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DISASTER IMPACT AND RECOVERY INITIATIVES OF WATER SUPPLY AND SANITATION SYSTEM: A CASE ON CYCLONE SIDR

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Abstract

The main objectives of the study are to find out the damage nature of Water Supply and Sanitation (WSS) sector owing to super cyclone Sidr; and assessing the post Sidr recovery initiatives of this sector. Data and information were collected mainly from primary sources. Among the pretentious families of 21,023 in the upazila territory, 167 households have taken as sample. Different advanced statistical and geospatial software like SPSS statistics 17.0 and ArcGIS 9.3 were used for data entry, process, analysis, mapping, plotting and visualizing of the study output. This study reveals that 100% water supply sources and sanitation structures were damaged due to cyclone Sidr but mainly it disrupted owing to storm surge water as the affected dwelling submerge by 6 meter coastal flooding. Total damaged value was about BDT 1,053 thousand while total recovered value is BDT 2,845 thousand after accomplishing recovery initiatives which indicates significant recovery have achieved. Government initiatives were negligible while non-governmental organization and international non-governmental organization were the main players of recovering the WSS systems among affected families.

Keywords: Cyclone sidr, Water supply and sanitation, Damage, Recovery, Storm surge

Introduction

Cyclone Sidr, one of the ten strongest cyclones for past 131 years struck the south-west coastal region in Bangladesh and caused the widespread serious damage (Hasegawa, 2008). It stuck on the coastal belt of Bangladesh with winds up to 240 km per hour on 15th November, 2007. The category-4 storm was accompanied by tidal waves up to five meters high and surges up to 6 meters in some areas, breaching coastal and river embankments, flooding low lying areas and causing extensive physical destruction. About 3,406 deaths, 1,001 missing, 55,282 injured have been blamed in the southwest coast of Bangladesh due to Cyclone Sidr. On the basis of damage and loss in Bangladesh four districts (administrative unit) such as Bagerhat, Barguna, Patuakhali and Pirojpur were identified as severely affected and a further eight (Khulna, Madaripur, Shariatpur, Barisal, Bhola, Satkhira, Jhalakathi, and Gopalganj) districts were identified as

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moderately affected. Of the 2.3 million households affected to some degree by the effects of Cyclone Sidr, about one million were seriously affected (MoFDM, 2008; GoB, 2008; Hakim, 2009; Kabir, 2009).

The Department of Public Health Engineering (DPHE) reported 11,612 tube wells, 7,155 ponds and over 55,000 latrines were damaged in the affected area due to cyclone Sidr. Damage for these totals 157 million BDT while total damage value concentrated in all sectors over the country was 79,904 million BDT (GoB, 2008). Sarankhola upazila of Bagerhat district has identified as worst affected coastal upazila (lowest administrative unit) of the country and water supply and sanitation sector also highly affected as considering damage nature. About 81% water sources and 72% sanitation systems were damaged (Official document, UNO[1] office, July, 2008). Although above severe interruption occurred in water supply and sanitation sector, the situation has now changed after being involved Government of Bangladesh (GoB), non-governmental organizations (NGOs), international non-governmental organizations (INGOs), and development partners in post cyclone recovery programmes.

A few studies have carried out by the several authors and organizations (GoB, 2008; Mallick and Vogt, 2009; Hakim, 2009; Kabir, 2009; Tithi, 2010; Ahmed, 2008; Oxfam, 2008; BUET, 2008; Islam *et al.*, 2010; Tooheen, 2008; Hossain, 2009; Paul, 2011) relating cyclone Sidr while WSS (Water Supply and Sanitation) sector has not been given attention. GoB (2008) examines the overall damage, loss and recovery requirements in the context of affected districts as well as Bangladesh. Mallick and Vogt (2009) studied the coastal cyclone management considering cyclone Sidr which concentrated on relief and rehabilitation opportunities, housing conditions, institutional and community involvement. Hakim (2009) assessed on post-disaster settlement, external assistance, shelter process, sustainability etc, in his study. Kabir (2009) focused on the governments and agencies family shelter interventions in post-cyclone Sidr. On the other hand, Tithi (2010) tried to assess post Sidr housing sector recovery at organizational level and Ahmed (2008) emphasised the impacts of cyclone Sidr on housing sector.

Oxfam (2008) deliberates the emergency response, coordination and communication gap between donor and government, shelter, self recovery, reducing vulnerability to disaster and empowering communities to prepare for the future. BUET (2008) highlighted on the performance of the cyclone shelter and coastal embankment of Mongla and Sarankhola post cyclone Sidr. Islam *et al.* (2010) tried to assess the performances of coastal structures during cyclone Sidr. Tooheen (2008) deliberated the post Sidr health intervention. He identified different gaps and perceptions in the intervention in health

[1] Upazila Nirbahi Officer (UNO) means lowest administrative unit coordinating officer who works in a sub-district called upazila.

service between the clients, the provider, coordination of government, and the role and coordination gap between the many NGOs working in health field. Hossain (2009) emphasised on the post disaster agricultural rehabilitation after cyclone Sidr which focusing on constrains like suitability of arable land during crop season, access of loans and quality seed. Paul (2011) focused on the three important components of emergency response: disaster-relief efforts, provision of emergency medical care, and construction of temporary shelters. The above literature could not touch the important WSS sector especially at household level. So, the main objectives of this research are to assess the damage nature due to super cyclone Sidr and its recovery activities in WSS sector at household level in the Sarankhola Upazila (a coastal sub-district of Bangladesh).

Materials and Methods

The research encompasses primary and secondary data and information. Primary data sources were basically questionnaire survey, official documents and informal interviews. About 167 samples were determined from 21,023 households using Raosoft (online sample size calculator) software with 7% errors and 93% confidence level. Table 1 presents the household and respective sample size of the study. Survey was conducted during 14-21 February, 2012.

Table 1. Sample sizes of the affected households of the study area

Union No	Union Name	Total damaged households	Total Sample Households
1	Dhansagor	3767	29
2	Khontakata	5889	48
3	Raenda	5766	46
4	Southkhali	6501	44
Total in Sarankhola Upazila		21,023	167

Note: Upazila is a lowest administrative unit and Union is sub-unit of Upazila. Source: Official document, UNO office, July, 2008

Before questionnaire survey, eight pilot questionnaires were tested at four unions (two in each union) in Sarankhola Upazila to find out whether the questions in the questionnaires were realistic or acceptable among affected household. After completing pre-test, essential corrections have been done and final questionnaire was prepared. Official information, raw data, documents were collected from the relevant offices of the upazila administration. During survey, several informal interviews were conducted among the affected people of the community understanding the ideas and facts of the research themes. Secondary data were collected from published documents relating cyclone Sidr and water supply and sanitation issues from governmental offices, several NGOs, and INGOs. Secondary data also collected from several books, journals, theses, reports and online sources.

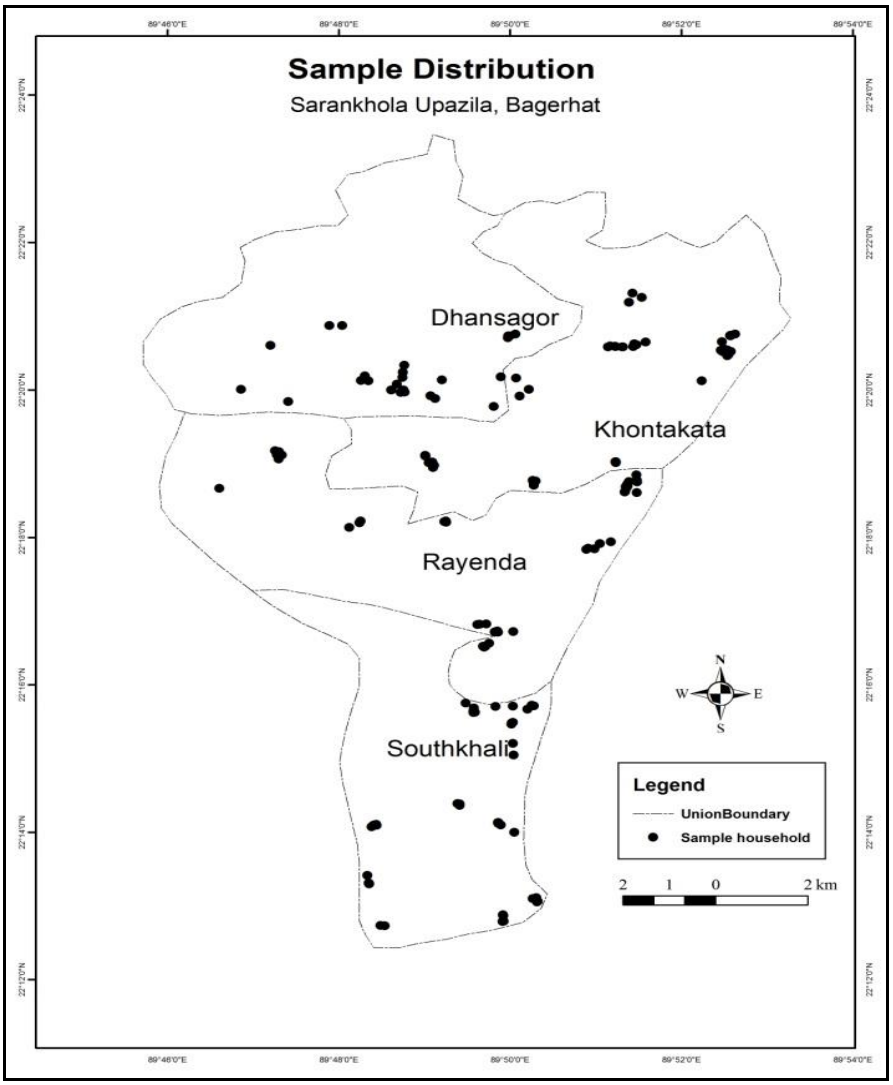


Fig. 1. Spatial distribution of sampled households

Data have been edited two times during field work and at data processing lab. Before data entry, answers of questions have been coded as numeric or string. Some questions were pre-coded and some were post coded. After completed coding, data entry and analyses have done using SPSS statistics 17.0. GPS (Global Positioning System) has used taking spatial data of those households. Upazila base map has collected from LGED. After digitizing administrative boundary of the study area, relevant (BTM) projection has incorporated. GeoEye image has overplayed with upazila boundary updating the physical and human features of the study area. After that GPS data have been transferred from GPS to GIS (Geographic Information System) platform creating relevant maps using ArcGIS 9.3 software which are being presented the spatial analysis of the data.

Study Area

The upazila is located between $22^{0}13^{'}$ and $22^{0}24^{'}$ north latitudes and between $89^{0}46^{'}$ and $89^{0}54^{'}$ east longitudes. The upazila is bounded on the north by Morrelganj Upazila, on the east by Mathbaria Upazila of Pirojpur District and Patharghata Upazila of Barguna District, on the south by the Bay of Bengal and on the west by Mongla upazila (Figure 2). The upazila occupies a total area of 756.61 sq.km including 594.58 sq.km (146,925 acres) forest areas (Sundarbans reserve forest) having 4 unions with 118,135 population including male 62,353 (52.78%) and female 55,782 (47.22%) (BBS, 2006; Moniruzzaman *et al.*, 2013).

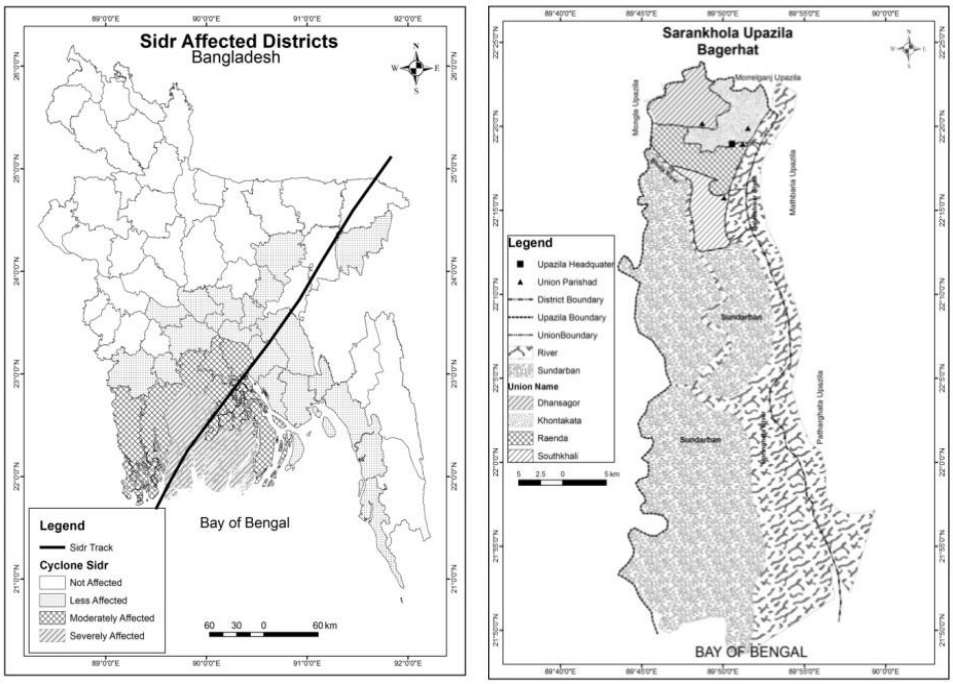


Fig. 2. Geographical Location of the Study Area

Results and Discussion

Background of Households

Total numbers of surveyed households were 167 (n=167) which consists of 770 members including 399 (52%) male and 371 (48%) female. Almost 83% nuclear family, 15% joint family and rest 2% extended. Here, extended family consists of grandparents, aunts, uncles, and cousins all living in the same household. Average household size is 4.61. About 30% (234 members) family members are economically active and rest of are dependent. Dependent population are either younger (age below 20) or older members

(age 60 and above) of the families. Among the income people 37.61% are day labourer, 20.51% involve in business, 8.55% in agriculture, 15.81% service holder, 11.56% fishermen and 5.56% involve in other non-farm economic activities. Average monthly income among households is 6,308 BDT (1 US$ equivalent to BDT 83) while maximum 130,000 BDT and minimum 1,000 BDT. But 37.1% households' monthly income is between 3,000- 6,000 BDT while 35.9% income less than 3,000 BDT. Moreover, only 3.6% households' income is above 15,000 BDT per month.

Among surveyed households, 50.9% are permanent (settlement duration above 90 years) and 49.1% are shifted from various places. They had to leave previous settlement locations because of riverbank erosion (5.4%); property sale (6%); unsuitable location (29.9%); disaster prone and insecure area (2.4%); and miscellaneous (5.4%) reasons. On the other hand, they have come at present settlement because of purchases land (36.5%), relatives land (6.6%), recovery requirement (1.2%), safety (2.4%), and access to government land (*khas land)* (2.4%). About 91% households remain inside of the embankment, only a few of households' locations are in outside of the embankment (1.2%). Almost 7.8% households' locations have been changed due to Sidr over the years. Among them only 3.6% households' locations have changed from outside to inside of the embankment and 4.2% have also been changed from inside to outside of the embankment.

Water Supply

Sarankhola is a coastal upazila of the southern part of Bangladesh. Most of the families of the upazila were used pond water (59.62%), rest of them were used tap water from Pond Sand Filters (PSFs) (12.03%), tube-well water (22%), deep tube-well water (4.79%) and other (1.56%) sources of water for their drinking purpose in before Sidr (BBS, 2006). Major sources of water supply of the surveyed households were pond, tube-well, PSF and river/canal (Fig. 4). Among 167 families about 42% households were used tube-well as their drinking water source, 36%; 17%; and 5% households used pond, PSF and river or canal as their water sources respectively. Total value of drinking water supply systems during before Sidr was 2,025,000 BDT including pond 945,000 BDT, tube-well 210,000 BDT and PSF 870,000 BDT (Table 2).

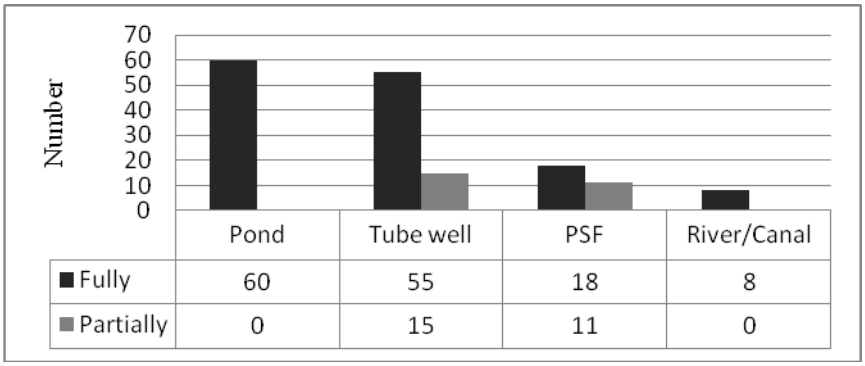
Table 2. Drinking water source before Sidr

Nature of water sources	Frequency	Percent	Total BDT	Mean (BDT)
Pond*	60	36	945,000	15,750
Tube well	70	42	210,000	3,000
PSF	29	17	870,000	30,000
River/Canal	8	5	0	0
Total	167	100	2,025,000	12,126

* Value of pond has estimated as digging cost of pond. Source: Field Survey, 2012

Damage Nature

Water supply systems of the surveyed families were fatally pretentious due to cyclone Sidr and associated storm surges. Total damaged systems were 167 including 84.43% (141 systems) fully and 15.57% (26 systems) partially damaged (Figure 3). Most of the systems (64%) were damaged by intrusion of waste water in the systems. About 8% water supply systems were floated by storm surge, 17% broken by storm water and 11% broken by trees (Table 3).



Source: Field Survey, 2012

Fig. 3. Damage nature of drinking water sources

Table 3. Causes of water sources damage

Causes	Frequency	Percent
Floated by storm surge	13	8
Broken due to storm water	29	17
Broken by fallen trees	18	11
Intrusion of waste water in the systems due to storm water	107	64
Total	167	100

Total damaged value of the water supply systems because of cyclone Sidr was 823,000 BDT including 705,000 BDT fully and 118,000 BDT partially damaged while average damage value was 4,928 BDT. The average damaged value of pond, tube well, and PSF was in BDT 950; 2443, and 20517 respectively (Table 4).

Table 4. Damaged value (BDT) of the water sources due to Sidr

Nature of water sources	Total systems	Damage Value (BDT)			Mean (BDT)
		Fully	Partially	Total	
Pond	60	0	57,000	57,000	950
Tube-well	70	165,000	6,000	171,000	2,443
PSF	29	540,000	55,000	595,000	20,517
River/Canal	8	0	0	0	0
Total	167	705,000	118,000	823,000	4,928

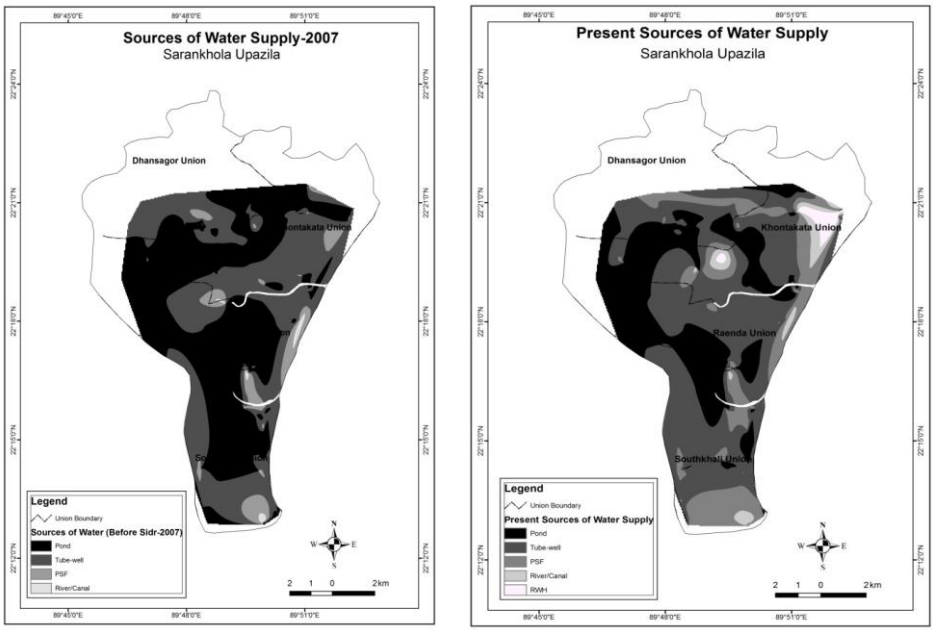
Recovery and Reconstruction

As earlier mentioned, pond, tube-well, PSF and river/canal were the main sources of water in pre-disaster situation of the surveyed households. The spatial nature of water sources during survey time have been postulated in Figure (4b) compared to pre- Sidr Figure (4a). Use of PSFs has increased rapidly after Sidr as the surface water sources were damaged and contaminated. RWHs (Rain Water Harvesters) were included as new system among the households. Total recovery value in the surveyed households was 2,173,000 BDT (mean 13,012 BDT) including pond 32,000 BDT (38 systems), tube-well 120,000 BDT (49 systems), PSF 1,541,000 BDT (62 systems) and RWHs 480,000 BDT (12 systems) (Table 5). Figure 5 also shows the comparative situation (before 2007 and after 2012 Sidr) of drinking water sources.

Table 5. Recovery value (BDT) of the water sources after Sidr

Nature of water sources	Total systems	Total BDT	Mean (BDT)
Pond*	38	32,000	842
Tube well	49	120,000	2,449
PSF	62	1,541,000	24,855
River/Canal	6	0	0
RWHs	12	480,000	40,000
Total	167	2,173,000	13,012

* Value of pond was estimated as maintenance cost of pond



a. Sources of water before Sidr (2007) b. Sources of water at present (2012)

Fig. 4. Sources of water before Sid (2007) and at present (2012)

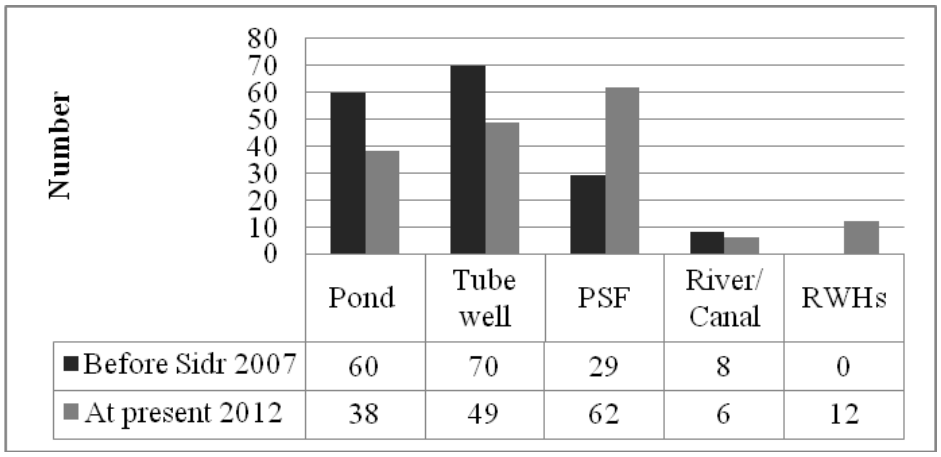


Fig. 5. Nature of water sources during pre and post Sidr in the studied households

Sanitation System

Sanitation system is the key indicator of healthy society. The sanitation system was good in pre disaster situation as government assessment and the study area declared as 100% sanitation coverage by the central government in 2005 (Official document, UNO office, July, 2008). But this study result shows different opinions among the people. Pre-disaster situation the structural conditions were temporary made by the locally available materials. Before Sidr, 164 families had toilet out of 167 surveyed families. Amongst 164 families, almost 75 families had *katcha* but without roof (39.02%) and *katcha* with roof (35.37%). Ring-slab with roof was about 20.73% and 4.88% was *pucca.* Total value of the sanitation systems (164 systems) were 447,000 BDT together with *katcha* but without roof 21,000 BDT, *katcha* with roof 70,000 BDT, Ring-slab with roof 51,000 BDT and *pucca* 305,000 BDT (Table 6).

Table 6. Nature and value of sanitation structures before Sidr

Sanitation Types	Frequency	%	Total value BDT
Katcha but without roof	64	39.02	21,000
Katcha with roof	58	35.37	70,000
Ring-slab with roof	34	20.73	51,000
Pucca	8	4.88	305,000
Total	164	100.00	447,000
			Mean Value 2,726

Damage Nature

Cyclone Sidr had created terrible situation by destroying the sanitation structures of this Upazila. Among 164 systems 81.7% (134 systems) were fully and 18.3% (30 systems)

were partially damaged. Most of the systems (28.7%) were floated by storm surge, about 23.2% broken by storm water, 17.7% broken by cyclone wind, 15.9% soaring cyclonic wind and 14.6% broken by fallen trees. Total damaged value of the sanitation systems (164 systems) was 230,000 BDT together with *katcha* but without roof 21,000 BDT, *katcha* with roof 64,000 BDT, ring-slab with roof 47,000 BDT and *pucca* 98,000 BDT (Table 7).

Table 7. Damage nature and value of sanitation due to Sidr

Sanitation Types	Fully damaged			Partially damaged			Grand Total damaged		
	Total	Percent	BDT	Total	Percent	BDT	Total	Percent	BDT
Katcha but without roof	64	47.76	21,000	0	0.00	0	64	39.02	21,000
Katcha with roof	42	31.34	50,000	16	53.33	14,000	58	35.37	64,000
Ring-slab with roof	26	19.40	39,000	8	26.67	8,000	34	20.73	47,000
Pucca	2	1.49	68,000	6	20.00	30,000	8	4.88	98,000
Total	134	100.00	178,000	30	100.00	52,000	164	100.00	230,000

Recovery and Reconstruction

After cyclone Sidr tremendous interventions were done by the non-governmental organizations (NGOs) and international non-governmental organizations (INGOs) the structural conditions of toilet system have changed. Affected families have enough toilets which have given the different agencies. Total recovery and reconstruction value is 672,000 BDT (mean 4,024 BDT) (Table 8). Fig. 6 depicts the comparative percentage of sanitation structures before Sidr (2007) and at present (2012) for more information.

Table 8. Nature and value of sanitation structures at present

Sanitation Types	Frequency	Percent	Total value (BDT) of sanitation structure
Katcha but without roof	21	12.57	8000
Katcha with roof	65	38.92	93500
Ring-slab with roof	67	40.12	100500
Pucca	14	8.38	470000
Total	167	100	672000
			Mean Value 4024

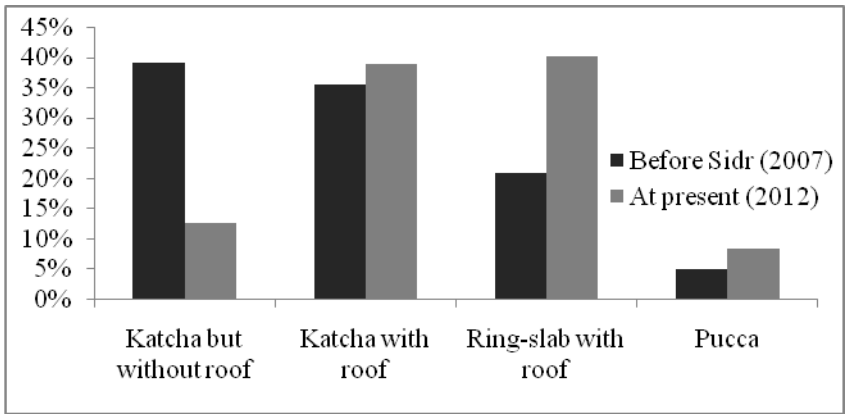


Fig. 6. Nature of sanitation structures before Sidr (2007) and at present (2012)

Key Observations

Following key observations have been identified from the research work with local people perceptions and authors' field observations:

1. 100% of water supply sources and sanitation structures were damaged due to cyclone Sidr.
2. Water supply and sanitation structures damaged mainly due to storm surge water of cyclone Sidr. About 89% water supply sources and 85% sanitation structures were damaged because of this reason.
3. Total damaged value in WSS sector was 1,053 thousand BDT including 823 thousand BDT in water supply and rest 230 thousand BDT in sanitation and total recovered value is 2,845 thousand BDT including 2173 thousand BDT in water supply and rest 672 thousand BDT in sanitation which indicates significant recovery have done.
4. Increased *pucca* as well as sustainable sanitation structure.
5. Use of PSFs has increased rapidly after Sidr as the surface water sources were damaged and contaminated.
6. Formal Rain Water Harvesters (RWHs) have incorporated as new system among the households.
7. NGOs and INGOs are the main providers of water supply and sanitation systems.

Conclusion

Bangladesh faces an average of 1.8 tropical storms or cyclones per year (Islam, 2006). Each cyclone had devastated effects in WSS sector and after the catastrophic disaster, the government; international community and local agencies usually addressed the post

disaster recovery programmes in the respective sector. The study area was experienced by a sever cyclone in 2007 called Cyclone Sidr and significant damages were done in WSS sector. According to upazila DPHE office, about 81% water sources and 72% sanitation systems were damaged in the upazila territory. But the study depicts about 84.43percent water sources were fully and 15.57% were partially damaged among the surveyed households. On the other hand 81.71percent sanitation systems were fully and 18.29% were partially damaged respectively. After accomplishing recovery initiatives it is evident that significant recovery have done in the WSS sector with the support of NGOs and INGOs and other voluntary as well as humanitarian agencies. It has been observed that WSS sector has given the priority issue in post disaster recovery programme in the study area. But the issues relating the sustainability of these structures and use or misuse of the systems were not assessed in the study. It is an important issue of the assisted WSS systems which can be a good study theme for further study

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