Open Access | Original Research
International Journal of Social Sciences and Economic Review, 1(3), 2019 | PP: 08– 16
https://doi.org/10.36923/ijsser.V1i3.43

People With Vulnerabilities To Cyclone In The Coastal Area of Bangladesh: An Overview

Abdul Karim Gazi[1]

Abstract: This paper aims to explore the vulnerability to cyclones and propose ways to mitigate this vulnerability in the coastal areas of Bangladesh. The study employs a content analysis approach within qualitative research, utilizing secondary data collected through content analysis and historical methods. The focus is on understanding the multi-faceted nature of vulnerability, which includes socio-economic, physical, environmental, geographical, and cultural factors. The findings reveal that vulnerability in the coastal areas of Bangladesh is not solely due to socio-economic conditions but is also significantly influenced by physical and environmental factors. Additionally, the study highlights the challenges faced in taking appropriate measures post-cyclone and discusses the potential benefits of an emergency action plan and collaboration between government and non-governmental organizations (NGOs). The study concludes that a comprehensive approach involving various stakeholders is essential to effectively reduce vulnerability to cyclones and enhance resilience in the coastal areas of Bangladesh. This research provides valuable insights for policymakers, and governmental, and non-governmental organizations working towards mitigating cyclone impacts and supporting vulnerable populations in Bangladesh.

Keywords: Bangladesh, Cyclone, Vulnerability, Vulnerability Mitigation, Social Policies

Article History:

Received: 08-02-2019
Accepted: 15-10-2019
Publication: 27-12-2019

Cite this article as:

Gazi., A., K. (2019). People With Vulnerabilities To Cyclone In The Coastal Area Of Bangladesh: An Overview. *International Journal of Social Sciences and Economic Review*, 1(3), 08–16. doi.org/10.36923/ijsser.v1i3.43

Corresponding Author(s):

Abdul Karim Gazi Department of Sociology, University of Barishal, Barishal 8200, Bangladesh. Email: gazikarimbu@gmail.com

1. Introduction

Bangladesh is the 6th most disaster-prone country in the world, with 97.7% of the total population and 97.1% of total areas at risk and threatened by climate change, including sea level rise, storm surges, and coastal cyclones (Hussain & Rahman, 2018; Goosen et al., 2018). Maintaining economic growth and alleviating poverty in Bangladesh necessitates an immediate reduction in vulnerability to cyclones (Goosen et al., 2018). Several factors, including economic, social, physical, and geographic nature, hinder the ability to cope with the impact of cyclones and are the root causes of vulnerability. Addressing these factors is crucial for the Bangladesh government to eradicate the vulnerable and deplorable situation.

The novelty of this study lies in its comprehensive approach to examining the multifaceted nature of vulnerability to cyclones in Bangladesh, encompassing socio-economic, physical, environmental, geographical, and cultural factors. While previous studies have often focused on singular aspects of vulnerability, this research integrates various dimensions to provide a holistic understanding. Furthermore, it proposes an emergency action plan and emphasizes the importance of collaboration between governmental and non-governmental organizations (NGOs) to mitigate vulnerability effectively.

The overarching goal of the study is to build a comprehensive understanding of vulnerability to cyclones in the context of Bangladesh, with specific objectives as follows:

- To define vulnerability and cyclone.
- To analyze types of vulnerability.
- To examine the causes of vulnerability.
- To analyze the mitigation process of vulnerability.

This integrated approach aims to contribute significantly to the existing literature and provide actionable insights for policymakers and stakeholders involved in disaster risk reduction and management in Bangladesh.

2. Literature Review

2.1. Concept of Cyclone

Cyclone, derived from the Greek word "Kyklos" (coil of snakes), occurs in the Indian Ocean area. It typically occurs in early summer (April-May) or late rainy season (October-November). A cyclone originates from low atmospheric pressure over the Bay of Bengal (Khan, 1992; Rahman et al., 2018). Cyclones in the South Asian Sub-Continent are presently classified according to their intensity, and the following nomenclature is in use:

[1]Department of Sociology, University of Barishal, Barishal 8200, Bangladesh. Email: gazikarimbu@gmail.com

Table 1: Measurement of the cyclone.

Category	Wind speed
Depression	winds up to 62km/h
Cyclonic storm	winds up from 63-87km/h
Severe cyclone	winds from 88-118km/h
Severe cyclonic storm of Hurricane intensity winds	above 118km/h

Source: Khan (1992)

Among these four types of wind speeds, 88-118 km/h is the most common and usually causes significant damage to the coastal areas of Bangladesh. Wind speeds above 188 km/h appear occasionally in Bangladesh, causing severe destruction. Wind speeds below 60 km/h occur frequently but cause less damage compared to the other types of cyclones.

The coastal area of Bangladesh spans 47,211 square kilometers, housing approximately 35 million people. Warnings are issued by the meteorological department using a system to alert shipping of impending cyclones. The information on cyclones is collected from international satellite images. The warning system uses a scale from 1 to 11 for the seaports and 1 to 4 for river ports (Shamsuddoha & Chowdhury, 2007). The Standing Orders for Cyclone (SOC) guides over warning stages:

Table 2: The signal of cyclone

Situation	Signal
Pre-disaster stage	off-cyclone season
Alert stage	signal No. I, II, and III
Warning stage	signal No. IV
Disaster stage	signal N0. V, VI, VII, VIII, IX and X
The post-disaster stage	immediately after the cyclone till normalcy is attained

Source: Miyan (2005)

However, signal X is the main type of signal that indicates more risk to vulnerable groups. All signals under X are important, but signals from I to III often appear and cause less damage compared to signals above IV.

Bangladesh has significant experience in dealing with devastating cyclones. A report conducted in 2017 highlighted 12 major cyclones in Bangladesh, which indicated substantial damage, such as:

Table 3: 12 major cyclones in Bangladesh

Date of cyclone	Amount of deaths
May 11, 1965	19279
December 1965	873
October 1966	850
November 11, 1970	300,000
May, 1985	11,069
November 30, 1988	5708
April, 1991	138,000
May 1997	155
November 15, 2007	3363
May 25, 2009	150
May 16, 2013	17
May 21, 2016	26

Source: Ahmed (2017)

These cyclones have severely impacted the economy of Bangladesh, resulting in numerous fatalities and property damage.

Cyclones affect not only Bangladesh but also have a deadly impact worldwide. UN member states adopted the Sendai Framework for Disaster Risk Reduction 2015-2030 to mitigate disaster losses because disasters hinder poverty reduction efforts and the achievement of Sustainable Development Goals (SDGs), especially in low- and middle-income countries (Wailemacq & McClear, 2017). From 1998-2017, the world experienced various disasters, with cyclones and storms being particularly noteworthy:

This table illustrates that, alongside other disasters, cyclones significantly disrupt the world's balance, causing numerous fatalities. It is evident that without proper measures, a safer living environment cannot be achieved.

Table 4: Disasters and their effects on the world

Name of Disasters	Numbers of disasters	Economic losses ($)	Number of affected people	Number of deaths
Storm	2,049	1330 billion	725 million	232,680
Earthquake	563	661 billion	125 million	747,234

Flood	3148	656 billion	2.0 billion	142,088
Drought	347	124 billion	1.5 billion	21,563
Extreme temperature	405	61 billion	97 million	166,346

Source: Wailemacq & McClear (2017)

This table illustrates that, alongside other disasters, cyclones significantly disrupt the world's balance, causing numerous fatalities. It is evident that without proper measures, a safer living environment cannot be achieved.

2.2. Concept Of Vulnerability

Vulnerability encompasses the human dimension of disasters, resulting from a range of economic, social, cultural, institutional, political, and psychological factors, including social group, age, gender, building design and construction, inadequate asset protection, lack of public information and awareness, limited official risk recognition, and preparedness, which make people isolated, insecure, and defenceless in the face of risk (PreventionWeb, 2015; Odpm, 2013; Ifrcrcs, 2019).

To discuss vulnerability, it is essential to understand the process of vulnerability. The 'Pressure And Release (PAR) model: the progress of vulnerability' demonstrates how vulnerability is created in the context of disasters, including cyclones. This approach provides insight into the mechanisms that make communities susceptible to disasters like cyclones.

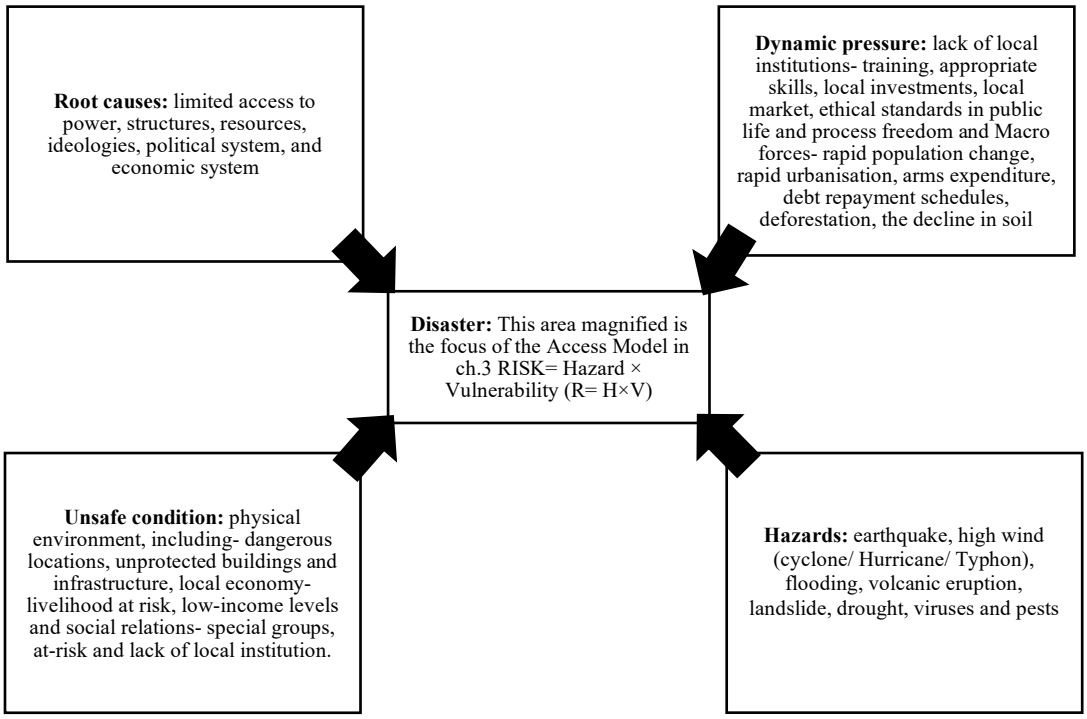

Figure 1: Pressure and Release (PAR) model: the progress of vulnerability. *Sources: Wisner et al. (2003).*

The root causes, dynamic pressure, and unsafe conditions are vulnerability, which makes risk with the help of hazards. Those people are secure and are free from the above conditions. So, eradicating the above factors must be needed to reduce the intensity of vulnerability.

2.3. Cyclone And Vulnerability

Disaster is the product of natural hazards on vulnerable people who are living in disaster-prone areas (Cannon, 2008). Vulnerability is a set of socio-economic conditions, including livelihood, baseline status, self-protection, and social protection, that is identifiable and related to particular hazard risks and can be mitigated by political and economic processes (Cannon, 2008). Bangladesh is situated in a vulnerable location because of its geographical and geomorphological conditions. Among all inhabitants of coastal areas, women are more affected by disasters because they depend on local natural resources and have limited decision-making power and access to resources (Sharmin & Islam, 2013). Poverty increases vulnerability during disasters in the coastal areas of Bangladesh. To reduce vulnerability, residents need to build disaster resilience, which will be possible when poverty is alleviated among the affected people (Chaudhury, 2017).

Besides poverty, several other factors increase vulnerability, such as unplanned settlements, dependency on dangerous and problematic places far from cyclone shelters and transportation. Many people in those areas increase religious activities to satisfy their God. Some cannot go to cyclone shelters and instead seek shelter in thatched-roof houses and under big branches of trees, with women and children being more affected by cyclones (Alam & Collins, 2010). On the other hand, vulnerability can be reduced through forecasting and warning, community preparedness, and land use planning (Bisson, 2012).

The author aimed to study vulnerability to cyclones because cyclones are the top disaster in Bangladesh. Different scholars have argued about vulnerability to cyclones from various perspectives. Some have focused on gender perspectives, while others have focused on geographical, economic, and other factors contributing to vulnerability in the context of Bangladesh. No scholars have focused on all factors of creating vulnerability to cyclones and presented clear causes of vulnerability. Therefore, the author has focused on all factors contributing to vulnerability to cyclones in Bangladesh and tried to present clear causes of vulnerability.

3. Methods And Materials

Bangladesh is ranked 15th according to total damage as a %age of GDP, 2nd according to the population affected, and 23rd according to the total number of disasters relative to the landmass. It is evident that natural hazards have short- and long-term consequences on economic growth and poverty. Long-term changes in vulnerability, structure, and composition of economic activity demonstrate the development of any country. Vulnerability to disaster is determined by a complex, dynamic set of influences, such as economic structure, stage of development, and prevailing economic and policy conditions (Benson & Clay, 2003).

3.1 Results Of The Study

First and foremost, disasters are not only natural events but also products of societal, political, economic, and environmental factors. Natural hazards directly impact life and property, but several factors make people vulnerable. Vulnerability is generated by social, economic, and political processes that increase the intensity of damage (Wisner et al., 2003). Scholars and organizations have identified several types of vulnerability to cyclones worldwide. The author has used those types of vulnerabilities in the context of Bangladesh, as all types of vulnerability to cyclones exist in the country.

A) Political Factors

Political factors have a direct link to vulnerability, primarily due to the lack of decision-making power, which makes a community vulnerable in various ways. Deep-rooted socio-economic elements, including denial of human rights, denial of access to power structures, access to quality education, employment opportunities, land tenure, access to resources, infrastructure, basic services, and information, create and increase vulnerability, shaped by political factors.

Political interference is fundamental to disaster risk reduction. For instance, in 1994, South Africa's new democratic government decided to adopt a new approach to managing disaster and risks, leading to a total reform of the country's disaster risk management policy and legislation (Niekerk, 2011). The flood in 1974, hyperinflation, massive damage to infrastructure, institutional disruption, and bloody political crisis turned Bangladesh into a famine in 1974-75 (Benson & Clay, 2003). Thus, political factors can exacerbate vulnerability to cyclones.

B) Physical Vulnerability

Physical vulnerability refers to susceptibilities to structural damage to buildings, vehicles, infrastructure, and lifelines (heat, food, water) and is determined by population density, remoteness of settlements, design and materials used for housing, difficulty in accessing water resources, means of communication, hospitals, police stations, fire brigades, roads, bridges, etc., and the lack of proper planning and implementation in constructing residential and commercial buildings (Tapsell et al., 2013; Donner & Rodriguez, 2011; ODPM, 2013).

The coastal areas of Bangladesh are physically vulnerable to riverine floods, tropical cyclones, devastating storm surges, and erosion, which cause severe economic and social disruption and considerable loss of life (Benson & Clay, 2003). For example, cyclones result from the tropical monsoon climate, proximity to the equator, warm oceanic temperatures, presence of high vertical wind, and low-pressure areas in the Bay of Bengal. Chottogram, Cox's Bazar, Khulna, and Noakhali are extremely vulnerable districts in Bangladesh, located near the Bay of Bengal (Hossain et al., 2019; Hussain & Rahman, 2018). Cyclone Sidr in 2007 exemplifies this vulnerability, causing approximately 3,406 deaths, 55,282 injuries, and $1.67 billion in damages (Dasgupta et al., 2010).

Bangladesh's distinctive climate has been rigidly affected by its location in the northeastern part of South Asia, with a 730-kilometer coastline along the Bay of Bengal. The physical differences between rural and urban areas also increase vulnerability; for example, rural inhabitants are more vulnerable than urban inhabitants due to a lack of health services and hygienic facilities. Additionally, rural women, who are more numerous and dependent on men and family, are particularly vulnerable (Toufique & Yunus, 2013). Hence, families dependent on women increase vulnerability in rural areas.

C) Economic Factors

Economic vulnerability refers to income sources, including ease of access and control over means of production (farmland, livestock, irrigation, and capital). The level of vulnerability depends on the economy; poorer individuals, communities, and nations are more vulnerable. Factors such as professional attributes, declining monthly average household income and savings, monthly loan payments, property and infrastructure damage, and food scarcity contribute to economic vulnerability (ODPM, 2013; Hossain et al., 2019).

The housing conditions in Bangladesh, especially in coastal areas, are poor. A survey revealed that 46.67 % of houses are kacha (made of mud, bamboo, and straw), 11.11 % are semi-pucca (with foundations of bricks and

concrete, walls of bamboo and wood, and roofs of tin), 20 % are jhupri (with ceilings less than 4 feet, made of cheap materials like bamboo, grass, leaves, polythene), and 22.22 % are huts. These houses are easily damaged by strong winds. Coastal residents claim they do not build resilient cyclone houses due to weak socio-economic conditions (Siddeqa et al., 2018).

Poor sanitation and access to clean drinking water, influenced by lower economic conditions, exacerbate vulnerability in coastal areas. Research shows that 28.89 % of people use ring slab toilets, 33.33 % use hanging toilets, and 37 % have no toilets. Additionally, 25 tube wells serve 557 households, with only 37.50 % of people having access to clean drinking water, 38.63 % having limited access, and 23.87 % having no access (Siddeqa et al., 2018).

Lower household economic conditions make coastal areas vulnerable. A report indicated that 35.55 % of people are in needy conditions, 44.44 % are in temporary needy conditions, 13.33 % are in an income-expenditure balance, and 6.67 % are wealthy (Siddeqa et al., 2018).

D) Social Factor

Social vulnerability is often hidden, complex, and nested in various human aspects. It is influenced by a variety of social factors including social class, income, education, lack of awareness, access to information and basic human rights, social equity, and strong cultural beliefs (Tapsell et al., 2013; Singh, 2014; Niekerk, 2011). Social vulnerability refers to the inability of people, organizations, and societies to reduce the impact of disasters due to characteristics inherent in social interactions, institutions, and systems of cultural values, which are linked to the well-being of individuals and the community. These include the level of education, the existence of peace and security, access to basic human rights, systems of good governance, social equity, positive traditional values, customs, ideological beliefs, and political accountability (ODPM, 2013).

Several reasons contribute to increased social vulnerability, such as lack of access to education, disaster risk reduction, and climate adaptation information, knowledge and technology, limited access to political power and representation, and social capital (networks, connections, beliefs, and customs) (Singh, 2014; Cardona et al., 2012). These factors influence all dwellers, especially children, women, the very young, the very old, orphans, nursing mothers, ethnic minorities, immigrant groups, and physically and mentally challenged people (Hossain et al., 2019; Niekerk, 2011).

E) Cultural Vulnerability

Culture relates to life, behavior, taste, ethnicity, ethnic values, beliefs, customs, ideas, institutions, art, and intellectual achievements shaped by society (Cardona et al., 2012). Coastal dwellers often believe that cyclones do not affect them and depend on God without seeking safe places. Most inhabitants are Muslims and adhere to the teachings of the Quran, which instructs them to seek life depending on Allah. However, many people are reluctant to change their attitudes toward disasters and blame their luck, thus making themselves vulnerable. It is essential to move away from fatalism and seek safe places. When seeking safe shelter becomes a tradition, more people will follow.

Children in coastal areas are socialized in an uneducated culture, and many refuse to attend school, influencing others to do the same. A report indicates that primary schools, high schools, Caritas, and the head Bangladesh office are used to educate children, with schools often about one kilometer away. About 41.45 % of children do not attend school, 16.24 % do not attend when injured, 26.22 % willingly attend, and 11 % attend school late in coastal areas of Bangladesh (Siddeqa et al., 2018). Educating children about cyclones is crucial.

The habit of delaying going to cyclone shelters is common among coastal dwellers. Some people delay seeking shelter, and others learn this behavior from them.

F) Geographical Setting

Climate change is inevitable and will physically and economically stress people in developing countries. Disasters result from a complex mix of natural hazards and human actions. Less developed countries are more vulnerable than developed ones. People in developing countries suffer from repeated, multiple, mutually reinforcing, and simultaneous shocks to their families, settlements, and livelihoods (Wisner et al., 2003).

Vulnerability can change through rapid economic growth, urbanization, and technical and social changes. Bangladesh and the Caribbean have shown progress through economic transformation and public actions (Benson & Clay, 2003). Poverty increases vulnerability in developing countries, but insurance, savings, investments, or other financial instruments can help reduce poverty (Niekerk, 2011). Social problems in developing countries also contribute to vulnerability, including lack of information and resources, and higher vulnerability among women, girls, and the elderly.

G) Environmental Factors

Environmental vulnerability involves natural resource depletion, resource degradation, loss of ecological resilience, biodiversity loss, and exposure to toxic and hazardous pollutants (ODPM, 2013; Niekerk, 2011). Several environmental vulnerabilities exist in the coastal areas of Bangladesh, including houses made of mud with straw roofs, proximity to rivers and the open sea, remoteness, distance from cyclone shelters, and salinity-prone

areas (Hossain et al., 2019). Open and bamboo-wooden structured latrines are common in rural areas, which can be damaged by cyclones, leading to waterborne diseases spreading post-disaster (Rahman et al., 2018).

H) Gender Perspective

Gender, a social difference between males and females, influences disaster vulnerability and risk distribution. Women and men face different risks in all settings—home, work, and neighborhood—where gender shapes their capabilities and resources to minimize harm, adapt to hazards, and respond to disasters (Enarson & Chakrabarti, 2009; Wailemacq & McClear, 2017). Cultural barriers, lack of education, economic security, political participation, and essential services, high poverty levels, higher fatality rates, slower recovery, displacement threats, and high levels of sexual violence constrain women's personal autonomy and physical mobility (Niekerk, 2011; Rahman, 2013).

A recent report indicates that only 90 % of women receive cyclone warnings, and only 41 % go to cyclone shelters. Others do not go due to distance, lack of road access, slippery roads, and stormy wind. Even if they reach the shelters, they face overcrowding, lack of ventilation, water supply, sanitation facilities, proper space, separate areas and toilets for women, and assistance for pregnant women. This uncomfortable situation, staying with unfamiliar men, and crying children in bad weather further discourage women (Shahjahan, 2018).

Women in Bangladesh primarily work at home and often do not receive warning signals. When their sons or husbands return home, women hear about cyclones. About two-thirds of women do not understand warning signals, and about one-third understand them due to attending training. When women receive warnings last, they have many tasks to complete before going to shelters, including gathering livestock, poultry, and dairy commodities. When the male partner is absent, women face significant difficulties. During cyclones, some men go to mosques and madrasahs, but women cannot due to cultural and religious restrictions. With limited cyclone shelters, women take refuge in brick-built homes (Shahjahan, 2018). Women in Bangladesh are often subordinate to men, with 90 % living in rural areas and engaging in various tasks, including cooking, cleaning, washing, agricultural work, and childcare (Nasreen, 2012). The main cause of women's vulnerability is their lack of participation and empowerment in decision-making processes for disaster prevention, preparedness programs, and recovery operations (Rahman et al., 2018).

3.2 Vulnerability Mitigation

In 1988, the Intergovernmental Panel on Climate Change (IPCC) was established jointly by the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP). The IPCC has focused on global warming and climate change, raising public awareness and concern about these issues. Inspired by the IPCC, the government and NGOs have started their activities (Shamsuddin et al., 2015).

Disaster risk depends not only on hazard intensity and population but also on vulnerable conditions. Comprehensive efforts to reduce vulnerability include implementing building codes, insurance, and social protection; emphasizing economic diversity and resilient livelihoods; raising knowledge and awareness; and preparedness measures (PreventionWeb, 2015). Some initiatives have significantly reduced cyclone-related mortality rates, such as early warning systems, cyclone shelters, evacuation plans, coastal embankments, reforestation schemes, and increasing awareness and communication. These efforts have decreased deaths from 500,000 in 1970 to 4,234 in 2007 (Shahjahan, 2018). Besides the government, other people and organizations must work to reduce vulnerability and damage rates. The author identifies four levels of activities for reducing vulnerability and developing these areas:

A) Individual Level

Siddeqa et al. (2018) argue that individual-level activities can help reduce vulnerability. These include the young generation helping others, males migrating to urban areas for work, avoiding indigenous knowledge and using TV and radio, immediate preparation for disasters (taking dry food, drinking water, and candles), and learning from past experiences. People often delay leaving their homes when a cyclone is imminent, fearing theft of their property. A recent study shows that 37.78% of dwellers take shelter at Caritas and head Bangladesh offices, 31.11% at schools, 6.67% on bridges, 6.67% on roads, 8.89% at neighbours' houses, and 8.89% at their own homes. Most coastal residents are illiterate and unaware of cyclone preparedness. For example, up to 15-year-old children are often excluded from education, with about 85 % having no idea about cyclone warnings and preparedness (Shahjahan, 2018). Training on preparedness must be ensured to increase awareness. When trained, people will be more aware of the consequences of cyclones (Siddeqa et al., 2018).

B) Community Level

The young generation has a vital role in reducing vulnerability. They should form committees to conduct various activities, such as repairing embankments, cyclone shelters, and communication systems, helping researchers conduct studies, distributing relief and other services, and assisting older and disabled people to reach shelters. Coastal areas lack trees around houses, with only raintrees and banana trees being common (Siddeqa et al., 2018). Planting wind-resilient trees is necessary to reduce wind damage. The young generation should motivate people to plant such trees around houses, embankments, roads, and villages and encourage them to cut down weak and risky branches before a cyclone. Many female-led families cannot manage crises (Siddeqa et al., 2018). The young generation should assist these families in reaching cyclone shelters.

C) National Level

The Bangladesh government must ensure access to open water resources (sea, river, char land, Khas land, and forest) and increase financial capital (Mahajon, Arotder, friends, and relatives). Workers in agriculture, health, family planning, and fisheries; Union Parishad; NGOs; and physical resources (market centres, village roads, cyclone shelters, tube wells, hospitals, and schools) can help reduce vulnerability and cyclone damage (Paul, 2013). Furthermore, ensuring continuous access to communication tools like mikes, sirens, and radios, separate shelter areas for men and women, medical facilities, training for women to assist ill women, shelter electricity, vulnerability mapping, and location analysis must be ensured (Shahjahan, 2018).

NGOs are the government's third executive arm. Government-NGO conflicts hinder vulnerability reduction. NGOs claim they are prevented from conducting their activities properly and that the government dominates them regarding project approval (Nawaz, 2019). Conversely, the government claims that NGOs exaggerate their actions and threaten sovereignty. However, NGOs' assistance is crucial in reducing vulnerability. The government must be liberal while maintaining sovereignty to benefit from NGOs' relief efforts. Additionally, the government should seek help from international organizations and convey the demand for reduced vulnerability in coastal areas. Rural residents often drink water from ponds and canals, and safe drinking water becomes scarce after cyclones, with prices rising. The government and NGOs should install more tube wells in rural areas (Toufique & Yunus, 2013).

To reduce cyclone damage, the government should enhance cyclone preparedness (investing in cyclone warning systems, building new cyclone shelters, improving evacuation plans), coastal management (coastal embankments, tree plantations, sustainable development in coastal areas), and post-cyclone activities (relief operations, recovery, reconstruction in affected areas) (Shamsuddin et al., 2015).

Authorities must ensure that officials perform their duties and establish monitoring bodies. Policymakers should formulate policies based on field observations. The Federal Emergency Management Agency - The State and Local Guide-101 (FEMA-SLG-101) has developed an Emergency Operation Plan Process based on fire disasters in the USA (Kramer, 2009). The author argues that this process may be helpful after cyclones in Bangladesh's coastal areas, as administrative problems often arise post-cyclone. The Emergency Operation Plan Process includes:

1. **Principles:** Creating new plans and policies consumes significant time. Authorities must work immediately, considering others' opinions in daunting tasks. Revising previous plans and policies can help start tasks quickly.
2. **Research:** Some tasks may conflict with laws and regulations, and higher authorities may prevent them. Planners should align tasks with laws and seek NGO assistance without compromising state sovereignty. Plans must adhere to state laws.
3. **Development:**
    - Identify and communicate the exact cyclone situation (potential results, at-risk people, and property) based on historical cyclone data.
    - Seek resources from response agencies (money, commodities) and invite new agencies to assist with recovery.
    - Reduce communication barriers to expedite aid delivery.
    - Draft plans, distribute them for review, and incorporate feedback.
4. **Validation:** Ensure plans comply with laws and regulations, test plans through exercises (tabletop, functional, full-scale), and incorporate reviews.
5. **Maintenance:** Plan-oriented individuals or agencies must act promptly to reduce damage and facilitate immediate recovery.

D) International Level

Vulnerability varies by country due to geographical differences. Bangladesh is vulnerable to global warming, exacerbated by developed countries. International organizations must address global warming's impact on Bangladesh and other developing nations, providing subsidies and budgets to reduce vulnerability and calling for assistance from Bangladesh.

4. Discussion Of Findings

Bangladesh has endured significant impacts from cyclones for many years, affecting people, property, infrastructure, environment, and social stability due to its geographical location, low economy, low coping capacity, and unaware population. Vulnerable conditions such as poverty, weak housing, and lack of awareness increase the severity of cyclone damage. Research has shown that women, girls, disabled people, and the elderly are particularly vulnerable. This study confirms that these groups are especially vulnerable when they have weak housing and lack awareness. Women in low-income families with weak housing are more vulnerable than other family members.

Bangladesh is also vulnerable due to global carbon dioxide emissions from capitalist countries, which affect coastal countries worldwide. The study aimed not only to identify vulnerability but also to find ways to mitigate it. The high vulnerability to cyclones in Bangladesh indicates a lack of proper steps, policies, and weak enforcement. The analysis identified that proper steps can reduce cyclone damage rates. The author suggests that the Emergency Operations Plan Process may be helpful in post-cyclone emergencies.

5. Conclusion

Cyclones make coastal dwellers vulnerable and hinder social and economic development (Shahjahan, 2018). Developing the coastal area of Bangladesh is crucial for overall national development. Cyclones occur annually in Bangladesh, causing varying degrees of damage. To develop these areas, vulnerability reduction is essential, which helps lower damage rates. The Bangladesh Government, coastal dwellers, national and international NGOs, and institutions must collaborate to reduce vulnerability. Awareness and training are vital. Government-NGO conflicts have hindered progress, so collaboration is necessary for development. Universities should focus on cyclone research to contribute to solutions. Eradicating vulnerability in the coastal area of Bangladesh requires everyone to play their role effectively.

6. Limitation And Study Forward

This study primarily relied on secondary data, leading to the absence of primary data and a lack of statistical findings that limit the generalizability of the results. Additionally, the focus was solely on vulnerability to cyclones, excluding other disasters affecting the coastal areas of Bangladesh. The study also utilized comparatively few data sources, further constraining its scope. Despite these limitations, the study provides a foundational pattern of vulnerability to cyclones, which can guide future research and action plans aimed at reducing vulnerability. Future studies should incorporate primary data collection, broaden the scope to include other types of disasters and employ a larger dataset to enhance the reliability and generalizability of the findings.

Acknowledgement Statement: I would like to thank my teacher, Md. Sadequr Rahman, for teaching and inspiring me to conduct this study. I also acknowledge my friends, Md. Muhimenul Islam, Md. Al Rakib, Nazmun Nahar Showmi, and Md. Parvez Hossain, for their support and inspiration.

Conflicts of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding statements: This research has not received any funding.

Data availability statement: Data is available at request. Please contact the corresponding author for any additional information on data access or usage.

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