

# Water Logging in South-Western Coastal Region of Bangladesh: Causes and Consequences and People's Response

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## Authors' contributions

This work was carried out in collaboration between both authors. Author MAA designed the study, wrote the protocol, managed literature searches and wrote the first draft of the manuscript. Author AFMTI helped in GIS mapping and facilitated field visits. Both authors read and approved the final manuscript.

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## ABSTRACT

**Aim:** Since decades, a major part of south-western coastal region of Bangladesh is being affected by water logging – a problem related to climate change along with some manmade activities. Therefore, the study was conducted to assess the causes and consequences of this problem and highlights the responses of affected people to attract policy planners' intention for taking proper intervention.

**Place and Duration of Study:** The study was conducted in the Laboratory of Plant Ecology, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, Bangladesh.

**Methodology:** Qualitative and quantitative techniques have been applied to collect and analyze both the primary and secondary sources of data from various waterlogged areas of south west Bangladesh.

**Results:** There is no single or a few factors are responsible for creating water-logging problem rather it is a combination of several factors and their cumulative effects over time. It is revealed from the analysis of primary and secondary sources of information that death of Mathavanga River in the 20<sup>th</sup> century, execution of Coastal Embankment Project since 1960's, withdrawing water flow to the Padma River through operating the Farakka barrage after independent of Bangladesh, improper management of rivers, faulty land-use by influential people in the areas, monsoon downpour etc are major causes of the problem. The silted up river systems in area could not drain monsoon rain that occurred even for a couple of days. The consequences brought to inundate hundred thousand hectares of cultivable land unsuitable for crop production. More than one million people are directly affected in the areas and the number is gradually increasing over the years. Water stagnancy around the settlement areas remains 6 to 9 months in a year and many places became permanently waterlogged. The affected people have no other way out but to live with water. The congested water is polluted with salinity, chemical effluents with heavy metals, household debris's and related other pollutants. Source of safe drinking water is destroyed. Therefore incidences of waterborne and skin diseases are increased. People are living with greatest inhumanity as food, shelter, sanitation, communications, educations and other prime needs are tremendously challenged. Many people lost their occupations and became destitute, some altered their livelihood to much lower grades, and many of them are forced to migrate to city areas. The marooned people demanded to the authority to declare their places as an affected area and sought the government intervention to bring an end to the crisis through operating the Tidal River Management plan and excavating or re-excavating of associated rivers, channels and rivulets.

**Conclusion:** The authority need to pay keen attention to the issue and should take proper initiative to mitigate the water-logging problem permanently to save people living in the south western coastal region of Bangladesh.

*Keywords: Barrage; drainage channel; embankment; polder; river system; siltation; water logging.*

## 1. INTRODUCTION

When the water table rises to a height that the soil pores become saturated, thus displacing the air, the land is said to be waterlogged. An area may be considered as waterlogged when the water level above the ground is too high that does not permit an anticipated activity, like agriculture. It occurs when the rate of accumulation of water through rainfall or some other means exceeds the combined rates of drainage, percolation and evapotranspiration of a catchment or when flood water submerges an area [1] followed by congestion of water by a boundary like embankment or polder. It arose in south-western coastal region of Bangladesh, since the end of the twentieth century, which creates a serious hydro-geological crisis in the area. Nevertheless, the problem was slowly developed since 60's that has been compounded from 2006 [2] and a maximum disaster was ever being observed from onset of 2011 monsoon downpour [3-5]. Thereafter, each and every rainy monsoon season in the area passes through water congestion. The areas are differed from the perennial water bodies of southern Bangladesh that the south-western coastal region, the places where the study is conducted were not previously waterlogged rather it is happened in recent times.

Due to the permanent water congestion, sudden flood is occurred during the rainy days in monsoon season. Therefore, water logging situation causes recurring flood in every monsoon. The cultivable land shrunk thus biodiversity threatened [6-7]. The situation makes agriculture practices impossible. The prolonged water-logging has caused significant displacement presenting humanitarian challenges in safe water supply, sanitation, and shelter and food security. There are areas where people are compelled to live in waterlogged condition for six to nine months in a year; even many settlements and cultivated crop lands are permanently inundated losing valuable agricultural production especially rice, fruits and vegetables. Socio-economic and agricultural activities have largely been hampered due to water logging [8-9]. The situation reaches to an extremely vulnerable condition for the people as there is no other way out, but to live with water. Due to climate change, sea-level rise, storm surges, back water effect, sudden monsoon downpour etc are common, the situation is expected to worsen more to the future. Adaptation options to fulfill the minimum needs are also very limited as the situation is much complex. The affected people are trying to survive facing innumerable sufferings but they are gradually losing their hopes over time. To solve

the problem, proper government interventions are of prime importance. To attract proper intention of authority, therefore, the root causes of water logging and its consequences and people's responses should be assessed.

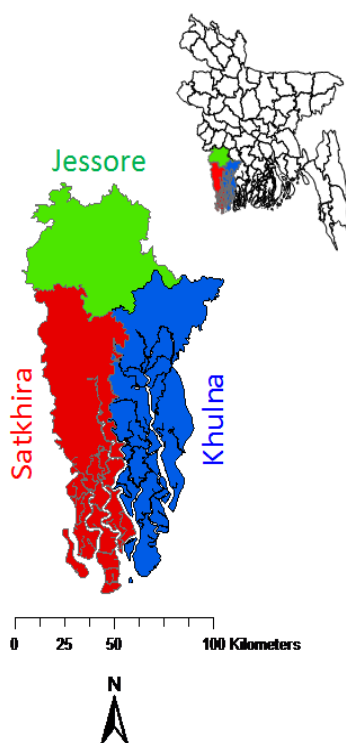
## 2. MATERIALS AND METHODS

The study was conducted in the Laboratory of Plant Ecology, Department of Crop Botany, Bangladesh Agricultural University, Mymensingh. Qualitative and quantitative techniques to analyze both primary and secondary sources of data collected from the various waterlogged areas of Jessore, Satkhira and Khulna districts have been applied (Map 1). The tools used for primary data collection from affected villages include Focus Group Discussion (FGD) and Case Studies, and direct visit of waterlogged land, rivers, etc.

The areas for primary data collection were selected in consultation with Department Agriculture Extension (DAE)'s officials. The primary data using FGDs and case studies were collected from Sagardhari and Sufolakathi unions of Keshabpur upazila (sub-district) of Jessore district, Tentulia and Sadar unions of Tala upazila of Satkhira district and Sachiadah union

of Terokhada upazila of Khulna district. The most affected villagers or households were randomly selected with the help of the local administrative personnel. The FGDs were conducted to collect the views and opinions of local people on the various aspects of the areas like root causes and consequences of water logging, and their responses. Case studies based on experiences of villagers were done to illustrate and identify key challenges to be addressed by the government and non-government agencies. Consultation meetings were conducted with relevant government officials (Table 1). Consultation meeting was also conducted with NGO officials working in the locality.

Rainfall data of meteorological observatories throughout the country from 1948 to 2010 were collected from Bangladesh Meteorological Department (BMD), Ministry of Defense, GoB. Rivers with their catchment areas and drainage systems were mapped from the information available on browsing in online. Data on cultivable land, number of people and infrastructures such as settlements, houses, roads etc affected by water-logging as triggered by monsoon rain were collected from relevant offices, newspapers, grey literatures, online reports etc.



Map 1. Three water-logged districts in south-western coastal region of Bangladesh

**Table 1. Stakeholders of various ministries at different levels**

Ministry	Department/ Officer	Implementing officer at district level	Implementing officers at upazila level	Implementing officers at local level
Ministry of Agriculture	Department of Agriculture Extension (DAE)	Deputy Director (DD)	Upazila Agriculture/ Extension Officer	Sub-Assistant Agriculture Officer
Ministry of Disaster Management and Relief	Disaster Management Bureau/ Director General (DG)	District Relief and Rehabilitation Officer (DRRO)	Project Implementation Officer (PIO)	Union Council Chairman <sup>a</sup>
Ministry of Water Resources	Water Resources Planning Organization (WARPO), Bangladesh Water Development Board (BWDB)/ Divisional or Sub- divisional Engineers (Operation & Management) working at the study sites			

<sup>a</sup>Ministry of Local Government, Rural Development and Co-operatives, Government of the People's Republic of Bangladesh

### 3. RESULTS AND DISCUSSION

#### 3.1 The River Flows and Drainage Systems in South-West Region of Bangladesh

The south-west region of Bangladesh houses a lot of rivers (Map 2). The density of rivers in this area is higher than that at the other regions of Bangladesh. The region is mainly drained through so many north-south flowing rivers [10-11]. Some major river systems are the Gorai-Madhumati-Baleswar, the Gorai-Bhairab-Pusur, the Kabodak-Betna-Kholpetua, the Mathabhanga-Ichamati-Kalindi etc. Most of the rivers flowing at the southern region are tidal in nature. Some rivers flowing towards east to west are also exist in the region which interconnect the rivers those oriented towards north to south. Flows of east-west oriented rivers are very important for the complete circulation of tidal flow all over the catchment. The river system crisscrossed the region through a complex network of smaller river and rivulets. The flows are laden with variable sediment.

The Mathabhanga, a transboundary river between India and Bangladesh, originates from the right bank of the Padma, at Munshiganj in Kushtia district flows to Kumar and Nabaganga Rivers. The Kumar takes off from the Mathabhanga River at Hatboalia and follows a circuitous course to the east and south-east, for a long distance forming the boundary between Kushtia district to the north and Alamdanga upazila of Chuadanga district and Harinakunda upazila of Jhenaidah district to the south. Finally it joins the Nabaganga River near

Magura town. Nabaganga is a distributary, one of the offshoots of the Mathabhanga River. The Nabaganga River originates near the Chuadanga town, flows eastward and receives the Kumar River at Magura and the Chitra River at Narail. Afterward, the river turns southward to meet the Bhairab River. In the past the Nabaganga was a tributary of the Ichamati that is a trans-boundary river which forms the boundary between the two countries. Now-a-days, the Nabaganga merges into the Kumar River after flowing through Chuadanga and Jhenaidah districts and gets new life receiving flow from the Kumar. Indeed, the Nabaganga after Magura is the extension of the Kumar. Now, the Nabaganga carries a major flow of the Gorai-Madhumati River at Baradia of Narail district.

The river Ichamoti branched into two streams at Darshana in Kushtia district. One flowing southeast is known as the Bhairab. At the south of Kotchandpur, an offshoot branches out from the Bhairab and flowing south meets with the Shibsha near Paikgachha in Khulna district. This offshoot of the Bhairab is the Kobadak. The Bhairab flows to Khulna-Ichamati forms a boundary between Bangladesh and India. The towns of Khulna and Jessore are situated on the bank of the Bhairab River. The Rupsa River is originated from the Bhairab and the Atai River, and flows into the Pasur River. Mukteshwari River from Jessore Sadar upazila flows south-east to Manirumpur and Abhaynagar upazilas.

The Chitra River is originated from the lower part of Chuadanga, runs about 170 km southeast through Kaliganj (Jhenaidah district), Jessore, Salikha (Magura) and Kalia (Narail) upazilas and joins with the Nabaganga in Gazirhat of Narail

district. Afterwards the combine flow meets to the Bhairab River in Daulatpur upazila of Khulna district. The river is heavily silted up and not navigable from its original point to Salikha. In the past, the Chitra was an offshoot of the Ichamati, but it turned into a distributary of the Nabaganga due to siltation at its mouth. The Chitra finally drained to Atharobaki River at Rupsa upazila of Khulna district and Kaliabardia River of Narail district.

The Betna River originates in Jessore district, flows through Satkhira and Khulna, changes to Kalia River, and forms a branch called Dalua River. The Kalia flows into the Kobadak River. The Betna changes to the Arpangachhia and reaches the Sundarbans, and then changes as Malancha River before flowing into the Bay of Bengal.

The Kobadak River is originated from the Mathabhanga in Chuadanga district, runs 105-kilometer through Chougachha upazila of Jessore district. After disconnected from Mathavanga the Kobadak resulted in feeble flow and receives water from local rain, seepage/runoff and percolation. Now, the Kobadak is the main branch of the Bhairab River. It flows to and fro through different areas of Jessore, Satkhira and Khulna districts and finally meets the Kholpetua River at Koyra of Khulna district. It is the main artery of the drainage system in the flowing areas.

### **3.2 Causes of Water-logging in the South Western Coastal Region of Bangladesh**

#### **3.2.1 Death of Mathavanga and reduction of the Padma's stream**

During the 20<sup>th</sup> century, the Mathavanga River was gradually disconnected and finally dead from the main river Ganges [12] as a result the Kumar and Nabaganga Rivers at the upper regions and the Chitra, Bhairab, Kobadak (Kopotakho), etc at lower regions (southern part) were deprived from the upstream fresh water flow. Then south-west region's rivers depend only on Padma's stream. However, due to the operation of Farakka barrage during the 70's of last century, freshwater inflows of the Padma and her distributaries and tributaries for south-west region decreased suddenly. This results come up with tremendous siltation thus riverbed elevation was occurred. Due to the loss of upstream inflows, gradually the rivers turned with run into

tidal rivers or estuaries and show a continuous process of siltation from the north-west towards the south-east direction. Among the aforesaid drainage channels (mentioned in sub-section 3.1) some local rivers like the Kobadak, Hamkura, Hapakhali, Harihar, Bhadra, Shalta, Teleghati, upper Solamari, Shree, Muktershari, Teka, Hari, Morirchap, Chitra etc those who flowing through most of the catchments in the south-west coastal areas, have lost their conveyance due to severe sedimentation (Photographs 1-2).

#### **3.2.2 Polderization – a green revolution intervention**

A polder (a Dutch word) is a low-lying tract of land that forms an artificial hydrological entity (locally called *Bee*), enclosed by embankments. To convert the seasonally flooded saline coastal wetlands into improved land for boosting crop production especially rice along with protection of human settlements from storm surges, the Water and Power Development Authority constructed 37 polders, and associated 1566 km embankment and 282 sluice gates through Coastal Embankment Project in the Khulna, Satkhira and part of Jessore districts in the early sixty's of twentieth century (some polders shown in Map 3). The construction of sluice gates was faulty along with small, low height and few in their number, and also managed improperly (Photographs 3-5). Thus, sea tides deposited silt on riverbeds and sluice gates, rather than inside the polder, halting natural flow of the rivers and sluices. Additionally, upstream river flow becomes weaker due to various human interventions on the river systems leading to sedimentation on the riverbed. Consequently land formation occurred on the riverbed and floodplains inside the polders are subsided and remained lower than riverbanks. That means natural land building process inside the polder was disrupted. As a result overbank spillage to the polder is occurred on monsoon surges and rainwater could not drain from the polder leading to permanent or perennial water logging.

#### **3.2.3 Human intervention and lack of proper administrative step**

The rivers and associated drainage systems over time are not properly maintained by the administration. Unplanned crop and fish especially shrimp farming by the grabbers in the society are also important reasons to blockage



Map 2. River systems in south-west region of Bangladesh. Adapted from Institute of Water Modelling (IWM), Dhaka, Bangladesh



**Photographs 1-2. Silted up Kobadak River in Tala upazila of Satkhira district (left) and Chitra River in Terokhada Upazila of Khulna District (right)**



**Photographs 3-5. Small and shallow sluice gates from Terokhada Upazila of Khulna District (Left and middle) and Tala upazila of Satkhira District (Right)**



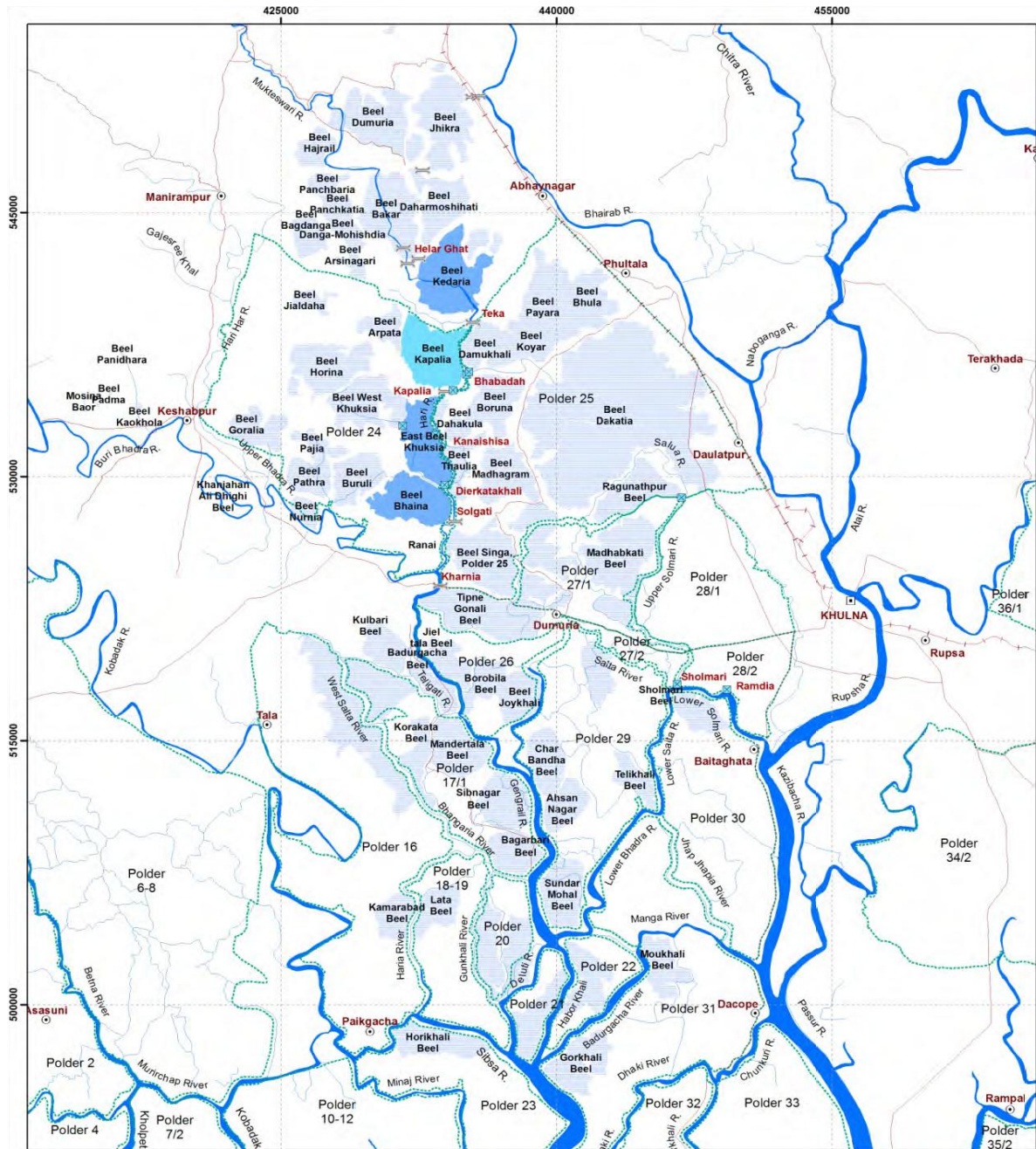
**Photograph 6. Blockage of drainage network due to fish culture [14]**



**Photograph 7. Blockage of river flow due to crop production activity along with unmanaged weeds on the riverbed of the Kobadak**

the river flow leading to water logging (Photograph 6). For example, influential political leaders and musclemen occupied 600 acres of land of the Bhadra, Salta, Khornia, Hari, Thukra-Hamkura Rivers flowing through Dumuria upazila, setting up brick fields, fish enclosures,

houses etc. As a result, 44 unions of Tala upazila of Satkhira district, and Phultala and Dumuria upazilas of Khulna district are affected by water-logging [13]. The river systems are also very much unmanaged in many areas (Photograph 7).



**Legend**

- ⊙ Upazila HQ
- ⊠ District HQ
- Existing Regulator
- Bridge
- River
- Railway
- Road
- International Boundary
- Polder
- Proposed TRM Basin
- Completed TRM Basin
- Beel

**Base Map**



Projection: BTM, Everest 1830

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Study area



**Map 3. Some rivers, polders and beels in the study area. Adapted from Institute of Water Modelling (IWM), Dhaka, Bangladesh**



Voice of general people in the locality for demanding proper action (TRM, for example) is very weak as most of the lands in the areas belong to shrimp hatchery (*gher*) owners [15]. Each of the polders has about 40% of *khas* (government owned) land. They have also managed, sometimes by force or trickery, to lease hundreds of acres of private land from farmers. Local influential's, especially the shrimp hatchery owners are dead against the operation of Tidal River Management (TRM) plan [15]. The TRM is an indigenous water management system to solve water logging problem by elevating floodplain inside the polder through continuous siltation over the successive years. Simply, the system allows high tidal flow into polderized beel and releasing it back away when the tide subsides (i.e. ebb flow). Through this process, sediments carried by tidal flow deposit on the wetland basin instead of riverbed. During ebb tide, sediment free water flow recedes with withdrawing silts from river bottom caused deepening the river [16].

### 3.2.4 Implementation of development projects

With funding from Asian Development Bank, the government took a mega initiative named Khulna – Jessore Drainage Rehabilitation Project (KJDRP) for a viable solution of the problem. Bangladesh Water Development Board is being implemented this project with advices from the Department of Agriculture Extension and Department of Fisheries. The KJDRP that was implemented between 1995 and 2004, included massive dredging work, construction of regulators, dams and embankments in the project areas, but it failed to improve the situation. Rather, the project further worsened the drainage problem in the region and led to the death of several rivers in the area, locals said [17]. The local people also apprehend that the project, if KJDRP implemented, will worsen the situation and multiply people's sufferings beyond the tolerable limit.

The KJDRP covered 100,600 hectares of waterlogged land from Abhoynagar, Keshabpur, Jessore Sadar and Manirampur upazilas of Jessore district and Batiaghata, Daulatpur, Dumuria and Phultala upazilas of Khulna district [17]. The water drains from the KJDRP area through the four river systems like the Harihar-Buri Bhadra-Upper Bhadra, Mukteshwari-Sree/Teka-Hari, Hamkura and Solmari Rivers. Local people resisted the project for years as its design and approach did not match with their expectations. The feasibility study did not also

consider any aspects of implementation area and any assessment of its possible consequences. It was perceived that the entire environment and geo-morphological information were not considered so far. Critics argued that the project could not solve the problems because the attempt is based on structural approach rather than the ecosystem based ideas [18]. Nevertheless, the activity plan of KJDRP has been modified after wastage of quite a long time with including some ideas (TRM, for example) of local people and civil societies. But faulty implementation resulted in failure of some of the TRM attempts [17].

### 3.2.5 Monsoon downpour

The mean data of monthly total rains that occurred from 1948 to 2010 in the south-western region along with country average are shown in Fig. 1. Most rains occurred from June to September with a peak monsoon thrust on July. Southwest regions receive relatively lower amount of rain throughout year than that at national average. However, the rainfall pattern is slightly shifted and monsoon thrust is increasing in the southwest Bangladesh in recent years (Map 4). Similarly, Kabir and Golder [19] reported that rainfall events in monsoon period over the fore southwestern Bangladesh are intensifying. From a calculation FAO [20] also found higher late monsoon (September-October) rain in Khulna region that occurred recent decade as compared to the past ones. This late downpour can be considered as one of the causal factors for water logging as the areas are already saturated by the rain that occurred in the months before.

The river systems couldn't drain the monsoon rain that occurs even for a couple of days. For example, an entire village (Beel Bakar) of a Bhabadah region went under waist-high waters following a heavy rain of 424 mm from 3 days in mid August of 2016 [21]. As the river and channel systems in the areas are already heavily silted up but polder areas (i.e. the Beels) remained lower height than riverbed thus higher spillover effect is happened over the polders.

### 3.2.6 Low topographic slope and sea level rise

Digital Elevation Model reveals that the south-west area of Bangladesh is dominated by flat topography with a gradual drop from northwest towards southern directions, and the coastal part is characterized with very low elevation varying between 0 m to 2 m above mean sea level (Map

5). Additionally, polderized pockets are characterized with much lower height. Thus the drainage capacity through seepage (run-off) and percolation is very poor. Rising sea level also plays as an obstacle for delaying discharge from the draining systems. Consequently, rain water could not go away towards the southern reach leading to water logging.

### 3.2.7 Unplanned urbanization

Urbanization is increasing all over Bangladesh and south west region is of no exception. However, unplanned urban structures with poor draining facilities associated to the neighbored rivers and channel systems caused water-logging [23].

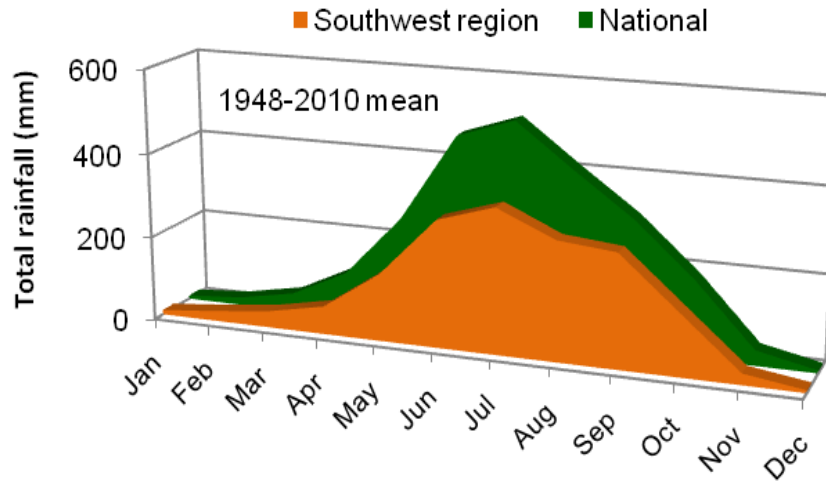
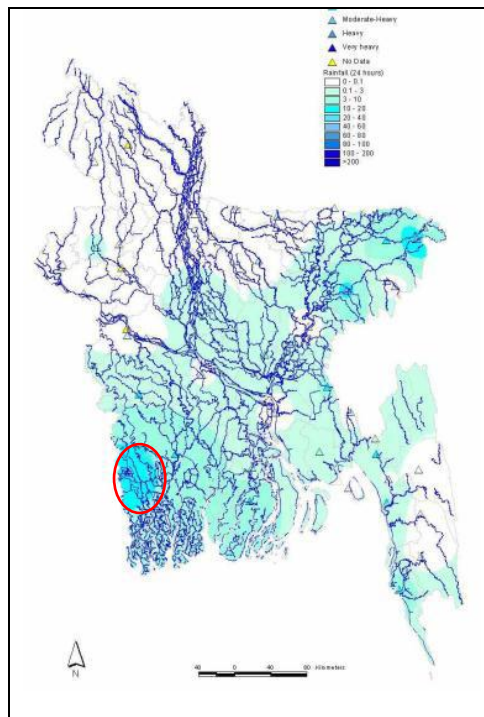
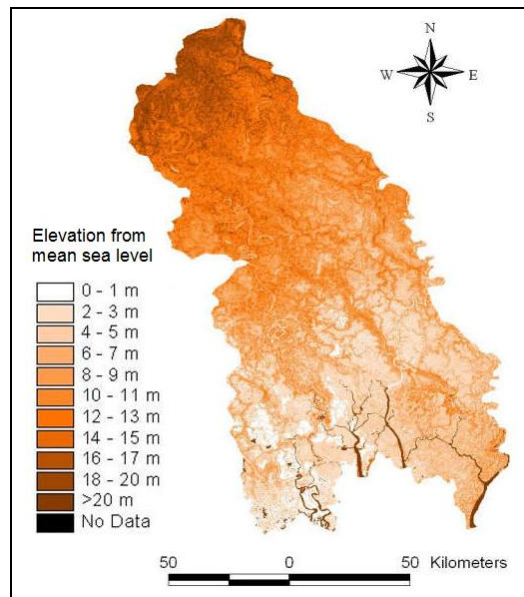


Fig. 1. Monthly total rainfall in southwest Bangladesh with National average



Map 4. Monsoon downpour occurred within a day (24-hour) in late August 2011. Red elliptical zone with higher rainfall refers the tentative study areas

Source: <http://www.fwc.gov.bd/>



**Map 5. Land elevation in South West region of Bangladesh [22]**

### 3.3 Area under Waterlogged in South West Coastal Region of Bangladesh

Three major areas became extensively waterlogged: (i) the Bhabadah, spread over 487 square kilometers with 27 beels, covers 200 villages in Keshabpur, Manirumpur, Abhaynagar and a portion of Sadar upazilas of Jessore district and Dumuria and Phultola upazilas of Khulna district (Map 6). It belongs to the Mukteshwari-Sree/Teka-Hari catchment system (42,000 ha) and the Harihar-Buri Bhadra-Upper Bhadra catchment system (37,000 ha). The area is intercepted by seven local rivers - the Mukteshwari, Teka, Hari, Sree, Aparbhadra, Harihar and Buribhadra with connecting many channels and canals; (ii) part of the middle Kobadak, south Betna and the Shalikh catchments consists of Keshabpur upazila of Jessore district, and Kalaroa, Sadar, Tala and Asasuni upazilas of Satkhira district. Among the areas of water logging, situation is most severe in more than 30 villages spread over the Tentulia, Kumira, Islamkati, Sadar, Khalilnagar and Jalalpur unions of Tala upazila of Satkhira district where the Kobadak River runs; (iii) the Bhutiar Beel that constituted from Shachiadah, Chagladah and Terokhada unions of Terokhada upazila in Khulna district (Map 7), became waterlogged with 5329 ha of land due to the siltation of the Chitra River which drained to the Atharobaki River (partially dead) and the Kaliabardia River. The associated rivers with channels and canals crisscrossed the

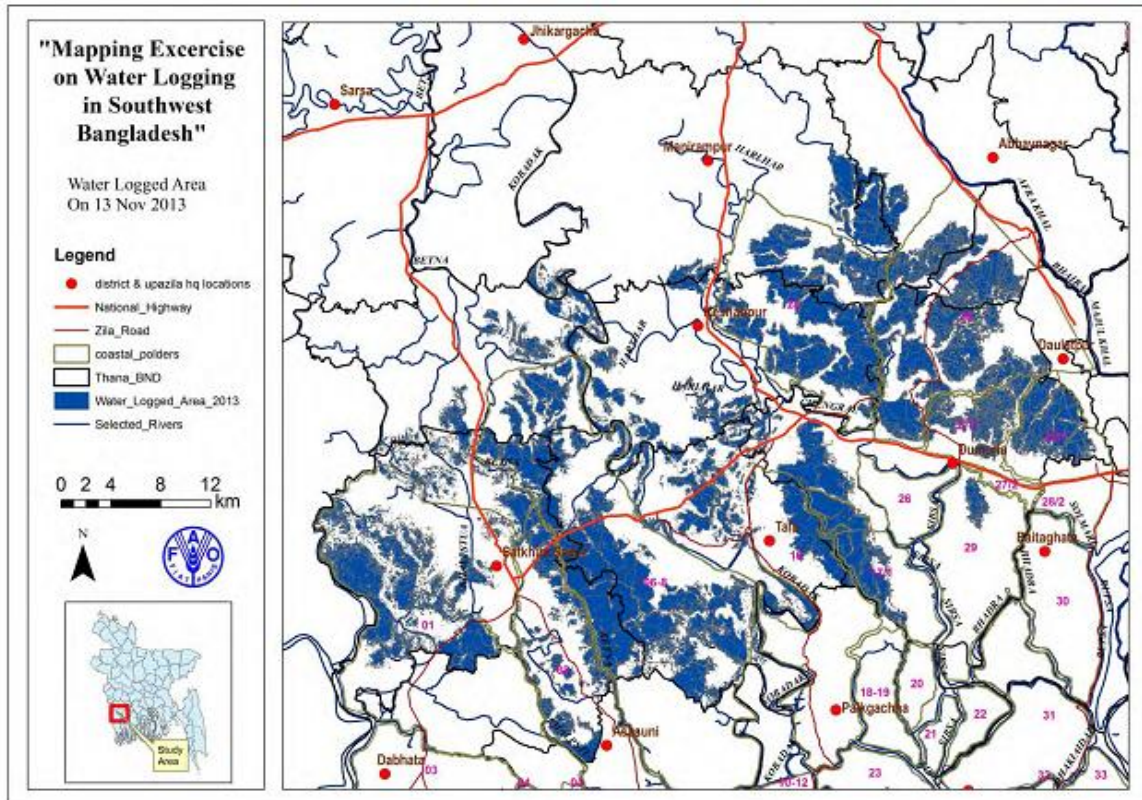
waterlogged areas before falling into the Bay of Bengal about 60 km to its south.

### 3.4 Consequences of Water-logging in the Southwest Coastal Region of Bangladesh

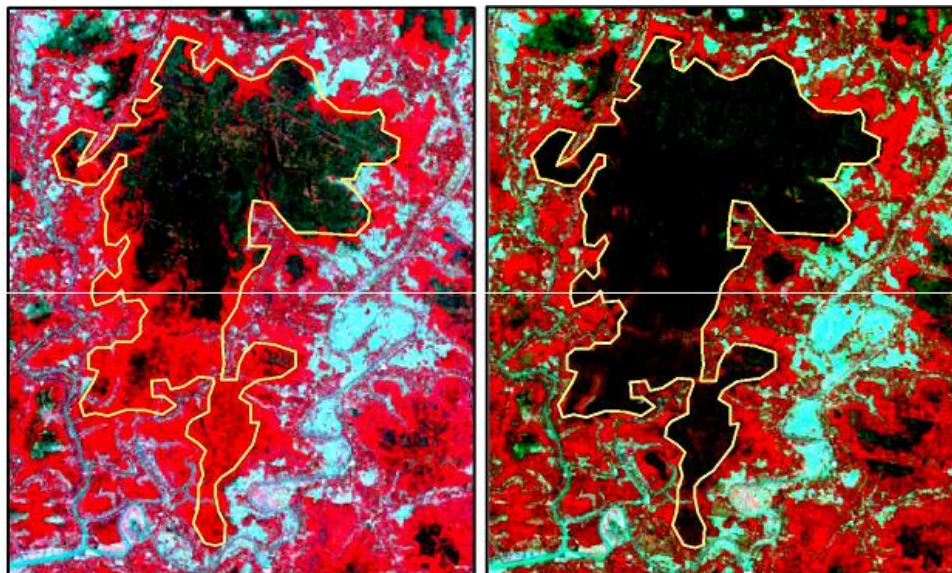
Table 2 shows the number of people and their essential assets which adversely affected by water logging due to 2011 monsoon thrust in two south-west coastal districts: Satkhira and Jessore. The damages were varied from place to place. It is reported that more people was worsened in Sadar and Tala upazilas of Satkhira district whereas the number of affected people was higher in Keshabpur and Manirumpur upazilas of Jessore district. Due to same incidence, a total of 62,500 people from Terokhada upazila and 33,413 people from Paikgacha upazila of Khulna district were severely affected (data not shown). Overall, more than one million people from said three districts were seriously affected due to water-logging of 2011. The number of affected people rose to 1.3 million in 2016 [13]. Additionally, the number of valuable assets with house, tube well, latrines, roads, culverts, institutions like schools, markets, etc. due to this havoc is increasing over the years [25-26]. Water recedes after 6 to 9 months following peak monsoon (Photograph 8), however, many places become permanently waterlogged (Photographs 9-10). Communication system is hampered due to either destroy or inundation of roads [25]. Sources of safe drinking

water are disrupted due to inundation of tube wells (Photograph 11). Children are born and brought up in water, and growing with playing in swamp and waterlogged courtyards. They attend

schools those lying under water (Photograph 11). The places to keep domestic animals like livestock's were hardly found (Photograph 12).



Map 6. Major part of waterlogged area (estimated as 68194 hectares) as of 13 November 2013 [20]. Waterlogged Bhutiar Beel from Terokhada upazila, Khulna is not included in the map



Map 7. Waterlogged area (as of 2000 in left image and 2009 in right image) in Bhutiar Beel from Terokhada Upazila of Khulna district [24]



**Photograph 8. Although floodwater receded in the area, people use bamboo bridges to move around, as the soil below is muddy [21]**



**Photographs 9-10. Vast cropland inundated by permanent water congestion in Tala Upazila of Satkhira District (left) and a waterlogged home in Terokhada Upazila of Khuna District (right)**



**Photograph 11. An inundated school (with a tube well) in Abhaynagar Upazila of Jessore District [27]**



**Photograph 12. A family from Abhaynagar Upazila of Jessore District started living with cattle in the shanty in a miserable condition after their house had gone under waist-deep water following heavy rains [21]**

**Table 2. Scenario of flooding and subsequent water-logging in the different upazillas of the Satkhira and Jessore districts during the monsoon rain of 2011**

Damage item	Satkhira district						Jessore District				
	Sadar	Tala	Kalaroa	Debhata	Asasuni	Kaliganj	Keshabpur	Manirumpur	Abhynagar	Jhikargacha	Bagharpara
Affected Union+ Pourashava (no.)	14+1	12	12+1	5	11	12	9	7	8	11	6
Affected area (km <sup>2</sup> )	310	285	96	17	199	80	-	-	-	-	-
Affected people (no.)	330,600	225,400	89,164	72,500	127,850	94,000	63388	49752	7020	28014	-
Affected houshold (no.)	60,400	52,902	22,420	24335	26,382	11,300	9650	13634	1000	7428	3454
Fully damaged house (no.)	5,660	19,328	28	552	865	780	1241	1394	-	-	34
Partially damaged house (no.)	17,175	12,500	1,540	3,200	2,975	5,700	4689	6000	350	1696	1630
Affected livestocks (no.)	30510	-	-	335	-	72	19829	14640	-	-	-
Affected pourty/bird (no.)	35796	-	-	15000	89	12000					
Fully damaged crops (ha)	5048	4684	1230	160	2098	82	1017	780	-	379	2062
Partially damaged crops (ha)	-	1020	3680	2140	427	103	836	318	1806	1435	1751
Damaged shrimp gher (ha)	7206	7435	314	3220	5425	3401	2034	-	-	-	52
Damaged educational institution, mosque etc (no.)	50	219	24	83	111	90	3	70	-	-	4

Fully damaged road (km), paved+unpaved	50+75	37+105	-	45+120	-	12+84	-	-	-	-	-
Partially damaged road (km), paved+unpaved	90+85	68+115	- +48	70+255	22+55	30+180	45+86	36+75	-	-	4+24
Fully damaged embankment (km)	-	5	1	0.08	-	-	-	-	-	-	-
Partially damaged embankment (km)	11	19	4.5	8.5	39	-	2	3	-	-	-
Affected fish farm (no.)	1500	6093	-	1020	-	300	-	-	-	-	-
Affected pond (no.)	850	5087	1889	1453	861	2250	1144	-	350	-	192
Affected tubewell (no.)	-	230	-	390	266	200	-	-	-	-	-
Temporary shelter (no.)	-	-	-	-	-	-	2	2	-	-	-
People living in temporary shelter (no.)	-	-	-	-	-	-	259	260	-	-	-

Source: D-Form collected from DRRO, and related web reports [4-5]

The water-logging problem has gradually intensified in three south-western coastal districts over the last four decades, significantly reducing arable land. It is reported from a SPARSO (Space Research and Remote Sensing Organization) study that around 6,279 hectares of land from different upazilas of Jessore, Khulna and Satkhira was waterlogged in 1973, and the amount rose to 47,143 hectares in 2016 [28]. Land for rice (main staple food) cultivation over the areas is extensively shrunk. In Bhutiar Beel (Photograph 13) of Terokhada upazila in Khulna district alone, the land used for cultivating *Aman* and *Boro* rice was shrunk from 4,853 hectares in 1989 to 709 hectares in 2015 [28]. At the early stage of water-logging situation in 2000, around 66% area of the Bhutiar Beel was under *Aman* rice cultivation while it reduced to 17% in 2011 [29-30]. Once upon, Bhutiar Beel was a main source of earning livelihood of the thousands of people of 50 villages through huge production of *Aman* and *Boro* crops. But the crop production is now in peril due to water logging with damage to crops worth hundred million of Bangladesh Taka every year. As a result, people who were so long dependant on Bhutiar Beel have become jobless and more than 37,000 farmers have changed their profession as day labourers [31].

Biodiversity is abruptly reduced as many plants don't tolerate water logging condition leading to killed-off fruit trees of many species [6-7]. Vegetation cultivation is also hardly possible. As a whole affected people are food and nutritionally in-secured. Middle class people could temporary

combat the situation through selling out their household assets but there is no alternative to survive for poor people. Social safety net coverage is also insufficient. Many people pass time with food intake less than 3-time even 2-time a day.

Many marooned peopled sheltered on high roads or embankment with their domestic animals [21]. As the area under tidal influence, the region is affected by salinity. Moreover, the water and soil are polluted with poisons and heavy metals including arsenic [32-34]. Due to scarcity of safe drinking water people are affecting with waterborne diseases like diarrhea, dysentery, and skin problems [35]. Agricultural productivity is under threat due to the salinity intrusion. As a whole it is difficult to support life in the areas. To survive, many people became destitute, some switched their profession to much lower grades and some migrated to urban centres due to economic hardship and lack of work opportunities.

### 3.5 People's Responses to Water-logging Situation in South Western Coastal Region of Bangladesh

The largely agrarian populace appears to have reached the end of their tethers in recent times. So many promises from authority have been made to rescue them from this quagmire, but they ended up in mere mirages. Protests, desperate petitions to the higher authorities, etc have failed to yield any positive results [36].



Photograph 13. A part of waterlogged Bhutiar Beel at Terokhada Upazila of Khulna District



Newspapers in recent times are publishing reports and editorials about the water-logging which causing unimaginable sufferings for the people living in the south west coastal region of Bangladesh. As the waterlogged situation is becoming more condensed, the people called on the government to take an effective step to withdraw the water from the area. The marooned people have demanded to the authority to declare their place as an affected area and sought the Head of the government' direct intervention to bring an end to the crisis. In a human chain recently inaugurated at Capital city of Bangladesh, the residents of Bhabadah region urged the government to take initiatives, including excavation of the Sree and Hari Rivers,

re-excavation of the Amdanga cannal, opening the Bhabadah sluice gate and making it fully functional and creating another sluice gate at the entrance of the Bhairab River (Photograph 14).

Affected people joined road march demanding immediate solution to water-logging (Photograph 15). The people want nothing from the authority but immediate withdrawal of congested water. Affected people also submitted a memorandum to the Head of the government through district authority of Jessore with a call to the government to implement Tidal River Management (TRM) plan immediately to save the people of areas from water-logging [39].



**Photograph 14. Participants in a chain organized at capital of Bangladesh demanded immediate solution to the water logging problem in greater Khulna [37]**



**Photograph 15. The affected people join the road march demanding immediate solution to water-logging in Bhabadah area of Jessore (Marching on a sluice gate of the Bhabadah area) [38]**

#### 4. CONCLUSION

South-west Bangladesh that partly covers Satkhira, Jessore and Khulna districts are facing prolong and permanent water-logging problem since two to three decades. The situation is being compounded day by day with the losses of agricultural production due to the inundation of more than hundred thousand hectares of crop lands that directly affect the life and livelihood of more than one million people. Marooned people cannot fulfill their basic needs due to the acute unemployment problem in the areas. Hundreds of thousands lost their occupations and became destitute. They demanded the government to declare their places as an affected area and sought the authority for taking immediate necessary steps to solve the problem.

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#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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