

CLIMATE CHANGE ADAPTATION THROUGH RISK ASSESSMENT AND DISASTER RISK REDUCTION IN THE CONTEXT OF CLIMATE-RELATED NATURAL DISASTERS IN BANGLADESH



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Acknowledgement

This publication is generated by the people of the four study areas and they are the real authors of this book. Prodipan takes pride in announcing their contribution to this publication.

During the study the field team had a real tough time with their long stay in the field. Prolonged working hour and difficult working conditions tested their commitment to the work. But every time commitment defeated difficulties. The whole field team deserves appreciation for their skill, commitment, devotion and trust in the work and in the creative capability of people.

Our Consultant, Mr. Zahid Hussain regained his youth in leading the study and almost defeated the youngsters of the field team in zeal and enthusiasm. But his real magic was in his efficiency, wisdom, understanding of development interventions and the society. He performed a wonderful task in providing a touch of class to this study.

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Ferdusaur Rahman.
President, Prodipan.

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hazardous and forced child labour. Prodiplan recognises the fact that climate change and natural hazards impede development initiatives and force people into deprivation and marginalisation. Its programmes include large elements of adaptation to climate change and disaster risk management. In addition to its existing programmes, presently, Prodiplan is planning a significant disaster risk reduction intervention and to support this plan, it initiated a disaster risk assessment.

DRR ASSESSMENT

Purpose of this assessment is to gain a better understanding of nature of the communities' hazard risk, vulnerability factors of the households and potential of local coping practices in reducing

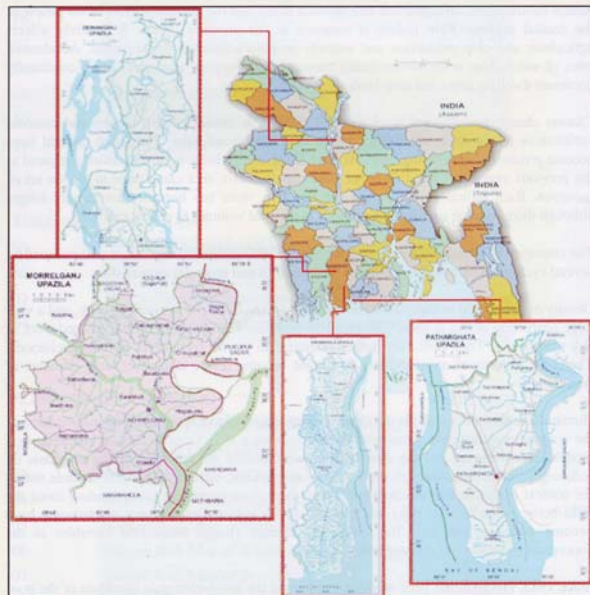


Figure 1: Study area of the DRR assessment : Khawlia Union, Morelganj Upazila; Southkhali Union, Sarankhola Upazila; Chikajani & Chukaibari Union, Dewanganj Upazila; Patherghata Union, Patherghata Upazila.

INTRODUCTION

Bangladesh is located between the Himalayan mountain range and cyclone brewing sea in the south and is adjacent to the highest rainfall zone in Meghalaya. The country, excepting some areas in the east and north-eastern zones, is flat and low-lying. Three large river systems flow through the country - they drain Himalayan snow-melt and rain water from very large catchments areas to the Bay of Bengal. It makes the country extremely disaster prone.

Flood is an annual phenomenon and, nearly, every alternate year it becomes devastating. It inundates large areas of land and destroys crops and damages infrastructure and assets. Severe cyclones associated with tidal surges occur frequently. They cause huge destruction to the natural environment, infrastructure and physical assets and life and livelihoods of the people in the coastal regions. Rain failure is common in the northern region. It severely affects agriculture and crop production and restricts people's livelihood opportunities. Accelerated rates of water flow in the rivers during monsoon lead to river bank erosion. It continually decreases dwelling areas and crop lands.

Climate change threats - sea level rise and changes in annual rainfall pattern and seasonal variation in temperature, are further aggravating the hazard risks. Flood and drought have become erratic and devastating. In 2010, flash flood in haor areas occurred earlier compared to the previous years, and flood in upper Barhamputra basin area came prior to the onset of monsoon. Rain failure period during the last five years has become increasingly longer although there were no significant variations in the total volumes in annual rainfall.

The country was devastated by the cyclone Sidr in 2007 and following that, was threatened by several cyclones which included Nargis, Rashmi, Bijli and more devastating Aila.

Density of population in Bangladesh is very high - over 1,000 per square kilometre, and a very large proportion of that is poor. Generally, the poor live in marginalised locations and work in risk prone areas. They have very limited resources to protect themselves or their livelihoods. Therefore, impacts of any incidence of hazard become severe and affect large numbers of people.

Humanitarian actors as well as the development practitioners have recognised the inadequacies of the conventional response paradigm. There has been a shift towards disaster risk reduction models. Humanitarian and the development communities are presently giving emphasis on reducing vulnerabilities through out a society and limiting adverse impacts of hazards within the context of sustainable development. Also, there is an increasing understanding about the links between the disaster risks and climate change issues. Development practitioners have become aware of the need for integrating climate change adaptation variables in the conceptual framework of disaster risk reduction.

Since 1983, Prodiplan has been working to improve the socio-economic condition of the poor and underprivileged people. It applies a holistic approach and runs a range of development initiatives that seek alternative livelihoods for poor households, sustainable environmental health for underprivileged groups, basic education for hard to reach children and elimination

disaster risk. It aims to define criteria for determining levels of communities' disaster risk and degrees of vulnerability of the households that the programme could apply for planning risk reduction activities and identifying programme participants.

The assessment seeks detailed information about the communities' exposure to flood or cyclone and families' experiences relating to such hazards. It considers the frequency and magnitude of flood and cyclone and the geographic feature of the area as well as the socio-economic conditions of the communities to determine the level of hazard risks of the localities and the degree of vulnerability of the households. It also examines the local coping practices and their value in reducing hazard risks.

The assessment has been undertaken, initially, in two selected localities that are known to be prone to flood or cyclone. One of these localities is on the east bank of the Jamuna River - part of Chikajani and adjacent parts of Bahadurabad and Chukaibari unions of Dewanganj Upazila under Jamalpur district and the other area is Patharghata union of Patharghata Upazila under Borguna district. Jamalpur is a flood prone district; and Barguna is located in the cyclone prone coastal region. Later on, a third location in cyclone prone coastal region which has significant protection by the Sundarban was selected. It covered two unions - namely, Khawlia under Morelganj upazila and Southkhali under Sarankhola upazila, in Bagerhat district. This area was most severely affected by cyclone Sidr.

In each area, levels of hazards risks of the individual villages in the locality were assessed first. It determines the degree of hazard risks of the individual villages and identifies "high risk" villages. Then, in the second stage, it concentrated on determining the degree of vulnerabilities of the individual households living in high risk villages.

The assessment team comprised of a team coordinator (Ferdusur Rahman), an international consultant (Peter Rotteck), a team leader (Zahid Hussain) and 4 study facilitators (Nasima Zahan, Umme Saida, Tahmina Akhtar and Purabi Rani). International consultant developed the study concept and framework of the assessment plan and prepared guiding principles of the study. Responsibilities of the team coordinator include management, logistics and liaison with donor and other stakeholders, team leader is responsible to lead and support the study facilitator in field work, ensure quality of field work, provide technical inputs in data collection and data analysis, compile process documentation and drafting study report.

METHODOLOGY AND TOOLS

As outlined in the concept note, the study areas were selected by Prodiplan applying the criteria that include (i) separate geographic areas each with a population size of about an union, in different parts of the country, (ii) one of the area should be from a known flood prone district in the north, one should be from a known cyclone prone district in 'open coast zone' and the other should be in coastal area protected by Sundarban and (iii) study areas are logistically and communication wise accessible to the assessment team.

Training of the field team on the conceptual framework, methodologies, tools, analytical framework and analysis process of the assessment was done at the very onset. It was through a one day orientation workshop followed by 10 days field work in a known hazard prone village near one of the assessment areas and a day-long data analysis and review sessions.

Based on this training exercise the team developed guiding principles (see annex i) that describe the procedure and framework for data collection and analysis. Field work for data collection and analysis apply predetermined procedure and framework as noted in the guiding principles.

Following the area selection first step was hazard analysis. It consisted of assessing the frequency (in the past) or probability (in the future) of a hazard and the magnitude (e.g. flood level, duration of dry days in case of drought, velocity and speed of storms, height of tidal waves etc.) of it. Sources of information were: consultation with local communities, key informant interview and discussions with Union Parishads, and disaster situation reports and assessment reports available through the Upazila Administration, Disaster Management Bureau, meteorological department and related NGOs.

The assessment team reviewed relevant documents available, mainly, at websites. These included chronology of disasters in Bangladesh and situation reports for Sidr and other cyclones and floods in recent times published by the Department of Relief and Rehabilitation, CDMP, NIRAPD and Disaster Forum. It also consulted available reports on assessments and response interventions and their evaluation of recent cyclones and floods responses by various agencies such as CARE, CONCERN, Save the Children, UNDP, FAO and WFP, and the strategic plans for DRR by CDMP and documents on climate change by NCC, B. In addition, the assessment team reviewed documents and reports on consultation with the local people by Prodiplan.

For assessment of hazards levels of individual villages, a series of FGDs with and mapping by exercise by the villagers was undertaken, separately, at different parts of the assessment area. Information collected through FGDs and maps drawn by village people were cross checked against Google Earth images and maps of the respective upazilas published in Web Portals of the Government of Bangladesh and the relevant reports and documents noted above. Then they were compiled to produce a hazard map to indicate high, medium and low hazard risks of different parts or villages of the area.

Degree of hazard risk of a village was calculated in reference to the respective union, and the indicated risk level of a village is relative to that of the other parts of the same union.

The formula applied for assessing the hazard is:

Frequency/probability + magnitude

2

As noted above, the individual study areas of the assessment were small (each about the size of a union), therefore, it was expected that at macro level the frequency/probability and magnitude of

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- Degree of damage to the house by cyclone Sidr or depth of flood water on the courtyard of the household.
- Whether or not a house is located in areas protected by embankment or on high ground.

Indicators for economic fragility are:

- Primary occupation or sources of income (and degree to which these sources might be affected by disasters)
- Age and gender of the family head (e.g. child, woman, old age person)
- Access to productive resources (including arable land)
- Ownership of homestead
- Indebtedness (e.g. loan from bank, NGO credit scheme, local money lender)
- Physical condition of dwelling house - house construction material used (e.g. just bamboo and thatch, bamboo poles and iron roof, complete iron house and reinforced cement poles) and technologies to make it storm resistant (e.g. cross beam, anchorage)

Indicators for resilience are:

- Educational level of family members
- Percentage of family labour force compared to total number of family members
- Multiple income source or more than one income earner in the family
- Availability of neighbourhood support systems (or extended family systems)

Villages with high hazard risk (based on the hazard assessment and mapping exercise) were selected for household vulnerability assessment. However, in Dewanganj, some villages with medium and low levels of hazard risk were included for household vulnerability assessment. It was mainly to test the rigour of the assessment and to ascertain whether there was any difference in the concentrations of 'high risk' households in the high risk, medium risk and low risk categories of villages. In the similar vein, in Patharghata, one medium risk village was included in the household vulnerability assessment. In Khawlia and Sarankhola, household vulnerability assessment was done only in identified high risk villages.

For household vulnerability assessment in Dewanganj and Patharghat house to house survey was conducted. A questionnaire was developed for the survey in Dewanganj. Based on the experience from Dewanganj and considering the local requirement, this questionnaire was revised for the survey in Patharghata. This questionnaire was further revised for Khawlia and Sarankhola.

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a significant hazard would be similar for all parts of each study area. However, there might be micro level differences for different villages within each area. To capture such differences indicators for frequency/probability and magnitude of the hazard were identified through consultations with the communities. The indicators were as follows

For Dewanganj

- Incidence of flooding during the last five years period;
- Inundation of 'high ground' of the village during those floods;
- Displacement (temporary) of households of that village due those floods;
- Duration of flood (# of days flood water remained);
- Depth of flood water on the high ground;
- Proportion of the people displaced.

For Patharghata

- Numbers of people killed or missing in the village by cyclone Sidr;
- Proportion households lost their dwelling houses fully due to cyclone Sidr;
- Inundation level in 2007;
- Increase in the area (distance from river bank) get inundated by the seasonal tides - presently as compared to the previous year;
- Number of months during the year fresh water available in the local river/canal.

For Sarankhola and Khawlia

- Numbers of people killed or missing in the village by cyclone Sidr;
- Level of inundation of the cyclone Sidr tidal surge
- Duration of the cyclone Sidr tidal surge;
- Numbers of households lost their houses due to cyclone Sidr;
- Proportion PSF/tubewells has become non-functional due to cyclone Sidr;
- Level inundation during the seasonal hide tide.

The vulnerability assessment is composed of 3 parameters:

- Exposure to hazards
- Fragility
- Resilience

The formula for figuring out the vulnerability value looks like follows:

Exposure + Fragility + Resilience

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Exposure is calculated

- Hazard risk level of the village in which the household is located (on the basis of the hazards map)

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Broadly, for Dewanganj questionnaire focused on issues related flood and river erosion and used open ended question form; and for Patharghata, Khawlia and Sarankhola, it centred on cyclone and tidal surge and used multiple choice option formats. Also, in Khawlia and Sarankhola information about individual household was collected through group interviews (instead of individual interviews in Dewanganj and Patharghata).

For all four areas (Dewanganj, Patharghat, Khawlia and Sarankhola) information about each individual household were recorded in a separate form; and the data were compiled and analysed, applying the formula noted above, to ranking the individual households on an ordinal scale under three categories - high risk, medium risk and low risk. Then, it was indicated on the household vulnerability maps of the respective areas.

Again, the risk levels of individual households were calculated in reference to the respective union, and indicated risk level of a household is relative to that of the other households of that particular union.

PROCESS

As noted above, the first step was training and orientation of the assessment team during 18-29 October 2008. Following that, four members of the team (including the team leader) went to Dewanganj on 19 November 2008.

Firstly, the team informed the upazila Administration about the objective and the processes of the assessment; then, they met the Chairmen and members of Chikajani, Chukaibari and Bahadurabad unions and explained to them the purpose of the exercise and the details of the process. The key message that the team explained was that

- a. Prodiplan would undertake six month long disaster risk assessment in the area - process would include discussion sessions and mapping exercises with community people at different localities;
- b. based on the results of the assessment, Prodiplan would propose for a disaster risk assessment intervention, subject to availability of funding support would mount a disaster risk reduction intervention;
- c. initially it would be a pilot project in one or two villages but not necessarily the villages where the assessment is conducted, which depending on the success may expand to cover the adjacent areas,
- d. accessing donor funding would depend, largely, on the quality of the assessment and its findings.

The team collected available maps from Union Parishad offices; and walked through the whole area - spent two days to get an overview of the topography and structure of the villages. During this walking, the team introduced themselves to the communities and explained purpose and processes of the exercise. Based on their observations and such introductory discussions, the team planned hazard mapping exercise.

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For hazard mapping the team went to a spot, met some women and men (who ever were available and willing) and requested them to participate in the mapping exercise. Team members supplied them with large sheets of paper and marker pens and asked them to draw boundaries of their village, roads, river and canals and mark the dwelling areas, crop fields, water bodies and resources such as school, madrasa, mosque, mandir, market place, and government and non-government offices.

While the villagers were drawing their map, one member of the team, separately, led an interactive group discussion some women and men.

Outcome of this exercise was a village map drawn by the community members and a set of information about frequency and magnitude of flood and river erosion, effects of these hazards on people's lives and how people have been coping with that. Information collected through this process was verified against institutional reports and maps and based on that, the team drafted a map of that specific village.

This process was repeated to cover all parts of the selected area. Then, individual village maps were compiled into one single map of the whole area. Data collected were analysed applying the framework and scoring system noted above to grade individual villages under high, medium and low risk categories; and thus, the team prepared hazard map of the selected area under Dewanganj upazila.

After completing hazard mapping in Dewanganj, the team was split into two groups - one started vulnerability assessment in Dewanganj. The other group went to Patharghat and initiated similar processes there to do hazard mapping that completed by 27 December 2008 and followed by vulnerability assessment there.

In each of Chikajani (Dewanganj upazila) and Patharghata (Patharghat upazila) unions a high risk village which is farthest from the upazila centre and several adjacent villages with total estimated 2,000 to 3,000 households were selected for vulnerability assessments. All households in those villages were individually visited and interviewed using a questionnaire. Interview results for each household were recorded on a form and the household's location was marked on the village map.

After completion of interview of all households in one area, results were tabulated and analysed applying the framework and scoring system as noted in the methodology section above. Based on this analysis individual households were ranked into high risk, medium risk and low risk categories and the locations of the individual households, indicating their respective risk levels by colour code, were marked on the households vulnerability maps.

Work in Dewanganj and Patharghat completed by June 2009. Findings of the assessment were reviewed by Prodiapan and its partners Bread for the World and Diakonika through a workshop. Based on the review risk assessment was done in Khawlia union of Morelganj upazila and Southkhali union of Sarankhola Upazila in April 2010. It targeted about 1,000 households in each union and applied the same procedure and methodology as in Dewanganj and Patharghat with exception that the conducted group interviews instead of interviewing every household singly and separately.

Advantageous and constrains

Timing of the exercise was helpful. It was when the monsoon was over; therefore, all parts of the selected areas were accessible to the assessment team.

Local Administration was receptive to the notion of disaster risk reduction and supportive to the assessment team. They understood well that the areas hazard prone and such assessment would be helpful plan and implement disaster risk management activities.

Communities, in Dewanganj, Patharghata, Morelganj and Sarankhola were cordial and friendly towards the assessment team. It was, largely, because, they have long experience of working with NGOs and many times, in the past, during emergencies, have received substantial assistance form NGOs. It was particularly so for Dewanganj and Sarankhola where Prodiapan has been operating for several years.

There were, however, several constrains. Firstly, although the post monsoon dry season allowed access to various parts of the areas, there were occasional cold waves - particularly in Dewanganj. Low temperature and foggy weather constrained travelling and organising mapping exercises. Similarly, there were cyclone warning and foul weather in April in Borguna. Risk assessment work had to be suspended during that time.

Secondly, selected location for assessment in Dewanganj was in charland areas. Households were scattered and in many places there were no proper roads. Reaching the households, particularly for vulnerability assessment, was very time consuming; therefore, the work progress was slower than that as estimated at the planning stage.

Thirdly, river erosion and resulting displacement was very common in Dewanganj - majority of the people has repeatedly suffered from that and resettled in locations which were not their original villages. Many of them tend to define their villages by their social attachments rather geographic reference. This confusion caused considerable difficulties in determining geographic boundaries of the villages and grading their hazard risks.

Fourthly, there were national election and upazila election during the assessment period. During the election times work has to be suspended.

LOCALITIES AND HAZARDS

Dewanganj is situated on the east bank of the Jamuna River. Water flow in the river greatly varies seasonally. In winter the river shrinks and in monsoon it overflows its banks. Large parts of the upazila are charland areas and under continued process of erosion and accretion.

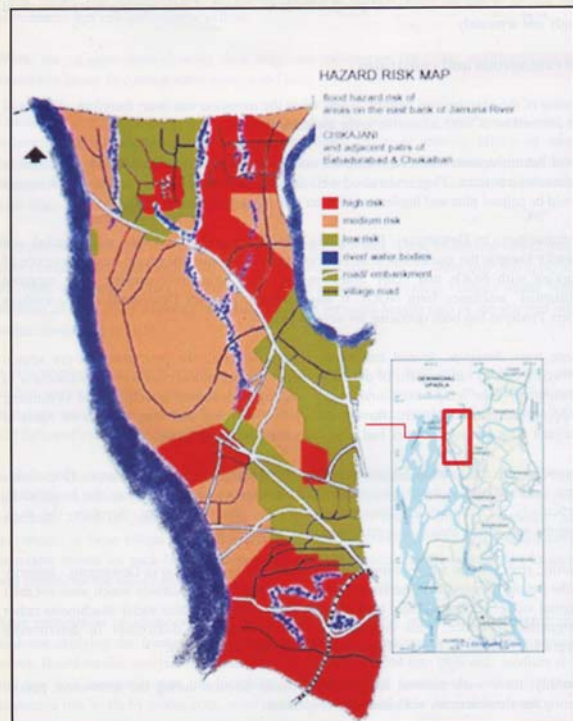


Figure 2: Risk map of Chikajani Union

The area is particularly prone to flood. Every year it experiences flood. Duration and intensity vary; but despite its magnitude, flood causes serious problems to life and livelihood. It inundates both cropland and dwelling areas - destroys crops, damages household and economic assets, breaches roads and embankments and disrupts economic and social activities. Only the major and visible floods attract response which often they are less than adequate.

Land is very unstable and prone to erosion. Rates of riverbank erosion accelerate during the flood period. Such phenomenon is not all conducive for development interventions and whatever is invested rarely sustain for longer period. Riverbank results in collapse of Infrastructure - e.g. road, embankment, clinics, schools, and decline and non-functioning of basic services such as health care, water and sanitation and education. Also, it diminishes availability of land for cropping and dwelling. Furthermore, it displaces people and forces them to live in marginal and risk prone areas. These displaced people rarely have enough incomes or resources to ensure protection against flood.

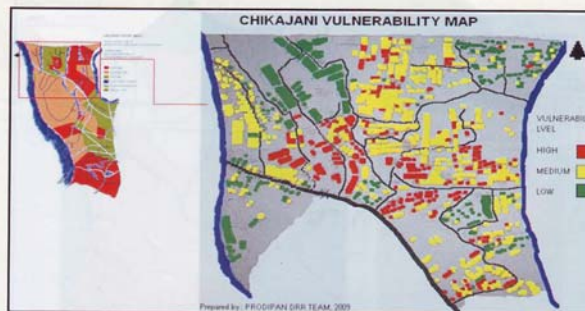


Figure 3: Vulnerability map of Chikajani Union

For income earning majority of the households in Dewanganj sell labour on daily basis. They take up any job available, which includes farming activities, earth cutting, loading and unloading goods at ferry ghat or local market or miscellaneous household chore. They also, do rickshaw or van pulling. In addition, some of them grow crops in land obtained through share cropping arrangements. Households with some land grow crops in their own land as well in land obtained through share cropping arrangements. Small number of households is involved in trading; however, volumes of their business are modest. Only a handful of households relies on salaried jobs - they are, mainly, school teachers or NGO workers.

Of the total 11,015 households in 31 villages under the village hazard risk assessment 55.3 percent live in 11 high hazard risk villages. Household vulnerability assessment covered 5 of these 11 high risk villages. In these 5 high hazard risk localities 71.2 percent household is found to be exposed to high disaster risk.

Patharghata is located near the Bay of Bengal with only a thin stretch of Sundarban between its southern boarder and the shoreline. Two big rivers, namely, Baleshawr and Biskhali flow along its west and east boarders, respectively. Several canals run criss-crossing the area. There are heavy embankments with sluice gates surrounding the union - mainly for protection against flood and tidal surge. Land is stable. Erosion is localised - occurs only in narrow strip of land along the main rivers.

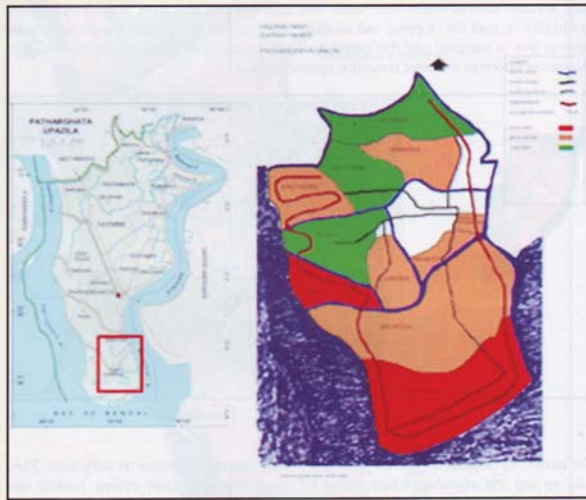


Figure 4: Risk map of Patharghata Union

The main threat in Patharghata is cyclone and associated tidal surge. It causes injuries and deaths, destroys houses and household assets, ruins crops and productive assets. Also, it seriously disrupts the basic services and livelihood activities.

Frequency of cyclone, compared to that of flood in Dewanganj is low. Destruction that it causes is huge and very visible and, generally, it attracts responses. However, often such responses are slow and inadequate. For example, only a very small proportion of households who had lost their houses during Sidr had been targeted for shelter support and the majority of the targeted households are still waiting to receive this support.

Continued increase in the magnitudes of salinity intrusion and astronomical surge has become a major concern for Patharghat. Salinity concentrations in both surface and ground water as well in the soil is increasing; and through the local river and canals saline water is penetrating deeper into to mainland. Also, also, the astronomical surges are increasingly inundating more and more areas. This phenomenon has been attributed to climate change factors.

Economy is primarily agro based - crop cultivation, also there is a thriving fishing sector that includes fishing in sea and river, inland fish farming and fish processing. There are substantial volumes of trading and transportation activities to support agriculture and fishing sectors.

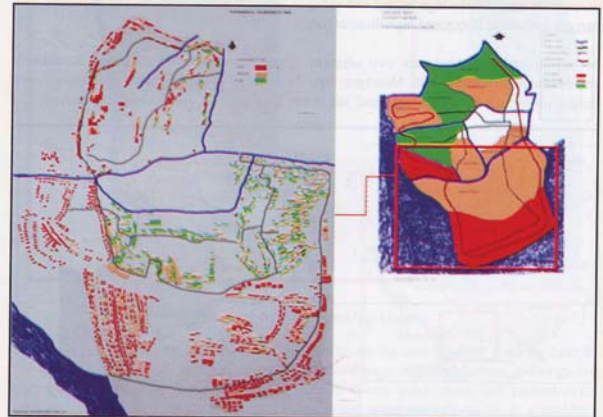


Figure 5: Vulnerability map of Patharghata Union

Majority of the households in Patharghata relies on daily waged labour for their incomes. As in Dewanganj, they take up any job available, do rickshaw or van pulling and migrate to the cities during lean periods. However, compared to their Dewanganj counterparts, they have

some additional opportunities which include working in fishing trawler, inland fish farm and mason and carpenter helper. In addition, during the spawning season, they catch fish fry and sell that to the local fish farms. Also, because of the thriving fishing sector and recent Sidr recovery interventions, job availability for the daily waged labour is greater than that of in Dewanganj.

About 24 percent of the households have arable land and about half of them have only very small plots. These small farmers cultivate crop or run small scale fish farm, alternatively they lease out their lands to large fish farms. Owners of large holdings cultivate crops and run fish farms; in addition, they are involved in business and trading as well in the transport sector.

A small proportion of the households rely on professional trades such as carpentry or masonry, or on driving motor cycle (carrying passengers), locally made three wheeler and engine boat (transporting people and goods or fishing). Similar to the daily waged labour, they earn on daily basis but levels of their incomes are higher than that of the daily labours.

In Patharghata assessment noted that 23.5 percent of the total 7,721 households in the assessment areas live in high hazard risk villages; and in these high hazard risk localities 70.6 percent household is exposed high disaster risk.

Morelganj and Sarankhola are two adjacent upazilas under Bagerhat district. Sarankhola shares common boarder with Morelganj upazila in the north. Baleshwar and Bhola rivers define its boundary on the east and the west; Dashbharani canal separates it from the

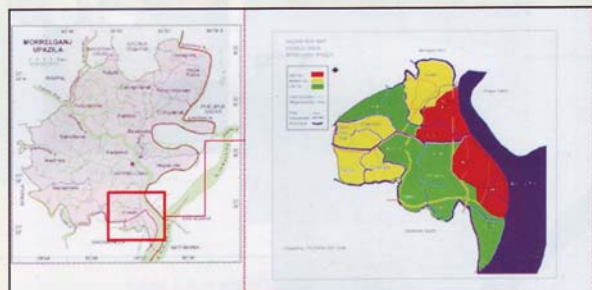


Figure 6: Risk Map of Khawlia Union, Morelganj

Sundarban in the south. Morelganj is bounded by Bagerhat Sadar and Kachua upazilas on the north, Sarankhola and Mathbaria upazilas on the south, Pirojpur Sadar and Bhandaria upazilas on the east, Rampal and Mongla upazilas on the west.

Several canals and minor rivers run through the area. Nearly all of them have embankments running along their banks; however, large sections of these embankments have been weakened due to the lack of proper maintenance or damaged by cyclone Sidr. Sundarban lies between Sarankhola and the Bay of Bengal covering the whole length of the upazila's boarder on the west and the south.

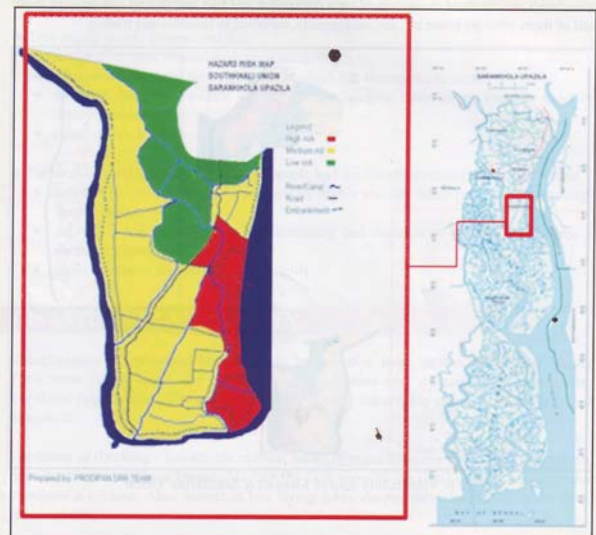


Figure 7: Risk Map of Southkhali Union

Like Patharghata, cyclone and associated tidal surge are the main hazard. Cyclone Sidr, in November 2007, severely affected the area. It caused huge human casualties and extensive damage to infrastructure - e.g. houses and schools blown away, roads and embankments breached, bridges and culverts collapsed, electricity and water services cut off. It completely devastated agriculture and fisheries on which majority of the people in the area rely for their livelihoods.

Economy is based on agriculture - crop cultivation and fisheries, and open fishing. Also, there is a sizeable volume forest resource harvesting from the Sundarban.

Similar to Patharghat, majority of the households earn their incomes daily through waged labour and combining it with rickshaw or van pulling and seasonal migration to the cities. However, because of the proximity to the Sunderban they go for forest resource harvesting. Smaller proportion of households rely on professional trades such as carpentry or masonry or driving motor cycle, three wheeler, trawler and engine boat. Estimated 30 percent of the households are involved in mixture of crop cultivation and fish and shrimp culture, and about half of them, who are better off, are, additionally, involved in business and trading.

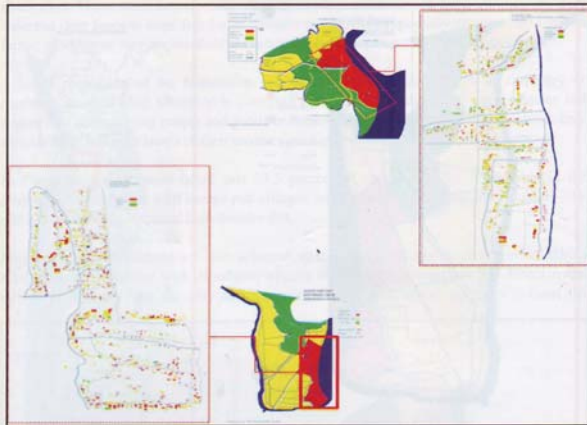


Figure 8: Vulnerability map of Khawlia & Southkhali Union

In Khawlia, total 6,763 households in 16 villages under the village hazard risk assessment 25.4 percent live in 4 high hazard risk villages. In these 4 high hazard risk localities 31.6 percent household is found to be exposed to high disaster risk.

In Sarankhola village hazard assessment covered 11 villages. Of the total 6,420 households, 24.9 percent live in 3 high hazard risk villages. In these 3 villages 68.2 percent households is found to be exposed to high disaster risk.

Fragile embankment contributes to disaster vulnerability of the households living in cyclone prone and flood prone areas. Poorly maintained embankments fail to cope with the pressure of flood water or tidal surge. They collapse and on rushing water swept away people, animals, houses and other infrastructure. Also, it causes water logging and increases soil salinity levels.

Households with fragile occupation (e.g. day labour, rickshaw pulling) in High Risk villages	# of households	% of HHs in high risk (level 3)
Dewanganj	323	57.9
Patharghata	965	83.6
Khawlia	721	32.7
Sarankhola	633	90.5

Table 2: HHs with fragile occupation

Repeated or recent exposure to disaster increases the households' vulnerability. Significant proportions of households which suffered damages due to flood (in Dewanganj) and cyclone Sidr (in Patharghata, Morelganj and Sarankhola) were found to be at high risk.

Dependency on daily waged labour enhances vulnerability of the households to disaster. Sources of their employments are rooted in agriculture and fishing which is susceptible to cyclone or flood. These hazards lead to serious reduction in the employment opportunities of the daily labours; and such situation does not improve until the local economy recovers sufficiently.

Not having a homestead of own makes a household extremely vulnerable. It is a manifestation of social marginalisation and resource scarcity. It denies the holds choices and forces to live in marginalised and risk prone location. In addition, the household has to live in perpetual threat of eviction.

Households without any ownership of homestead in High Risk villages	# of households	% of HHs in high risk (level 3)
Dewanganj	567	89.6
Patharghata	74	71.6
Khawlia	170	38.8
Sarankhola	74	93.2

Table 3: HHs without any ownership of homestead

Households with women, children or old aged persons as main income earner are particularly vulnerable to disaster. Their incomes are low even during 'normal times'; in crisis times, their opportunities shrinks drastically and they have to compete with better able and better skilled male counterparts.

Households with children/ old age/ women as main income earner in High Risk villages	# of households	% of HHs in high risk (level 3)
Dewanganj	27	70.4
Patharghata	73	84.9
Khawlia	99	38.4
Sarankhola	93	82.5

Table 4: HHs with children/women as main income earner

CLIMATE CHANGE ISSUES

People in Dewanganj, Patharghata, Morelganj and Sarankhola have noted and were explicit about the changing patterns in the seasonality, frequencies and magnitudes of flood and cyclone as well the emergence of newer hazards in the respective areas. Their comments and views are generally supported by various research and studies.

In Dewanganj people commented that

- rates of river bank erosion have been accelerated;
- monsoon delays and it prolongs drought which has become more acute;
- monsoon starts with sudden and heavy rains, and the rainy season end few short but heavy spells of rains;
- winter season has become shorter.

In Patharghat, Morelganj and Sarankhola people had similar observations. They viewed that

- high tide surges have become increasingly higher and tide water penetrates increasingly deeper inland;
- salinity levels in the rivers are increasing and duration of salinity free season is shrinking rapidly;
- canals and rivers are getting silted steadily.

DISASTER VULNERABILITY

Vulnerabilities of individual households to hazard arise from various interrelated factors. Their roots lie in social and economic marginalisation and in constraints in accessing livelihood opportunities. The assessment noted several discernable attributes of the high risk households.

Locations of dwelling - households near the banks of major or active rivers are susceptible to river bank erosion. These households face the first wave of the flood or the tidal surge that associates a cyclone. Also, houses in low lying areas, despite their distance from the river, get inundated.

In adequate protection against wind force (e.g. tree) or flooding (e.g. embankment) adds to the households' vulnerability to disaster. Sunderban provides people living in Sarankhola protection against wind force; however, singly it is not sufficient because cyclones are associated with tidal surges which require strongly built embankments to prevent inundation.

Households living in low-lying/unprotected locations in High Risk villages	# of households	% of HHs in high risk (level 3)
Dewanganj	52	98.1
Patharghata	data not available	
Khawlia	657	63.0
Sarankhola	95	77.9

Table 1: HHs living in vulnerable area

Agro and fishery based local economy is susceptible to cyclone or flood. Households with large holdings may be able to accumulate resources to ride over a crisis; however, households with small holdings and, in particular, the casual labours who depend heavily on local agriculture or fisheries remain very vulnerable to disaster

Non-functioning health care service and poor education system, at root level, contribute to households' vulnerability to disaster. Former contributes to ill health and later denies the families their human resource development potentials.

Fragile water and sanitation system increases households' vulnerability to disaster. During the aftermath of Sidr people in Patharghat, Morelganj and Sarankhola suffered greatly due to the scarcity of safe water and lack of proper sanitation facilities.

COPING PRACTICES

Expanding expertise and interest about the nature and types of job has become a major element in their efforts to sustain incomes of the day labours in the study area. The notion of specialised labour, such as 'farm labour' or 'fishing folk', has become outdated in hazard prone Dewanganj, Patharghata, Khawlia and Sarankhola. Daily waged labourer, as noted above, take on any job - e.g. farming activities, earth cutting, porter, house repair and construction, as well they do rickshaw or van pulling, fishing and forest resource harvesting.

Similarly, small farmers have become a mixture of farmers and part time or seasonal waged labourer. Richer households also diversify their sources of incomes. In addition to crop cultivation and fisheries, they engage in various trades and commerce.

Specific local coping practices reflect the communities' preparedness to anticipated hazard as well their reactions during a crisis. They reported that prior to the cyclone or flood season they actually do or strive to do the followings

- repair their houses and make them stronger;
- raise level of their dwelling areas with earth filling;
- re-establish latrines on higher ground;
- collect and store fuel wood and make moveable hearth;
- keep a stock of dry food (e.g. puffed or rolled rice) for emergencies.

Their reactions during of cyclone or flood are

- listening to weather forecast and cyclone warning;
- move to cyclone shelter or safer places when they are warned to do so;
- try to take their animal in safe places
- take dry food and drinking water when they move to cyclone shelter;

In flood prone areas, they live on raised platform inside their houses or if the flood water level is too high, they move to the embankment, roads or any high ground.

During the aftermath of a disaster they try to

- clean their dwelling areas, re-establish latrine;
- collect drinking water un contaminated or cleaned water sources, even they have to travel a distance;
- contact Union Parishad and other relief agencies and seek relief;
- seek assistance from relatives;
- eat less and stretch available food stock over longer period;
- send male adults to cities for earning;
- send children to job when household food stock dwindle;
- sell household assets when situation becomes disparate.

Majority of these coping practices is reactive and concerns mainly about survival and enduring distress. Also, some of them are not necessarily beneficial in the long run - e.g. eat less, migrating to the cities, weaning children from schools.

Preparedness and strategic coping actions however require considerable investment in terms of money, materials and efforts. For example, making houses flood proof or cyclone safe needs investment, and effectiveness of cyclone warning depends on comprehensive broadcasting system and chain of shelters to accommodate the whole community.

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- modifying design and reinforcing road, bridge and culvers that they include adequate drainage facilities and are strong enough to cope with flood and tidal surge
- modifying design and reinforcing dwelling houses to withstand cyclone shock in cyclone prone area
- raising homestead and dwelling areas above the flood level;
- earthen Killa for sheltering animals during cyclone warning;
- social forestry and systematic plantation of trees to minimise impact of cyclone;

Strengthening livelihood - key elements are:

- crop diversification and introducing alternative crops - e.g. new varieties of rice, in particular, that mature in shorter period and could be harvest before the onset of cyclone or flood, tolerate high concentration of salinity and could be cultivated in the coastal region or require less water to grow;
- skill for alternative and viable income earning activities and provide technical, material and financial assistance to community members to pursue such alternatives;
- organisational and financial supports for local people to find and secure employments outside of their communities;
- promoting overtop shedding on agricultural land to protect crops from temperature
- introduce fish culture in cage or net
- raised grazing land to keep it useable during flood

Climate change adaptation - key elements are:

- environment friendly village structure and power generation - e.g. solar power; wind mill, hydraulic power and bio-gas plant;
- resettling communities in raised dwelling areas;
- shifting towards alternative farming - e.g. forestry or animal rearing, instead of conventional crop (e.g. rice, jute, ground nut) cultivation;
- hanging bridge and submergible road construction;
- introducing and popularizing hydroponics

Water management - key elements are:

- recharging of aquifers,
- re-excavate canals and rivers and use them as reservoir
- village based rain water harvest and storage system

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DISASTER RISK REDUCTION

Removing or minimizing the vulnerability factors of individual households is vital for disaster risk reduction in assessment areas. Analysis of the findings from the mapping exercises; FGDs and consultations with the communities suggest several specific measures for that. It could be summarised as follows.

Establishing Early Warning System in the community - key elements are:

- mechanism for tracking and monitoring hazard - cyclone in particular, and timely dissemination of warning in the communities in a manner that they could act upon it;
- easily accessible safe places - designated shelters with relevant facilities and sufficient capacities to accommodate all members of the community, including children and old age and differentially able people, during an event of cyclone or flood;
- raising awareness of communities that they pay attention to warning and act upon that;
- skilled and organised personnel and materials and equipments in the community to disseminate of warning and to help people evacuate.

Preparedness for response - key elements are:

- designated responsible body with skills and understanding of disaster management and necessary resources, located at the community level;
- preparedness and response plan of individual communities that provides guidance and clearly explains actions relating to need assessment, targeting and beneficiary selection, organising support, packaging and delivery of relief materials and logistics;
- necessary material, financial and human resources for response at community level and linkages for accessing such resources;
- public education and raise awareness of communities on preparedness plan and response procedures

Structural and non-structural measures protecting assets - key elements are:

- repair, maintenance and construction of embankments;
- modifying design and reinforcing all public infrastructure in the community that they withstand cyclone shock;

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- pipe water supply for high salinity locations;
- reverse osmosis machine for supplying drinking water

Improving the basic services - health care and education

- organise a hierarchy of service providers at community level;
- reorient focus of the service providers in reference to the hazard risks;
- capacities of the service providers through training, technical inputs and equipments.

CONCLUDING REMARKS

Disaster risk assessment in Dewanganj, Patharghata, Khawlia and Sarankhola is a two stage process. It firstly determines risk levels of the assessment area using indicators for frequency and magnitude of hazards and a scoring system to the individual villages on an ordinal scale. Then, it determines risk levels of individual households in the high risk villages. Risk assessment at household level use 3 criteria (exposure, fragility and resilience) and a set of indicators for each and a scoring system for ranking individual households on an ordinal scale.

Risk assessment down to household level helps identifies beneficiaries of potential future interventions and helps in targeting.

Risk assessment at household level identifies the factors combination of which determines the risk levels of the individual households. Disaster risk reduction involves eliminating or minimizing these risk factors. It helps in designing interventions and outlining the activities by clearly defining the problem area.

The assessment identifies 3,174 high risk households in the four locations, the major factors that contributed to the risk and potential risk reducing measures.

Some of the identified risk reducing actions should be with high risk households, individually or as groups - for example, skill for alternative and viable income earning activities; raising homestead and dwelling areas. Some risk reducing actions should be at community level - for example, awareness raising on early warning; village based rain water harvesting and storage; repair, maintenance and construction of embankments.

Problem of disaster risks for people living in flood prone river basin areas and cyclone prone coastal areas is huge. To deal with that it requires concerted large scale multi-sector programme interventions. It is therefore more sensible Prodiplan to critically look at the issues noted in the earlier section and clearly define a segment of that for its programme intervention. Also, Prodiplan should engage significantly to influence others to supplement or complement to this efforts.

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