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Assessment of Flood Damages to Inland Water Transport Sector of Bangladesh

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Abstract

This paper contains results of survey carried out to assess the damages caused to the inland water transport sector of Bangladesh during the colossal flood of 1998. The results of the survey show that the flood caused extensive damages to this sector. A large number of accidents involving mechanized country boats took place during the flood. A number of factors including high current of water flow, excessive load on the boats, poor technical standard of the boats, poor maintenance and unskilled operation contributed to the accidents. A large number of installations of the Bangladesh Inland Water Transport Authority (BIWTA) suffered extensive damage due to submergence or the water level rise above the design limit. Many pontoons and jetties were either damaged or dislocated. Siltation of rivers during and immediately after the recession of the floodwaters also caused closure of waterways. This forced the crafts to use alternative routes, which were much longer. Dislocations of ghats have also caused inconvenience to the passengers and disruption in cargo movement, increasing the cost of the transportation. It is recommended that the damaged structures be immediately restored and funds be made available for dredging the entire water transport system. Immediate measures should be taken for regulation of the mechanized country boats so as to ensure their safer operation even in times of natural calamities like flood.

INTRODUCTION

Bangladesh, a land of 1,48,393 km^2, provides drainage to 1,660,000 km^2 of the combined catchment of the Ganges-Brahmaputra-Meghna System i.e., to an area

of 11 times the area of Bangladesh. The catchment area comprises the northern slope of the Himalayas in Tibet of China, Northern India, Northeastern India, Bhutan and Bangladesh. Out of the whole basin area only 7.5% is within Bangladesh, while 92.5% of the basin area lies outside the territory of Bangladesh i.e. in India, Nepal, Bhutan and China. Table 1 provides some statistics on river basin and drainage area.

Table 1: Statistics on river basin and drainage area

Area of Bangladesh	1,47,570 sq. km.
Total rivers	230 nos.
Cross boundary rivers	57 nos.
Major river basin area (India, Nepal, Bhutan, China and partly Bangladesh)	
(a) Brahmaputra basin	5,83,000 sq. km.
(b) Ganges basin	9,07,000 sq. km.
(c) Meghna basin	65,000 sq. km.
(d) Southeastern hill basin	45,000 sq. km.
Total	16,00,000 sq. km.
Drainage area	
(a) Drainage basin inside country	7.50 %
(b) Drainage basin outside country	92.5 %

The Ganges rises from the Gongotri glacier on the southern slope of the Himalayas at an elevation of over 7,000 m west of Nanda Devi range in Himachal Pradesh and northernmost Uttar Pradesh, west of Nepal. The river comes out of the Himalyan and Siwalik range near Dehradun and enters the plains at Hardwar.

The Brahmaputra rises in the northern slopes of the Himalayas in the Kailash range and flows 1127 km straight to the east parallel to the Himalayan range. In Tibet the river is called Tsanpo. The Tsanpo is a sluggish river in the southeastern part of Lasha where the river is possibly highest navigable river in the world. The river makes a hairpin bend in the eastern edge of the Himalayan range where the Himalayan also makes a right angle bend to form the Arakan – Yoma of Burma. The Tsanpo cuts a number of deep gorges here at Namcha Barwa (7755m) and enters the Assam valley at Sadiya (135 m) in Northeast Assam. The Brahmaputra in Assam is called Dihang. Enriched by a number of large tributaries in the Assam valley the river enters Bangladesh some 12 km upstream of Noonkhawa in Kurigram district.

The Meghna River drains an area of 77,000 km^2 of which about 46,500 km^2 (60%) lies in Bangladesh. The Barak is the principal headquarters of the Meghna.

The Barak rises at an elevation of 2900 m on the south side of Mount Javpo on the Navaland-Manipur border. The Barak in India has a catchment of 25,265 km^2 and on entering in Bangladesh at Amalshid bifurcates into the Kushiyara and Surma. At the point of bifurcation the larger portion of flow enter the Kushiyara while the smaller portion of the flow enters the Surma.

The Surma in its westerly course carries the flow from the Meghalaya and the Kushiyara in its southwesterly course carries the flow from the Tripura hills and meet at Markuli and the combined flow is known as upper Meghna. The Boulai system draining Garo hills in the north Mymensingh confluence with the upper Meghna at Dilalpur not far from Bhairab Bazar.

The major rivers mentioned above and their innumerable tributaries like the Rupsha, the Lakhya, the Dhaleswari, the Bhaguakul, the Pasur, etc. give a good access to most areas of the country when flowing at low level. Moreover, these rivers also give almost complete access to all parts of the country during flood. The geographical features have made Bangladesh one of the most difficult areas of the world with respect to developing a modern surface transport system suitable for guaranteed communication round the year. In almost all parts of the country, the highways and railways require embankment, sometimes as high as 6 meters, so that they are usable during floods. However, sometimes these floods become severe and cause devastating damages to human lives and properties in addition to causing breach and damages to the embankments.

In 1998, Bangladesh experienced one of the most severe flood in its history. The two-month long deluged caused damage to every sector of the national economy. For a riverine country like Bangladesh, inland water transport is vital for the transport system of the country. The water transport system and especially the mechanized country boats have been of great help to the people for movement and distribution of relief goods during the floods. However, soon after the deluge was over, people started to discover the damages caused to the water transport sector by the flood. One of the major reasons for the damage was the massive siltation and sediment transportation in the river system of the country during the flood. The floodwaters is estimated to have carried more than 3 billion tons of silts with it and a large part of the same have settled in the rivers and floodplain. Also, the onrush of water has caused massive movement of sands, silts and clays in the floodplain. This has resulted in loss of navigability in many navigation canals, damage to ports, *ghats* and other transport infrastructures as well as loss of forestry, which is likely to seriously affect the country boats sector.

The overall objective of the present study was to assess the extent of damage to the water transport sector of the country, with specific reference to the rural waterways mainly used by the mechanized country boats. The specific objectives were: (i) to investigate accidents of marine vehicles during flood, (ii) to assess

damages of the water transport infrastructures, and (iii) to assess disruption in navigation channels due to siltation during and immediately after the flood.

In order to achieve the objectives, extensive field visits were made for data collection. A questionnaire was prepared and distributed amongst the inland water transport operators, traders, passengers and other related persons. The data were collected mainly from Bhairab, Kishoreganj, Pabna, Khulna, Bagerhat, Barisal, Kurigram, Sunamganj, Brahmanbaria, Patuakhali and Pirojpur. Data were also collected from organizations like Bangladesh Inland Water Transport Authority (BIWTA) and Local Government Engineering Department (LGED).

FLOOD OF 1998

The 1998 flood has been termed as the most severe flood of the century. The fury of the flood in terms of magnitude and duration, and its devastation and human suffering was unparallel. Starting from 8th July when the Brahmaputra-Jamuna crossed danger level for the first time, the country was in the grip of flood for about 79 days until the Meghna at Bhairab Bazar dropped below danger level on 25 September of 1998.

During the 1998 flood four flood waves in succession passed through the Brahmaputra. These waves arrived before the river level could drop down sufficiently (from the effect of the previous wave) to accommodate for the next wave. These flood waves were recorded at Bahadurabad (IEB, 1999) with respect to danger level as shown in Table 2.

Table 2: Flood waves during the 1998 flood

Peak ID	Start date	End date	Peak date	Peak level	cm Above DL
1st	9/7/98	19/7/98	15/7/98	19.95	45
2nd	19/7/98	2/8/98	26/7/98	20.05	55
3rd	12/8/98	31/8/98	20/8/98	20.17	67
4th	31/8/98	12/9/98	8/9/98	20.37	87

It may be noticed that the peaks of the four flood waves were increasing and the river at this point was above danger level for 57 days and very close to danger level for another 9 days (from 3rd to 11th August 1998). What is more important is that the peak flood of the Ganges at Hardinge bridge occurred on 9th and 10th September at a record breaking level of 15.19 and coincided with the Brahmaputra-Jamuna peak at Aricha.

The effect of these flood levels and propagation was obvious. The left bank distributaries of the Brahmaputra from the old Brahmaputra down to Chital, Jhenai, Fatikjani, Lohajang and Dhaleswari flooded the greater districts of Mymensingh, Tangail and Dhaka. Backwater effect originating at the Hurasagar-Jumuna confluence traveled into the Chalan beel depression and flooded the vast area in the greater Pabna, Rajshahi and Bogra districts.

Lower reach of Mohananda was seriously affected from the backwater effect of the Ganges and flooded areas in Chapai-Nawabganj district including district headquarters. Flows through the Gorai and the Arial Khan and right bank distributaries of lower Meghna flooded the Gangetic delta in Bangladesh. Water level hydrograph of Panka, Chapai-Nawabganj (of Mohananda) and Rajshahi testifies this. A quick assessment inferred that global warming, glacier melt, sea level rise or the Tsunamis were not the causes of the 1998 flood in Bangladesh. Very high rainfall in all the three major river basins is the immediate cause of the 1998 flood.

Government of Bangladesh has already published the damages caused by the 1998 flood. Bangladesh water Development Board (BWDB) has also published a flood inundation map showing the flood-affected areas. The summary of losses and damages upto September 30, 1998 caused by flood is shown in Table 3.

Table 3: Summary of losses and damages caused by the 1998 flood (upto September 30, 1998)

Total area affected by flood	About 1,00,000 sq. km.
Total shortfall in production	About 2.2 million MT
Number of Districts	52
Number of Police Stations	366
Number of Affected Union Parishad	3,323
Number of Affected People	3,09,16,351
Affected Standing Crops in Acre	14,23,320
Number of Affected Homesteads	9,80,571
Number of Deaths	918
Cattle heads killed	26,564
Road Damaged (km)	15,927
Embankment Damaged (km)	4,528
Number of Damaged Bridge/Culverts	6,890
Number of Educational Institutions	1,718
Number of flood Shelter	27
Number of People taking refuge	10,49,525

The water transports, especially the mechanized country boats, were the only means of transportation in the flood-affected areas of the country. In one way, the floods were a blessing to the inland water transport sector of the country. However, the benefits appeared to be short-lived and were followed by harmful effects soon after the water receded. In this study an attempt has been made to identify how the flood affected certain navigation routes and how siltation forced boatmen to take detour. Such phenomenon caused losses to the vessel operators and traders. The flood also damaged a large number of *ghats* and pontoons and this resulted in extra difficulties and costs to be borne by the people and traders for using the same. There will be a cost involved for relocating the *ghats* at an appropriate place. The results of the study will also assist in preparing strategy and program for repair and rehabilitation of the identified damages.

ANALYSIS OF DATA

The data available from the survey was compiled and analyzed with the objective of estimating the extent of the damages caused to the inland water transport system in the regions investigated. Some of the damages could be easily quantified in monetary terms, while certain types of damages could not be quantified easily. The passengers had to pay directly or indirectly due to damage to the jetties/pontoons or shifting of the same. Evaluation of such damages was very difficult. Within the limited scope of the present works, it has not been possible to quantify such damages. Such damages have only been recorded and presented in the paper.

Accidents

Table 4 shows the data and information on accidents with the mechanized country boats that took place in the areas covered by the study. The data and information contained in the table shows that quite a good number of accidents (capsize/damage) of mechanized country boats took place during the flood throughout the country. However, the number of accidents has been reported to be highest at Nabinagar, Brahmanbaria. The total number (i.e., 20) of capsize was reported for Meghna. This is apparently due to the abnormally high level of water in this river during the flood. There was continuous flow of large volume of water for more than two months (Chowdhury and Islam, 1999). This flow was obstructed by the very large spring tides from the opposite direction that resulted in building up of a very large water depth.

The action of the strong current and wave has been identified to be the main cause of the accidents. There were accidents due to stoppage of the engine and collision with launch. Discussions were made with the boat operators regarding

the reasons for such accidents during the flood. The following major reasons were identified:

(i) The number of mechanized country boats in Bangladesh is estimated to be more than 600,000. During the floods, these boats were the main and practically the only mode of transportation. Consequently, the boats were operated beyond their capacities and often were operated by inexperienced crew.
(ii) The hull of the boats is basically meant for non-mechanized propulsion,. Moreover, the quality of the mechanization is very poor with very poor quality components being used. The workmanship is also extremely poor by marine standard (Rahim et al., 1993).
(iii) During the flood, boats were being built hurriedly and as a result of the quality of construction and fitting of the engines as well as the propulsion system were poor, even by the indigenous standard.
(iv) Due to the excessive demand during the flood, maintenance of these boats was poor.
(v) The direct drive and absence of reverse/reduction gearbox made the boats extremely poor in terms of maneuverability and control.
(vi) The currents were generally very strong during the flood, which made maneuvering of the vessels very difficult.

Some data on monetary losses arising out of the accidents has been reported as presented in Table 4. There was no opportunity to verify the accuracy of the figures. Moreover, the survey could not cover the whole of the country. Thus practically no inference could be drawn from the reported data. However, it can be emphasized that considerable monetary losses were incurred due to the accidents.

Siltation of Rivers Causing Loss of Navigability in the Dry Season

The biggest problem facing the inland waterway transport after the recession of flood was the unprecedented siltation in the navigational channels and routes, caused by the unprecedented flood. Hydrographic surveys by BIWTA and reports from pilots indicate the shoal formation in Meghna River (Dhaka-Chittagong and Dhaka-Barisal route), Kirtonkhola River (Barisal inland port basin area), Jamuna River (approach and basin of Notakhola Ferryghat), Padma River (approach and basin of Daulatdia Ferryghat), etc. The quantum of dredging requirement has been estimated to be very high. Various infrastructure development works have to be undertaken by the BIWTA to mitigate the damages. However, no hydrographic survey or data collected have been undertaken in the thousands of canals and *khals* throughout the country, which

are mainly used by the country boats for navigation. Some useful data and information have been obtained by the present survey on the type and extent of such damages to the waterways as a result of the flood. These are furnished in Table 5. The main effect has been found to be the shifting of the routes causing loss and disruption to business activities and movement of passengers and cargoes. Many routes have been closed altogether. The worst case reported is the closure of a 30-km waterway in Nabinagar, Brahmanbaria. The route is the one connecting Bhairab with Belabo. As a result, the vessels, mainly country boats have to take a much longer route with consequent increase in the transportation cost. This increase in cost is not fully compensated by the increase in the freight. Some routes were closed as early as October 1998. Closures of waterways have necessitated the use of alternative routes that are much longer. For example, the Nasirnagar-Kuliar char route at Nasirnagar, Brahmanbaria had a length of 25 km. However, this closure has also created an alternative route, which is 55 km long.

Damage or Shifting of Ghats Due to Erosion or Accretion Causing Inconvenience to the Passengers, Crew and Boat Operators

Most of such damages were experienced by the formal inland water transport sector. Various establishments of the Bangladesh Inland Water Transport Authority (BIWTA) were extensively damaged by the flood. Being a formal sector and under one organization, survey were taken up immediately after the recession of flood to assess the extent and nature of damage. The following excerpts are reproduced from the BIWTA flood damage assessment report (IEB, 1999).

The installations related to the inland waterways were constructed/reconstructed or rehabilitated by the BIWTA based on the experiences of the 1998 flood. The levels of the jetties and bank protection works, approach roads, etc. of the waterfront structure were raised above the 1988 flood levels wherever possible. Some of the problems faced during the 1998 floods in water transport sector are as follows:

(i) Many pontoons in the rural areas were set adrift by strong currents.
(ii) All wooden jetties were damaged. In some cases the river and bank erosion caused the wooden piles to dislocate. In other cases, the country boats, engine boats etc. plied over the decking severely damaged them.
(iii) Small-scale bank protection works between the jetties and the approach roads were damaged mainly by vessels ramming against them in their attempt to discharge passengers and cargo to flood-free points.
(iv) The approach roads to jetties, the internal roads, the parking yards within the ports remained underwater for considerable time causing soil subsidence and potholes.

(v) The floors and walls of the inundated port terminal buildings were severely damaged by country boats plying and dragging over them.

Table 4: Accident occurring with mechanized boats during the 1998 Flood

Place	Name of river	No. of boats affected		Property loss (Tk.)	Loss of life	Reason of accident (see below)
		Cap-sized	Dama-ged			
Sunamganj, Sylhet		1		70,000	-	-
Bajitpur, Kishoreganj	Khora Utra	5		400,000	-	-
Rjabari Sadar		-	13	230,000	-	-
Brahmanbaria Sadar	Titas		1	10,000	-	-
Birgaon, Nabinagar	Meghna		1	20,000	-	**a**
Nasirnagar, B. baria	Meghna	20		920,000	-	-
Kalapara, Patuakhali	-	4		370,000	12	-
Mahipur, Patuakhali	-	1		375,000	60	**b**
Kalapara, Patuakhali	Shapurer Khal	2		600,000		-
Indurkani, Pirozpur	Panguti River	1		380,000	1	**b**
Bhairab Ferryghat	Meghna		1	10,000	-	**c**
Sujanagar, Pabna	-		14	220,000	-	-
Chilmari, Kurigram	Brahmaputr a		1	30,000	-	**d**
Kotwali, Khulna	Kaji Bacha		1	80,000		**e**
Dakop, Khulna	Shibsa	4		400,000	4	**f**
Paikgacha, Khulna	Korulia river	2		200,000	-	**f**
Paikgacha, Khulna	Rupsha river		1	75,000	1	**g**
Kotwali, Barisal	Kirtinasha	19		1,600,000	-	**g**
Tahirpur, Sunamganj	-	25		1,200,000	-	**h**
Swarankhola, Bagerhat	Jamtalar Khal	1		125,000	-	**g**
Morolganj, Bagerhat	Payra River	2		200,000	-	**h**
Swarankhola, Bagerhat	Bishkhali	1		180,000	-	**h**
Morolganj, Bagerhat	Sundarban Khal	1		125,000		**g**
Swarankhola, Bagerhat	Bhola river	1		200,000	1	**g**
Swarankhola, Bagerhat	Boleshar river	1		180,000	-	**g**
Morolganj, Bagerhat	Kochar	1		200,000	-	**i**
Morolganj, Bagerhat	Pangachi	1		210,000	-	**h**

a: collision with launch in strong current, **b:** strom, **c:** collision with ferry, **d:** Engine stopped and boat drifted by strong wind, **e:** Bottom damaged by strong current and wave, **f:** Drifted by strong current, **g:** Drifted by strong current and wave, **h:** Slamming against wave, **i:** Drifted by current and hit by shoal.

Table 5: Siltation of rivers causing loss of navigability in the dry season

Location	River/route	Damages occurred	Shifting of river route
Kotwali, Barisal	Kalijira River	Silted at places	minor shift
Kotwali, Barisal	Kumarkhali River	Almost fully silted	-do-
Kotwali, Barisal	Jagua-Gutia	Massively silted	-do-
Kotwali, Barisal	Dapdapia-Ranirhat	Massively silted	-do-
Kotwali, Barisal	Char Jagua-Kumarkahali	Silted in many places	-do-
Shujanagar, Pabna	Dhawapara-Rajbari	Silted in many places	-do-
Shujanagar, Pabna	Nasirganj-Belgachi	Massively silted	-do-
Bera, Pabna	Notakhola-Nagarbari	Silted in many places	-do-
Dakop, Khulna	Bhangon-Nowai route	-do-	-do-
Chalna, Khulna	Joarkhali-Purtan Masjid	-do-	-do-
Paikgacha, Khulna	Bhangan-Paikgacha	-do-	-do-
Raipura, Narsingdi	Chitri-Nabinagar	-do-	-do-
Raipura, Narsingdi	Gokon-Nabinagar	-do-	-do-
Raipura, Narsingdi	Baluchar-Maijchar	-do-	-do-
Kalapara, Patuakhali	Bhangan-Kumirmara	-do-	-do-
Nabinagar, B'baria	Bhairab-Belabo	Massively silted	30 km closed (Nov.)
B'baria, B'baria	Chitri-Bhairab	-do-	20 km closed (Nov.)
B'baria, B'baria	Chitri-Narsingdi	Silted in many places	30 km closed (Nov.)
B'baria, B'baria	Chitri Gokan	-do-	Increased from 17 to 20 km
Nabinagar, B'baria	Baish Mouza-Bhairab (Meghna)	-do-	Increased 8 km
Nabinagar, B'baria	Baish Mouza-Nabinagar (Titas)	-do-	Increased 10 km
Nabinagar, B'baria	Baish Mouza-B'Baria (Pagla)	-do-	Increased 20 km
Nasirnagar, B'baria	Nasirnagar-Kuliar char	-do-	Increased from 30 to 55 km
Rajbari, Rajbari	Dhawapara-Rajbari	-do-	Increased 8 km
Rajbari, Rajbari	Nazirganj-Belgachi	-do-	Increased 8 km
Mitamoin, Kishoreganj	Sadhana-Ajmeer	-do-	25 km closed
Mitamoin, Kishoreganj	Banglapara-Adampur	-do-	8 km closed
Bajitpur, Kishoreganj	Chatalganj-Mitamoin	-do-	3 km silted
Sarankhola, Bagerhat	Sarankhola-Badaghat	-do-	1 km silted
Tahirpur, Sunamganj	Fazilpur-Durlavpur	-do-	closed in late October
Tahirpur, Sunamganj	Fazilpur-Lalpur	-do-	-do-

(vi) The semi pucca pilothouses were seriously damaged.
(vii) The buoys drifted off and the shore beacons became dislocated due to erosion and strong currents. The navigational markings made of bamboo and bamboo mats were washed off.
(viii) The problem went out of control when the floodwater rose so high as to make the driving of the bamboo poles impossible.
(ix) Low-cost waiting sheds constructed near the launch stations or *kheaghats* got damaged by floods. In some cases, they were even washed away by flood or bank erosion.
(x) All RCC jetties were inundated by floodwater by a meter or more, but their use for the purpose of handling food grains, relief materials, etc. continued. The bottoms of loaded country boats and engine boats dragging over them damaged the decking. Dashing of the vessels damaged the columns and outer beams.
(xi) The pontoons of the port terminals were floated up beyond their design limits and reached extreme conditions making them dangerous. Any further increase in flood level could have made them drift off and cause the gangways supported on them to slip into the river. This could have resulted in almost irrecoverable damage in terms of time and money.
(xii) The Decca stations were flooded for an inordinately long period and water submerged the floors and foundations of the machines. Lighter equipment could be removed to higher places. However, the operation of the hydrographic survey was kept undisturbed by taking emergency measures but the station at Chandpur could not operate for about 10 days when the power unit had to be disconnected and shifted to safer places.
(xiii) The lifeline between the capital city Dhaka and the country's northern and southern region through the Aricha-Notakhola, Aricha-Daulatdia and the Mawa-Charjanajat ferry routes were maintained in extreme conditions with great labor and costs. They went out of operation only when their connecting highways became unusable.

However, the surveys and assessments carried out by the BIWTA were limited to their installations. Such installations are limited to the defined Class A, B, C and D waterways as defined and fully or partially maintained by the BIWTA. These waterways do not cover practically the bulk of the waterways of the country. The country boats carry more than 50% of the passengers and cargo throughout the country. These boats ply largely on the arterial canals and *khals*, which is not maintained by the BIWTA except for a limited number of *ghats*, installed by the authority. Surveys were carried out to assess the extent of damages to the *ghats*. The objective was not only to assess the physical damages

to the *ghats* but also the difficulties faced by the passengers and traders due to the dislocation of the *ghats* or the relocation of the channels or waterways.

In order to assess the same, information were collected on the *ghats*, which have either been damaged or dislocated or rendered useless/difficult due to the flood. The results of the investigation of such *ghats* are presented in Table 6. It is seen from the table that a quite large number of *ghats* have developed wet access ways up to 50 meters which were not present before the flood. As a result, the passengers faced difficulty in embarkation and disembarkation and the cost of loading and unloading of the cargo increased considerably. Moreover, the dry access way became as much a 1 km, which was previously much less. This caused similar effects as the wet access way, albeit to a lesser intensity. It can also be seen from the table that quite a good number of *ghats* shifted due to the flood by up to 3 km. These shifting were reportedly made to adjust with the shifted river course or siltation during and immediately after the flood.

Table 6: Damage or shifting of *ghats* due to erosion or

P. Station	District	Dry Access way	Wet Access way	Shifting of ghat
Mitamoin	Kishoreganj	90 meters	40 meters	-
Bhairab	Kishoreganj	15 meter	10 meter	-
Chilmari	Kurigram	1 Km	Nil	-
Rajbari	Rajbari	125 meter	Nil	-
Nabinagar	B'Baria	200 meter	20 meter	-
Nabinagar	B'Baria	125 meter	20 meter	200 meter
B'Baria	B'Baria	250 meters	50 meter	125 meter
Nasirnagar	B'baria	-	-	2 km
Sujanagar	Pabna	125 meter	-	-
Bera	Pabna	1.5 Km	-	-
Kotwali	Barisal	1 Km	20 meter	-
Kotwali	Barisal	-	-	3 km
Swarankhola	Bagerhat	500 meter	20 meter	1 km
Tahirpur	Sunamganj	-	-	1 km
Hatiya	Noakhali	50 meter	50 meter	-
Hatiya	Noakhali	100 meter	20 meter	-
Chilmari	Kurigram	1 Km	20 meter	500 meter

CONCLUSIONS AND RECOMMENDATIONS

The colossal flood of 1998 has damaged the inland water transport sector as well as other sectors of the Bangladesh economy. Accidents occurred with mechanized country boats during the flood due to a host of reasons, such as excess pressure on the boats, poor maintenance, untrained crew etc. Such

damages could be quantified in monetary terms. However, there are other damages such as those due to siltation of rivers and canals and damaged/dislocation of the *ghats*. The financial and economic impact of such damages can not be easily quantified. The extents of such damages have been quite serious and directly affected the lives of the poor boat operators. This also caused an increase in the transportation cost.

In order to mitigate the sufferings of the people a series of measures may be taken which include:

i) There is a need of restoring the landing stages such as pontoons, jetties, *ghats* pilothouses, channel markings, Decca chain equipment etc.
ii) The dredging of the river routes with equal emphasis on the large rivers and the small arterial canals and *khals* to ensure easy movements of vessels in all river routes of the country throughout the year.
iii) Regulate the country boat operation to ensure minimum technical standard of the boats and efficient operation by skilled crew
iv) Necessary fund should be allocated to repair and rehabilitate the damages caused by the flood.
v) A database should be prepared and maintained on the water transport sector of the country incorporating the mechanized country boat sector. Such database should contain information on the river transport routes, their economic importance, siltation situation etc.

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