, while some did not have anything due to unreachability and the remote location of their shelter. We then called a nearby businessman we had met at another hall, who kindly offered to lend a gas stove. Notably, some shelters possessed uncooked donated food. Our fluidity between different shelters meant that we were able to advocate for those who were not yet in receipt of other basic donations. It became eminent that the role of a social worker as a broker is therefore crucial during disasters. While we were using our MA'AT Institute as our vehicle for community engagement, we visited communities with a preconceived plan of offering trauma debriefing. Undoubtedly, psychosocial support was required, but as social workers, we were confronted by the reality that some of the displaced community members in neglected shelters were reasonably unable and unwilling to participate in group work activities without being offered food. Some would report that they had their last meal on the previous day. It was undoubted that psychosocial services were also required, as these community members were suffering from trauma, bereavement, grief, and shock. However, their physical needs, such as food provision, water, sanitation, blankets, mattresses, etc., took priority compared to psychosocial interventions. As Lester (2013) states, Maslow's Hierarchy of Needs argues basic needs are categorized into five categories: physiological, safety and security, belongingness, esteem, and self-actualization. According to this theory, physiological needs (the lowest in the Hierarchy of Needs) were more powerful (prepotent) than the higher needs. This theory was actualized and realized through our engagements with communities displaced by South Africa's floods. Our presence in the temporary shelters/community halls meant that we were able to organize and coordinate services in order to prevent repetition.

It was only after the fulfillment of physiological needs (food provision) that psychosocial interventions such as trauma debriefing became possible and meaningful.

4.3.3. Ethical Dilemmas, *Ubuntu*, and Collaboration

As mentioned earlier, individuals and families were displaced and left without basic needs. Our humanness and our value of *ubuntu*, in some instances, conflicted with our professional code of ethics. Notably, our professional code of ethics as social workers prevents us from offering personal donations or gifts to our clients, as this could have ethical implications. However, the magnitude of the problems was bigger than our fellow *ilima* role players. As an ethical dilemma, we all individually donated baby foods, unused clothes, and other basics that we had in our homes. It was, however, important that we did this while we attempted to balance morality and the reputation of our social work profession. It is also important to note that we were intervening to these communities, but we were also emerging from the same communities. Our empathy and acts of *ubuntu* were motivated by the realities that we were co-facing with these communities; the interconnection was inevitable. As social workers, we also did not have electricity and water in our own homes because the basic infrastructure of the City of Durban was also destroyed by the floods. During collaborations with stakeholders, we became coordinators, empathetic human beings, and professionals who were unsure whether to engage in philanthropy or strictly uphold the rigid "ethics of non-gifting to clients", even in an era of crisis. Based on these engagements, it was clear that the devastation of the floods called for collaborative humanitarian interventions; it called for *ubuntu* and empathy because individuals, families, and communities were affected holistically by the floods.

As a lesson, it became eminent that as social workers, we are instrumental in coordinating and linking people with required service providers.

4.4. Trauma-Informed Social Work Principles in Unconducive Settings of Concurrent Disasters

As argued earlier, the devastating effects of the floods in several townships of the KwaZulu-Natal province of South Africa called for urgent multidisciplinary responses from multiple stakeholders, including ourselves as social work academics. One of the readily available responses in the time of crisis (and that we were ready to offer, as academics) was our expert skill and service of trauma debriefing. However, offering trauma debriefing in an era of pre-existing challenges and concurrent disasters, COVID-19, and floods was a complex challenge for us. Notably, according to Levenson (2017, p. 1) "trauma-informed social work incorporates core principles of safety, trust, collaboration, choice, and empowerment".

The spatial displacement of our clients meant that they and their families were housed in community halls and other temporary accommodation centers. Consequently, these inevitable challenges meant that principles of trauma-informed

social work, such as safety and choice, were compromised. A safe physical space for rendering individual and family trauma debriefing services was unavailable in community halls. Our clients were each using a corner with their families to mark their territory in the community hall. This impacted our primary method of intervention, which was group work. On the same note, Boshoff and Strydom (2017, p. 447) argue that "group treatment brings with it the possibility of the restoration of meaning in social participation", but also exposes the vulnerability and emotional safety of the service users. Bearing in mind the principles of trauma-informed social work, such as choice and safety, the above narrative indicates that these were indeed compromised.

Other than the effects of the floods, which were the main cause of trauma, the COVID-19 pandemic also compounded our challenges in rendering trauma-informed social work. The reality that our clients were housed in temporary accommodation centers meant that we had to be conscious of the COVID-19 health protocols as well. However, the magnitude of the floods resulted in the destruction of water supply infrastructure in some facilities. This then posed a health threat to our clients and ourselves. Navigating this dual crisis was a difficult moral and ethical dilemma for us. We were conflicted about whether to deal with multiple flood-related crises that faced our clients or to mitigate health and safety concerns, such as damaged water-supply infrastructure, which was beyond our control. However, our psychosocial interventions were necessary because we managed to "break the silence" and reconfigure a sense of community through our engagement. The reality of working in a context of dual disasters enlightened us about the flexibility and post-modern nature of social work (Hölscher 2005). In an era of climate disasters, it becomes difficult to employ and/or adopt all the protocols of trauma-informed social work, but the reality often calls for a context-specific intervention.

5. Recommendations and Conclusions

Our reflections unveiled that social work services are ineffective without strong participation and partnerships between multi-sector social workers, community leaders, caretakers, and community members and without inter-stakeholder collaborations. As a result, social work processes and indigenous processes such as coordinated *ilima* are crucial and must be institutionalized when dealing with climate change disasters and negotiating entry into communities. Stakeholder mobilization and community involvement committees exist at our university. Members of this group come from a variety of academic fields, including engineering, urban planning, drama, media studies, and many others. This committee includes the MA'AT Institute. Ensuring that this committee responds to disasters as a collective is one of the important lessons learned. The disaster response will be more comprehensive and successful in this approach. In turn, the university will be more relevant and gain recognition and respect as a key contributor to community building. We value the finances set aside for a Disaster Response team by the College of Humanities'

Deputy Vice Chancellor, who offered leadership during the MA'AT Institute's flood response. This dedication is one of the ways to make sure that the university team participates in the prevention, recovery, community reconstruction, and promotion of sustainable livelihoods.

These reflections illustrate that social workers need to be context specific, conscious of indigenous ways of living, and center the peoples' interests, cultures, and values in their intervention strategies. Indigenous knowledge systems should be integrated into the social work curriculum in the era of common climate-associated disasters. As academics, we recognize the need for curriculum transformation and research on African indigenous practices that are relevant to social work. In this way, we will respond to a call for a decolonial social work theory and practice raised during the "*#Fees Must Fall/#Rhodes Must Fall*" strikes of 2015.

It is now apparent that dealing with concurrent disasters, such as floods and COVID-19, provides significant lessons for the profession of social work. The topic of green social work and disaster-specific social work should be strengthened in order to tackle unpreparedness and raise awareness about the catastrophes of climate change that are now becoming common occurrences across the globe.

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Heat-Related Climate Change Impacts on a Small Island Developing State (SIDS): A Case Study of Trinidad, W.I.

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Abstract: Small Island Developing States (SIDS) have high levels of vulnerability to climate change due to their inherent physical and socio-economic characteristics. Levels of heat within urban areas in the Caribbean are not well-understood or studied. Consequently, heat-related human health impacts can be underestimated or exaggerated. The main objective of this chapter is to determine the extent of temperature variations in Trinidad. Investigations were conducted regarding the temporal variations in land surface temperatures, heat indices, and projected heat accumulation in Trinidad. Analyses showed that urban regions in Trinidad are prone to experiencing higher temperatures and heat due to dense urban infrastructure that absorbs and radiates greater amounts of heat. Heat Index (HI) analyses showed that there were significant ($p \leq 0.001$) increases in the maximum HI in Trinidad from 1976 to 2015. Projected Heat Accumulation (HA) analyses showed that the western and southwestern regions of Trinidad were most prone to heat risks. These findings suggest significant adverse implications for human and ecological health as well as to the broader socio-economic sectors of Trinidad and Tobago.

1. Introduction

Climate change is considered an issue of major concern globally, and there is even greater concern for disproportionately vulnerable groups such as Small Island Developing States (SIDS) within the Caribbean region. Even though the contribution towards greenhouse gas (GHG) emissions from SIDS is negligible (compared to developed countries), the impacts of climate change can be even more severe due to the inherent physical characteristics of SIDS which make them more vulnerable to multiple climate change stressors (IPCC 2021). Climate change vulnerability and adaptation is variable between the islands in the Caribbean due to the high diversity of physical and human attributes such as geophysical characteristics as well as socio-economic structures (Leal Filho et al. 2021). Recent available projections show that climate change is already affecting the growth and development of SIDS, and further effects are inevitable in the near future. According to the Intergovernmental Panel on Climate Change (IPCC), current and future risk drivers for climate change in SIDS include sea level rise (SLR), tropical cyclones, increasing air and sea surface temperatures, disease prevalence, and changing rainfall patterns (IPCC 2021). The Special Report on Emissions Scenario (SRES A2 and B2)

scenarios as well as Representative Concentration Pathway (RCP) models project that there will be increases in temperature across the Caribbean with drier conditions and an increasing frequency of droughts, increased sea level and coastal flooding, as well as increased sea surface temperatures (IPCC 2021).

Trinidad and Tobago is an archipelagic republic in the southern Caribbean, located between the Caribbean Sea and the North Atlantic Ocean. Trinidad is split into 14 regional corporations and municipalities (Figure 1 below).

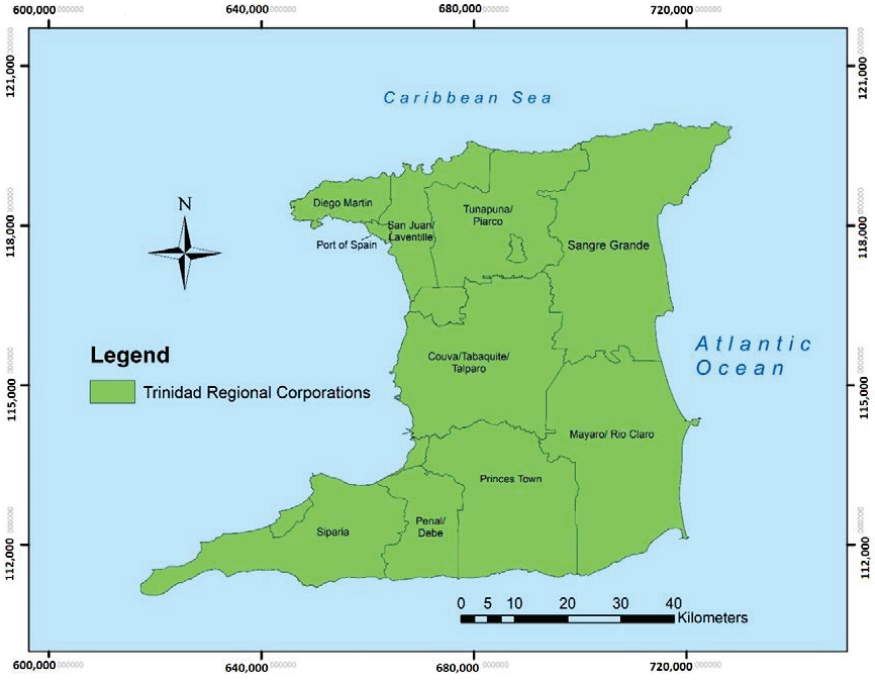

Figure 1. Map of Trinidad. Source: Figure by the authors.

Trinidad is a Caribbean SIDS, and one of the current and future climate-related risk drivers for SIDS is increasing temperatures (both ambient and surface temperatures). This can result in impacts such as a loss of ecosystem services and adaptive capacities, which are essential to lives and livelihoods in many small islands (IPCC 2021). There is a consensus that small islands do not have uniform climate risk profiles due to variations in both the physical and human attributes of each island. In particular, small islands are by no means the same when it comes to physical size, character, or economic development, creating variations in adaptive capacities (IPCC 2021). Therefore, approaches to mitigate and adapt to climate change would differ among these islands, particularly tropical SIDS within the Caribbean. Persons that live and work within highly urbanized regions will also be greatly impacted by increased heat since urban areas trap and retain heat due to the urban heat island effect (Shi et al. 2021). It is therefore imperative that urban populations be targeted

for adaptation and mitigation so that relevant precautions can be taken to reduce health impacts in urban areas within Trinidad and the Caribbean region.

Traditionally, heat-related impacts on humans and the environment have only been attributed to increases in temperature, and due to a lack of long-term data, the impact of humidity was often neglected in climate research (Marx et al. 2021). However, in recent years, this has changed with the introduction of various heat stress indications such as the Heat Index, which are now frequently used to determine the effects of heat on human health and to predict heat waves (Dahl et al. 2019).

Increased heat levels are a major cause for concern globally, as most biological life is sensitive to small variations in temperatures and function optimally within a narrow range of temperatures (Alinejad et al. 2020). Threats can be even more pronounced in humid regions such as the Tropics (Matthews 2018). It is therefore crucial that the heat in tropical regions such as the Caribbean should be closely monitored and evaluated in order to prevent and lessen potential negative impacts (Matthews 2018; Di Napoli et al. 2022).

2. Materials and Methods

Three different types of heat data were collected and analysed. These included Landsat thermal imagery, heat index variations, and projected heat accumulation. Descriptions of data collection and analysis for each type of heat data are provided below. Additionally, an impact analysis on various sectors was carried out through a literature review and synthesis and described in the discussion.

On 9 January 2014, 25 January 2014, and 28 January 2015, Landsat thermal infrared data were obtained online from the United States Geologic Survey (USGS) Global Visualization (GloVis) tool. Thermal band 10 was used to create a mosaic of Trinidad at 30 m resolution. These years and days were selected because they were easily available, and the mosaic pictures at the site on those dates were cloud-free, allowing for full visibility of the study areas. The temperature scale on the map was times 100 to eliminate decimal values. Maps were displayed in ArcGIS 10.2.

In order to calculate the heat index (HI), temperature and relative humidity data are needed. The Trinidad and Tobago Meteorological Services (TTMS) is the main meteorological and forecasting facility for Trinidad's weather and is considered the most reliable data source. Therefore, hourly temperature and relative humidity data for this study were acquired from the Trinidad and Tobago Meteorological Services (TTMS). Intermittent data from 1976 to 2015 from the following years were utilized for the study: 1976, 1982, 1986, 1992, 1996, 2002, 2006, 2012, 2014, and 2015. The data consisted of hourly temperatures and relative humidity readings for 24 h days. These data were utilized because they were available and complete datasets for representative years per decade for approximately four decades. This present study confines itself specifically to the changes in maximum HI.

The heat index was calculated using the formula by Rothfusz and NWS Southern Region Headquarters (1990):

$$\mathrm{HI} = -42.379 + 2.04901523T + 10.14333127R - 0.22475541TR -$$
$$6.83783 \times 10^{-3}T^2 - 5.481717 \times 10^{-2}R^2 + 1.22874 \times 10^{-3}T^2R +$$
$$8.5282 \times 10^{-4}TR^2 - 1.99 \times 10^{-6}T^2R^2$$

where T = temperature (°F); R = relative humidity (integer percentage).

The HI was calculated in Fahrenheit and converted to Celsius. The HI calculations were made for every hour of every day for the ten years used in the study. The maximum HI that occurred per day was then determined from the data using the hourly temperature and relative humidity as well as the HI formula. The formula was applied to data for every hour of every day, and the maximum HI per day was obtained. The maximum HI per day was used to calculate the average maximum HI per month and year. Calculations were also made based on seasonal variations. The dry season in Trinidad occurs in the months of January to May, while the wet season occurs from June to December (TTMS 2023).

Statistical analyses were carried out using SPSS version 23. The raw dataset was also examined under quality control measures to remove any erroneous data. The datasets obtained did not contain any missing data. There were also no negative values (which could be an indication of errors).

In order to determine if there were significant changes in maximum HI, statistical analyses were completed to determine significant changes. These included Student's T tests and one-way ANOVA tests as well as additional post hoc Tukey tests, which were used to analyse the data in greater detail.

The Heat Accumulation for Trinidad was calculated and mapped using the SimCLIM Desktop 4.0 degree day site-specific model that calculates degree day based on daily time series of maximum and minimum temperatures. The degree day estimates were then calculated using the area under the diurnal temperature curve and between the thresholds using a double sine estimation method, as shown in Figure 2 below.

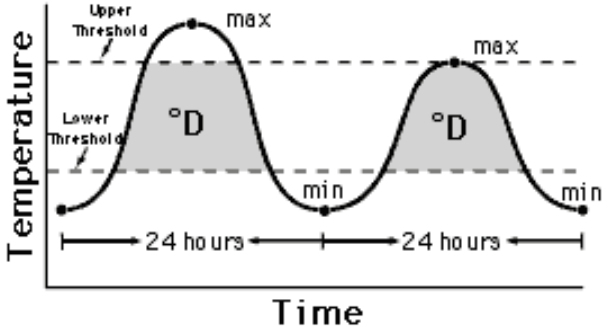

Figure 2. Thresholds and accumulated degree days. Source: Adapted from Wilson and Barnett (1983).

The degree day impact model was visualized for Trinidad using a base temperature of 25 °C. This value was used based on similar average historical temperatures for Trinidad. The degree day impact model was run using the IPCC's four low to high global warming Representative Concentrations Pathways (RCPs) (2.6, 4.5, 6.0, and 8.5) for a time series (2014, 2015, 2016, 2017, 2018, 2020, 2030, 2040, 2050, 2060, 2070, 2080, 2090, and 2100). Maps of the years 2014, 2018, 2030, 2050, and 2090 were used for analyses to visualize trends in the heat accumulation based on the highest degree day values. These changes were calculated for each representative concentration pathway (RCP). The representative scale on each map is measured in units of accumulated degree days.

The year 2014 was used as a base for analyses and comparison to future projected changes as this was the earliest year used for analyses. Heat accumulation (HA) was simulated with an ensemble of the same 40 General Circulation Model (GCM) patterns used by the IPCC and applied with high sensitivity. High climate sensitivity was chosen so that corresponding low and high bounds of the climate uncertainty ranges could be accounted for in Trinidad. The median projection of the GCM ensemble was used for each scenario.

3. Results

3.1. Thermal Imagery

Comparative maps were completed using ArcGIS 10.2. The maps in Figure 3 show thermal imagery of Trinidad on the left and the distribution of urban infrastructure on the right.

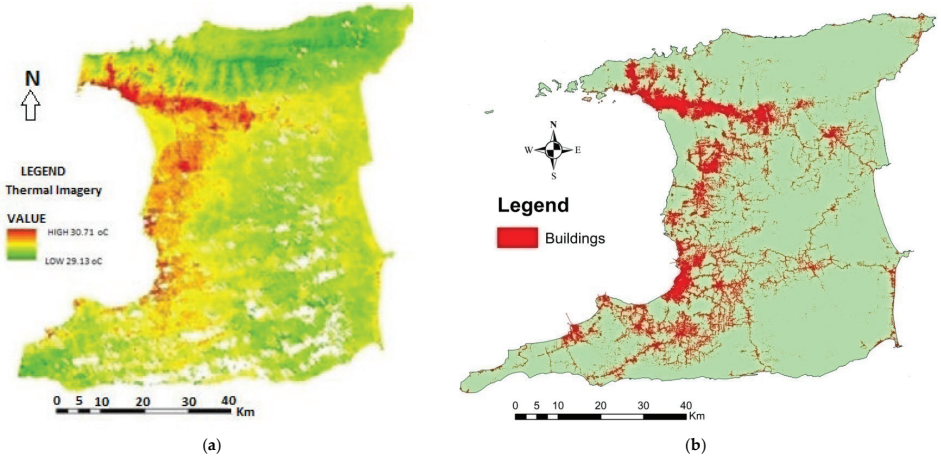

Figure 3. Trinidad (**a**) Landsat thermal imagery; (**b**) distribution of buildings. Source: Authors' compilation based on data from the United States Geologic Survey.

3.2. Heat Index

3.2.1. Heat Index Variations

The average monthly maximum HI for the time period (1976–2015) was calculated using daily maximum HI values (Figure 4). The maximum HIs in August (37.4), September (38.1), and October (38.1) were significantly higher compared to other months ($p \leq 0.001$).

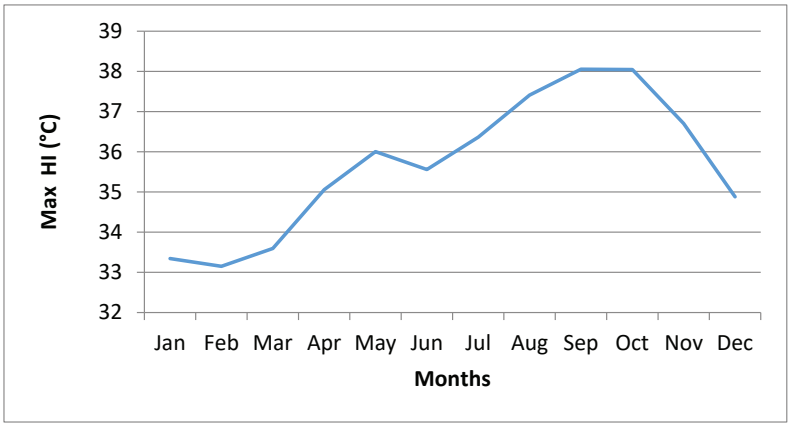

Figure 4. Monthly average maximum HI (1976–2015). Source: Authors' compilation based on data from the Trinidad and Tobago Meteorological Services.

The average yearly maximum HI for the time period from 1976 to 2015 is shown below in Figure 5. Statistical analyses showed that there was a significant increase ($p \leq 0.001$) in the average maximum HI (from 1976 to 2015).

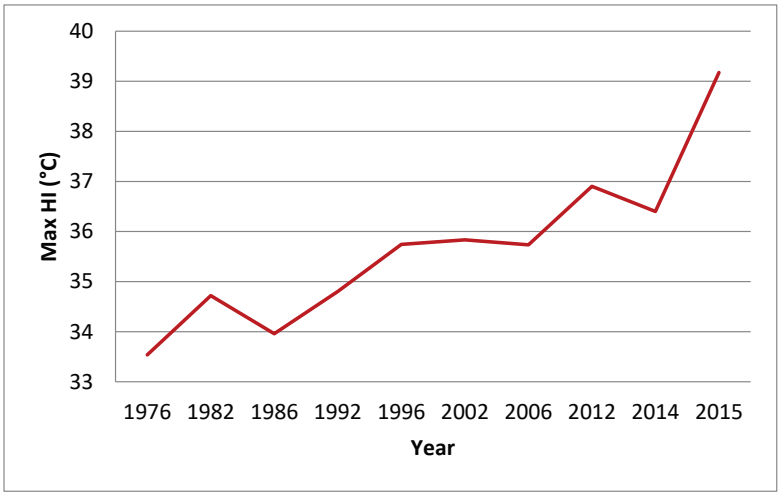

Figure 5. Yearly average maximum heat index (1976–2015). Source: Authors' compilation based on data from the Trinidad and Tobago Meteorological Services.

3.2.2. Seasonal Variation in Maximum Heat Index

The seasonal variation in the yearly average maximum HI is shown below in Figure 6. The maximum HI was higher in the wet season compared to the dry season. A Mann–Whitney U test was carried out, comparing the average maximum HI during the wet and dry season from 1976 to 2015. The analyses showed that the average maximum HI was significantly higher ($p \leq 0.001$) in the wet season compared to the dry.

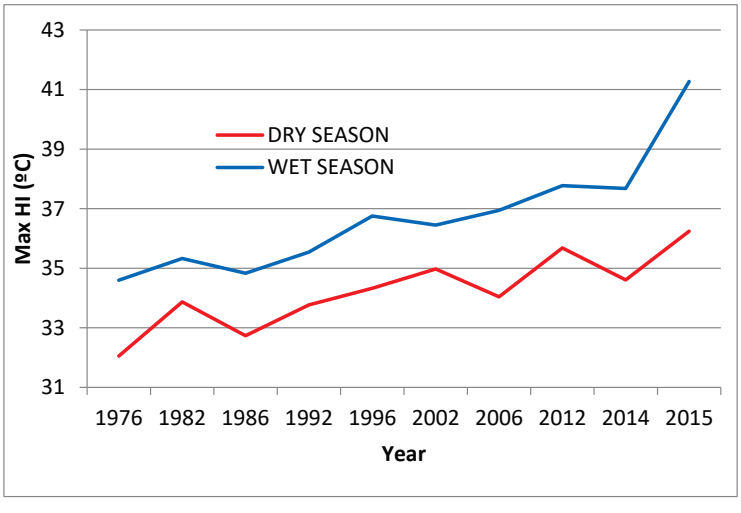

Figure 6. Seasonal variations in average maximum HI (1976–2015). Source: Authors' compilation based on data from the Trinidad and Tobago Meteorological Services.

3.3. Heat Accumulation

The HA maps for RCP 8.5 show that the areas with the highest HA (purple and deep purple) were again within the western portions of Trinidad. Port of Spain and Diego Martin Regional Corporations were the hottest regions in Trinidad. However, there were even larger areas of the warmest regions (purple and deep purple) in 2090 under RCP 8.5 compared to all other RCPs. The highest HA values were approximately 2319-degree days in 2090 under RCP 8.5 (Figures 7–11 below).

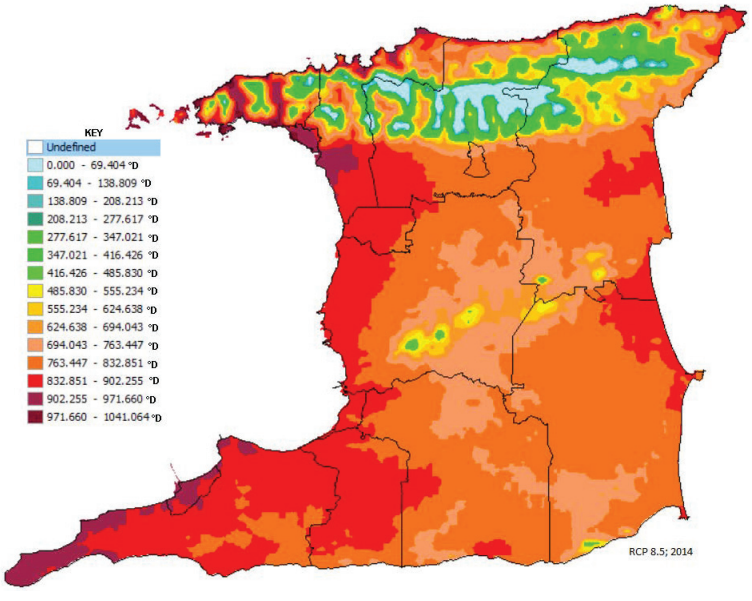

Figure 7. Heat accumulation in Trinidad for RCP 8.5 in 2014. Source: Authors' compilation based on data from the Trinidad and Tobago Meteorological Services and CLIMsystems Ltd.

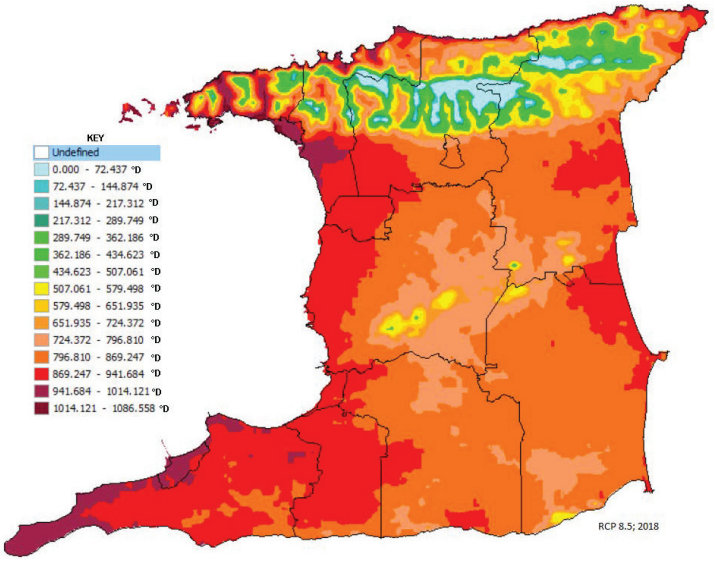

Figure 8. Heat accumulation in Trinidad for RCP 8.5 in 2018. Source: Authors' compilation based on data from the Trinidad and Tobago Meteorological Services and CLIMsystems Ltd.

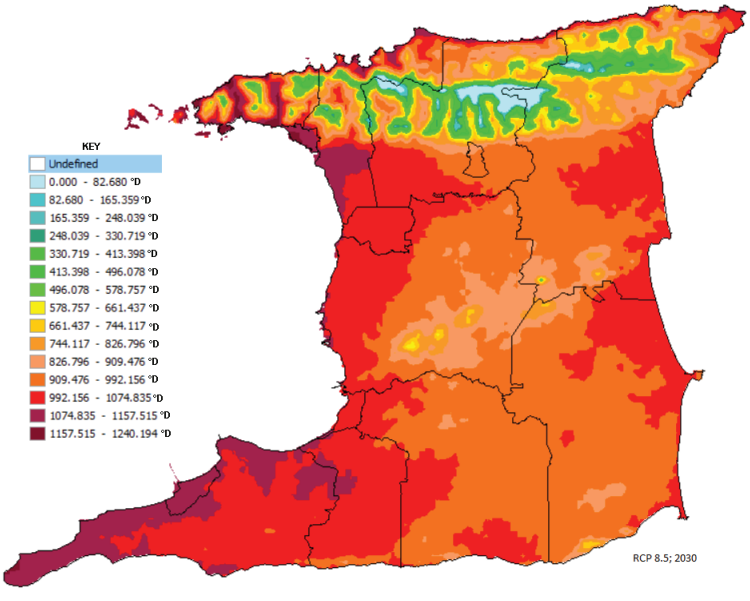

Figure 9. Heat accumulation in Trinidad for RCP 8.5 in 2030. Source: Authors' compilation based on data from the Trinidad and Tobago Meteorological Services and CLIMsystems Ltd.

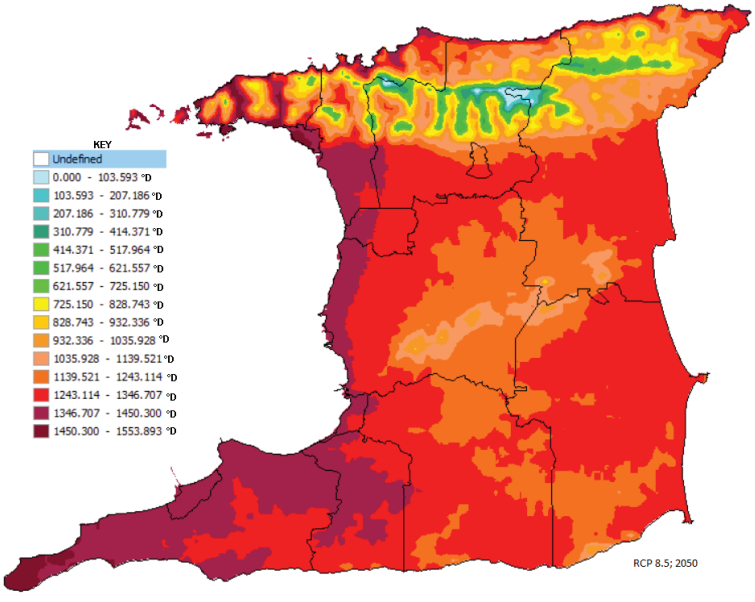

Figure 10. Heat accumulation in Trinidad for RCP 8.5 in 2050. Source: Authors' compilation based on data from the Trinidad and Tobago Meteorological Services and CLIMsystems Ltd.

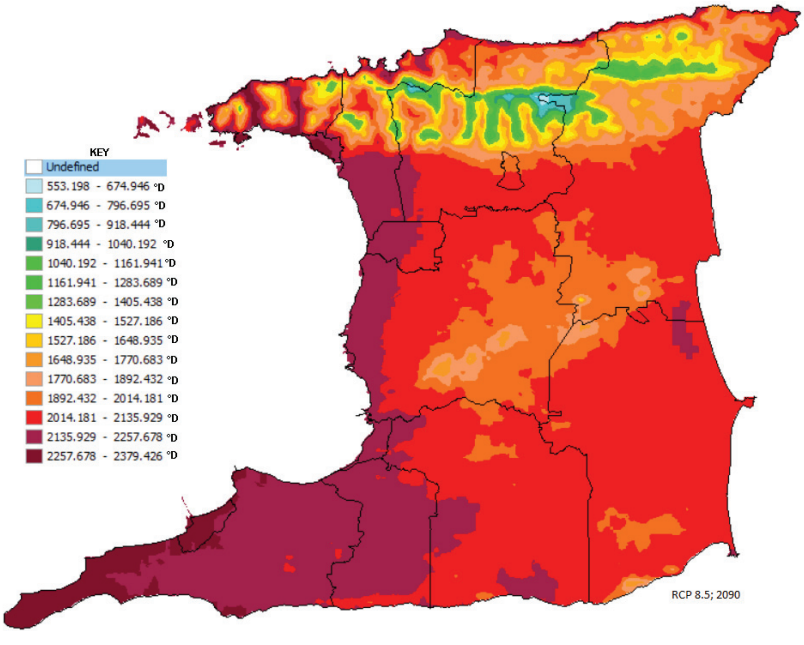

Figure 11. Heat accumulation in Trinidad for RCP 8.5 in 2090. Source: Authors' compilation based on data from the Trinidad and Tobago Meteorological Services and CLIMsystems Ltd.

4. Discussion

4.1. Heat Trends

4.1.1. Land Surface Temperatures

The comparative maps of land surface temperature and urban development in Trinidad show striking similarities in distribution. The hottest regions in Trinidad are demonstrably centred around urbanization. This is a visible indicator that urbanization and urban infrastructure in Trinidad plays a significant role in heat absorption and retention. Landsat thermal imagery showed that the western portions of Trinidad are warmer compared to the surrounding areas. This is indicative of the presence of a surface urban heat island (SUHI) as the urban regions are warmer than the surrounding areas (Figure 3).

The urban environment can be characterized by a conglomeration of anthropogenic surfaces, vegetation, and water features. All of these urban features dictate and influence temperature regimes within the environment and can create a separate microclimate (Le and Tran 2019; Giyasova 2021). Urban areas, particularly those within the tropics, have experienced population movements, urban growth, and industrialization which have led to elevated temperatures and the creation of urban heat islands (UHIs) such as the UHI in San Juan, Puerto Rico (Molina et al. 2020). Similar formations of UHIs are possible within other Caribbean SIDS. Thermal imagery indicated that the majority of the developed western portion of Trinidad is warmer than the rural undeveloped regions in Trinidad. Anthropogenic infrastructure within urban areas can result in increased temperatures due to the increased surface areas of buildings that absorb thermal radiation and reduce wind speeds. The thermal characteristics of urban surface materials allow for increased heat storage and higher heat capacities and conductivities than vegetated surfaces. Urban areas also have vast amounts of impervious surfaces such as asphalt/pitch and concrete that decrease cooling. (Vujovic et al. 2021). Persons living within highly urbanized regions are exposed to greater health risks due to heat stress and heat strokes with most heat mortalities occurring in highly urbanized cities as a result of the urban heat island effect (Heaviside et al. 2017; Piracha and Chaudhary 2022). The most vulnerable groups include the elderly, the very young, the chronically ill or disabled, expectant mothers, and the socially isolated. Low-income and minority groups are also high-risk groups since they lack the social and financial capacity to withstand adverse climatic conditions (Heaviside et al. 2017; Piracha and Chaudhary 2022). It is therefore necessary for accurate temperatures to be disseminated to the general public so that they can undertake the necessary measures and precautions to protect themselves from the health risks and impacts associated with elevated temperatures, particularly in regions of high population densities such as Port of Spain. It is understood that humidity is an important factor in assessing heat-related impacts on human health as well as the quantification of the UHI effect. Therefore,

further studies should be conducted inclusive of humidity for heat index and HI effect calculations in order to quantify the heat-related health impacts within urban regions in Trinidad.

4.1.2. Heat Index

The maximum HI in Trinidad has increased significantly from 1976 to 2015, particularly during the wet season. The increasing heat index found in this study was similar to findings in other parts of the Caribbean, including islands in both the Greater and Lesser Antilles, where the HI has notably increased over a 35-year period (Ramirez-Beltran et al. 2017). Additionally, observations in other parts of the Caribbean revealed that the maximum HI was higher during the wet season, similar to the findings in this study (Ramirez-Beltran et al. 2017). Temperatures in Trinidad and Tobago are generally higher during the wet season due to higher levels of humidity (TTMS 2023).

4.1.3. Heat Accumulation

The increase in HA was visually projected to occur mostly in the western portion of Trinidad under all emission scenarios, with southwestern regions being at high risk due to increasing HA. The change in HA was found to be increasing among the various emission scenarios, with the greatest increases occurring under RCP 8.5, which was expected considering RCP 8.5 assumes that GHG emissions would continue to increase throughout the 21st century. This is similar to other studies conducted on HA in Thailand and Pakistan, where RCP 8.5 yielded the greatest increases in HA over projected time periods (Nasim et al. 2018).

The eastern parts of Trinidad also see an increase in HA, but to a lesser extent than the western portion of Trinidad. All scenarios show that the western regions of Trinidad are projected to be some of the most impacted areas, as they are seen to be the hottest regions in all projections. The southwestern portion of Trinidad is also one of the most impacted, with the HA being very high at the southwestern tip of the island, indicating that this region is at high temperature-related climate change risk and vulnerability. The mountainous regions of Trinidad (the northern, central and southern ranges) were some of the coolest regions. All scenarios also show that there would be a decrease in the coolness of these mountainous regions.

There are a few limitations and uncertainties associated with the methods involved in developing SimCLIM. These include the fact that the pattern scaling and downscaling methods used for each region are based on the best available knowledge of that location and available data. Therefore, the values presented should be viewed as best estimates (Li et al. 2017). However, the climate data used within SimCLIM are considered legitimate (according to the IPCC and country-specific standards), wide-ranging (high-resolution data), defensible (scientifically robust), and actionable (Li et al. 2017). This heat accumulation information derived from SimCLIM can therefore be considered fit for adaptation and mitigation planning. Additionally,

the maps generated using all four RCPs (emission scenarios) similarly indicate that the western and southwestern portion of Trinidad is at most temperature- and heat-related risk. It is therefore imperative that action is taken within these regions in order to reduce further impacts, which can lead to human morbidity, mortality, and a range of ecological impacts.

This study highlights the western and southwestern regions of Trinidad as being most vulnerable and at risk due to heat related impacts. It is therefore important that adaptation strategies are implemented for these particular regions in order to minimize impacts. The majority of the population of Trinidad resides within the western portion of Trinidad, putting them at high heat-related risk and vulnerability.

4.2. Threats Posed by Extreme Heat

4.2.1. Threats to Human Health

There are a number of occupational health concerns associated with increased heat. Psychomotor, perceptual, and cognitive performances in the workplace are all affected due to increases in heat. These all exacerbate the risk of injuries on the job (Kjellstrom et al. 2016; Borg et al. 2021). There are established standards for workplace heat stress management according to the International Organization for Standardization (ISO) (Parsons 2018). However, according to the Intergovernmental Panel on Climate Change (IPCC), some parts of the world have already notably exceeded the ISO level for safe work activity during the hottest months of the year. As heat increases, job exertion, heat stress, and heat exhaustion also increase, and this reduces the amount of work that can be carried out, particularly by outdoor workers, during the hottest periods of time (Kjellstrom et al. 2016; Parsons et al. 2021). This can potentially reduce the overall productivity of a country and thus affect the economy.

The extreme heat caused by climate change poses significant threats to human health in a myriad of ways. Indirect adverse health effects such as air pollution due to wildfires coupled with direct effects of extreme heat on the human body often lead to morbidity and mortality. These effects tend to disproportionately affect vulnerable populations of society, including, but not limited to, low-income individuals, disabled persons, chronically ill persons, and the elderly. Globally, the negative health impacts of extreme heat have been evident as heat waves in July 2022 affected Europe and the USA, which put stress on societies and increased mortality risk (Nature 2022). One study considered 43 countries during the period 1991–2018 and determined that 37% of "warm-season heat-related deaths" could be attributed to anthropogenic climate change (Vicedo-Cabrera et al. 2021). Furthermore, increased mortality due to climate warming is evident on every continent (Vicedo-Cabrera et al. 2021).

When increased heat leads to wildfires, the subsequent emissions in the smoke produced result in adverse effects to human health and may lead to death through smoke inhalation (Guo et al. 2019). In Trinidad, as discussed previously, there have

been wildfire events that exacerbated asthma in students as well as those that caused the death of a 67-year-old man due to smoke inhalation (Felmine 2019).

If the human body is subjected to increased temperatures and is unable to cool itself efficiently, a person may suffer from heat stress with a spectrum of symptoms such as nausea, excessive sweating, headache, muscle cramps, and collapse. Heat stress can be categorized as heat exhaustion, where a person can take measures to cool down; heat injury, where organ damage may occur; or life-threatening heat stroke, where medical assistance is required (Morris and Patel 2021). In 2022, the year's highest recorded temperature in Trinidad was 34.2 °C in Piarco (Hosein 2022). Notably, the threat of heat stress is increased in urbanized areas in Trinidad such as the city of Port of Spain due to the surface urban heat island. Furthermore, there is increased morbidity and mortality among vulnerable groups such as children, older persons, pregnant persons, and disabled persons, as these groups are typically more sensitive to heat. Additionally, due to physical activity, athletes and individuals who work outdoors such as on construction sites are also at higher risk of heat stress.

The observed impacts of climate change include adverse health effects across geographical regions and are largely negative on all scales. Climate change has been positively associated with an increase in illnesses such as dengue, chikungunya, and Lyme disease. Additionally, due to heavy rainfall and flooding events, there are observed increases in vector- and waterborne diseases in affected regions. Furthermore, increased heat due to climate change has resulted in increased respiratory diseases from ozone air pollution, smoke associated with wildfires, and shifting pollen seasons (IPCC 2021). Extreme heat due to climate change has also negatively impacted the mental health, quality of life, cognitive performance, and happiness of individuals who are affected by heatwaves. Climate change has also been observed to contribute to food insecurity through extreme weather and climate events such that populations consume inadequate food. This results in malnutrition, which disproportionately affects children and pregnant women and results in disease susceptibility in low- and middle-income populations (IPCC 2021).

4.2.2. Droughts

Extreme heat levels result in an increased frequency and intensity of droughts which are prolonged periods of abnormally low precipitation leading to water shortages. Droughts can be classified as short-term or long-term. Short-term droughts tend to affect agriculture and result in wildfires, while long-term droughts affect water resources and lead to ecological losses (Gamelin et al. 2022). In recent years, there has been a notable increased propensity of droughts globally, resulting in lowered crop yield, increased food prices, and the lowered production of hydropower (European Commission 2022; Moens 2022).

In Trinidad and Tobago, although drought is a natural phenomenon, it has been noted that droughts have been becoming more severe and less predictable, leading to adverse effects on the water resources and agriculture (Beharry et al. 2019). Trinidad

and Tobago experienced notable droughts in 1997–1998 and 2002–2004; however, in 2009–2010, the country experienced a severe, wide-spread drought with rainfall reaching 25% of expected levels. This resulted in a 6.9% increase in food prices, with cattle livestock being affected by disease and two of the reservoirs recording lower than average levels (Beharry et al. 2019).

In 2018–2019, Trinidad and Tobago, along with many other Caribbean nations, was placed on drought watch, with the Water and Sewerage Authority (WASA) advising the public to conserve water due to reduced rainfall levels (Government of the Republic of Trinidad and Tobago 2019). During this time, one of Trinidad and Tobago's largest rice producers noted that due to the lack of water, he was forced to scale back production from 300 acres of rice planted to 10 acres of rice as of January 2019 (Paul 2019). Agricultural Society President Dhano Sookhoo urged the public to prepare for increased food prices and the non-availability of food. Sookhoo also predicted that the country would be driven to import more food that would usually have been grown locally (Paul 2019). According to Kishan Kumarsingh, Head of the Multilateral Environmental Agreements at the Ministry of Planning and Development, these weather extremes experienced in 2018 and 2019 may become the norm as the global temperature increases (Doodnath 2020).

4.2.3. Wildfires

Wildfires are unplanned fires in a natural environment such as forests or grasslands. Since wildfires are driven by dry, organic material that can ignite and burn when heated, the extreme heat, drought and low relative humidity generated by climate change exacerbate this natural phenomenon (UNFCCC 2022). With business-as-usual circumstances, the number of wildfires is expected to increase by 14% by 2030, 30% by 2050, and 50% by 2100 (UNFCCC 2022). Not only does climate change exacerbate wildfires but wildfires exacerbate climate change, creating a positive feedback loop (UNFCCC 2022). The ramifications of wildfires include adverse health effects due to smoke inhalation, the economic burden of rebuilding areas ravaged by wildfires, watershed degradation, soil erosion, and loss of biodiversity (UNFCCC 2022).

Historically, areas throughout Trinidad and Tobago, particularly along roadways and hillsides, have been known to burn during the dry season from January to May (ODPM 2011). However, increased wildfire events have been noted to correspond with periods of drought due to increased heating. In 2019, during a period of drought, a notable wildfire incident occurred in Princes Town near two primary schools, leading to the forced evacuation of over 900 students (de Silva 2019). It was reported that the smoke from the fire affected students with asthma, and a galvanized water line was damaged by the fire and subsequently ruptured (de Silva 2019). In some cases, such as in another wildfire in La Romaine of 2019, the effects have been fatal. A wildfire along Allahar Street resulted in the death of a 67-year-old man and the destruction of his house. According to the autopsy report, he died from smoke

inhalation (Felmine 2019). As global temperatures continue to increase, there will be an increased frequency and intensity of droughts and resulting wildfires.

4.2.4. Threats to Ecological Health

Terrestrial ecosystems are negatively affected by extreme heat in different ways, ranging from loss of habitats due to wildfires, dehydration due to lack of rain, increased stress on the organisms involved, and general loss of biodiversity. In Trinidad, when extreme heat causes the degradation of the habitats of wildlife, it leads to the reduction in feeding rates, lower reproductive success, and greater energetic loss (Ratnayake et al. 2019) This can result in the migration of species to species being at risk of extinction and the subsequent loss of biodiversity.

4.2.5. Threats within the Agricultural Sector

The USAID Climate Risk Profile lists agriculture as one of the areas most impacted by climate change in the eastern southern Caribbean (ESC), where Trinidad and Tobago lies. This can be attributed to climate trends observed in the region that can make an already brittle agriculture sector even more fragile (USAID 2021). Heat-related changes of major concern for the sector are temperature patterns and the frequency and duration of natural disasters such as droughts (Makara 2021). Reports have shown that annual temperatures have increased 0.2 °C–0.7 °C, which varies (USAID 2021), and drier dry seasons have been observed in the country (Beharry et al. 2019).

Even though the agriculture sector in Trinidad and Tobago is overshadowed by its energy-driven economy (Oxford Business Group 2020), the effects of climate change will still be felt on the livelihoods of almost 2.9% of the population who are employed in the sector and the contribution of agriculture to the gross domestic product (GDP) of the country (1.1%) (World Bank 2020). Many farmers utilize water from rivers for the irrigation of their crops; therefore, droughts during the months of January to May reduce their ability to do so (Beharry et al. 2019). This can lead to unproductive soils and timing and the reduced yield of crops (USAID 2021). Warmer weather from increased temperatures will result in arid soils, the proliferation of pests and diseases, and further irrigation challenges due to reduced water resources. In order to protect against these livelihood losses, climate risk insurance policies such as the Livelihood Protection Policy (LLP) under the Climate Risk Adaptation and Insurance in the Caribbean (CRAIC) project can be utilized by credit unions and farmers cooperatives (MCII 2020). However, after extreme climatic events such as tropical storms in the Caribbean, insurance premiums will likely rise in the region (Caribbean Development Bank 2020).

However, the combination of changes in temperature, precipitation, and CO_2 concentration have created new levels of agricultural productivity and adaptation in the Caribbean region (Reyer et al. 2017). These regimes may reshape growing days as well as modify the phenology of several crops. Some of the biophysical impacts

of climate change can be amplified or mitigated by the management responses of farmers (Banerjee et al. 2021). For example, by 2050, there is expected to be a significant reduction in areas suitable for tomato growing, but alternatives can be used such as cassava, sweet potato, and yam. Additionally, the cocoa crop is expected to be more climate resilient, but precautions should be taken in the form of access to irrigation during more severe dry spells. Furthermore, there is increased climate suitability in the upland areas and surrounding mountain ranges for crops such as banana, cassava, sweet potato, yams, and ginger (Eitzinger et al. 2015).

With regard to the livestock and dairy sector of the country, rising temperatures and humidity can also result in a condition in animals called heat stress, resulting in reduced feed intake, increased risk of diseases, production losses, heat stroke, and even death. Moreover, these conditions will further exacerbate the current unfavourable situation in the dairy industry in the country (Ali et al. 2019). According to farmers, there is a greater predicament to produce milk. This is due to the increase in feed prices, which can be attributed to global shipping costs as the country does not produce corn or grass suited for dairy production (Chaitram 2021).

The reliance on external sources for animal feed is a trend that can also be seen in the food supply for the rest of the country. This is evident in Trinidad and Tobago's high food import bill of TTD 5 billion, which makes up 18% of the country's entire imports (World Bank 2021). Furthermore, the country is the second largest exporter of US agricultural products in the English-speaking Caribbean. Domestic agricultural production is limited due to factors such as land space and natural disasters such as droughts and flooding (International Trade Administration 2022). However, agricultural production has recently been on a path to recovery. Inflation in the country is driven by food prices in both international and domestic fluctuations, and therefore, a goal of the National Food Production Action Plan aims to reduce the food inflation rate (Shik et al. 2019).

4.2.6. Threats within the Energy Sector

As global temperatures continue to rise, there has been greater demand for efficient cooling for both comfort and health reasons. Globally, as of 2018, the use of air conditioners and electric fans to stay cool accounted for about 20% of the total electricity used in buildings (International Energy Agency 2018). China saw the greatest and fastest increase in energy use for cooling since 1990, resulting in a 69-fold increase by 2016 with the growth showing no signs of slowing (International Energy Agency 2018). Although these space coolers alleviate the heat, they also paradoxically contribute significantly to further warming, as these alone could cause 0.4 °C of additional warming by the end of the century. This leads to a positive feedback loop where extreme heat necessitates space cooling, while more space cooling results in increased ambient heat.

In Trinidad and Tobago, the demand for cooling is influenced by its proximity to the equator and its average temperature of 26.5 °C along with increased urban

development (Government of the Republic of Trinidad and Tobago 2020). In 2020, Trinidad and Tobago imported a value of USD 21.5M in air conditioners alone, accounting for 0.45% of total imports (Observatory of Economic Complexity 2020). Furthermore, the country imported a value of USD 19.1M in refrigerators, amounting to a further 0.4% of total imports (Observatory of Economic Complexity 2020).

Apart from space cooling, many industrial processes require systems to be cooled via a coolant. In many cases, the most common coolant used is water due to high heat capacity and low cost (Benedict et al. 2020). Water used for cooling typically enters the industrial system from water storage tanks or manmade ponds located within the facility. If the ambient temperature is higher due to extreme heat, the cooling capacity of the water decreases as it enters the system at a higher temperature than usual (Buryn et al. 2021). This subsequently reduces the efficiency of the process itself and can ultimately result in increased prices of the final product. In Trinidad, the industrial estates of Point Lisas, Frederick Settlement, Otahiete, La Brea, Point Fortin, and Galeota can be affected by this as these industrial plants are listed to use water as a raw material for cooling purposes (Water and Sewerage Authority 2014).

4.3. Social Responses: Heat Resilience Strategies

Trinidad and Tobago is classified as medium for extreme heat hazard, which means that there is more than a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years (ThinkHazard 2020). Out of the eleven regions in the country, only three (Tunapuna/Piarco, San Juan/Laventille, and Diego Martin) fall within the category of low (less than 1% chance); the others remain consistent with medium. Within these regions, those with pre-existing medical conditions such as respiratory-related illnesses, the elderly, children, persons who are uninsured, and persons employed outdoors are especially affected (Di Napoli et al. 2022).

In order to address the problems faced by citizens due to heat, the Government Republic of Trinidad and Tobago (GORTT) created the National Cooling Strategy of Trinidad and Tobago. The 2020–2030 policy sets out national initiatives to address sustainable and environmentally friendly refrigeration and cooling, aligning with the Montreal Protocol and Kigali Amendment. Furthermore, in partnership with the United Nations Development Program (UNDP) and the GORTT, 'The Energy Efficiency through the Development of Low-carbon RAC Technologies' project was created and funded by the Global Environment Facility (GEF). This project seeks to meet the nation's cooling needs in an energy-efficient manner and will deliver multiple benefits at the local, regional, and global levels (Simon and Constance-Huggins 2022). Other energy-efficient strategies to reduce carbon emissions include an Electric Mobility (e-mobility) Policy for Trinidad and Tobago, which is at an advanced stage of development according to Mr. Kishan Kumarsingh, Head of the Multilateral Environmental Agreements Unit of the Planning and Development Ministry (Government of the Republic of Trinidad and Tobago 2021).

In addition to human health, livelihoods are also affected by extreme heat. Extreme heat has major repercussions for the agricultural sector (Khosla 2022). The National Food Production Action Plan 2012–2015, called "Agriculture Now," aimed to increase commodities grouped into staples, vegetables, fruits, aquaculture, livestock, and pulses and named cocoa and honey as their strategic crops (Shik et al. 2019). The cocoa crop is listed being as more resilient to climatic changes and would have greater potential than other crops (Eitzinger et al. 2015). However, greater investment is required to maintain innovations that will ensure stable and increased crop productivity in the changing climate (Lynch 2016).

Drought is a heat-related climatic variability and one which would be increased in frequency and intensity. To improve and manage the water resources of the country, the GORTT established the 'National Integrated Water Resources Management Policy'. It includes an objective to "minimize, mitigate and manage the impacts of flood, drought, and other water-related emergencies". On a household level, citizens utilize tanks during scheduled outages and cope with water stress (Fraser 2021). During drought conditions, grasses and trees dry out, becoming fuel for fires, and this can increase the probability of ignition and the rate at which fire spreads (NIDIS 2018). Therefore, the Ministry of the Environment launched the Forest Fire Prevention Programme in 2014 so members of the public can report the incidence of a fire (GORTT 2014).

There are other mitigation measures that benefit ecosystem health and help reduce temperatures, such as reforestation and tree planting. In 2005, the National Gas Company (NGC) replanted hectares of trees lost due to pipeline construction, and in 2018, they conducted a carbon sequestration study with the University of the West Indies (UWI) Office of Research Development and Knowledge Transfer. They found that the trees had sequestered 2243 tons of carbon, and the research team estimated that the numbers would reach 5228 tons by 2030. This accounts for at least 1% of the CO_2 tonnage the country aims to cut from the transportation sector by that date (Belle 2020). Furthermore, Adopt A River, which is an initiative developed by WASA, regularly plans and executes tree planting exercises and reforestation activities (Adopt a River 2021).

In more urbanized parts of the country, green roofing systems not only provide the owners of buildings with a proven return on investment but also moderate the heat island effect. Green roof temperatures can be up to 4 °C lower than those of convectional rooftops and reduce building energy use by 0.7% compared to conventional roofs, reducing peak electricity demand and leading to annual savings (EPA 2022). Another mitigation strategy which has not been utilized in the country but would be beneficial to heat reduction are cool pavements. These are composed of paving materials that reflect more solar energy and enhance water evaporation. Researchers predicted that an increase in pavement reflectance from 10 to 35% could potentially reduce city temperatures by (0.6 °C) which would lower energy use and reduce ozone levels (EPA 2012).

5. Conclusions

The information gathered in this study provides not only insight into the historical, current, and future changes in temperature and heat in Trinidad, but also the areas and regions most at risk. This study has highlighted a few key facts that require serious consideration. These are as follows:

- Trinidad has become significantly warmer with an increase in the maximum heat index over the past few decades, with temperatures expected to continue increasing.
- Urban areas in Trinidad have already developed into surface urban heat islands (SUHIs) and can potentially develop into full-fledged urban heat islands (UHIs) if there are continuous increases in unregulated urban development in Trinidad, as seen over the past few decades.
- The western and southwestern portions of Trinidad are most at risk (in all emission scenarios) regarding heat accumulation and heat-related impacts.

Looking forward, urban planning and design in Trinidad needs to be modified and adjusted in order to reduce expected heat-related climatic impacts within the most populated regions of Trinidad, which also coincide with the regions projected to be most impacted by heat. It is important that already-existing green spaces within these highly urbanized regions, such as Port of Spain and Diego Martin, are not removed, as this would exacerbate increases in temperatures and heat-related health risks to the people that work and reside in those areas. These green spaces serve to increase shadow effects and evaporative cooling, thus reducing heat accumulation. It is also important that the adaptive capacity and resilience be strengthened within these regions.

Unregulated urban development within vulnerable regions of west and southwest Trinidad should be carefully and thoughtfully rendered or ceased altogether in order to prevent large portions of the population of Trinidad being situated in regions where they would be prone to health risks due to heat-related impacts. At present, Trinidad is at a point where positive change can be enacted at an early stage to reduce future impacts on the multiple facets of life and various sectors already affected by increased heat.

This study provides detailed knowledge and insight into urban vulnerability to heat-related climate risks. This can allow for other scientists, policymakers, planners, and governing bodies to have a more comprehensive understanding of the urban thermal environment within small island developing states (SIDS). It also highlights the conditions that can aid in adaptation and mitigation, creating greater awareness and thereby informing the planning process regarding heat-related impacts within Trinidad and Tobago and the Caribbean region.

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Writing—Original Draft Preparation, Methodology, Validation, Formal Analysis, Supervision. A.M. (Azad Mohammed): Conceptualization, Writing—Original Draft Preparation, Review and Editing, Supervision. A.A.: Writing—Original Draft Preparation. A.M. (Aashrita Mohess): Writing—Original Draft Preparation. A.M. (Anand Mahabir): Writing—Original Draft Preparation. Professor J.A.: Conceptualization, Software, Writing—Original Draft Preparation, Review and Editing, Supervision. All authors have read and agreed to the published version of the manuscript.

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