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アジアの台風・竜巻被害

Wind-related Disasters in Bangladesh and Changes in Regulations and Practice

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1. INTRODUCTION

Bangladesh has been frequently damaged by tropical cyclones and severe local storms including tornadoes. Cyclones in the Bay of Bengal occur in March, April and May of the pre-monsoon season and in October and November of the post-monsoon season. Tornadoes relating to severe local storms also mainly occur in the pre-monsoon season.

The damages by high winds of cyclones and tornadoes were very serious to the human life of Bangladesh because the infra-structure were very fragile. The number of death in cyclone in November 1970 was reported as three hundred thousand or five hundred thousand, which is one of the worst disasters in the world in the past. This cyclone is recognized as one of the triggers of the independence of Bangladesh in 1971. The number of death during the cyclone of April 1991 was around one hundred forty thousand^(1),2).

In this report, the general view of tropical cyclones and severe local storms are described with estimated wind speeds estimated by the meteorological data and relating damages. The Cyclone “Sidr” in 2007 and Tornado in 1996 in Tangail in the middle of Bangladesh are typical case studies of cyclone in the Bay of Bengal and severe local storm on this report.

2. CYCLONE “Sidr”

This Cyclone “Sidr” in the middle of November, 2007, was one of the severest cyclones before in the last three decades years. The Cyclone “Sidr” occurred at 21BST (Bangladesh Standard

Fig.1 Path of Cyclone “Sidr” reported by Bangladesh Meteorological Department. Indicated times are in UTC.

Time) or 15UTC on 11th November, 2007 in the southern area of the Bay of Bengal and landed at the southern coast of the Bay of Bengal in Bangladesh at 21BST on 15th November, as shown in the path of the cyclone “Sidr” of Fig.1.

Fig.2 shows the satellite image of the Cyclone “Sidr” at 0530UTC of November 15th, 2007, as the mature stage of this cyclone by the meteorological Satellite “Kalpana” of India Meteorological Department (IMD). The diameter of the cyclone is around 400km and the clear eye existed in the center of the cyclone. Bangladesh Meteorological Department (BMD) reported that the minimum pressure of 944hPa and the peak gust of 69ms^{-1} were observed at the time of landing on the coast of Bangladesh.

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Fig.2 Satellite image of the Cyclone “Sidr” by “Kalpana of IMD.

The distribution of affected area is shown in Fig.3 and the main damaged area concentrated at the coastal part of the southwestern region of Bangladesh. The total number of death was 3,363 and that of missing persons 871. The affected persons were around eight million and ninety thousand and damaged houses were one million and fifty two thousand. The typical damaged house by the high wind is shown in Fig.4, which was located at Sharankhola village of Barguna, Kulna. BMD issued the early warning of evacuation to the area at the

Fig.3 Distribution of Affected area reported by the Disaster Management Bureau²⁾.

coastal area of the Bay of Bengal, where the landing of the cyclone would be expected using the analytical results of weather charts, aerological data, satellite data, radar data etc. Two Doppler radars were installed at Khepupara and Cox’s bazar for monitoring the approach of cyclones at the coast of the Bay of Bengal and are utilized for the exact prediction of the

Fig.4 Damaged house in Sharankhola.

Fig.5 Doppler Radar at Khepupara

path of cyclones and the appropriate warning (Fig.5). People in the dangerous area evacuate in cyclone shelters. After the cyclone in 1991, the cyclone shelters prevailed as the most powerful and fundamental counter measure to save the human

Fig.6 Cyclone Shelter

life in Bangladesh. These cyclone shelters have high story floor and RC structures.

More than 2,000 cyclone shelters were constructed already by Bangladesh government as well as the financial support of many other countries in the world.

3. TORNADO in TANGAIL on 13th MAY, 1996

Typical twenty five tornadoes between 1961 and 2013 are listed in Table 1 together with main damages. The number of death is more than one hundred at one tornado in thirty three tornadoes. One thousand and three hundred persons died at Manikganj in 1989⁴⁾. Fig.7 shows the monthly occurrence of

Table1 Typical Tornado Events in Bangladesh between1961 and 2013⁴⁾.

Year	Month	Day	Time(UTC) HHMM	Location	Region	Death	Injured
1961	3	19	10:00	Faridpur	C	210	
1963	4	19	10:50-12:30	North BD	NC, NW	300	
1964	4	11	10:30	Magura, Narail	WC	500+	
1969	4	14	10:45-11:15	Demra	C	922	16,511
1972	4	1	12:30	Mymensingh	NC	200+	
1973	4	17	08:45	Manikganj	C	681	1,000
1974	4	11	Local afternoon	Bogra	NW	100	75
1976	5	9	Local evening	Narayanganj	C	1	42
1977	4	1	10:00	Faridpur	C	500	6,000
1986	4	14	12:00	Copalganj	C	120	
1988	4	26	12:30	Manikganj	C	1,300	Innumerable
1990	4	20	Local afternoon	Sirajganj	NW	76	2,000
1991	5	7	Local afternoon	Gazipur	C	46	400
1995	4	8	11:00	Munshiganj	C	40+	Seval hundreds
1996	5	13	10:30-12:00	Tangail, Jamalpur	C, NC	700+	30,000
1998	4	8	05:10	Nilphamari	NW, C	21	
1999	3	26	12:00	Dhaka	C	2	60
2002	4	26	12:20-15:11	Bogra, Tangail	NW, C	25	
2003	5	4	14:00	Bheria	ED	22	
2004	4	14	13:40	Mymensingh	NC	111	1,700
2005	3	20	12:45	Gaibandha	NW	66	4,688
2010	4	13	17:30-19:30	North Districts	NW, NC	5+	
				Dhaka, Mymensingh	C, NC	139 in India	
2011	4	4	13:00	Dhaka, Mymensingh	C, NC	12	
2012	4	28	16:00	Dhaka	C	7	
2013	3	22	11:00	Bheria	ED	36	500

severe local convective storms (SLCS) in Bangladesh between 1990 and 2005. The SLCS occurrences concentrates in the pre-monsoon season of March, April and May^{5),6)}.

The spatial distribution of SLCS is shown in Fig.8. Dots indicates the location of the headquarters of districts and the shade and the size of a dot indicate the magnitude of occurrence of SLCS for each district. Main occurrence districts are Dhaka district (indicated as "D" in Fig.8), with one hundred and eleven events, "N" is Netrakona with one hundred and nine events, "T" is Tangail with ninety events, "S" and "C" are Sirajganj and Comilla with eighty three events. The main occurrence area of SCLS is the middle part of Bangladesh.

One of the typical tornado occurred in Tangail district at 1830BST or 12UTC on 13th May, 1996. The tornado path

Fig.7 Monthly occurrence of severe local convective storms between 1990and 200⁵⁾.

Fig.8 Spatial distribution of severe local convective storms in Bangladesh between 1990 and 2005⁵⁾.

and the area of damaged area are shown in Fig.9. The Fujita scale of this tornado was F3.5 and the length was 80km and the width 3km in maximum⁷⁾.

The statistics of damages are shown in Table 2, and the death were 525, the injured 32,601, the affected 84,100 and the destroyed houses 35,691. The most damaged area were Goalpur, Kalihatti and Bashail tanas in Tangail district, 120km north of Dhaka. The damaged area is traced southward running through Tangail district and the direction changed to southwest at the southern end of this district in Fig.9. The wind speed was estimated by this damage as F3.5. The damaged school building is shown in fig.10, of which structure was RC. The first trial of tornado shelter is conducted in the rural village in Tangal to evacuate under the ground by the support of Japan program.

Table 2 Main damages in Tangail tornado, 1996.

Personal Damages	The Dead		525
	The Injured		32,601
	The affected		84,100
Damaged Structures	Houses		35,691
		Completely damaged	16
	School	Partially damaged	34
Damaged Water	Public well		500
	Private well		1,000
Damaged Food	15% of whole crops		
Damaged Cattle	Cow		2,800
	Sheep		1,410
	Hen & Cock		404,000

Fig.9 Path and damaged area of tornado in Tangail on May 13th, 1996. “D” and “T” indicate Dhaka and Tangail. Shaded area is damaged area.

Fig.10 Damage of school building at Bashail.

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