Menu of options for Triggers
Bogra District – Flood Vulnerable Area

Danger Level : The magnitude of an extreme event that causes impact (e.g. 100mm of rainfall-time duration/intensity required). The danger level will depend on the vulnerability and exposure of a region (also timing, when it is happening), and should be updated regularly as the region changes over time

From which levels (different stage of water level/rain/discharge) damage starts to affect the crop production, household's assets – the livelihoods, infrastructures use at the time of extreme even such as flood – this is called the Danger level (damages not only related with crossing Dl but also duration and depth). BWDB (Bangladesh Water Development Board) define the Danger level at a river location is the level above which it is likely that the flood may cause damages to nearby crops and homesteads. This danger level is not generalized for all elements to any given location. Since the major occupations of the pilot areas are farmers and day labors thus they are likely to be impacted by submergence of the existing infrastructures and agricultural land. Therefore, for the pilot area in the Bogra district (exposed to the flood), the danger level has classified into three classes base on vulnerability (also timing of flood is necessary) due to flood (extreme event) are:

a. The Danger level – Agriculture (DA) is the water level exceeds the average agriculture land elevation where the farmer grows the monsoon rice/rain feed crop/Aman (expected to grow crop in the rainy season are exposed to flood). And submereged for at least three days;

b. The Danger level – Households (DH) is the water level expected to submerged House's plinth in the respective pilot area and water level remain above (DH) three consecutive days; and

c. The Danger level – Infrastructure (DI) is the water level expected to submerge the roads for three consecutive days.

The Danger level for all four pilot sites in the Bogra District were calculated based on above criteria and detail land elevation survey data on Agriculture fields, house plinth level and top elevation of roads/infrastructures and tabulated in Table1. The danger levels were validated by the respective communities through consultation.

Table **Error! No text of specified style in document.**. Danger Levels for Flood Hazard for pilot areas in the Bogra District

	Sharikandi Upazila		Dunot Upazila	
	Kajla	Kamalpur	Bhandarbari - 3	Bhandarbari - 6
Danger Levels (m PWD)				

DA – Agriculture	16.56	15.00	14.79	14.50
DH – House	17.20 (17%)	16.20 (17%)	15.83 (5%)	15.50 (10%)
DI – Infrastructure	17.78	16.70	17.00	17.00

In the first year of implementation, trigger for preparedness action will use only the Danger Level correspond to Household.

The probability of occurrence, in terms of return period, of flood to exceed the danger levels for each pilot site (see table 1, using historic observation data) were analyzed using Gumbel Distribution (Gumbel 1958).

The Gumbel distribution has been used to estimate frequency of the water level for the villages, Kajla, Kamalpur, Bhandarbari (ward 3 and 6) in Bogra District against the danger levels. The Danger levels for Kamalur village for the agriculture and household are 15 m PWD and 16.2 m PWD and the return periods are 2 and 10 year respectively. The return periods of danger levels for flood hazards were calculated and tabulated in Table 2.

Table: 2 Return Period of Danger Levels, Pilot Areas, Bogura District

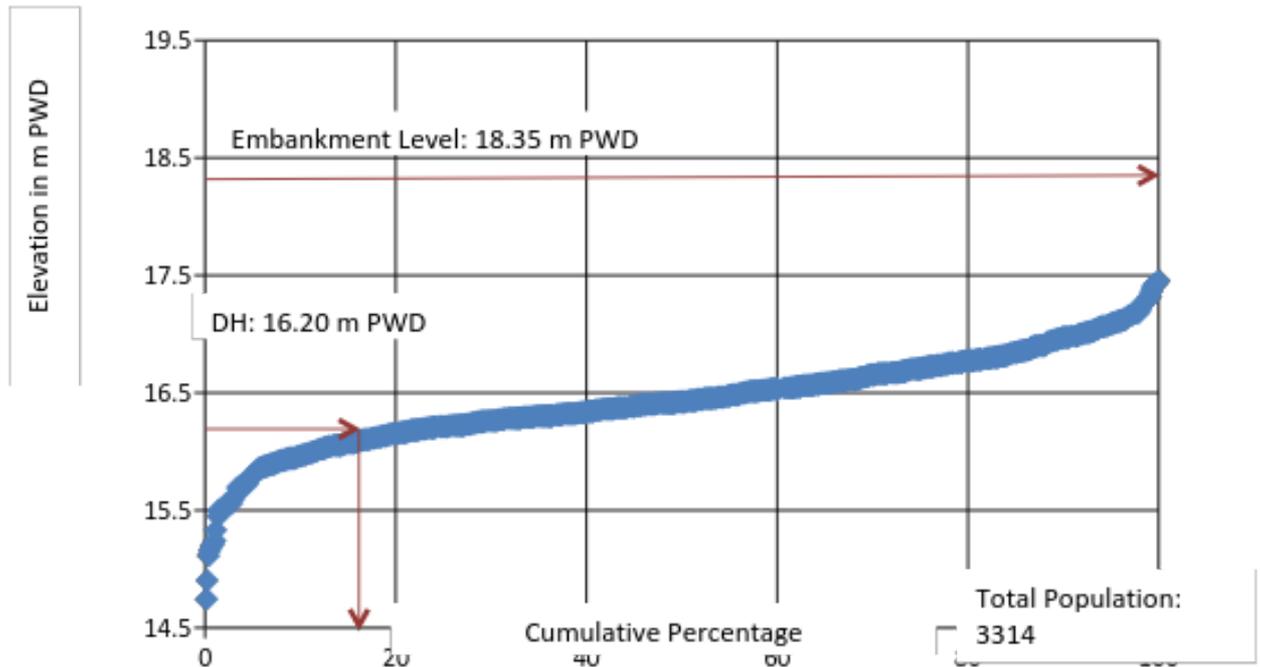| Pilot Area			Return Period (years)
	Category	Value (m PWD)	
Kajla	DA	16.56	2
	DH	17.20	10
Kamalpur	DA	15	1.9
	DH	16.20	10
Bhandarbari (Ward-3)	DA	14.79	2
	DH	15.83	8
Bhandarbari(Ward -6, 7)	DA	14.5	2
	DH	15.50	8

Population elevation curve

It is important to know how much will be exposed to flood at different stage of water level in the river. The population elevatin curve for pilot sites Kajla, kmalpur, Bhandar bari 3 and Bhander bari 6&7 in the Bogra District are shown bellow.
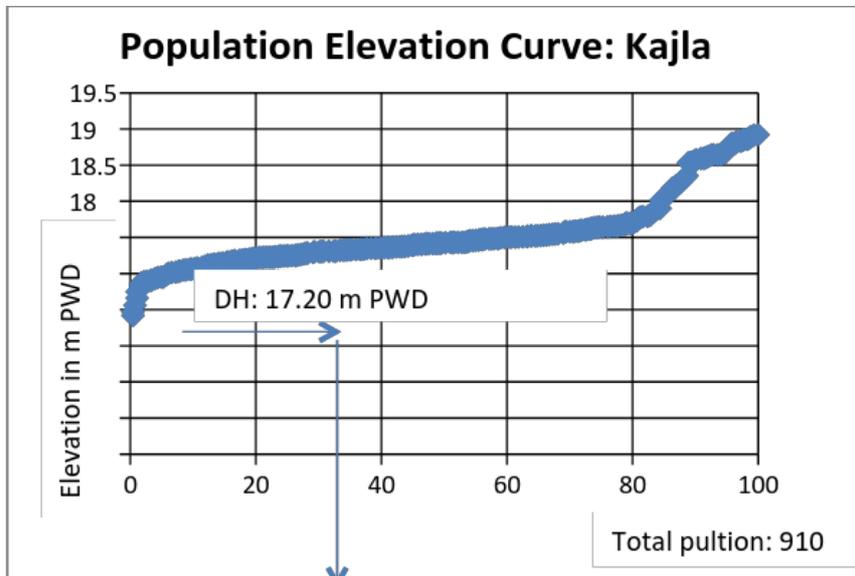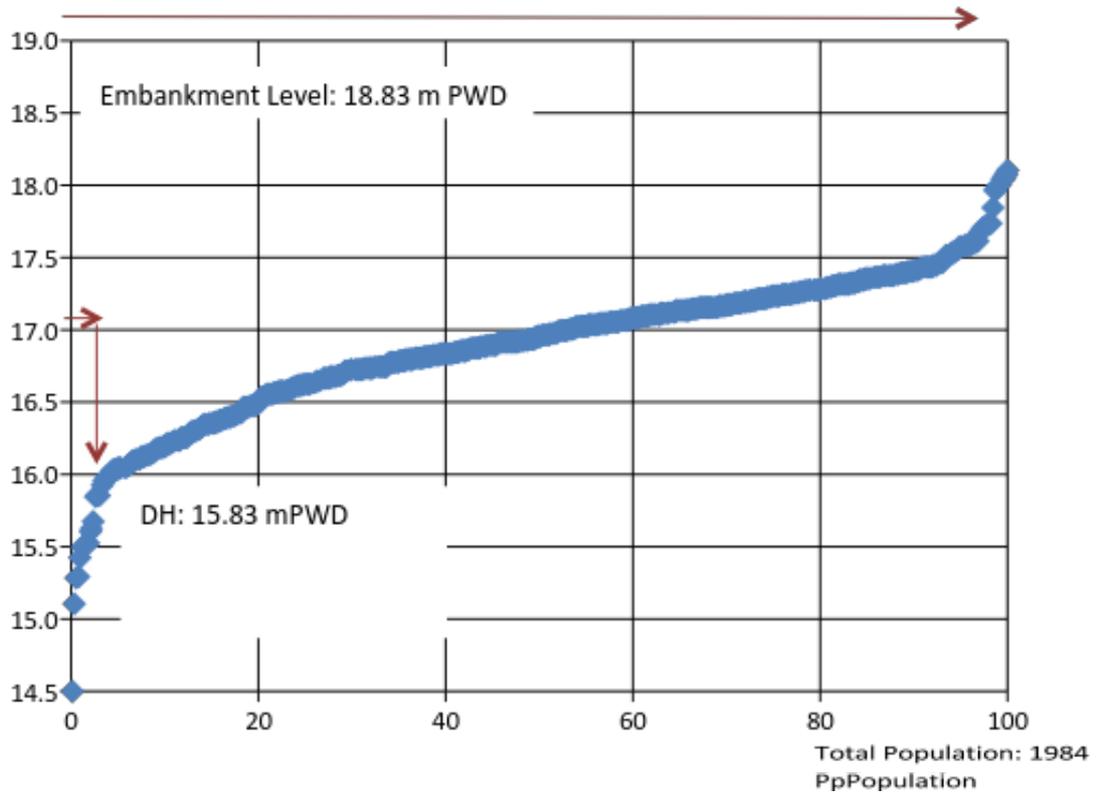

The area has no embankment with a total population of 910 with 6.59 %of cattle house, 8.35% of tube well, 3.63% of toilet facility. Danger level of Kajla is 17.20 m PWD. In this level around 17% people will be vulnerable. When the water level will cross around 1 m above of this danger level around 80% people will be in a vulnerable situation. Submergence will be at the level of 16.8 m PWD.

Population Elevation Curve: Kamalpur

Elevation in m PWD

Embankment Level: 18.35 m PWD

DH: 16.20 m PWD

Cumulative Percentage

Total Population: 3314

19.5
18.5
17.5
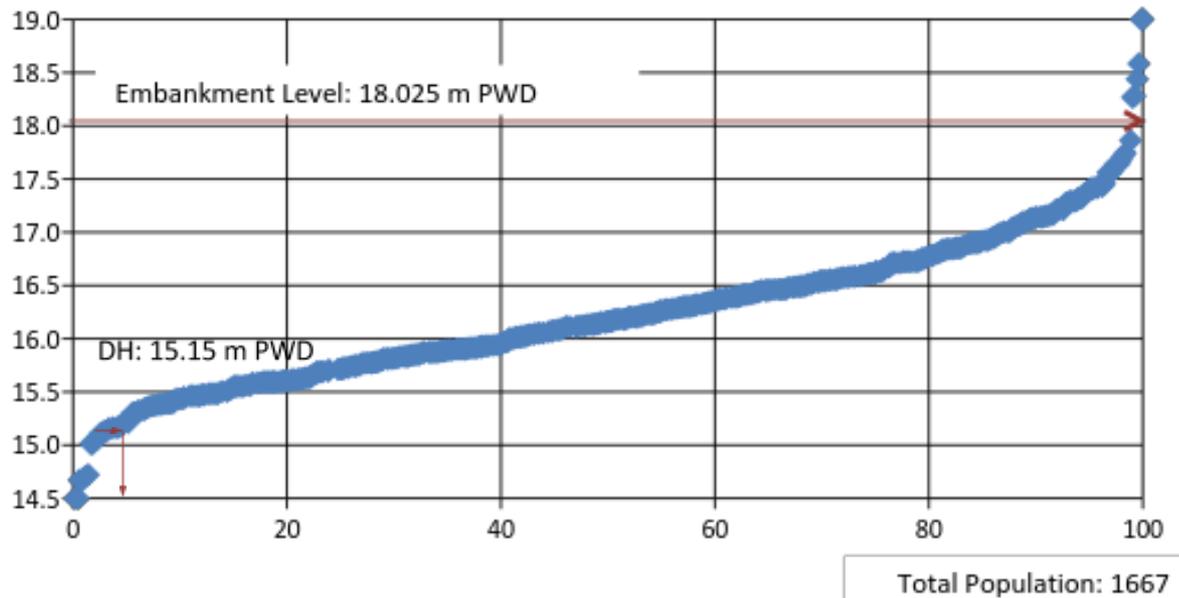16.5
15.5
14.5

0   2υ   4υ   6υ

The area has an embankment level of 18.35 m PWD with a total population of 3314 with 4.98% of cattle house, 12.88% of tube well, 13.07% of toilet facility. Danger level of Kamalpur is 16.20 m PWD. In this level around 17% people will be vulnerable. When the water level will rise up to 1.3 m above danger level around 83% people will be vulnerable. Submergence will occur around 14.65 m PWD.

Population elevation Curve: Bhandarbari_3

Embankment Level: 18.83 m PWD

DH: 15.83 mPWD

Total Population: 1984
PpPopulation

This area has an embankment level of 18.83 m PWD with a total population of 1984 with 7.96% of cattle house, 14.11% of tube well, 11.09% of toilet facility. Danger level of Bhandarbari-3 is 15.83 m PWD. In this level around 4 % people will be vulnerable. When the water level will rise up to 2 m above danger level around 96% people will be in a vulnerable situation. Submergence will occur at the level of 15 m PWD.

Population Elevation Curve: Bhandarbari_6,7

Embankment Level: 18.025 m PWD

DH: 15.15 m PWD

Total Population: 1667

The area has an embankment level of 18.025 m PWD with a total population of 1667 with 7.4% of cattle house, 12.6% of tube well, 14.46% of toilet facility. Danger level of Bhandarbari-6, 7 is 15.15 m PWD. In this level around 4% people will be vulnerable. When the water level will rise up to 2.85 m above danger level around 96% people will be in a vulnerable situation. Submergence will occur at the level of 14.6 m PWD.

Triggers: Menu of options for damage level in Bogra pilot areas.

Menu of Trigger

TRIGGER: A forecast issuance is a trigger for action when the danger level is forecast at a high enough probability. The probability is agreed upon before hand amongst all stakeholders. For example, a forecast of a 50% chance of exceeding a danger level is a trigger to disburse chlorine tablets.

In FbF, the trigger will be defined based on attributes of a scientific forecast of likely extreme event. It is the moment when the forecast is informed to enable the implementation of actions, for example 70% chance of exceeding the danger level. Trigger is to say yes to take early action (i.e. act activate the SOP) based on Early warning. Example – trigger is a early warning message – There will be an extreme event in three days time with accuracy of 70% to cross/exceed the DL may have frequency of 1 in 10 year.

The trigger is triggered by early warning of the event. The flood early warning in Bangladesh has been carried out by Flood Forecasting Warning Centre (FFWC) under the ministry of Water Resources. The FFWC use both deterministic and probabilistic forecast cover about 70% of the flood vulnerable area and cover the Bogra flood FbF pilot sites. The deterministic model forecast 3 days lead time with high accuracy and from 2012 extent the lead time to 5days, while probabilistic model forecast with a lead time up to 10 days.

As the more lead time means more time for preparedness activity but less accuracy means more chance to "act in vain". Hence need a menu of Triggers to provide options for the decision makers to choose. The menu of triggers have three criteria are: (a) lead time - how much time will have to act on it (implement the SOP); (b) accuracy - what is the probability crossing/exceeding the Danger Level; and (c) frequency – how many times trigger can be happened in a given year.

Table: 2

Menu of Triggers, Pilot Sites in Bogra District

Criteria		Trigger Options		
		1	2	3
Lead Time (days)		3	5	7
	Hit Rate	0.73	0.533	0.20
	False Alarm Ratio	0.27		
	Mean Absolute Error (m), 2014	0.1	0.15	1.0

| Accuracy	r^2			
		0.95	0.9	.20
Frequency		10	10	10

The above table 2 represents menu of triggers for the pilot sites in the Bogra district. Three menus were developed with the variables like the lead time, accuracy and frequency of the forecast to exceed the Danger level. Where, the danger level is different for each pilot sites as shown in Table 1. It is the political decision to choose the menu to activate the SOP.

Depending on the lead time 3days, 5days and 10 days, accuracy for short term forecasting is done by Hit Rate and False Alarm Ratio which is found to be 0.73 and 0.27 respectively for only 3 days. Mean Absolute Error (MAE) and co-efficient of determination ($r2$) is done for medium range up to 10 days starting from 3 days. The values of MAE are 0.1, 0.15 and 0.13 respectively for 3, 5 and 7 days and the value for $r2$ is 0.95, 0.9 and 0.2. The frequency is 2 for the discussed three scenarios as in Bangladesh flood hydrograph has two peaks so frequency will be 2.

Hence following are the options for triggers:

Option 1: Take action when there is a forecast of 73% chance of exceeding damage level (HH plinth level) and remain above the DL for three days in Bogra project areas, with at least 3 days lead time. This give us a 27% chance of acting in vain.
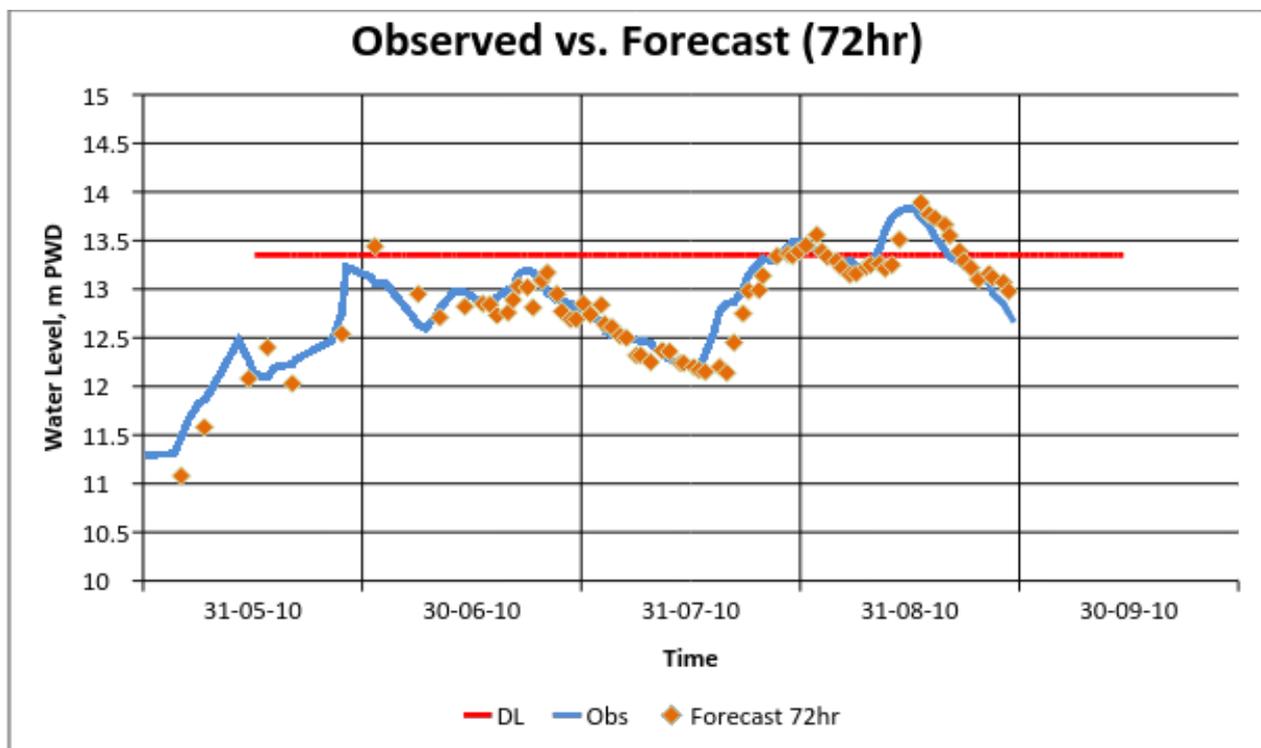
Option 2: Take action when there is a forecast of 53% chance of exceeding damage level (HH plinth level) and remain above the DL for three days in Bogra project areas, with at least 5 days lead time.

Gazirtek: Comparision of Observed and Forecast (5-Day) Water Levels
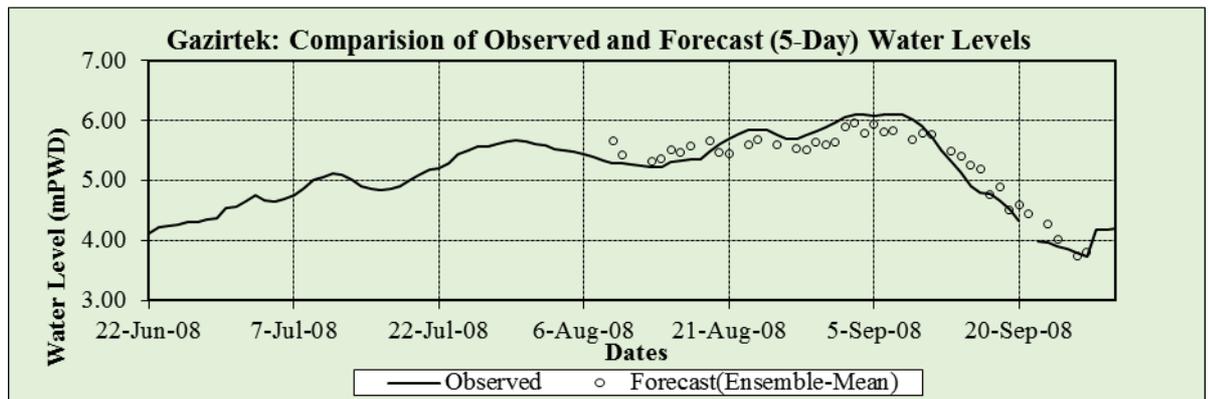
Option 3: Take action when there is a forecast of 20% chance of exceeding damage level (HH plinth level) and remain above the DL for three days in Bogra project areas, with at least 7 days lead time.

Jamuna River at Aricha (Year 2015)