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How to cite: Ngcamu, B. 2022. Climate change and disaster preparedness issues in Eastern Cape and Kwazulu-Natal, South Africa. *Town and Regional Planning*, no. 81, pp. 53-66.

Climate change and disaster preparedness issues in Eastern Cape and Kwazulu-Natal, South Africa

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Review article

DOI: <http://dx.doi.org/10.18820/2415-0495/trp81i1.5>

Received: August 2022

Peer reviewed and revised: September-October 2022

Published: December 2022

*The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article

Abstract

This article sought to review the literature on the effectiveness of the disaster preparedness plans in two provinces that were struck by climate-induced disasters in South Africa in 2022. Making use of a qualitative desktop study, the effects of urbanisation and infrastructure development on the deadly disasters of April 2022 were examined, using thematic analyses. The review reveals a complex combination of the causes of disaster in both KwaZulu-Natal and the Eastern Cape, which included unplanned urbanisation; ineffective warning systems; inadequate infrastructure, and houses being built on floodplains, in wetland, and in coastal areas. The lack of climate knowledge among government officials and communities prone to climate-induced disasters was considered to have led to the severe devastating effects of the April 2022 disasters. These challenges were compounded by the failure of municipal officials to harness learnings from the rich indigenous knowledge systems of the vulnerable groups and to reverse impacts of the disasters. The article summarises the causes, challenges, impacts, and solutions that can be considered to plan for disaster preparedness.

Keywords: Climate change, climate literacy, disasters, disaster preparedness, early warnings, preparedness plans, urban planning, unplanned urbanisation

KLIMAATSVERANDERING EN RAMPGEREEDHEIDSKWESSIES IN OOS-KAAP EN KWAZULU-NATAL, SUID-AFRIKA

Hierdie artikel het gepoog om literatuur oor die doeltreffendheid van die rampgereedheidsplanne in twee provinsies wat in 2022 deur klimaatgeïnduseerde rampe in Suid-Afrika getref is, te hersien. Deur gebruik te maak van 'n kwalitatiewe lessenaarstudie is die uitwerking van verstedeliking en infrastruktuurontwikkeling op die dodelike rampe van April 2022 deur tematiese ontledings ondersoek. Die oorsig toon 'n komplekse kombinasie van die oorsake van rampe in beide KwaZulu-Natal en die Oos-Kaap, wat onbeplande verstedeliking ingesluit het; ondoeltreffende waarskuwingstelsels; onvoldoende infrastruktuur, en huise wat op vloedvlaktes en in vleilande en kusgebiede gebou word. Die gebrek aan klimaatskennis onder regeringsamptenare en gemeenskappe wat geneig is tot klimaatgeïnduseerde rampe, is beskou as die faktore wat gelei het tot die ernstige verwoestende gevolge

van die April 2022-rampe. Hierdie uitdagings is vererger deur die versuim van munisipale amptenare om kennis uit die ryk inheemse kennisstelsels van die kwesbare groepe te benut en om die impak van die rampe om te keer. Die artikel som die oorsake, uitdagings, impakte en oplossings op wat oorweeg kan word om vir rampgereedheid te beplan.

PHETOHO EA MAEMO A LEHOLIMO LE BOITOKISETSO BA LIKOLUOA KAPA BOCHABELA LE KWAZULU-NATAL, AFRIKA BOROA

Sengoliloeng sena se ne se ikemiselitse ho hlahloba lingoliloeng tse mabapi le katleho ea meralo ea ho itokisetsa likoluo liprofinseng tse peli tse anngoeng ke likoluo tse bakoang ke boemo ba leholimo Afrika Boroa ka 2022. Likoluo tsa 'Mesa 2022 li ile tsa lekoloa ho sebelisoa lithlahlobo ea lintlha tsa sehlooho. Boithuto bo senola lisosa tse 'maloa mabapi le likoluo tsa KwaZulu-Natal le Kapa Botjhabela, tse neng di kenyeletsa ho fallela litoropong ho sa reroang; mekhoha ea temoso e sa sebitseng; meaho e sa lokang, le matlo a ntseng a hahuo mabaleng a likhohola, libakeng tse mongobo joaloka mekhobo, le libakeng tse lebōpong la leoatle. Ho haella ha tsebo ea boemo ba leholimo har'a ba boholong 'musong le lichabeng tse atisang ho ba le likoluo tse bakoang ke boemo ba leholimo ho ne ho nkoa e le sesosa sa litla-morao tse bohloko tse bakoang ke likoluo tsa April 2022. Liphephetso tse na li ile tsa eketsoa ke ho hloleha ha liofisiri tsa masepala ho sebelisa lithuto tse tsoang mekhoeng e ruileng ea tsebo ea matsoalloa a lihlopha tse tlokotsing le ho khutlisa litlamorao tsa likoluo. Sengoliloeng se akaretsa lisosa, liphephetso, litlamorao, le litharollo tse ka nahanoang ho rera ho itokisetsa likoluo tsa kamoso.

1. INTRODUCTION

The year 2022 is considered to have been a year of great tragedy, with two coastal provinces in South Africa experiencing catastrophic and unprecedented floods and landslides because of abnormal torrential rains. This left thousands

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of people displaced and having to live in shelters, with hundreds dead and property damage estimated at R17 billion/US\$1.57 billion (IOL, 2022: 1). Since 2013, South Africa has been prone to a myriad of disasters, including floods, droughts, and storms that are climate change-induced and that have led to water restrictions in the urban agricultural sector (Climate Analysis Group, 2018: 1; Institute for Security Studies, 2018: 2). Nonjinge (2019: 1) mentions that, since 2018, multiple surveys have been conducted in South Africa to test the views on whether climate-induced disasters such as floods and droughts have worsened over the past decade. Nearly half of the respondents were semi-literate women and rural areas dwellers who stated that they had never heard of climate change. This differed from those who had more education, and who cited the adverse consequences of climate change and the urgent need for it to be halted. The crafting of the National Climate Change Response White Paper in 2011 by the South African Government was the acknowledgement of the climate change realities being regarded as major threats to sustainable development and compromising the country's development goals (DEA, 2011: 6).

Researchers (Chapungu, 2020; Mavhura, 2020; Phiri, Simwanda and Nyirenda, 2022) conducted an evaluation of the South African Weather Service's (SAWS) weather information on tropical cyclone Idai. The cyclone struck three countries (Zimbabwe, Malawi, and Mozambique) in 2019, with over 1 500 deaths reported (Bopape *et al.*, 2021: 1). The authors suggest that the weather systems predicted the events in advance and that warnings were issued, but many people did not respond to warnings or were not aware thereof. Model simulations relating to the location of the flood events in KwaZulu-Natal (KZN) were underestimated, showing that there were shortcomings in the model. In view of the identified weaknesses in the models, Bopane *et al.* (2021) recommended that weather

awareness be increased and that disaster risk management systems, including disaster preparedness and risk reduction be developed.

An empirical study by Mthembu and Zwane (2017), which assessed the Ncunjane (Msinga, KZN) farming community's vulnerability and adaptive capacity in response to the drought disasters of 2010 and 2014, yielded interesting results. The high cattle mortalities and low crop productivity increased food costs, reduced household income, and increased agricultural input costs (Mthembu & Zwane, 2017: 1). These authors found that the drought relief provided by the government had hardly any effect on farmers, who had to contend with large herds of cattle, prolonged heat spells, and variability in rainfall. This adversely affected small-scale farmers, with dire impacts on rural farming communities such as Msinga. Meanwhile, women have been severely affected by the impacts of climate change in KZN, with a reduction in harvests, due to devastating droughts. Fishing has also been negatively affected, something that traditionally plays an important role in households' food security (Masinga, Maharaj & Nzima, 2021: 1002).

Accordingly, in the Eastern Cape (EC) province, the three informal settlements without storm water-drainage systems were selected to assess the factors influencing the structural flooding in such settlements (Dalu, Shackleton & Dalu, 2018). The study found that the patterns of land cover, proximity to water bodies, and increasing slope factor had influenced housing structures in the informal settlements of Grahamstown, Port St Johns, and Port Alfred (Dalu, Shackleton & Dalu, 2018: 481). Chari, Hamandawana and Zhou (2018: 670) studied the Nkonkobe Local Municipality, which is significantly vulnerable to the adverse effects of climate change (aggravated by high incidences of poverty and inaccessibility to basic services). A quarter of the villages that were sampled by these authors were found to have limited adaptive capacities in responding to the effects of climate change.

In the devastating floods that occurred in 2022, the vulnerable people – mostly those who are marginalised and living in informal settlements – had limited access to warnings from the eThekweni Municipality and the South African Weather Service. There was also an indication that these people did not know what to do with the limited information they received (Singh, 2022: 12). Despite the accurate prediction of the South African Weather Service, Kunguma (2022) opines that this was inadequate. The impacts of disasters are devastating and necessitate other measures such as research informing town planning and adequate maintenance of underground drainage systems to be in place, in order to prepare for disasters. Consequently, a report compiled by the Moses Kotane Institute (2022: 2) revealed that the damage caused by the 2022 floods in Durban were exacerbated by poor town planning, inadequate infrastructure, and houses built in mountainous areas.

In a systematic review of literature by Ryan *et al.* (2020), the lack of benchmarking exercises for the community to engage in disaster preparedness resulted in the recommendation for face-to-face techniques that support community-led preparedness activities. This could yield positive results as opposed to using mass media campaigns. An empirical study conducted by Abunyewah *et al.* (2020) in Ghana to examine the role of community participation in improving the effectiveness of disaster preparedness, solicited fascinating findings. These show that the accessibility of information and comprehensively tailored plans to respond to the needs of the public strongly influenced people to prepare for disasters (Abunyewah *et al.*, 2020: 8).

Against this detailed backdrop of climate-induced disasters and its adverse effects, this article reviews the existing literature on the effects of preparedness strategies in mitigating the impacts of disasters that were experienced in two provinces in South Africa in 2022. The article also

analyses the effects of urbanisation and infrastructure development on the climate-induced disasters. This study, therefore, questions whether the disaster preparedness plans by different actors and the existing infrastructure was effective in mitigating the impacts of the climate-induced disasters.

2. METHODS AND REVIEW STRATEGY

A qualitative desktop study was used to review the phenomenon on climate change and disaster preparedness in two provinces, KZN and the EC in South Africa. First, the conceptual and theoretical underpinnings of the study are introduced to the readers. Secondly, the realities of climate change in South Africa and in two eastern coastal provinces (KZN and EC) are briefly summarised with their impacts on the vulnerable communities mainly residing in rural, peri-urban, and urban townships and informal settlements. Thirdly, a summary is provided on how climate change-induced disasters across the globe have enhanced the Disaster Risk Reduction (DRR) strategies in high-risk and vulnerable areas. The factors that have been considered to have aggravated the impacts of climate change-induced disasters in vulnerable communities have been identified. Fourthly, the determinants of disaster preparedness, the role private-public partnership plays, the adverse effects of poor preparedness plans to vulnerable communities, and the role of the stakeholder partnership and Fourth Industrial Revolution (4IR) in proactively preparing for the climate-induced disasters are reviewed. Fifthly, the contravention of the Disaster Management Act (DMA), which promotes stakeholder partnership and training of the government officials, and the shortcomings in those programmes in realising the DMA provisions are reviewed. Sixthly, urbanisation, the apartheid planning model, and its effects on climate change in South Africa are reviewed. In the discussion section, the causes, challenges, impacts, and solutions to reducing vulnerabilities

are grouped and the strategies to counter floods are introduced.

The study was conducted between January 2022 and July 2022 and entailed a desktop review of relevant literature related to the impacts of climate change and flood disasters. The key focus was to address current realities of climate change and disaster preparedness in two South African provinces. Secondary data was collected via online searches and from electronic databases. The initial search retrieved 30 online newspaper articles that were reviewed, in order to discover the underlying meaning of the reported stories mainly on the impacts of climate change and flood disasters in the two South African provinces. The second search was conducted between 2 May 2022 and 12 July 2022 and retrieved 30 empirical journal articles from Google Scholar, IUP Publications, academic journals, AOSIS, ASCE Library and Emerald Insight, Technium Science, using the phrase 'climate change and disaster preparedness in the KZN and EC provinces, South Africa'. The articles that had been published in other provinces with dissimilar climatic and weather conditions were excluded, as they might not have added value. Research reports, books, and book chapters that were not empirical were excluded. Articles from the Beall's List of Predatory Journals were also excluded, in addition to those with extremely low citations. From the 30 retrieved journal articles, only nine were aligned with the research aims of the study. Of the nine articles, only two employed a mixed-research method where municipalities were targeted: officials and communities vulnerable to climate-induced disasters and the impacts of these climatic variations on the tourism industry were investigated. Two articles focused on a reflective analysis in Thailand and the Philippines on the role of education in disaster preparedness and public-private partnerships in preparing for disasters. Only one study used archival data to examine the trends and impacts of coastal flooding in the Western Cape province. Lastly, two authors used in-depth interviews,

in situ interviews, and desktop studies to study floods, specifically in Limpopo province and Ekurhuleni.

A review of the articles provided an understanding of the key issues of climate change and disaster preparedness at the local government level. Thematic analysis was used to group climate-induced disasters and solutions. Microsoft Excel (version 16.0-2016) was used to generate the themes and to identify the methods used and major conclusions by scholars. Existing gaps were identified and a scholarly direction to future research was provided (Paul & Criado, 2020).

3. KEY ISSUES

3.1 Conceptual and theoretical underpinnings of the study

Atreya *et al.* (2017: 428) define disaster preparedness in terms of residents' actions to respond to, deal with, and minimise the risks of natural disasters, and reduce losses and risks at the household level (Peng, Xu & Wang, 2019: 469). Hoffmann and Muttarak (2017: 33) divided the determinants of disaster preparedness into personal/household, structural/geographical variables, socio-demographic characteristics, and psychosocial factors. Reininger *et al.* (2013: 52) considered married, middle-class groups, households with children, and citizens with disabilities as being associated with high preparedness. Meanwhile, households with members who have lived in the same house for longer periods were perceived to have enhanced local knowledge, with an increase in disaster awareness of their immediate environment (Tanaka, 2005: 201). Under psychosocial factors, higher understanding of perceived risks were noted as increased preparedness behaviour (McNeill & Bryden, 2013: 1654). In the South African context, section 1f of the Disaster Management Amendment Act, 2015 (Act No. 16 of 2015) defines emergency preparedness as:

- a. a state of readiness which enables organs of state and

other institutions involved in disaster management, the private sector, communities and individuals to mobilise, organise and provide relief measures to deal with an impending or current disaster or the effects of a disaster; and

- b. the knowledge and capacities developed by governments, professional response and recovery organisations, communities, and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current hazard events or conditions”

The World Bank (2021: 3) defines climate change as “the significant variation of average weather conditions becoming, for example, warmer, wetter, or drier – over several decades or longer. It is the longer-term trend that differentiates climate change from natural weather variability.”

Cobbinah (2017: 223) and Cobbinah and Darkwah (2017: 1231) refer to urban planning as a process where various stakeholders interact. The motive is to shape the urban environment in the process of development. This study explored a plethora of theories such as the Complexity Theory (Kim and Sohn, 2018), the Theory of Planned Behaviour (Ajzen, 1985), and the Political Systems Theory (Easton, 1953). Kim and Sohn (2018) investigated and provided an understanding of complex and contemporary phenomena such as meteorology, in order to find appropriate countermeasures. This theory’s lenses are framed, based on contemporary disasters that have shown the characteristics of complex disasters. These include the 2011 earthquake that struck Japan with 20 000 reported fatalities, and the 2011 devastating flooding in Thailand which resulted in tremendous economic losses. The Complexity Theory has an important characteristic with “emergency”, which provides an important lesson for people to understand ways to cope with disasters (Pelling, 2003). The Theory of Planned Behaviour (TPB) is applied to assess disaster preparedness, beliefs,

and attitudes in shaping accepted and not accepted behaviours. It can create a particular attitude on why certain individuals’ attitudes towards disaster preparedness are accepted or not (Zaremohzzabich *et al.*, 2021). However, this overview of the study is underpinned by Easton’s Political Systems Theory (1953), which is centred around stakeholder interactions and is influenced by the members of the system’s behaviour when playing their roles. This implies that, when the theory is applied, a plethora of risks, crises, and difficulties can be avoided. This theory’s environmental behaviour pillars are consistent with the current study’s objectives (see Table 1), as they focus on the following constructs:

- System: Interaction of people in implementing public policies.
- Environment: Extra: international political, socio-economic, and cultural systems, socio-structural, and demographics. Intra: social environments-ecological, biological, cultural, and personality.
- Response to its environment to adapt to the crisis.
- Feedback: On the information and understanding the effects.

This study draws insights from the determinants of this theory, as it dissects the effectiveness of vulnerable communities and government and their preparedness for climate-induced disasters, the effects of urbanisation, and infrastructural development in two South African coastal provinces.

3.2 Climate change and vulnerabilities in South Africa

In South Africa, the consequences of climate change were predicted to worsen the impacts of natural disasters (floods, droughts, and storms), and contributed to socio-economic losses, as observed in the January 2013 flooding of the Limpopo River (Twumasi *et al.*, 2017: 308). In addition, the recurrence of flood disasters has been attributable to heavy rainfall, with 91 fatalities recorded in 2011 owing to the Orange River flooding and causing over

US\$100 million in damages. The World Bank (2021: 3) opines that South Africa is considered the best among the great African countries that are resilient to climate change. This is because of its vast adaptive capacity, despite the fact that the country reported 100 disaster events between 1900 and 2017, with 21 million people affected, 2 200 fatalities, and US\$4.5 billion in monetary losses. The World Bank (2021: 4) reported that South Africa is a drought-prone country with very high temperatures that have resulted in over 50 000 people living below the poverty line. This has been supported by Hoffman *et al.* (2009), who confirmed that recent variations in climate change will increase the frequency of extreme drought events, especially in the winter-rainfall region of southern Africa.

In 2022, the propensity and magnitude of the devastating impacts caused by unprecedented weather variations and events in the KZN and EC provinces, in particular, motivated the president of South Africa, on 19 April, to declare a disaster in KZN in accordance with section 27(1) of the Disaster Management Act, 2002 (Act No. 57 of 2002). The deadliest storm occurred in April, when nearly 300 mm of rain fell within 24 hours in KZN. A total of 435 people lost their lives, and 80 are still missing (Government of South Africa, 2022). This surpassed the September 1987 floods in Durban (in terms of rainfall and destructions) that brought 900 mm of rainfall recorded over four days and resulted in 506 fatalities (Singleton & Reason, 2007: 2). Meanwhile, the killer floods in Durban in 2019 with 165 mm rainfall left approximately 80 people dead, with clear warning by the SAWS communicated in advance, according to the International Federation of Red Cross and Red Crescent Societies (IFRC) (2022) and the Moses Kotane Institute (2022: 4).

Table 1 shows highlights that emerged from the review which has been thematically presented, showing the impacts of climate-induced disasters and solutions to the vulnerable populations.

Table 1: Climate change and vulnerabilities in South Africa

Themes	Impacts/Solutions	Authors
Climate change variations	Frequency of extreme drought events, flooding, and rise in sea level.	Dhiman <i>et al.</i> , 2019; Hoffman <i>et al.</i> 2009; Twumasi <i>et al.</i> , 2017
Socio-economic	Losses of families residing in coastal cities and damage to urban environments.	Dube & Nhamo, 2020a; Fitchett, Grant & Hoogendoorn, 2016; Fatti & Patel, 2013; Twumasi <i>et al.</i> , 2017
Urbanisation and infrastructure	Uncontrolled urbanisation and construction of infrastructure in coastal areas. Vulnerable groups in high-risk areas.	Cutter <i>et al.</i> , 2008; Dhiman <i>et al.</i> , 2019; Price & Vojinovic, 2008
Government response	No urgency regarding planning for climate change. Historical distrust of government officials. Limited capacity of municipalities to implement policies. Inadequate responses to disasters.	Fatti & Patel, 2013; Faling, Tempelhoff & Van Niekerk, 2012
Private-public partnerships	NGOs and government to implement disaster education programmes. Private-public partnerships are key to disaster management and DRR. Developing community partnerships and conducting specialized training programmes.	Hagelsteen & Burke, 2016; Mishra & Suar, 2007; Wood <i>et al.</i> , 2012
Disaster preparedness and education	Insufficient disaster preparedness in designated groups. Farming experience and the presence of the elderly equate to preparedness. Education increases preparedness.	
Municipal weaknesses	Municipalities have limited time to put structures in place. Lack of implementation of the Act.	Hagelsteen & Burke, 2016; Wentink & Van Niekerk, 2017
Early warning systems and disaster preparedness	Improved DDR efforts; early warning systems; investment in structural mitigation for large buildings and infrastructure; adapt and build resilience through effective decision-making; raise awareness and increase household preparedness.	Birkmann <i>et al.</i> , 2008; Mishra & Suar, 2007; Andrews & Quintana, 2015; Vogel <i>et al.</i> , 2007; Koch, Vogel & Patel, 2007
4IR and disaster preparedness	Application of the Digital Government Competency and Capability Readiness. Application of the Artificial Intelligence tools (GIS, Remote Sensing)	Abid <i>et al.</i> , 2020

Source: Author

3.3 Climate change, flood disasters, and resilience strategies

It has been consistently observed that the variations in climate change, which have resulted in extreme precipitation and temperatures, have caused considerable threats to low-lying coastal towns, with flood disasters and a rise in sea level (Fitchett, Grant & Hoogendoorn, 2016). While extreme temperatures adversely affect the socio-economic development of families residing in coastal cities, the latter are exacerbated by a backlash from tropical cyclones, intense rainfall, frequent coastal flooding, storm surges, rise in sea level, and tidal activity (Dube & Nhamo, 2020a; 2020b; Hallegatte *et al.*, 2013). The unprecedented occurrence of climate-induced disasters in developing countries (for example, the Indian Ocean tsunami in 2004, and typhoon Haiyan in the Philippines in 2013) have improved DDR efforts. This has been done by implementing early warning systems and increasing investment in structural mitigation for large buildings and infrastructure meant to prevent loss of life (Andrews & Quintana, 2015; Birkmann *et al.*, 2008).

Handayani *et al.* (2019) suggest that, in order to ensure that coastal areas are sustainable as a result of climate change, building resilience should be a key focus. Researchers (Amoako & Frimpong Boamah, 2015; Dhiman *et al.*, 2019) have attributed unplanned, rapid, and uncontrolled urbanisation and the construction of infrastructure in coastal areas to have led to extreme costs because of flooding and other hydrological hazards, rise in sea level, and climate change. Other researchers (Douglas *et al.*, 2008; Price & Vojinovic, 2008) insinuated that, in the Global South, rapid urbanisation and increased development in urban cities have noted the poorest of the poor and the marginalised residing in the most vulnerable and peripheral areas (mostly floodplains), with inadequate infrastructure and poor provision of services.

In South Africa, two regions in different provinces with dissimilar climatic conditions were selected in a research study initiated by the South African National Disaster Management Centre, with George in the Western Cape, being susceptible to flash floods, droughts, and rise in sea level, and the Khara Hais Local Municipality in the Northern Cape, being prone to drought (Faling,

Tempelhoff & Van Niekerk, 2012). The researchers unravelled the most fascinating findings such as, for instance, there is no urgency regarding planning for climate change, despite the regulations which mandate that municipalities must prioritise such plans. This could be as a result of the backlog of developmental needs, which are taking priority. Fatti and Patel (2013) conducted a study in Ekurhuleni, testing the perceptions of both municipal officials and communities that are prone to flood risks. They found that the local communities have a historical distrust of government officials, whereas the officials cited the limited capacity of the municipality to implement policies (Fatti & Patel, 2013).

It is common that, despite the low level of resilience to disasters, developed areas can easily adapt and build resilience through effective decision-making (Vogel *et al.*, 2007). The underlying issues and priorities such as reducing poverty and creating jobs may increase resilience among vulnerable groups (Koch, Vogel & Patel, 2007). This latter view is supported by Cities Alliance (2009) and Douglas *et al.* (2008) in that floods translate to disasters with severe and adverse

impacts, predominantly in areas where vulnerable communities and vulnerable areas intersect. A perception study in two villages in the Limpopo province was conducted by Musyoki, Thifhufhelwi and Murungweni (2016), dissecting communities' responses to flood disasters. The findings indicated that local communities are vulnerable to disasters such as floods, with negative impacts on infrastructure and livelihoods. Respondents perceived the municipality's response to disasters to be inadequate. The study recommended that both the communities and the government apply coping mechanisms to better manage flood disasters.

3.4 Insufficient disaster preparedness and vulnerable groups

In both developed and developing countries, the level of preparedness varies in terms of the level of education, age, and economic status, with vulnerable groups in high-risk areas always found to be less prepared for disasters. Goal 13 of the Sustainable Development Goals (2030) encourages countries to take urgent action to combat the impacts of climate change. However, unprecedented and extreme weather conditions, with negative impacts on the socio-economic development of coastal communities, have threatened the realisation of the 2030 inclusive SDGs of the United Nations.

Private-public partnerships are key to disaster management, with four determinants applied in the international arena, namely disaster preparedness partnerships, awareness and advocacy, partnerships, and social investment partnerships (UNISDR, 2005). In Tokyo, Japan, gas company initiatives on risk reduction involve the fire departments' individuals from the local community, the disaster management volunteer groups, and the fire departments. These groups and volunteers train and educate communities to be involved in household preparedness and mitigation measures, assisting them to reduce risks (UNISDR, 2008: 26; Tokyo Gas Group, n.d.: online).

According to Fatti and Patel (2013), intense and frequent flooding, due to climate change, has caused major damage in the urban environments of the Global South, which has been perpetuated by a lack of disaster preparedness. The most vulnerable areas, predominantly informal settlements, are overlooked in terms of consistent knowledge. Budgets that are allocated and spent are already prioritised for developed areas, owing to poor planning and services (Cutter *et al.*, 2008).

In developed countries such as Japan, which is severely prone to earthquakes and tsunamis, disaster preparedness at a community and household level are accentuated. Miceli, Sotgiu and Settanni (2008) conducted an empirical study, in a provincial city in Japan, to examine the determinants of disaster preparedness among households. These researchers found insufficient disaster preparedness, with the literate, the elderly, female or married having preparedness plans. People with farming experience and the presence of the elderly in a household meant that households were more prepared for disasters.

Fascinating themes emerged from another research study that aimed to understand the role of education in promoting disaster preparedness (Hoffmann & Muttarak, 2017). Education increased preparedness for those families that had been prone to disasters, as education improves abstract reasoning and anticipation skills. The study clearly concluded that educated households apply preventive measures without first experiencing a disaster (Hoffmann & Muttarak, 2017). These authors further concluded that stockpiling and having an evacuation plan could minimise loss and damage from hazards, even though levels of household disaster preparedness are not prevalent in disaster-prone areas. This has been supported by authors such as Adiyoso and Kanegae (2014) and Kohn *et al.* (2012) who state that, despite a concerted effort to promote disaster preparedness, the low levels of disaster preparedness reported in highly prone areas and the pertinent questions raised as to how

people vulnerable to disasters can be motivated to take precautionary actions and, in particular, those without prior experience being struck by disasters (Van der Keur *et al.*, 2016; Shreve & Kelman, 2014; Harvatt, Petts & Chilvers, 2011). Other authors such as Wood *et al.* (2012) and Mishra and Suar (2007) mentioned that various stakeholders, including NGOs and local and national government, have put a concerted effort into implementing disaster education programmes in disaster-prone areas. The intention of these programmes is to raise awareness and increase household preparedness so that people become self-reliant. Muttarak and Pothisiri (2013) suggest that there is a paucity of data that focuses on the dimensions of disaster preparedness in developing countries. They conclude that there is a dire need to understand the underlying factors explaining the adoption of preparedness measures, in order to promote disaster resilience.

3.5 Capacity development and stakeholders' partnership as panacea to disaster risk reduction

The non-compliance with the Disaster Management Act in South African municipalities has been noticed. Malfunctioning, under-resourced, and poorly trained officials in disaster management centres have significantly contributed to municipalities' failure to be prepared and to proactively respond to climate-induced disasters. A mixed-methods study, conducted by Wentink and Van Niekerk (2017), examined whether South African municipalities are aligned with the provisions of the Act. They found that these municipalities have limited time to put structures in place, in order to proactively respond to disasters, thus showing a clear lack of implementation of the Act. Botha, Van Niekerk and Wentink (2011), meanwhile, opine that local municipalities play an important role in mitigating disasters, as mandated by the Disaster Management Act. This is primarily to formulate diverse disaster-management committees (constituted with various role

players, including volunteers, local businesspeople, and municipal managers). This is with a view to developing community partnerships and conducting specialised training programmes. These training programmes should be aligned with municipal disaster plans and should focus on risk and hazard awareness, risk reduction and prevention, and vulnerability assessments.

Hagelsteen and Burke (2016) cite partnerships as being important in capacity development, but they further add elements that are pivotal to capacity development for DDR. These include ownership, monitoring, evaluation and learning, roles and responsibilities, ownership, understanding the local context, terminology, and a variety of activities. Although the various authors mentioned earlier regard capacity development as being important in DDR at a local level, they also unravelled some drawbacks to developing programmes. The duration is short and DDR is considered to be a development issue rather than a humanitarian one (Hagelsteen & Becker, 2013: 11; Van Niekerk & Annandale, 2013: 173). Secondly, the time-consuming programmes should be integrated into development policies and planning (UNISDR, 2005).

3.6 Fourth Industrial Revolution technologies and disaster management

There has been a concerted effort to encourage both public and private sector organisations to specifically deploy 4IR technologies to manage and be prepared for climate-induced disasters across the spectrum. Mahmud *et al.* (2022) suggest that the 4IR readiness in disaster management can be understood by the extent to which these sectors harness the 4IR technologies in managing disasters and advocate for the development of the 4IR readiness model. This has been exemplified in Malaysia in 2017, for instance, where the Public Service department developed a 'Digital Government Competency and Capability Readiness (CDGCR) to build government officials' competency and

digital capabilities at all levels and provide services to people through digital tools (MMITI, 2018). A study by Abid *et al.* (2020) provided a high-level overview of the applications of Artificial Intelligence (AI) tools such as GIS and Remote Sensing in managing disasters that have led to a faster, more concise and equipped response, higher planning, situational analysis, and recovery operations. Researchers such as Arinta and Andi (2019), and Chen, Wang and Deng (2020) are of the opinion that AI and GIS are important digital tools applied by a plethora of scholars to map the spatial dispersal of flood hazards and susceptibility to flooding. In disaster preparedness, AI facets are evident with drones, machine learning, robotics, sensors, deep learning, and algorithms applied in the context of catastrophe predictions (Chakraborty *et al.* 2020; Mosavi, Ozturk & Chau, 2018). Meanwhile, Kumar and Sud (2020) created DHARA, a flood-supported mobile application to anticipate the likelihood of flooding, in order to implement early warning preparedness and restoration technique before a disaster. In addition, using remote sensing and satellite imagery to monitor disaster preparedness operations and aerial surveys to determine disaster zones by identifying disaster flood-prone areas mitigate the damage caused by disasters (Fara, Fritza and Castellano and Tsai, 2019).

3.7 Urbanisation, apartheid planning model, and its effects on climate change in South Africa

The rapid and unplanned urbanisation in the Global South (South Africa is not an exception) has been seen to have perpetuated the impacts of climate change-induced disasters, with the rippling effects on the poor population observed. According to Culwick (2019), the urban poor are at the greatest risk, as rapid urbanisation and climate change are likely to increase the propensity and intensity of disasters. The author argues that South Africa faces a myriad of challenges and an unprecedented increase in climate change and

urbanisation-inclined challenges. This has been exemplified by Mhangara *et al.* (2017), who cited the socio-economic and the City of Cape Town foundation inequalities because of the apartheid historical growth which created distinctly unequal human settlements with the affluent suburbs characterised by adequate services and opportunities and the poor residing in the informal settlements with the shortage of access to core urban services. An empirical study by Busayo, Kalumba and Orimoloye (2019) examined Mdantsane Township's (the largest in South Africa located in the EC province) spatial planning and climate change adaptation which espoused interesting highlights. This case study was chosen as the authors suggest that it is reminiscent of apartheid legacies to prepare people to adapt to climate change, while the residents are still prone to urban poverty, environmental challenges, and inadequate access to basic needs and facilities. The latter has been echoed by Kalumba *et al.* (2013) that the government of South Africa is still grappling with redressing the segregated apartheid spatial planning and improving communities' adaptation to climate change and other hazards which can have negative repercussions on human and environmental health. In their groundbreaking research study, Rice, Lond and Levenda (2022) coined an interesting construct: climate apartheid which they have considered as emerging globally. The scholars considered the term as a form of segregation, violence, and discrimination which is evident in terms of class, race, sexuality, and gender. In addition, Rice *et al.* (2022) proposed populations under the ambit of the climate apartheid: climate privileged (those who insulate themselves and make a profit from the threats of climate change) and climate precarious (those with inadequate infrastructure, lack resilience), and their vulnerability exacerbated by the impacts of climate change which can lead to harm and displacement. Other scholars have used this term to highlight the extent of racialised climate policies and practices (Tuana, 2019). The extent

of the nature of the effect of climate variations; the vulnerabilities of the displaced persons and refugees (Dawson, 2017); the weak political will and proactive response to the climate crisis have directly affected poor communities (Bond, 2016).

Watson (2009: 151) argued that the majority of the Global South towns, which are heavily urbanised in cities/towns and peri-urban areas, are compounded by a crisis of rapid population growth with the lack of access to infrastructure, proper shelter, and inadequate provision of services to predominantly poor populations. The author further alluded to the factors exacerbating the situation, namely weak governments, environmental issues brought by climate change, food insecurity, and the financial crisis. Watson (2009) hypothesised that urban planning served to exclude the poor, while there is an ongoing application of the older forms of urban planning. He concluded that there are significant shifts and new ideas without ready-made solutions for the Southern urban contexts. An overview paper written by Dodman *et al.* (2017), reviewing the key features of African urban experiences and the implications associated with such risks, concluded that both urban development and risk-reduction actors should engage all the elements of urban development, including urban poverty, provision of

services, infrastructure, informality, and local governance management. A study exploring an association between urbanisation and living conditions in South Africa by Turok and Borel-Sladin (2014) found that the vast majority of people continue to live in informal settlements, as the provision of adequate services has not kept up with household growth.

4. DISCUSSION

Four major focus areas emerged from the reported online articles on the April disasters in the KZN and EC provinces, which encapsulate the causes, challenges, impacts, and solutions (refer to Figures 1 and 2).

During the disasters of 2022, a number of stakeholders, including NPOs (e.g., UNICEF South Africa, Famine Early Warning Systems team, GroundWork); non-governmental organisations (NGOs); academic institutions (e.g., the University of KwaZulu-Natal), and government officials played different roles. This is in line with Wood *et al.* (2012) that various stakeholders including NGOs and local and national government disaster education programmes partake in disaster response. Concerning the causes of the April 2022 disasters, numerous media commentators and experts have stated that this was attributed to a cut-off low pressure, heavy rainfall, an increased greenhouse

effect, global warming, and extreme weather conditions. Two predominant disasters have been consistently mentioned – floods and droughts – which led to widespread devastation and subsequent rescue operations. One of the experts provided this background: “Flooding started when a cut-off low pressure system delivered extremely high rainfall levels of 450 mm in some areas in just 48 hours” (Engelbrecht *et al.*, 2022). The challenges espoused by media reports were a lack of risk awareness and a lack of education programmes for high-risk communities. Absent, outdated, and unreliable information as well as a lack of literacy about geography and climate change have perpetuated the impacts of flood disasters, more especially in KZN. One of the experts, quoted in a media article (Evans, 2022), stated: “Early warning systems on floods are not enough; climate crisis literacy saves lives.”

Based on the reviewed literature, South Africa is still perceived as the best country in terms of climate change adaptation, despite the severe human, economic, and infrastructural losses that have been recorded over the past two decades. Similarly, in developing countries that are severely prone to climate-induced disasters, their DRR initiatives have yielded positive results. However, the unplanned urbanisation has led to vulnerable

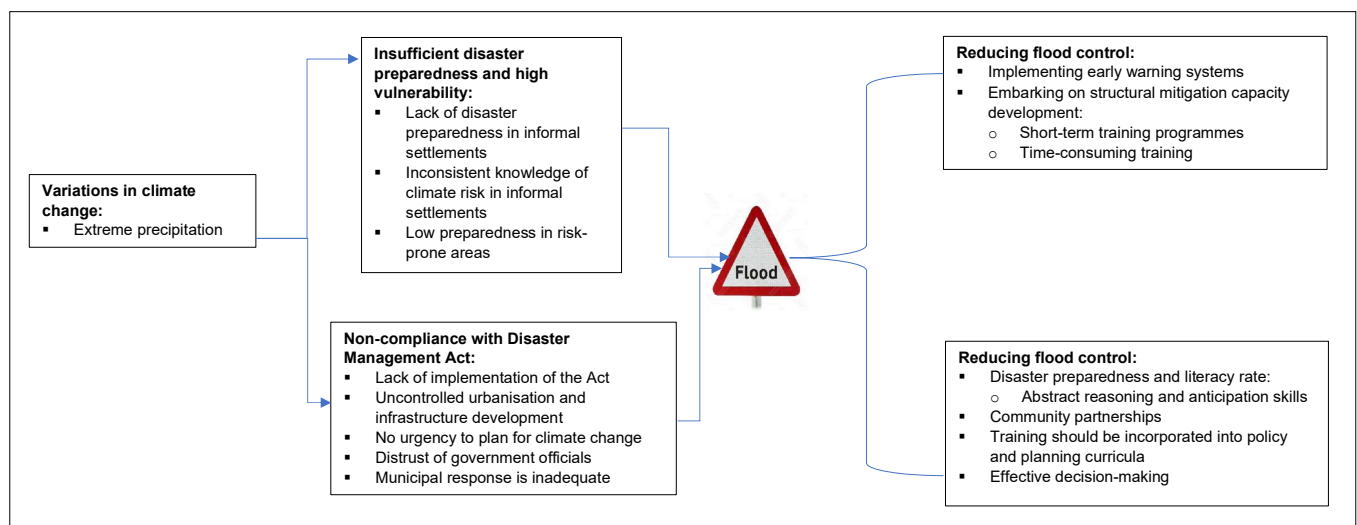


Figure 1: Reducing vulnerabilities and strategies to counter floods

Source: Author

Disaster causes	Challenges	Impacts	Solutions
<ul style="list-style-type: none"> Cut-off low pressure system Heavy rainfall Increased greenhouse gas Global warming Warming of the atmosphere Extreme weather conditions 	<p>Awareness and education</p> <ul style="list-style-type: none"> Absence of reliable disaster loss and damage data Inadequate and outdated early warning systems and flood mitigation measures Communities in informal settlements not informed about climate risks Communities' lack of climate change language Communities' lack of knowledge or understanding of risk warnings, which make them difficult to respond Geographical literacy is lacking <p>Urbanisation and apartheid urban planning</p> <ul style="list-style-type: none"> Uncontrolled urbanisation Lack of land-use zoning enforcement Frequent flooding Inadequate spatial planning Apartheid and colonial planning Apartheid planning and poorly constructed cities <p>Types of disaster</p> <ul style="list-style-type: none"> Drought Flood Widespread devastation Search-and-rescue operations 	<p>Infrastructural destruction</p> <ul style="list-style-type: none"> Telecommunications, electricity, and water supply and sewerage terminals disconnected Port terminals and rail disconnected Damage to roads <p>Socio-economic vulnerability</p> <ul style="list-style-type: none"> Highly vulnerable to socio-economic and environmental risks Children missing Schools remain closed <p>Agricultural production and infrastructure</p> <ul style="list-style-type: none"> Loss of crops and livestock Farming industry destroyed Diseases killed livestock Farming infrastructure: irrigation equipment, machinery destroyed Piggery-related infrastructure damaged Feed storerooms damaged Chickens drowned 	<p>Effective warning systems and trainings</p> <ul style="list-style-type: none"> Early warning system to be improved Reliable warnings can be advanced through 'climate science' Early warnings through disaster preparedness: Communities and officials can proactively respond Climate hazard literacy To produce and ownership of knowledge by local communities to address climate challenges The use of digital tools such as, for example, WhatsApp <p>Identification, adaptation, and mapping</p> <ul style="list-style-type: none"> Climate change adaptation to reduce vulnerabilities Identification of high-risk land exposed to natural hazards Flood-control mechanisms should be used to identify and protect at-risk infrastructure Farming communities need conservation plans to adapt Households residing in high-risk zones should be educated and relocated Fit-for-purpose for municipal officials: Disaster management capabilities Build resilient infrastructure Mapping of floodplains that are prone to flooding Mapping of key infrastructure Development of hazard maps Urban planners to identify and prevent people from building on river banks and floodplains or in areas geographically inadequate for habitation <p>Stakeholder partnership</p> <ul style="list-style-type: none"> Strengthen institutional arrangements Partnerships between communities and government Municipality to partner with traditional leaders and residents Unsuitable land for development should be guided and regulations enforced for any future development Construction of settlements should be guided by municipalities Valuing community-based knowledge <p>Flood preparedness and disaster response</p> <ul style="list-style-type: none"> Monitoring and forecasting data Flood preparedness plan to inform departments about mitigation measures Provision of seedlings and fertilisers by government Disaster response plans

Figure 2: EC and KZN 2022 disasters: Causes, challenges, impacts, and solutions

Source: Author

communities living in high-risk areas with inadequate infrastructure (see Douglas *et al.*, 2008). What is noteworthy in this study is local government's failure to plan for climate change and to prioritise other development initiatives; the trust deficit of communities, and government officials' lack of capacity to implement policies. There is also a common consensus in the literature that resilience to climate-induced disasters can be increased by eradicating poverty and creating jobs. What is disturbing in this review are common views regarding the lack of preparedness plans among vulnerable groups and illiterate communities, as well as the lack of intra and extra stakeholder partnerships, without any empirical evidence depicting the opposite.

The inadequacy of disaster preparedness plans goes against the ethos of Easton's (1993) political systems theory, which is anchored around stakeholder interaction in implementing government policies (refer to Figure 1). As the service delivery or provision of basic services lies at the local government level, it is disturbing that municipal officials are inadequately

trained with inappropriate training programmes provided to them that are not aligned with the demands of climate-induced disasters. The extent and lack of climate change skills and knowledge among municipal officials have caused them to fail to implement policies and develop partnerships, be unprepared for climate-induced disasters, and failed to introduce effective disaster preparedness programmes for vulnerable communities. The application of AI and digital tools such as GIS and Remote Sensing has been considered to equip public sector officials to be prepared for climate-induced disasters (Abid *et al.*, 2020; Mahmud, 2022).

Two other themes that were considered to have aggravated the impacts of the 2022 disasters were unplanned urbanisation and the apartheid planning model, which led to poorly constructed cities. The head of an NPO called Groundwork (which focuses on environmental justice), who is also a member of the Presidential Climate Commission, was cited by *Daily Maverick* (Evans, 2022) as saying that "Durban was the first apartheid-designed city ... and apartheid planning created

poorly constructed townships and a division and duality of managing Durban by the Ingonyama Trust and the eThekweni Municipality." A focal theme linking rapid and unplanned urbanisation to the apartheid model coincides with the conclusions drawn by scholars (Mhangara *et al.*, 2017; Rice, Lond & Levenda, 2022) who have cited the emerging of 'climate apartheid' and apartheid historical growth characterised by unequal human settlements in this epoch in urban South African cities. The unprecedented and unequal human settlements in South African cities have been considered to have exacerbated urban poverty, inadequate access to proper infrastructure and basic services, and continuation of the outdated apartheid spatial urban planning without ready-made solutions. The nature and extent of unplanned urbanisation have also increased the divide between the rich and the poor, infrastructure and environmental challenges, climate privilege and precarious, weak governance, and food insecurity.

5. CONCLUSION

By critically reviewing the literature, this study sought to investigate the effectiveness of preparedness plans as they relate to the climate-induced disasters that occurred in two South African provinces in 2022. Furthermore, the study dissected the effects of urbanisation and inadequate infrastructure and how this affects the severity of disasters. An inference can be drawn in view of the themes that emerged from this study: local government's ability to prioritise climate change interventions, municipal officials' incompetency relating to climate change, and a lack of stakeholder partnerships gave rise to the devastating effects of climate-induced disasters in these two regions. In addition, inappropriate training programmes for municipal officials and a lack of climate change knowledge can be associated with a lack of climate literacy among vulnerable communities that are susceptible to climate change-induced disasters.

A noteworthy finding was a link between the legacy of apartheid urban planning and the catastrophic impacts of flooding in KZN. However, the literature depicts poverty, the scarcity of land, as well as rapid and unplanned urbanisation as adversely impacting on the designated groups. In addition, the economic repercussions on agricultural production, livestock, and infrastructure were severe, especially in the EC province. Finally, the lack of disaster preparedness plans was ascribed to a shortage of staff and resources, preventing municipalities from implementing such programmes.

In view of the above highlights of the study, it is recommended that a holistic investigation by both municipal planners and communities be undertaken to assess the risks, hazards, and effects of each ward and to ascertain what type and extent of disasters may strike these areas. The municipalities should develop, implement, and enforce by-laws that deal with unplanned urbanisation and influence the provincial and national governments to enact

legislation to manage sporadic immigration. The shortage of safe land should be countered with the benchmarking of the integrated knowledge management systems applied in other developing countries where communities have built houses on floodplains (Douglas *et al.*, 2008; Price & Vojinovic, 2008), in mangroves, on wetlands, and on hilly slopes. Disasters are synonymous with poverty in developing countries, and in-person consultations and educational programmes on preventing, preparing for, responding to, and recovering from disasters should be prioritised by stakeholders, including municipal officials, academics, and NGOs. Finally, at the centre of driving preparedness programmes in vulnerable areas, intra- and inter-departmental partnerships are encouraged in the form of service-level agreements and partnerships with NPOs and NGOs (Botha *et al.*, 2011).

This study relied on online newspaper articles, empirical articles, and a review of the literature. Future researchers should conduct surveys to test the communities on their access to effective early warning systems; the value of Indigenous Knowledge Systems (IKS) in mitigating the impacts of disasters, and the diverse stakeholders' effects in the disaster continuum in their areas.

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