Chapter 15
Disaster Risk Reduction Investment and Reduction of Response Cost in Bangladesh

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Abstract Disaster Risk Reduction (DRR) is one of the prime concerns of development policies throughout the world. Bangladesh, being a disaster prone country affected by severe natural hazards like flood, cyclone, drought, has been undertaking disaster risk reduction initiatives from past few decades. A large amount of investment was made with assistance from development partners. The general assumption that informs these activities is that investment in DRR will result in less damage and loss when a disaster strikes and thus a less costly and timely response and recovery. This paper focuses on the results of a study conducted in Bangladesh based on the available data on disaster events, damage, DRR and response activities to test the hypothesis that disaster risk reduction reduces response costs. Using simple data analysis, taking absolute values of costs on both risk reduction and response measures of the limited data available, the results of the study provide a very clear indication in favour of the hypothesis. The findings of the study indicate that there has been a dramatic downward shift in the cost of responding to disasters since 1984 due to a steady increase in DRR investment.

Keywords Bangladesh • Cyclone • Disaster risk reduction • Investment • Response cost

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15.1 Background

Bangladesh frequently suffers from devastating natural hazards such as floods, cyclones with accompanying storm surges, tornadoes, river-bank erosion and drought. The significant loss of life and assets caused by natural disasters classify Bangladesh as one of the most disaster prone countries in the world. Evidence also suggests that natural disasters in Bangladesh are occurring with repeated frequency and in short intervals that leave little time for recovery.

These natural disasters greatly hinder the development of the country because of the loss of human lives, loss of livestock, destruction and damage to assets and infrastructure including access roads, protective embankments and agricultural land. This is particularly relevant in the Bangladesh context, where disasters, although random and unpredictable, are not surprising. Following the devastating floods of 1988 and the cyclone of 1991, the Bangladesh government adopted a holistic approach to natural disaster management embracing the processes of hazard identification, disaster mitigation, community preparedness and integrated response efforts. Relief and recovery activities are now planned within an all-risk management framework seeking enhanced capacities of at-risk communities and thereby lowering their vulnerability to specific hazards. In line with this paradigm shift from relief and response to comprehensive disaster management, a range of disaster risk reduction activities have been initiated.

Although there is conventional wisdom around the idea that disaster preparedness will improve disaster response in terms of fewer losses and more effective response there is limited empirical evidence to demonstrate this assumption. The Stern report (2007) found that 1 US$ of investment in DRR saves US $7 in disaster response. A limited number of studies have demonstrated that disaster prevention can pay high dividends, one study found that for every Euro invested in risk management, broadly 2–4 Euros are returned in terms of avoided or reduced disaster impacts on life, property, the economy and the environment (Mechler et al. 2008). It is also true that despite assumed benefits, disaster risk management (DRM) measures are not widely implemented and there continues to be, for the most part, a reliance on reactive approaches that only address the impact of disasters. Bilateral and multilateral donors allocate 90 % of their disaster management funds for relief and reconstruction and only 10 % for disaster risk management. This low level of investment in prevention can be explained by a lack of understanding and concrete evidence regarding the types and extent of the cost and benefits of preventive disaster risk management measures.

Bangladesh has shown itself to be a leading proponent of DRR, gaining recognition at the global level by pioneering a number of interventions and innovative approaches for reducing the impact of disasters on people, infrastructure and property. DRR activities have become part of the development culture in Bangladesh as a necessity because of the country's frequent exposure to natural disasters. This paper aims at initiated with the objective to interpreting and establishing relation between DRR investment and post-disaster resource requirements for response and recovery. The core concept behind this paper is to examine the effectiveness of DRR investment in terms of reduced response requirements and to identify the gaps that presently prevent achieving the Hyogo Framework for Action (HFA) goals (including inadequate DRR investment, inadequate implementation and processes and weaknesses in planning).

15.2 Vulnerability to Cyclones

Coastal region of Bangladesh is one of the most vulnerable regions to cyclonic storms (Fig. 15.1). The region comprises the 16 coastal districts covering 40,919 km^2 area and hosts about 38.2 million populations (estimated in 2009). About 5.5 % of global total tropical storms (with wind speed 62 km/h) form in the Bay of Bengal. Of these, Bangladesh is hit by about 1 % of them (Ali 1999). Figure 15.2 shows the

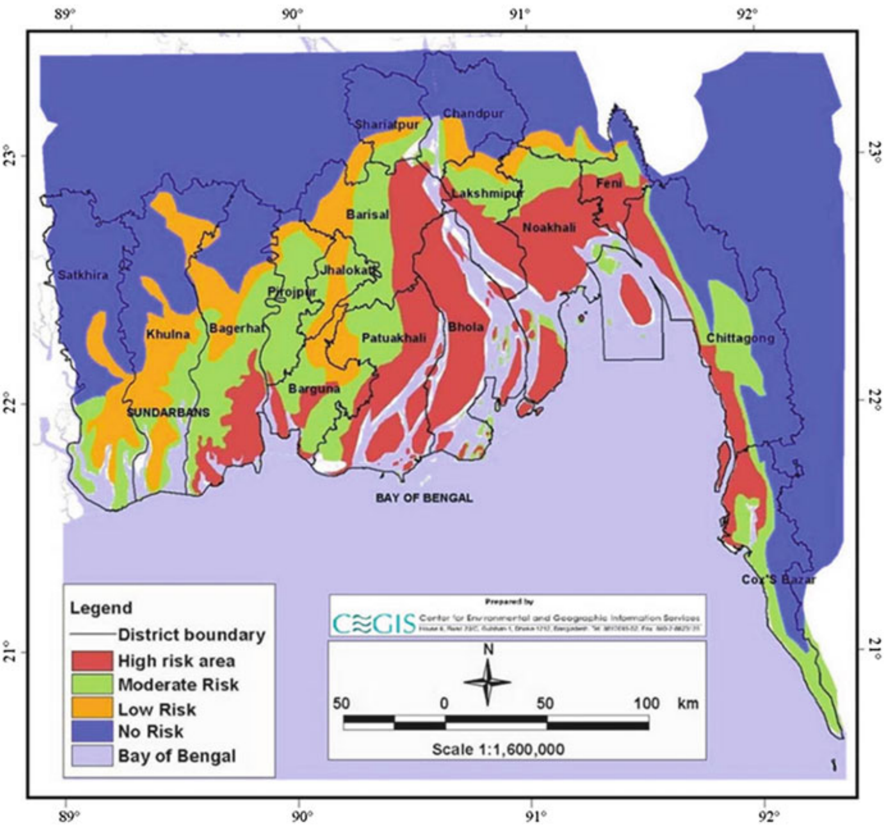

Fig. 15.1 Coastal area of Bangladesh showing cyclone risk zones

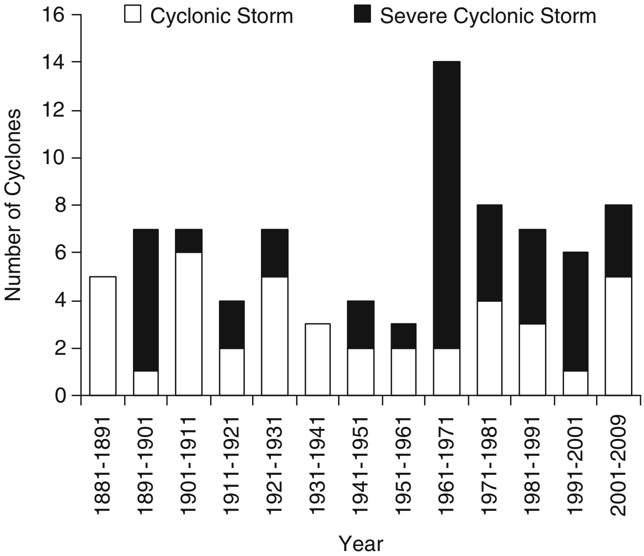

Fig. 15.2 Number of Cyclonic Storms Hitting Bangladesh Coast (1881–2009) (adopted from Hye and Kabir 2006 and BMD data)

Table 15.1 Impacts of severe cyclones

Cyclone events	Storm surge	Maximum wind speed (km/h)	Affected districts	Affected people	Human casualties
1970	6–9 m	223	5	1,100,000	470,000
1991	6–7.5 m	225	19	13,798,275	138,958
2007	Up to 10 m	240	30	8,923,259	3,363

Source: DMB (2008) and GoB (2008a, b)

number of cyclonic storms that have hit the Bangladesh coast from 1881 to 2009 (based on Hye and Kabir 2006 and updated up to 2009 from BMD data). In recent history, major cyclones struck the coastal areas of Bangladesh in 1970, 1991, and 2007. Human life, housing, infrastructures, agriculture, commerce and fisheries sectors were severely affected by the cyclones. Table 15.1 shows a summary of these major cyclones and their impacts. The high number of casualties is due to the fact that cyclones are always accompanied by storm surges. The large casualty rate of 1971 and 1991 cyclones is generally attributed to an absence of adequate cyclone shelters and other preparedness facilities. Due to the cyclone Sidr, the financial losses incurred as a result of the cyclone was estimated around 0.5 % of the national GDP based on pre-cyclone projections for the financial year 2008 (GoB 2008a, b).

Although impacts of cyclones were estimated in terms of human casualties, house and infrastructure destroyed or agriculture crop damaged for cyclonic events, a comprehensive vulnerability and exposure of human life, houses, infrastructures and economic activities to cyclone hazards is not well known in Bangladesh. In this study, we have estimated the vulnerability and exposure of coastal areas of Bangladesh to cyclonic storms considering four elements or sectors—housing, agriculture, livestock and infrastructure. Historical records of each of the four elements of 19 coastal districts were collected from Statistical Yearbooks published by the Bangladesh Bureau of Statistics (BBS 1992–2007), which were used to assess the potential exposure to cyclones and storm surges. The vulnerability and exposure of an element to cyclone is calculated based on the specific location within the "risk zones" of coastal region defined by IWM (2008) and distribution of the element within the risk zones. IWM (2008) defined four risk zones in the coastal region of Bangladesh: wind/no risk (no inundation), low risk (inundation 0–1 m), Moderate risk (inundation 1–3 m) and high risk (inundation >3 m) (Fig. 15.1). The historical data of each element was available for each coastal district. The distribution of the four elements within the risk zones was estimated as proportional area of a district falling in risk zones multiplied by the density of each element within the district. Then the potential damage of each element in each risk zone was calculated by the amount of the element present in the risk zone multiplied by the damage factor of that element. Finally, total potential damage of four elements due to cyclone was computed by combining damage values of four individual elements. The study assumes various damage factors for each element based on risk zones and infrastructure type as follows.

Housing: Household damage is normally doubled when surge height increases approximately 2 m. Based on this observation, damage percentage area have been assumed as 80 % for High risk, 40 % for Moderate risk, 5 % for Low risk and 0 % for Wind/no risk area. Besides, house types are also important in its vulnerability to damage, so a damage percentage of 10 % and 80 % for pakka and kacha house respectively have been considered. Finally, the number of potentially exposed households for different years has been calculated multiplying the number of houses by all the factors.

Agriculture: The potential exposure of agricultural production has been calculated using an estimated "percentage of crops damaged" for the different risk zones (25 % for wind/no risk, 50 % for low risk and 100 % for moderate and high risk areas). The height of crops in field is normally below 1 m, whereas the expected inundation depth in high risk area is more than 3 m and 1–3 m in moderate risk area. As a result, damage factor for crop is assumed as 100 % for high and moderate risk, 50 % for low risk and 25 % for wind risk area. After assigning these zones, values of agricultural products had been estimated using yearly crop procurement prices and inflation rates.

Livestock: As there are not enough safe haven facilities for livestock in the coastal areas, they normally stay either at homestead or fields during a cyclone. The potential damage to livestock has been assumed to be 80 % for high risk, 40 % for moderate risk, 5 % for low risk and 0 % for wind/no risk areas. Based on these values the damage and exposure of livestock assets are calculated using livestock prices and inflation rates.

Table 15.2 Potentially exposed asset worth and actual damage occurred by severe cyclones

	Potentially exposed asset worth (in billion Taka)			Actual damage (in billion Taka)		
Year	1991	1997	2007	1991	1997	2007
Housing	83	94	113	59	23	47
Agriculture	61	45	41	48	22	28
Livestock	90,779	131,434	26,435	40	0.44	18
Infrastructure	30,200	301,14	41,959	6	2	25

Infrastructure: The potential exposure for roads has been calculated incorporating damage percent for different risk zone (0 % for wind/no risk, 5 % for low risk and 40 % for moderate risk and 80 % for high risk areas). The potential exposure for embankments have been calculated incorporating damage percent similar to roads along with a factor considering the exposure of different types of embankments (0.4 for interior dyke, 0.7 for marginal dyke and 1 for Sea dyke). Based on the calculations, values of these assets are calculated.

The worth of potential exposure of these sectors is presented in Table 15.2. This table also presents the actual damage worth for different cyclones which was calculated using the damage figures available from the disaster management bureau (DMB 2008).

15.3 Investment in Disaster Risk Reduction

Disaster risk reduction is a complex process. Effective DRR needs to address social, institutional, technical, environmental, financial and economic issues in a way which is cohesive and interconnecting. Calculating total investment in DRR is challenging because the scope of DRR is so broad. Not only does DRR cut across a range of different issues, it also takes place at different levels and in conjunction with other processes, at household level, community level, local government, district and national level. The disaster risk reduction measures to reduce impacts of cyclones in Bangladesh includes cyclone early warning system, Cyclone Protection Program (CPP volunteers trained to assist those affected by cyclones), construction of cyclone shelters and embankment for surge protection, afforestation and green belt development. Recent data show that CPP program holds 42,000 trained volunteers in 2008 (about 14 volunteers per 1,000 vulnerable households); about 2,500 cyclone shelters were constructed by the year 2007 (served about 2.7 million people, 17 % of total vulnerable population); about 4,600 km embankment were constructed in the coastal areas by 2007 (approximately 11,000 km^2 area is benefited); coastal afforestation program benefited 88 km^2 area of coastal region in 2007; and the cyclone early warning system was improved significantly with high accuracy of prediction and dissemination throughout the coastal region. Government of Bangladesh (GoB) as well as international NGOs (INGO) has been implementing these types of DRR measures

Table 15.3 Investment in disaster risk reduction projects

Year	DRR investment (in million Taka)		
	GoB	INGO	Total
1984–1991	53	13	66
1992–1997	829	481	1,310
1998–2007	11,068	321	11,389

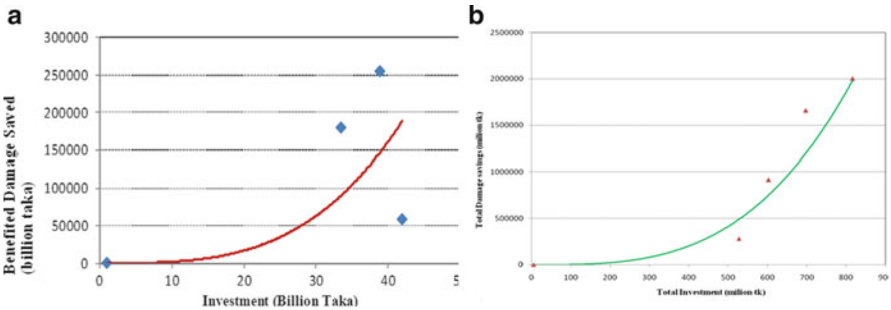

Fig. 15.3 (**a**) Relationship of benefited damage saved and investment in coastal embankments. (**b**) DRR cost in afforestation and corresponding savings of damage

for past few decades. Both GoB and INGOs invested a huge amount of money in those projects. A summary of investments in DRR projects in different periods is presented in Table 15.3, which show that total investment in DRR projects was increased about ten times after 1997 cyclone till cyclone Sidr in 2007.

The benefits of cyclone shelter, together with CPP pool and other supports are reflected in Fig. 15.3a, b for a gross understanding. The figures show that, the investment in cyclone shelter construction is increasing and this is contributing to serve more people at the risk due to cyclone. The percentage of served population at risk has grown from merely 2 % to around 17 %.

The purpose of embankments is to protect agricultural land, household assets, infrastructure and livestock from all water related hazards including cyclone. Table 15.4 presents the potential cost of damage and the benefit incurred in terms of savings due to embankments. The percentage of damage savings to potential cost of damage estimated to be was 15 % in 1997 and has increased to 85 % in 2007 as more embankments have been constructed.

The value of investment in embankments and estimated savings against damage that this investment has resulted in when cyclones occurred are presented in Fig. 15.3a, b. This figures show that the ratio of potential savings to investment is increasing with time. In 1985, investing one Taka resulted in a saving of 326 Taka while in 2007 this saving is 1386 Taka.

Afforestation can reduce damage to houses, crops, livestock and infrastructures because of the protection a green belt can provide in reducing the severity of tidal surges during disasters. The degree to which damage is reduced will depend on

Table 15.4 Benefited damage savings and potential damage worth

Year	Potential damage worth (Taka)	Benefited damage savings (Taka)	Percentage (%)
1997	161,687	24,134	15
2007	68,549	58,086	85

when the cyclone makes landfall (at high tide or low tide), the specific nature of the cyclone (in terms of wind-speed, proximity to origin) and the surge height that accompanies the storm. Historical events from 1984 to 2007 (cyclone Sidr) are recorded in the following table with an estimation of the savings incurred as a result of afforestation.

Afforestation is a cumulative process which multiplies the benefits gradually to sectors. The information above demonstrate that cumulative investment in afforestation at three stages (1991, 1997 and 2007) has increased at an average rate of 1.6 % per annum and damage has reduced at an average rate of 1.9 %.

The relation between investment and damage savings is represented in Fig. 15.3a, b.

15.4 Relief and Response

Relief activities take place in immediate aftermath of a disaster and typically include distributions of cash and of commodities essential for survival in the post disaster context including food, water, clothes, blankets as well as provision of medical support and temporary water supply and sanitation.

After the immediate relief phase has prevented further loss of life in the aftermath of a disaster, reconstruction/rehabilitation activities begin. The focus of rehabilitation activities are the longer term needs for affected communities to recover. This includes the repair and reconstruction of houses, roads, bridges, embankments and water supply system as well as technical support for the rehabilitation of agriculture, livestock and fisheries and other measures to ensure food security which might include creation of alternative income sources for the affected community.

Relief and rehabilitation (R&R) are the two major components of disaster response costs in Bangladesh. Table 15.5 illustrates the spending on these activities over the period.

15.5 Assessment: Ratio of Preparedness and Response

Establishing a direct relationship between DRR investments and Response costs is a complex exercise. Because of an absence of systematic data it is very difficult to arrive at a conclusive statement that reflects the relationship between DRR investment and response costs. The emergence of DRR as a sector globally is relatively new. The limited data available to disasters is sufficient to give some indicative notions of the effect of investment in DRR has on the cost of responding on the

Table 15.5 Response costs for disasters in Bangladesh (Taka in millions)

Year	GoB response cost		INGOs response cost		Total response cost
	Relief	Rehabilitation	Relief	Rehabilitation	
1984–1991	6.67	64	2.26	0.24	9.57
1992–1997	2.98	63.25	5.24	2	71.49
1998–2007	105.52	38.43	2.75	3.99	150.68

Source: GoB (1990–2007), Ministry of Food and Disaster Management, INGOs

Table 15.6 Relation between DRR and Response costs (Taka in millions)

Year	DRR investment	Increase in cost	Response cost	Increase in cost	Percentage (response/DRR)
1984–1991	66	1	957	1	1,446
1992–1997	1,310	20	7,149	8	545
1998–2007	11,389	172	15,068	16	132

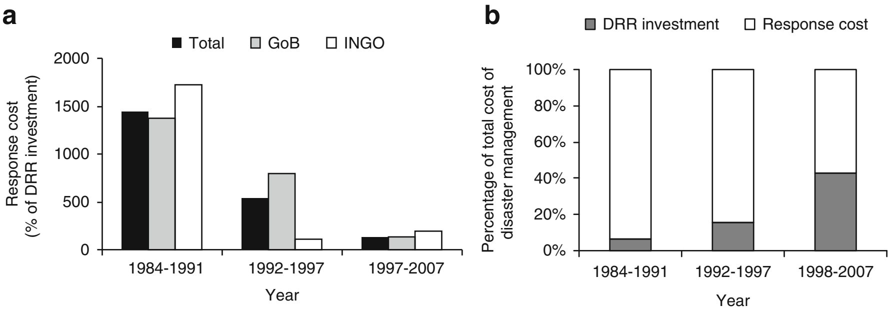

Fig. 15.4 (**a**) Relation between DRR and response total costs, government investment and INGO investment. (**b**) Relation between percentage of DRR investment and response cost

major cyclones in Bangladesh. As more information becomes available over time and is more systematically managed there is scope for reviewing and testing this tentative conclusion.

Table 15.6 presents the relationship among DRR and response costs. Table 15.6 indicates that, both the investment in DRR and the cost of responding to cyclones has increased over the period reviewed for this study. Investment in DRR has increased by 172 times from 1991 to 2007, at the same time; response cost has increased by 16 times. In Table 15.6, "increase in cost" indicates the ratio of DRR or Response cost of a specific time period to that of 1984–1991 period. The "Percentage (Response/DRR)" indicates the percent of response cost to DRR investment for the time period. Over the years, the percentage of response cost to DRR investment has been decreased rapidly. In 1991 this percent was 1,446 % and in 2007 for the cyclone Sidr it had reduced to 132 %.

Table 15.6 gives a summary relationship which is quantified in Fig. 15.4a, b.

A general inference from the information available is that as investment in DRR increases, the relative cost of response decreases. In order to establish a more

Table 15.7 Benefits in different sectors due to DRR investments

DRR investment	Household	Agriculture	Livestock	Infrastructure	Life saving
Early warning	+++	0	++++	0	++++
CPP	+++	0	++++	0	++++
Cyclone shelter	+	0	++++	0	+++
Embankment	++++	++++	+++	+++	++
Afforestation	++	++	+	++	0

Note: "+" indicate positive impact, "0" indicate less/no relation

specific relationship between DRR investment and resultant response cost a more detailed analysis would ideally involve a greater breakdown of the types of DRR investment over more disasters. Table 15.7 shows that investment in early warning and CPP activities has a positive impact on preserving household assets, protecting livestock and in reducing casualties as a result of cyclones. Investment in cyclone shelter is found to result in preserving the lives of people and livestock in the affected areas. Investing in coastal embankments can benefit in all sectors and the benefit of coastal afforestation is mainly seen in household, agriculture and livestock sectors.

15.6 Conclusion

Some aspects of DRR and preparedness are easier to measure and calculate the cost than of others; for example infrastructure investments such as the construction of cyclone shelters, building embankments and raising homesteads are straight forward indicators to account for, non-structural measures including increasing community knowledge about early warning and the use of cyclone shelters are more difficult to measure but may also play an important part in saving lives and avoiding injuries during cyclones and should be factored in to analysis of investments and savings. One important lesson that can be learned from this study is that detailed information on disasters should be collected and maintained in a comprehensive information management system.

Another way to understand the benefits of DRR investments is to include a cost–benefit analysis (CBA). The interest in economic aspects of DRM has been increasing with high profile disaster events due to climate change impacts already being observed and projected. However, the short timeframe in which the study was carried out and the limited information in Bangladesh on DRR spending and disaster response spending have limited the scope of this study only on cyclonic storm surges.

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