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An overview of disaster risk reduction and anticipatory action in Bangladesh

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Climate change has and will continue to increase the intensity and frequency of extreme climate events. Bangladesh is one of the most vulnerable countries to climate change owing to its low elevation, dominance of floodplains, its high population density and its low economic, infrastructural and technological capacity. Despite the vulnerability, Bangladesh has managed to reduce the adversity of the extreme events over the years. This study assesses the effectiveness of the country's governance structure, implications of national policies, legal framework, involvement of local government, and non-government organizations in developing an efficient disaster risk reduction and anticipatory action system in Bangladesh. Through an extensive and systematic literature review the study reveals that the country has become a role model through its disaster management journey by successfully developing an efficient disaster management system from a reactive approach focused on relief rehabilitation to a proactive approach that includes hazard identification, improvement of community preparedness, reducing vulnerabilities, integrated response and recovery efforts. Also, the recent data shows that the loss of human life due to climatic extreme events is significantly reduced due to improved early warning and forecasting systems, effective use of local governance structure, active involvement of community-based organizations, risk informed and evidence-based policy formulation and effective implementation of the policies and strategies. Despite the success, the country is yet to secure livelihood and properties of vulnerable communities from disaster-induced loss and damage. Besides, there are adaptation failures which also need to be addressed through the lessons from the past. The article also discusses the disaster risk reduction and anticipatory action system requiring further strengthening, focusing mainly on building a climate risk resilient system by incorporating locally-led approach.

KEYWORDS

early warning system, disaster risk, disaster management, anticipatory action, extreme events, policy, governance

Introduction

Bangladesh, a low-lying deltaic country situated in the South Asian region, is crossed over by numerous rivers and their tributaries and distributaries. The country's subtropical climate, geographical location, and flat topology, makes it susceptible to a wide array of natural disasters. Day by day, the frequency and intensity of such unprecedented events and calamities are being exacerbated by climate change (Huq and Rabbani, 2011). Given its vulnerability due to the geological and morphological characteristics, and having a dense population of more than 166 million, Bangladesh stands as the seventh most vulnerable country to climate change impacts according to global risk index 2021 (Eckstein et al., 2020). Based on climate induced vulnerability, the country has been segregated into six major disaster-prone areas as the coastal zone (19 per cent of the total land area), Barind and drought-prone areas (15 percent), wetland ecosystem (also known as Haor) and flash flood areas (11 percent), Chittagong Hill Tracts (CHT) and landslide hazard (9 percent), river system and estuaries (24 percent) and urban areas (13 percent) (NPDM, 2020). Along with the geographical location and dense population, the low economic status, poverty, high dependency on natural resources, lack of financial and technical capacity, and institutional challenges, also makes the country a front-line victim of climate change impacts (Alam et al., 2021).

Loss and damage induced from extreme events and natural disasters caused a catastrophic loss to Bangladesh over the years. Before independence, in 1970 the 'Bhola cyclone' hit the country claiming more than 500,000 lives and causing massive economic loss (Kazi, 2020). After independence, the country witnessed extreme flooding in 1987, 1988, and 1998 where majority of the landmass was inundated; impacting crop production, threatening livelihood, and leading to mass displacement (Nishat et al., 2013; Diya and Bussell, 2017). The Gorky cyclone of 1991 also caused massive loss in terms of life and economy. Around 3,406 people lost their lives during cyclone Sidr in 2007 with an economic loss of $1.7 billion, or acquired 2.6 percent of the country's GDP (Huq and Rabbani, 2011; Haque and Huq, 2015). According to Germanwatch's Global Climate Risk Index (CRI) 2021 which is based on analysis of data from 20 years between 2000 to 2019, a total of 185 extreme events took place within the country due to climate change within this time period, having caused 11,450 casualties and economic losses worth $3.72 billion (Eckstein et al., 2020).

The frequent and intensive occurrence of natural disasters impacts the livelihoods of the vulnerable communities, and threatens their food security. For instance, a total loss of 250,000 hectares of harvestable lands from natural disasters led to crop failure and a resultant 30% rise in price of rice between 2014 and 2021 (IPCC, 2022). Extreme events not only damages livelihoods but also disproportionately compounds on gender vulnerability, disrupting mobility of women and creating health and security complications for them (Juran and Trivedi, 2015); affects education and education infrastructure, with more than a million students being forced to drop out of schools from 2015 to 2020, 70.53 percent of which were caused by flooding, 10.72 percent by tornadoes and 5.37 percent by waterlogging; and more than 5,000 educational institutions shut down in the year 2022 itself (Bangladesh Bureau of Statistics, 2022). All these challenges resulting from episodic climate induced disasters have further made climate induced displacement an issue of concern lately. An estimated 4.7 million people were displaced due to disasters in Bangladesh, during the period of 2008–2014 (Displacement Solutions, 2014).

Despite all these odds stacked against the country, Bangladesh has made an impressive headway in its climate resilience efforts, particularly in reducing loss of human lives, becoming a model of disaster management (DM) transformation from traditional approach-based system to a comprehensive disaster risk management (DRM) system (Mannan et al., 2021), through development improved early warning and forecasting system (Akhand, 2003; BDRCS, 2022), climate-responsive national policies, risk informed and climate-inclusive governance structure and regulatory framework, active involvement of local actors – including local government especially in managing disaster, community-based organizations (CBOs) and non-government organizations (NGOs) (Bodrud-Doza, 2022).

Disaster Risk Reduction (DRR) is defined by United Nations Office for Disaster Risk Reduction (UNDRR) as the 'application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses'. UNDRR also defines Disaster Management (DM) as the 'the organization, planning and application of measures preparing for, responding to and recovering from disasters' and Disaster Risk Management (DRM) 'the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses' (UNDRR, 2009).

Although literature on various aspects of DRR system in Bangladesh exist, there is a lack of a comprehensive study on the overview of this system and its journey, which also outlines the DRR plans for the future.

This paper examines and outlines the successful journey of DRR system in Bangladesh, through investigating the role of different factors contributing to it, along with the shifting trajectories of the country tackling the disasters. Through this examination, this paper clearly highlights what makes Bangladesh a role model for DRR system throughout the world. Besides, the paper also discusses the various challenges plaguing the country's DRM system and how to overcome such challenges. It also tries to dissect the lessons drawn from the country's DRM journey so far and use them in an attempt to

illustrate the way forward for the country's disaster context in the future.

Methodology

The paper relies on review of secondary sources of literature to capture the journey of Bangladesh toward resilience. Here we aim to portray the country's experiences, failures, challenges faced and remarkable progress made while achieving development goals and addressing climate change in a systematic way.

The main method for this research article was textual analysis extracted from Google Scholar and other relevant search engines such as Web of Science, Scopus, and Science Direct. Literature present between 1972 and March 2022 were reviewed and considered for developing this article. Primarily, articles with key words "Disasters Bangladesh", "Disaster Risk Reduction Bangladesh", "Disaster Risk Bangladesh", "Disaster Management Bangladesh", "Disaster Preparedness Bangladesh", "Early Warning System Bangladesh" were used to search for articles in the search platforms.

The initial search exercise gave a total of 2,841 results, and 152 literatures were found to have met the selection criteria which were set prior to the online search. These criteria were considered based on the presence and absence of certain phrases and keywords across indexed journal databases mainly focusing on Bangladesh. Literatures published in the last decade were prioritized. The phrases and keywords used to navigate literatures were: "Disaster preparedness in Bangladesh, Climate change vulnerabilities and resilience in Bangladesh, Disaster risk management and response in Bangladesh." Other than indexed journal articles, gray literature and national policies of Bangladesh were also reviewed.

Relevant data regarding disasters in Bangladesh and their timeline were extracted and tabulated from secondary sources such as official websites, research reports, journal articles, and gray literatures. The policies, local strategies, national plans, and international treaties related to disaster management of Bangladesh and at international arena were all represented in tabular format for better illustration. Further, we tried to demonstrate the pathway toward prosperity through thorough review of current plans of the Government of Bangladesh for the upcoming years. The overall methodology is presented in Figure 1.

Based on the findings from the literature, the major climatic vulnerabilities of the country are addressed in segment three of this article. Segment four illustrates the chronological journey of Bangladesh from a reactive (response) to proactive (resilience) approach in terms of DRR. Several challenges and recommendations are also included in the final segment.

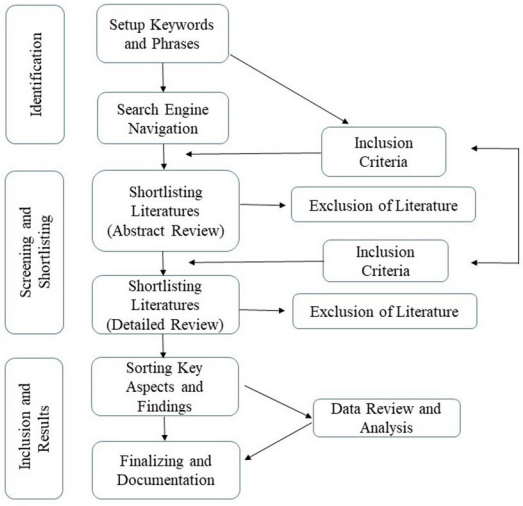

FIGURE 1
A systematic flow chart of the methodology.

Climate vulnerbility

Due to the geographical factors including deltaic topography, low lying elevation and funnel-shaped coast, Bangladesh is prone to natural disasters (Ahmed, 2019). These extreme events include rising temperature and heat stress; frequent and longer droughts; higher river flows and flood risks; increasing rainfall intensity; greater riverbank erosion; sea level rises and salinity intrusion; landslides; and increasing intensity of cyclones; storm surges, and coastal flooding (Ministry of Foreign Affairs, 2018). It is estimated that, the country has experienced more than 100 catastrophic disasters only between 2000 and 2021 (Talukder and Hasan, 2018).

These extreme and slow onset climatic events are adversely affecting human life and socio-economic development (Figure 2). However, the Six Assessment Report of IPCC pointed out that climate change induced disasters and associated impacts are evident in Bangladesh and will only exacerbate in the future (IPCC 2022). Some specific climatic events in Bangladesh are described below:

Tropical cyclone and storm surges

Bangladesh experiences tropical cyclones almost every year, with substantial differences in intensity and severity. A total of 508 cyclones hit the coast of Bangladesh over the last century of which the Bhola cyclone (1970), Gorky cyclone (1991), cyclone Sidr (2007), cyclone Aila (2009), cyclone Bulbul (2019), and cyclone Amphan (2020) left severe impacts on the life and livelihood of the coastal communities

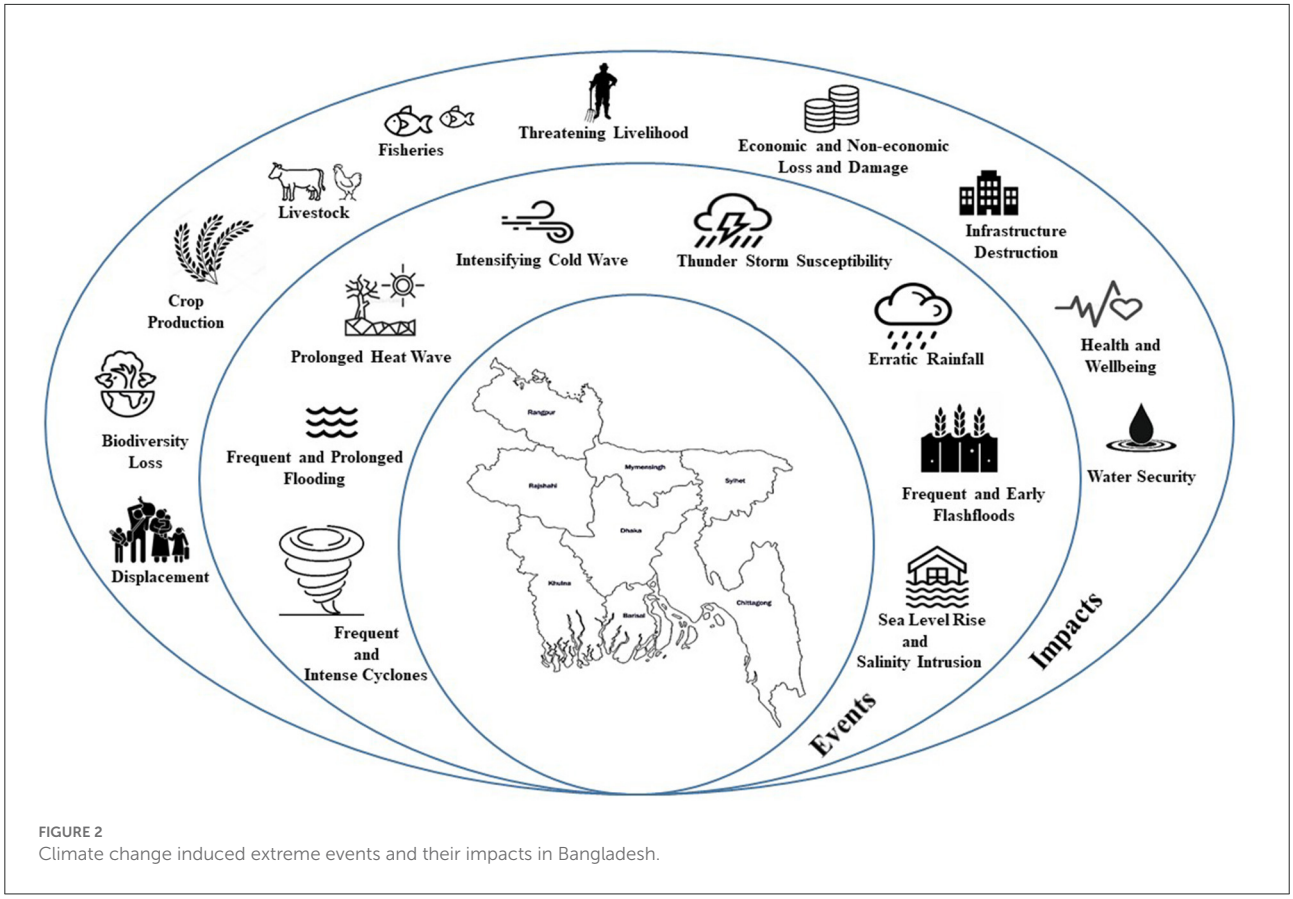

FIGURE 2
Climate change induced extreme events and their impacts in Bangladesh.

(Tahsin and Bodrud-Doza, 2022). Bangladesh is one of the worst sufferers of cyclones in terms of causalities and since 1965, cyclones have caused 718,000 deaths (Haque et al., 2011).

After independence, Bangladesh witnesses the devastation of the super cyclone Gorki in 1991. The category five super cyclone hit the coast of Bangladesh causing death of 138,000 people (Chapling, 2016). Despite having early warning system, the country still failed to save lives, as most people were reluctant to evacuate. In contrast, during Sidr (2007) of similar severity, far less death (3,363) was reported and such a drastic reduction in deaths was attributed to development of a successful upgrades of early warning system and evacuation of vulnerable communities (Paul, 2009). Similarly, in May 2020, Amphan, a super cyclone, attacked the southern coast of the country again (WMO, 2021). Although Amphan claimed only 26 lives, it displaced 2.5 million people, damaged over 400,000 hectares of land and households.

Erratic rainfall, floods, flash floods, riverbank erosion, and landslide

Climate change has also increased the frequency and intensity of heavy rainfall, whilst decreasing frequency of lighter rainfall. As per the IPCC regional fact sheet, the precipitation pattern will drastically change in the South Asian region and extensive to erratic rainfall are expected (IPCC, 2022). Additionally, climate change is particularly responsible for shifting pre-monsoon weeks earlier than usual; particularly in Meghalaya region of north-eastern hills of the country (Ahmed, 2021). Such changes in rainfall patterns have contributed to flood events in the country (Haque et al., 2018). Almost 40 percent of the country was under water with 880 lives lost, 500,000 people displaced and an estimated US $1 billion damages were recorded in the flood of 1987; whereas in 1988, the country experienced another flood event, which displaced over 5 million people and led to US $450 million economic damages (Diya and Bussell, 2017). Further, flash flood events in 1998, 2004, 2006, 2007, 2010, 2015, 2017, and 2020 caused devastating damages in the country and had inundated 25% of the total area on an average every year of Bangladesh (UNDRR, 2020).

The erratic and extensive rainfall also results in massive river bank erosion. Study conducted by water ministry found the loss of 28 square kilometer of landmass, eroded in the year 2021 alone (Molla, 2021). This volume of erosion will increase with frequent flood susceptibility. At present, river bank erosion is considered a prime threat to livelihoods and vulnerable communities, as it

leaves people homeless and landless, and also triggering displacement rate.

Landslide is another natural calamity related to extensive rainfall. Particularly communities from the Chattogram Hill tracts (CTH), in the southeast part of Bangladesh, have been experiencing an increasingly recurrent landslides during the monsoon season. Although the primary driver for landslides are heavy rainfall, this extreme event is also triggered by other socio-economic factors such as unregulated development and urbanization driven hill-cutting, deforestation and illegal land-grabbing. These activities exacerbate physical susceptibilities such as difficult terrains, unstable and highly gradient slopes, and degrading soil quality in particularly the areas of Chattogram division where landslides are common and increasing at an alarming rate (ACAPS, 2018).

Drought like situation

The north-western part of the country receives the least amount of precipitation, and climate change is exacerbating the situation with elongation of the dry season. In the last fifty years, Bangladesh has experienced more than twenty droughts, affecting its rice production and other perennial agricultural resources (Miyan, 2015). Droughts have had severe impacts on livelihoods of nearly half the population in the country. particularly for those engaged in small-scale agriculture. Given the contribution of the agriculture sector in the GDP of the country, if the current situation continues, droughts can potentially have a negative effect on Bangladesh's overall economy (Sammonds et al., 2021). Recently, water scarcity and drought like situation is also being witnessed in Chittagong Hill Tracts region (Barua 2022).

Sea-level rise and salinity intrusion

Sea-level rise (SLR) is one of the most severe consequences of climate change, particularly for low-lying coastal areas. According to the Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC) by IPCC (2019), the global mean sea level will rise between 0.29 and 1.1 m by the end of this century. SLR has had profound impacts on sustainability and has caused serious damage to both livelihood and food security, specifically in coastal zones (Ministry of Disaster Management Relief, 2017). If global temperature keeps rising at the current rate, then over 3 mm/year SLR is expected, which will put mega-deltas like Bangladesh at extreme high risks. The World Bank has projected an increase of 0.1, 0.25 and 1 m in sea levels by the years 2020, 2050 and 2100 respectively, which would subsequently affect 2, 4 and 17.5 percent of the land area (GFDRR., 2011). This would further amplify both magnitude and frequency of coastal floods, tidal surges, and cyclones which would lead to increasing economic losses in coastal zones, lack of employment opportunities, and will have significant impacts on internal human migration (Asaduzzaman et al., 2013; Kabir et al., 2016). Repercussions of SLR include coastal inundation, flooding, land erosion, and salinity in soil and water, which exposes 35 million coastal inhabitants of Bangladesh to saline water, leading to significant health hazards (Brammer, 2014).

Salinity intrusion related to SLR has in particular, adversely impacted drinking water quality, agricultural production, and the delicate ecosystem of Sundarbans mangrove forest in the southern part of the country. Usage and consumption of saline water have led to health issues such as diarrhoea and cholera cases, skin diseases, hypertension, impaired liver function and many other health adversity (Rahman et al., 2019). Also, studies have identified that pregnant women are particularly more vulnerable to saline water as drinking it has increased intrauterine growth retardation, preterm birth, and both maternal and prenatal death cases (Brammer, 2014). Besides, lack of fresh water has simultaneously affected irrigation, decreased soil fertility resulting in reduced crop diversity and lowered agriculture yield. Such loss of arable land has had significant impacts on the GDP of the country as 30% of the cultivable land in Bangladesh are in coastal areas (Ahmed, 2019). Additionally, saline intrusion in the coastal ecosystem of Sundarbans, the world's largest mangrove forest, has adverse impacts on biodiversity. A report published by the World Bank in 2016 states that if the current level of salinity continues to rise then fourteen mangrove species will be marked as endangered, Sundari (Heritiera fomes) tree being one of them (Karmakar et al., 2016).

Other climatic events

Apart from the major climatic events described above, other climatic events like thunderstorms and lightning, cold waves and heat waves also cause adverse impacts on people's lives and livelihoods. Very few studies have been conducted on such climatic events as their consequences are less destructive compared to the major disasters that Bangladesh witnesses every year. Thunderstorms are mostly known as Nor'westers in Bangladesh and their frequency have increased over the years. Studies conducted in southern parts of the country have provided evidence of loss of lives, dwelling houses, household properties, agricultural crops, fisheries, and infrastructure damage were the major impacts of nor 'westers in Bangladesh (Karmakar, 2019).

Response to vulnerabilities and the journey towards resilience

Given climate vulnerabilities and associated impacts on Bangladesh, it is estimated that fatalities in the last fifty years have declined by 100 folds (Wahra, 2021). In 1970 around 500,000 deaths were reported by the Government of the People's Republic of Bangladesh (2021) (GoB) due to the cyclone Bhola; 50 years later, fast- when Amphan in 2020 hit the coast at a similar speed, only 26 deaths were reported despite a substantial increase in the number of people residing in coastal zones have significantly increased in the last 50 years (Kazi, 2020). This remarkable progress was a result of a reformed disaster management system to bring about a paradigm shift from reactive relief-based measures to a more holistic, proactive, integrated and inclusive approach and systematic investment in resilience. Bangladesh government significantly invested in measures such as cyclone preparedness, community based early warning systems, delta management, and structural interventions for protecting development gains (Table 1). With the help of international partners Bangladesh implemented the first project on Cyclone Protection and Coastal Area Rehabilitation in 1972. Gradually, the country introduced disaster risk reduction plans, legal frameworks, climate change strategies, and supported communities, investing in climate resilient infrastructure and in advance technologies (Salzenstein and Montu, 2021). In the first global conference on Environment in Stockholm in 1972, Bangladesh actively participated as a new country to deliberate on the global environment. Later, aligning to the objectives of Rio Convention, the GoB implemented a Nation Environmental Policy in 1992, which had components to ensure minimization of impacts of natural disasters (Planning Commission., 1995).

The reformation of the Disaster Risk Management (DRM) was not an overnight process. It came as a result of successive disasters in late 1980s and the beginning of 1990s, most prominently by the catastrophic devastation left by the super cyclone Gorky in the year 1991 with an estimated 138,000 fatalities (WMO, 2021). This series of events exposed the acute flaws in the traditionally reactive approach of disaster-response, with focus only on relief and rehabilitation. Studies attributed this major failure of the disaster risk reduction (DRR) and early-warning system to a lack of gender-inclusiveness with women casualties amounting to five times more than that of men (Ikeda, 1995). This failure led the GoB to bring about serious reforms to its disaster preparedness and response system. Such reforms caused a substantial decrease in the number of human lives lost against the overall climate-vulnerable context of the country, over the years (Sammonds et al., 2021). The growing prioritization of the GoB towards disaster management focusing on developing DRR centric national plans and policies has helped the country emerge as a global leader in Disaster Management (DM). Figure 3 represents the journey of Bangladesh towards resilience and prosperity in a changing climate.

From response to anticipatory actions

Bangladesh is often cited as a role model for investing in disaster risk management as the country became successful implementing projects such as the Coastal Embankment Improvement Project (World Bank, 2013), and the Emergency Cyclone Recovery and Restoration Project (World Bank, 2008). These investments have helped the country in achieving long-term benefits such as safeguarding against floods and storm surges, coastal erosion, and salinity intrusion (Table 1). Further 700 km long embankments have resulted in increased agricultural productivity, food security, and job opportunities.

Supporting the (Cyclone Preparedness Programm (CPP), 2022), Multi-Purpose Disaster Shelter Projects were initiated and around 1000 shelters were built under the climate adaptive initiatives by the World Bank with support from local government and local NGOs (BDRCS, 2022). These shelters would serve as schools all year and would accommodate vulnerable people during disasters. Initiatives like these have helped save lives during super cyclone Amphan in 2020 (Wahra, 2021). The country has shifted towards a more proactive approach from a reactive approach with the support of development partners which helped it to achieve resilience from disaster response.

Starting from 2003 when the Ministry of Food and Disaster Management (MoFDM) first launched the Comprehensive Disaster Management Program (CDMP) in partnership with various international development partners like Department for International Development (DFID), UK, United Nations Development Program (UNDP) and the European Commission (EC). The GoB adopted the Hyogo Framework for Action in its national plans and strategies from 2005 – 2015. Incorporating this framework in its national plans and strategies, Bangladesh developed National Sustainable Development Strategy, Bangladesh Perspective Plan 2010–2021, Sixth Five-Year Plan 2011 – 2015 (Ministry of Disaster Management Relief, 2017). The National Plan for Disaster Management (NPDM), 2010–2015 was also implemented by the government (Hasan et al., 2013). NDMC is in charge of taking strategic decisions, issuing directives and reviewing policies for disaster management, while Inter Ministerial Disaster Management Committee (IMDMC) holds the responsibility for inter-ministerial coordination (Baten et al., 2018).

Remarkable progress has been noticed in the early warning system of the country which has reduced casualties significantly over the years. Compared to Cyclone Bhola,

TABLE 1 National plans, policies, strategies and programs related to Disaster Risk Management.

Year of implementation	National plans, policies, strategies and programs	Remarks related to disaster risk reduction and anticipatory action
1973	Cyclone Preparedness Program (CPP)	Dissemination of early warning and information of the cyclone, giving primary aid during cyclone, searching, rescuing and transferring people to the safe shelter
1988	Flood Action Plan	A long-term program for obtaining a permanent and inclusive solution to the flood problem of Bangladesh
1993	Disaster Management Council	Provide policy guidance towards disaster risk reduction and emergency response management
1997	Standing Order on Disaster	Disaster risk reduction and strengthening emergency response system
2001	National Water Management Plan	Implement an information network; Management of water and land resources during disaster like flood, erosion, river morphology changes
2005	Coastal Zone Policy	Intensifying the coverage of safe drinking water facilities during disaster; Sustainable livelihoods for vulnerable communities
2008	National Disaster Management Policy	Emphasizes on strategic policy framework, national principles, broad national objectives and strategies of disaster management
2009	Bangladesh Climate Change Strategy and Action Plan (BCCSAP)	Climate change strategy management to eradicate poverty and reduce disaster risk reduction while prioritizing adaptation
2012	Disaster Management Act	Disaster zone declaration, disaster management fund relief, helps in coordination of disaster management activities, strengthen and formulate rules, regulates the mandatory rules and responsibilities of Ministries, committees and appointments, and build infrastructure for effective disaster management
2013	National Water Act	Protect any water bodies (pond, lake) used for safe drinking water supply, more urgently in the disaster-stricken area.
2013	The Climate Change and Gender Action Plan (CCGAP: Bangladesh)	Gender inclusive comprehensive disaster risk management
2015	National Plan for Disaster Management	Shift towards a comprehensive disaster risk reduction culture, from just disaster relief and response
2019	Standing Orders on Disasters, and Guidelines for Government at all levels	Established the essential actions that are required in implementing Bangladesh's Disaster Management Model
2022	National Adaptation Plan (NAP)	Identify specific adaptation needs; develop and implement strategies, adaptation investment to undertake actions for protecting vulnerable communities.

when the country only had two radars, now it has more than 50 weather stations, balloons, and radars which receive information from national and regional offices of World Meteorological Organization (WMO) (Salzenstein and Montu, 2021). The case of Sidr in 2007 can be considered as an example, where the Storm Warning Centre (SWC) of the Bangladesh Meteorological Department (BMD) issued seven special weather update bulletins. In compliance with the bulletins from BMD forecast which consist of the danger level of river, maritime port, and wind speed,, people were evacuated to cyclone shelters from cyclone vulnerable areas (Ahsan et al., 2020). Additionally, the Flood Forecasting and Warning Centre (FFWC) provide flood-related information to boost capacity of communities and improve disaster management system of the national agencies. FFWC uses up-to-date scientific data, mathematical models, satellite imagery, voice data, rainfall radar and weather forecast information to provide communities with accurate information regarding flood events (BWDB, 2022). Founded in 1972, FFWC has helped the country to reduce number of causalities in flood over the years.

Although the DRR journey of the country began with disaster management policies, keeping pace with time and increasing uncertainties, Bangladesh slowly moved towards disaster risk reduction and climate change adaptation from disaster management. Bangladesh prepared and became the first country to adopt the National Adaptation Programme of Action (NAPA) in 2005. The Ministry of Environment and Forests (MoEF) prepared and later updated the NAPA in 2009, as a response to the decision made at the Conference of the Parties (COP7) of the United Nations Framework Convention on Climate Change (UNFCCC). NAPA identifies the adaptation needs of the country and develops adaptation activities that address the existing and

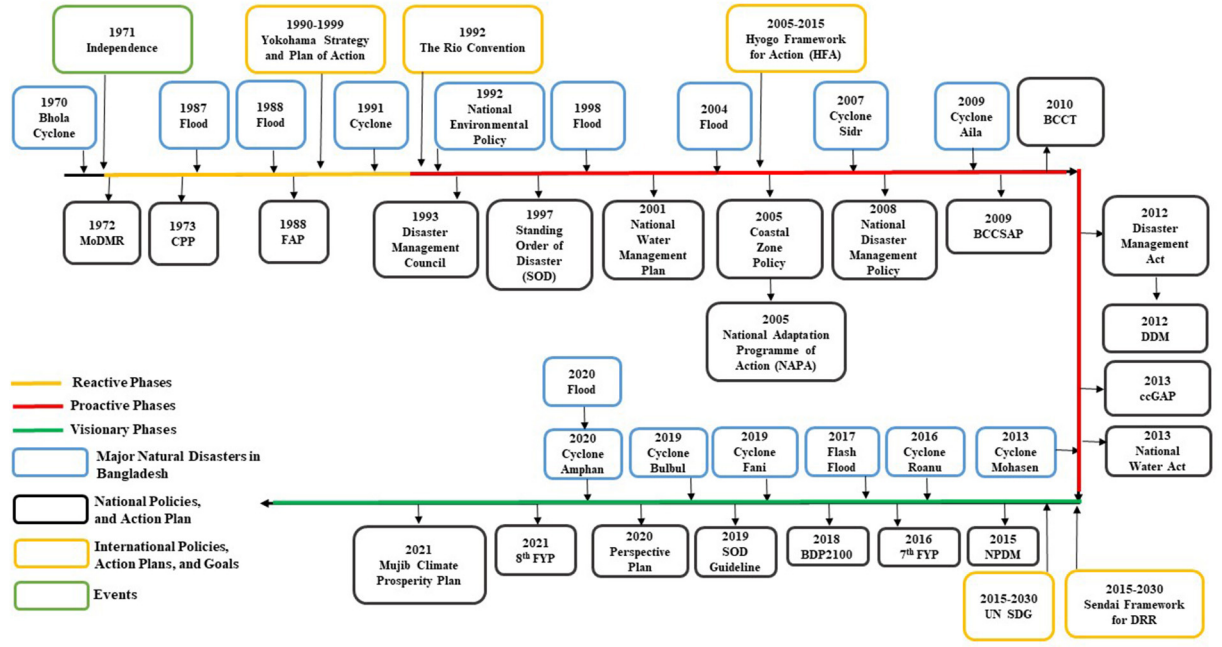

FIGURE 3
Journey of Bangladesh towards resilience.

anticipated adverse effects of climate change (MoEF., 2009). The Bangladesh Climate Change Strategy and Action Plan (BCCSAP) was prepared in 2008 and revised in 2009, and more involvement of relevant stakeholders was incorporated. BCCSAP mentions climate change strategy management to eradicate poverty and reduce disaster risk reduction while prioritizing adaptation (Ministry of Foreign Affairs, 2018).

Local level Disaster Management Committees (DMCs) have been set up at sub-national levels (district, upazila, union, pourasava, and city-corporation) to coordinate disaster management and DRR activities at the respective levels (Haque et al., 2019). The local level committees are now more active during any disaster. The Ministry of Disaster Management and Relief (MoDMR) governing at regulatory level is concerned with risk reduction and food security of affected communities during disasters. The Disaster Management Act of 2012 is one of the regulatory frameworks, which aims to mitigate the overall impacts of a disaster and reduce the vulnerability of communities. This Act is associated with post disaster scenarios- rescue and rehabilitation programs, humanitarian assistance for improving the coping capacity of poor and disadvantaged, programs undertaken by various government and non-government organizations. It also aims to strengthen the capacity of Bangladesh's disaster management system to reduce risk and improve response and recovery management at local and national levels (Haque et al., 2019).

From anticipatory action to resilience

In the last 50 years, the development of embankments, cyclone shelters, coastal disaster resilience infrastructure, improved early warning systems, social awareness and community engagement have had crucial roles in disaster risk reduction (Sammonds et al., 2021). Such changes were progressively supported by the government, NGOs, private sectors, and development partners in Bangladesh. As a result, the country has achieved significant poverty reduction, self-sufficiency in food production, technologies, infrastructure development, higher GDP, improved education system and therefore better economic growth despite growing concerns of frequent climate induced disasters.

Bangladesh has established a domestic funding window for improving climate change resilience of vulnerable communities called the Bangladesh Climate Change Trust Fund (BCCTF). According to BCCTF, 66% of the total fund is spent on implementing the prioritized actions and programmes of the BCCSAP, and rest 34% is saved for national emergencies in bank as a fixed deposit. Through BCCTF more than 100 projects have been implemented between 2015 and 2020 focusing on water infrastructure, mitigation and low-carbon development, food security, health and disaster management (Irfanullah, 2021).

Compared to many other climate vulnerable countries, Bangladesh has made remarkable progress in infusing disaster

management and risk reduction in key legislatives, policies and development plans. While the National Plan for Disaster Management (NPDM) for 2016 to 2020 is based on Sendai Framework for Disaster Risk Reduction (SFDRR), it also approves that DRR for resilience is the foundation for achieving Sustainable Development Goals (SDGs). The Standing Orders on Disasters (SOD) 2019 also abides by the commitments in Sendai Framework on Disaster Risk Reduction (SFDRR) while ensuring adoption of a more comprehensive and inclusive model that is nationally and internationally acceptable for DRR (NPDM, 2020). Further, Bangladesh confirmed that by joint action as mandated by the Paris Agreement the country will work on climate change mitigation (Ministry of Disaster Management Relief, 2017). Most of the policies and development plans in the country are in line with the Paris Agreement which have also encouraged private sector engagement, enhanced capacity building for vulnerable communities, improved social protection, and promoted social inclusion; a requirement for achieving resilience (UNDRR, 2020).

The Inter-Ministerial Committee also supports SDG implementation in Bangladesh, and works for Monitoring and overseeing the process with support of other relevant ministries. This has led to SDG being integrated in the 7th Five Year Plan of the country. The 8th Five Year Plan was also developed in accordance with SDG and NPDM 2021–2025, and complied with national, regional and local priorities.

In addition to the government's proactiveness, the private sector and NGO's active involvement in disaster management activities has played an integral role in the country's successful disaster management journey, with organizations like Concern Worldwide and Envoy Group investing in these activities which include research and financial instruments (Izumi and Shaw, 2014). NGOs also work at grassroot level with local communities and local governments as partners through participatory approach with organizations such as BRAC, CARE, ASA, Oxfam, ActionAid, SKS and SHACO having had serious impact; through activities like that of training programs to increase preparedness and awareness, providing relief and medical facilities after hazards, and rehabilitation programs (Hossain, 2020).

Recently, innovative methods were introduced to early warning systems; BMD initiated Interactive Voice Response (IVR) accessible over any of the existing mobile phone operators in Bangladesh. Users have to dial a specific number through which the service provider informs about hazards, weather forecast, cyclones, rainfall, flood, and landslides. The warning provided by SWC is free of cost and works as a primary source of information for coastal people at risk. Locals from coastal region people are more familiar with the weather updates and bulletin. Now, even fishermen can follow the weather update before going fishing. Earlier there used to be gender-stereotypes that forced women to stay at home during any extreme event but currently the local government have successfully along with local NGOs,CPP workers and volunteers have raised community awareness through dissemination of warnings via mega phones, peer groups, door-to-door alerts and mosque mikes.

International donor agencies also have backed the GoB in its DRR activities. The World Bank funded implementation of a project by Department of Disaster Management (DDM) to conduct Multi-hazard Risk Vulnerability Assessment (MRVA) Modelling and Mapping to improve response preparedness. The GoB was supported by The World Bank Group in disaster management and protective infrastructure on projects related to multi-disaster shelter, coastal embankment, urban resilience, cyclone recovery and restoration and climate services. The Japan Aerospace Exploration Agency (JAXA) and the Asian Development Bank (ADB) also supported DDM and Flood Forecasting and Warning Centre (FFWC) in piloting of community-based flood early warning dissemination system and inundation mapping. UNDP 's Early Recovery Facility (ERF) also played a pivotal role in lending technical support to MoDMR in endorsing and publishing an early-recovery guideline and handbook on the SOD (NPDM, 2020).

From resilience to prosperity

Bangladesh's laudable success in achieving climate resilience and reducing economic risks has been highlighted all over the world, particularly among climate vulnerable countries. Bangladesh often echoed as a role model country in terms of disaster management. Although the right trajectory of resilient-to-prosperity is yet to be explored, there are a few provisions which sketch future Bangladesh in the path of achieving prosperity (Table 2). On the 50th anniversary of Bangladesh, the Government prepared the Perspective Plan (2021–2041) based on Vision 2021, which provides a roadmap for accelerated economic growth, eradication of poverty, inequality, and human deprivation, therefore leading to prosperity (Mallick and Rahman, 2020). Vision 2021, associated with development targets aims to transform socio-economic status of the country, higher standard of living, and climate proof development.

Another pivotal national plan that Bangladesh has developed, particularly in context of climate and disaster risk is the Mujib Climate Prosperity Plan (MCPP) which positions Bangladesh with long-term strategy into the mid-century beyond 2040, in alignment with the Climate Vulnerable Forum (CVF) Vision and the Paris Agreement, aiming to bridge the knowledge and technical gaps that persist (Government of the People's Republic of Bangladesh, 2021). At the heart of MCPP, is the goal to accelerate climate adaptation and resilience efforts, shifts Bangladesh's trajectory from one of vulnerability to resilience to prosperity (VRP). This plan counteracts climate-induced loss and damage by enabling vulnerable communities,

TABLE 2 Major national policy and plan for achieving prosperity under changing climate.

Year	Name of policies	Remarks
2016	7th Five Year Plan	Build resilience of the poor and reduce their exposure and vulnerability to geo-hydro-meteorological hazards, environmental shocks, manmade disasters, emerging hazards and climate related extreme events to make our cities, human habitat and resources safe, resilient and sustainable
2018	Bangladesh Delta Plan 2100	Mitigate the likely effects of climate change and natural disasters, long term water and food security, economic growth and environmental sustainability while effectively reducing vulnerability to natural disasters and building resilience to climate change, Investments in flood control, river erosion, and river management including dredging
2021	Mujib Climate Prosperity (MCPP)	Proactive risk management, risk reduction, disaster risk financing and insurance, poverty reduction, social inclusion, combining labor market programs with climate risk insurance, climate and disaster literacy to Micro, Small and Medium Enterprises
2021	Vision 2041	Long term investments in Flood Control and river management, establishment of a Green Belt, more efficient use of water resources, investments to ensure dry season river flows and water storage
2021	8th Five Year Plan	Comprehensive long-term water management strategy, modern early warning systems to minimize economic losses from flood and other disasters

industry and the government with optimized financing tools and models to embrace a new risk management paradigm.

Bangladesh Government also prepared the Delta Plan 2100 (BDP, 2100) which integrates delta-related sectors across the country. BDP 2100 is a long-term, strategic plan which aims to coordinate multi-sectoral policies for better development within the Ganges-Brahmaputra-Meghna (GBM) Delta in the context of climate change. BDP 2100 lays out crucial plans to reduce disaster risks and improve economic growth, moving towards a more prosperous Bangladesh. Such plans will further be used to reduce vulnerability in internally displaced and migrant communities whose numbers are escalating every year (Mallick and Rahman, 2020).

Challenges and recommendations

Bangladesh's commitment to combat disaster and climate risk is undeniable and the country is well on its path to achieve prosperity. However, several challenges have been identified which pose issues towards achieving the goals to this end. Bangladesh needs to address these challenges to successfully transform into a prosperous country.

One key challenge for Bangladesh is institutional weakness and a prevalent lack of inter-governmental coordination. Most of the ministries work in isolation on their areas of responsibility which creates problems in case of those ministries working on cross-cutting issues. Such ministries and departments include MoEFCC, MoDMR, MoF, MoA, Planning Commission, to name a few. Greater attention is required in this area. Time, manpower, and money could all be saved if a comprehensive coordinated approach in policy formulation and implementation is followed.

The chain of command at different levels of the local institutions can also be strengthened to reduce distance between institutions and local community, to make the action taken against disaster challenges more progressive (Karim and Thiel, 2017). Improved climate infrastructure and integration of climate change in every individual institution, while underway, needs to be scaled-up and implemented at every level from local to national institutions.

It is the adaptive capacity of the households and communities that decides their abilities to address avoidable loss and damage and it needs to evolve as a continuous process matching the projected climate change and extreme climate events scenarios (Bhowmik et al., 2021). The adaptation strategies from local communities can be effectively directed by the proper implementation of the national plans, through a bottom-up approach (Sultana and Luetz, 2022). Capacitating local communities and households is crucial as they need to take ownership of their own adaptation actions to face disaster risk, to achieve empowerment and self-efficacy. Such locally-led and owned adaptation will be key to bringing prosperity to the local communities. Introducing disaster risk and resilience into school curricula, particularly in vulnerable communities is another effective bottom-up option to strengthen locally-led and owned adaptation measures. Promoting disaster-resilient education in disaster-resistant schools effectively resolves problems of unawareness and unreadiness through a precautionary stance of preparedness (Luetz, 2020). Incorporating national plans and policies-informed DRR education in school curricula will ensure a more overarching capacitation of local communities.

The loss and damage induced from natural hazards and disasters are disproportionate with vulnerable and marginalized groups being affected more. Women, girls and children have

increased vulnerability due to natural hazards and disasters, which manifest in forms of reduced mobility, limited access to resources and ownership of lands and other assets, exacerbated by gender-differentiated roles within households and in societies at large (Otto et al., 2017). Vulnerable households reeling from disaster and hazard induced loss and damage are more likely to spiral into poverty due to lack of safety nets leading them to adopt erosive coping strategies such as dropping children from schools in lieu of child labour, forcing girls into early marriage and selling productive assets (Warner and Geest, 2013). These factors contribute to increased social, economic and gender inequality. The local institutions and communities should also be facilitated and capacitated to put Disaster Risk Reduction plans and strategies into actions through an inclusive and holistic approach, which leaves no groups or individuals behind.

Local people possess generations of experience. This enables them to be creative, to overcome and adapt to the challenges of adverse natural conditions. Local and indigenous knowledge can provide socially acceptable and technically feasible solutions to the impacts of climate change (Rozario et al., 2021). It is crucial to prioritize and capitalize on adaptation options and strategies that leverage existing indigenous and local knowledge towards coordinated implementation of government strategies and policies, and sustainable climate change adaptation processes and outcomes (Sultana and Luetz, 2022). Hence, locally lead adaptation practices should be promoted and considered in the mainstream policies.

While the country has approved multiple policies/strategies/plans on disaster management, implementing those provisions still remains a challenge due to insufficient funds. Fund constraints are further halting capacity building for sub-national levels, and such lack of capacities at sub-national level can lead to ineffective implementation of DRR and CCA aspirations in the country (Sarker et al., 2022). Through rigorous literature review it was also identified that some of the Upazilla level disaster management officials have very limited knowledge on the existing DRR policies and framework of Bangladesh. Hence, more investment is required to capacitate government officials at local and sub-national levels.

Given the rapid changes in climate and associated unprecedented events, the consequences may overrun the capacities of the country to manage such impacts in time. Thus, the country needs to plan ahead considering all the dire climate waves that are yet to come. Massive investment is required to bridge the persisting funding gaps in disaster management, and greater involvement of stakeholders and development partners is necessary for climate-proofing development.

Besides, existing research has highlighted challenges in early warning systems of the country. Lack of computational resources, issues in integrating data across multiple agencies, and irregular data updates regarding wind direction and speed often misleads communities before cyclones and storm surges (Ahsan et al., 2020). Further, adequate information about extreme events in disaster prone areas and how such events alter lives and livelihood is required for area specific investments and directing funds where needed the most. Thus, a considerable amount of investment is required. Looking at the funding needs it is advisable to run economic feasibility for identifying and achieving the level of public and private funds required.

Incorporating a multi-hazard early warning system in the national plan and policies of Bangladesh. The existing early warning system only identifies single hazards but, in most cases, there are mostly secondary hazards such as flood after any cyclone or riverbank erosion during any cyclone are also seen. But incorporating it in the national plans and policies also cause some challenges for Bangladesh as it would require more expertise.

Conclusion

Bangladesh has come a long way in managing natural hazards; the unpredictable and unprecedented effects of climate change may offset all the progress that GoB has made in Disaster Risk Management (DRM). More progress needs to be made for achieving a paradigm shift to keep pace with the constantly evolving climatic hazards. The journey of the DRR in Bangladesh has been fascinating and shaped up by its shift in trajectory from vulnerability to resilience to prosperity. Several challenges such as exacerbated climate change impacts leading to increased severity and frequency of hazards and disasters, climate change induced disproportionate loss and damage, growing social and economic inequalities continue to persist for the country in achieving its vision for prosperity. Bangladesh is on the right path and has already proved to be a role-model for the world, in disaster management and climate change adaptation. Upscale efforts from the national and local level including national plans and strategies, institutional and legal framework, improved early warning systems, nature-based solutions, locally-led adaptation, with inclusive and smart-technology focused approaches will be integral to the country's journey to prosperity.

Author contributions

TZ, KT, AK, and MB-D conceptualized the research. TZ, KT, and AK complied the information and drafted the initial manuscript. SR developed the figures, drafted several sections from results and discussion, and formatted the manuscript. MB-D, MK, and SH revised and improved the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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