Working paper – draft

Scaling up early action

Lessons, challenges and future potential in Bangladesh

Thomas Tanner, Bill Gray, Kiswendsida Guigma, Jafar Iqbal, Simon Levine, David MacLeod, Khairun Nahar, Kaiser Rejve and Courtenay Cabot Venton

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Key messages

- **'Forecast-based early Action' (FbA) is emerging** among humanitarian and disaster risk management practitioners as an approach that can reduce the impact of shocks on vulnerable people and their livelihoods, improve the effectiveness of emergency preparedness, response and recovery efforts, and reduce the humanitarian burden.

- **This paper investigates the technical, economic and institutional challenges to scaling up FbA in Bangladesh**. Taking a political economy approach it examines the structures and policies around disaster management in the country; options for financing; and the forecasting infrastructure and dissemination systems

- **The concept of FbA is not new to Bangladesh but triggers for action are often unclear.** The Cyclone Preparedness Programme has long used forecasts to trigger early warning, preparedness and evacuation. However, in most other cases most existing triggers for action are determined more subjectively.

- **The risk of 'acting in vain' is a major perceived barrier to scaling up FbA**. Taking early action when forecasts prove inaccurate has potential implications for accountability and perceived misallocation of limited resources. But if targeted at poor groups, actions could anyway help to enhance resilience.

- **Institutional incentives and finance are still skewed towards relief**. Post-disaster response is seen as more visible and defensible, forming a barrier to early actions. Scaling up of FbA could help to reform prevailing cliental biases in relief by making targeting and delivery of aid more transparent, equitable and needs-based.

- **Value for Money?** Stakeholders are demanding for better evidence on the (cost)-effectiveness of FbA approaches. Pilots in Bangladesh suggest improved food security, reduced lending costs and lower anxiety/depression among those taking early action before disasters.

- **Forecasting is limited but has future potential.** Tidal influence makes it difficult to forecast flooding in the southern and coastal zones, while the inaccuracy of cyclone forecasting leaves a limited window for early actions. Riverbank erosion and flash flood forecasts have future potential, along with efforts to improve impact-based forecasting.

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About this paper

This is a case study report for the Scaling Early Action research project.

Contents

Acronyms

BCR	Benefit–Cost Ratio
BMD	Bangladesh Meteorological Department
BDRCS	Bangladesh Red Crescent Society
DDM	Department for Disaster Management (under MoDMR)
DFID	UK Department for International Development
FAR	False alarm ratio (in weather forecasting)
FbA	Forecast-based Early Action
FFWC	Flood Forecast and Warning Centre
GFS	Global Forecast System
GRC	German Red Cross
HR	Hit rate (in weather forecasting)
LCG	Local Consultative Group
MoDMR	Ministry of Disaster Management and Relief
NDMC	National Disaster Management Council
NDMP	National Disaster Management Plan
RSMC	Regional Specialized Meteorological Centre
SOD	Standing Orders on Disaster
SWC	Storm Warning Centre (under BMD)
UNDP	United Nations Development Programme
WFP	World Food Programme
WRF	Weather Research and Forecasting Model

Executive summary

Humanitarian and disaster risk management practitioners are becoming increasingly interested in the potential for 'Forecast-based early Action' (FbA) to reduce the impact of shocks on vulnerable people and their livelihoods, improve the effectiveness of emergency preparedness, response and recovery efforts, and reduce the humanitarian burden. FbA entails the use of forecasts of extreme weather events and other shocks to trigger funding and/or action in advance, or before acute impacts are felt.

Although there are now plenty of examples of forecast-based early action being taken around the world, funds committed to early action remain small compared to post-disaster humanitarian spending. Nonetheless, there is growing interest in the potential for scaling up early action beyond small-scale pilot exercises, including through the development of national government-led FbA mechanisms. Taking a political economy approach, this paper investigates the technical, economic and institutional challenges to scaling up FbA in Bangladesh; the structures and policies around disaster management in the country; and the forecasting infrastructure and dissemination systems, with a particular focus on cyclones and floods. The paper also examines an FbA pilot by the Bangladesh Red Crescent Society (BDRCS) and German Red Cross, which provided cash assistance based on flood forecasting in Bogura District in northern Bangladesh.

With frequent storms and flooding and high levels of vulnerability, Bangladesh has been at the forefront of the shift towards pre-disaster planning and has a well-developed institutional and legal structure for disaster risk reduction. The Cyclone Preparedness Programme has used forecasts since the 1970s to trigger early warning, preparedness and evacuation actions. Similarly, government policy and guidelines already incorporate anticipatory approaches to disaster management. The Standing Orders on Disaster, for example, define some responsibilities and actions based on warning periods, suggesting a good foundation for scaling up FbA.

However, most triggers for action are determined subjectively on perceptions of a crisis, rather than by quantified thresholds defined by forecast data. Institutional incentive structures and financing are also still skewed towards relief activities. Post-disaster response is widely regarded as more visible and defensible, and decision-making at national and local levels is often based on relationships of political patronage. If funding was made available for FbA, it is likely that the selection of scaled-up FbA actions and beneficiaries would be subject to political influence in similar ways as existing disaster response. A scaling up of FbA would therefore need to either accommodate prevailing clientelist structures or could potentially provide the means to reform them by making targeting and delivery more transparent, equitable and needs-based. Institutionally, scaling up FbA also still requires synthesis of evidence to promote more widespread awareness of FbA approaches, particularly outside the humanitarian community, and greater involvement of government agencies in FbA piloting exercises.

The risk of ‘acting in vain’ (delivering early action when forecasts turn out to be inaccurate) is another major perceived barrier to scaling up FbA in Bangladesh, particularly given the implications for accountability and perceived misallocation of finite resources. This research offers some counter-narratives to these concerns. If FbA ends up targeting people and places that are not directly affected by a shock (due to forecasting error), it can still tackle indirect impacts, which are often significant. With good targeting of poor and vulnerable people, it can also help enhance their resilience to future shocks. The research also suggests that, to scale up FbA, it needs to be presented as part of the suite of approaches to managing disaster risks, rather than as a replacement for existing relief and response mechanisms.

Stakeholders in Bangladesh called for a more robust evidence base to warrant developing a national FbA mechanism or similar. In particular, there were concerns about the effectiveness of early actions, and evidence of ‘value for money’. To help address these concerns the project team undertook a learning study looking at the economic value of acting early vis-à-vis post-disaster humanitarian response. Evidence from the BDRCS FbA pilot suggests that forecast-based cash transfers did not necessarily change the types of actions taken before a disaster but did enable people to do more to prepare, had psychological benefits and lowered the costs of acting early, as food was purchased before prices spiked during flooding. Market-oriented approaches that factor in changes in prices might be the way forward for expanding FbA in Bangladesh, but this will require understanding people’s needs and spending priorities, how local markets and lending conditions change during a flood, and when people invest in longer-term resilience (such as by purchasing productive assets). How people behave is also influenced by how certain they are of when and whether a grant will arrive for a given level of hazard. This is as important as the amounts transferred, or the mechanisms used. The study of the Bogura cash transfer also served as a reminder that there can be multiple peaks in flooding during the monsoon or rainy season. A cash transfer from the BDRCS was made before the first peak, but most people did not spend it all upfront because they knew that there was likely to be another peak in flooding later in the season.

This paper also highlights some of the forecasting and targeting challenges of FbA. The system for forecasting riverine floods in the north of Bangladesh is well-developed, but modelling in southern and coastal zones is complicated by tidal influences. The inaccuracy in forecasting cyclone tracks until 12 hours before the event leaves a limited window for early action beyond evacuation and shelter preparedness. Existing seasonal forecasts for riverbank erosion, currently used to inform the Bangladesh Water Development Board, may have the potential for furthering FbA approaches.

A final step required for scaling up FbA in Bangladesh relates to how forecasts are disseminated. The technical formats and language used are difficult for local actors to understand and often inappropriate for the kinds of decisions being taken. With the exception of the Cyclone Preparedness Programme, forecasts are not linked to established triggers for action.

As such, FbA provides an opportunity for further developing early warning systems in Bangladesh so that these are better linked to decision-making. In particular, impact-based forecasting has great potential in Bangladesh. By describing forecasts in terms of impacts, impact-based forecasting could be used to develop and run scenarios and improve the focus of preparedness planning. Doing so will require co-production of information on disaster risk between forecasting agencies and the decision-makers at different scales who are ultimately the end users. One important initial institutional step towards scaling up impact-based approaches in Bangladesh would be for the national forecasting and disaster management bodies to agree joint responsibility for developing and issuing impact-based warnings.

1 Introduction: FbA as a policy problem

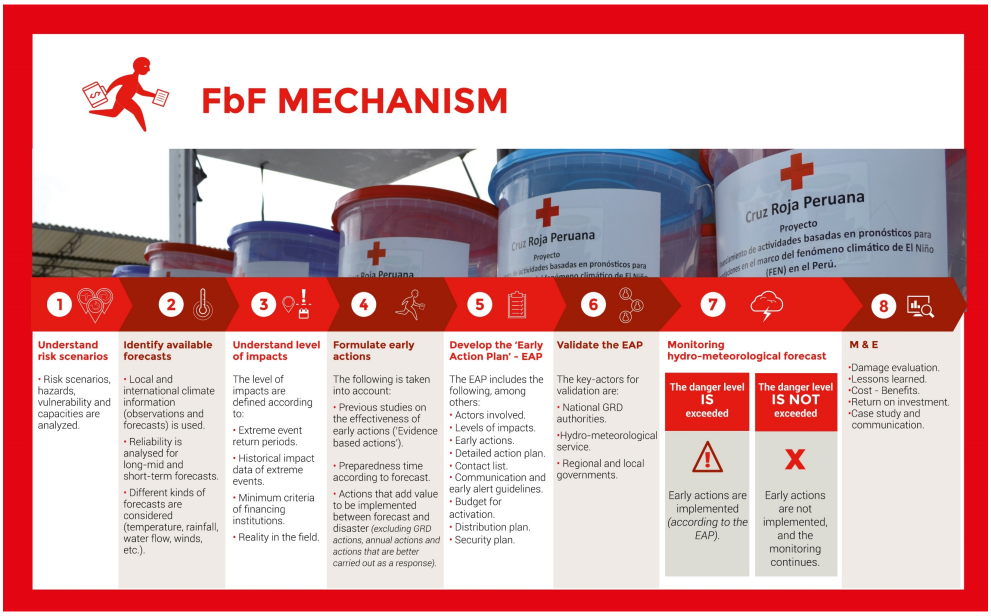
1.1 What is FbA?

While disaster risk management (DRM) and humanitarian action have tended to focus on ongoing disaster prevention measures and post-disaster responses respectively, there is growing interest among DRM and humanitarian professionals in examining the potential for taking action in the window between the release of a forecast and the occurrence of a disaster event (Coughlan de Perez et al., 2015). This paper focuses on what has come to be known as 'Forecast-based early Action' (FbA) for extreme weather events, but FbA is also being developed for other crises, such as conflict and food insecurity.

While there is no single definition of FbA, it generally entails the release of funding for taking (often pre-determined) actions in advance of a shock before acute impacts are felt. The actions and forecast-based triggers for action can be agreed in advance and on the basis of an analysis of the risk, setting some kind of threshold for the forecast and the likely impact of the actions. These triggers and thresholds can be a fixed point in the forecast data, or actions can be sanctioned on the basis of an expert-led consultation. To date, early actions based on forecasts have ranged from bolstering organisational capacities and programme activity to delivering food and non-food relief, cash transfers and scaling up social protection mechanisms (Wilkinson et al., 2017).

There is growing interest in the potential of FbA approaches to reduce the impacts of disasters on people's lives and on the burden of humanitarian response, alongside other potential administrative, financial and coordination dividends (Wilkinson et al., 2018). In particular, proponents of FbA are keen to see small-scale pilot initiatives scaled up. Using a political economy approach, this report explores the processes and potential for scaling up FbA in Bangladesh, and the technical, economic and institutional challenges involved. As both an emerging innovative approach and potentially a major shift in humanitarian and disaster risk financing and practice, scaling up FbA has implications for many different actors, from households vulnerable to climate-related impacts to humanitarian workers, forecasters, risk analysts, governments and businesses.

Figure 1 The FbF mechanism



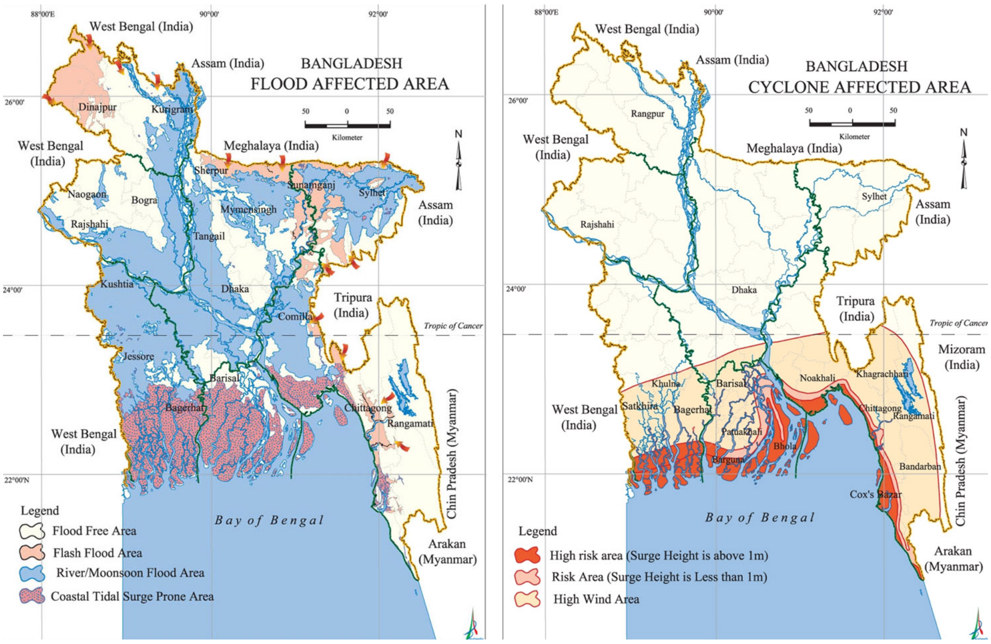
Source: German Red Cross/Peru Red Cross/Climate Centre, 2019.

1.2 Scaling up FbA in Bangladesh

The geography of Bangladesh has a significant influence on levels of disaster risk. The country supports three major river systems and their deltas: the Brahmaputra (known locally as the Jamuna), the Ganges and the Meghna. These rivers receive runoff from India, China, Nepal and Bhutan in a wider catchment area around 12 times the land area of Bangladesh itself. Some 80% of Bangladesh lies in a floodplain, and much of its coastline is formed of low-lying deltaic areas. About 16% of the country's area lies less than 1.5m above mean sea level, and roughly 50% is within 6–7m above mean sea level. Just under 70% of the country is vulnerable to flooding, and 25–30% is inundated during a normal monsoon period. Cyclones hit coastal areas almost every year, usually accompanied by high winds and waves. There is also earthquake risk, particularly in the north-east of the country. Figure 2 shows the main areas of flood and cyclone risk in Bangladesh.

The high risks and frequency of disaster events and long-established practices of disaster management and humanitarian relief make Bangladesh a natural testing-ground for FbA. Government disaster management policy has embraced concepts of disaster risk reduction, anticipation and climate adaptation, including through the anticipatory actions under the Cyclone Preparedness Programme. This makes the country an ideal location for exploring the opportunities for scaling up FbA, particularly within government structures and institutions. This paper concentrates on the potential application of FbA approaches to riverine flood events and cyclones. Historically, these hazards have had the greatest and most frequent impact on lives, livelihoods and assets. Their severity has also prompted the long-term engagement of the humanitarian community in Bangladesh, and the development of better forecasting models. Links are also being made to other major hazards where forecast applications are available or emerging, such as flash floods, riverbank erosion and landslides.

Figure 2 Flood- and cyclone-affected areas of Bangladesh



Source: http://en.banglapedia.org/index.php?title=Natural_Hazard

This paper takes a political economy approach to highlight the interplay of structural factors, institutions and stakeholders in determining the interests in and incentives for scaling up FbA approaches. Rather than breaking down the challenges into technical problems, political economy analysis attempts to understand the underlying drivers that shape the incentives of decision-makers (Tanner and Allouche, 2011). Experience from governance assessments in other areas has suggested that analysing these factors is particularly useful when it starts with a diagnosis of a specific unresolved challenge or opportunity. This paper therefore adopts a ‘problem-driven’ approach, but with an emphasis on the potential positive drivers of change (Fritz and Levy, 2014).

The study reviewed policy and programming documents, as well as research literature. This was combined with interviews with key actors engaged in, or who could potentially be engaged in, FbA, including government representatives (the Department of Disaster Management, Ministry of Disaster Management and Relief (MoDMR)), government and inter-governmental meteorological bodies (the Institute of Water Modelling, Flood Forecast and Warning Centre, the Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)), funding agencies (the START Fund, the UK Department for International Development (DFID)), multilateral agencies (the World Food Programme (WFP), UN Development Programme (UNDP)), NGOs/civil society organisations (the Bangladesh Red Crescent Society (BDRCS), German Red Cross Society, CARE Bangladesh, Oxfam Bangladesh, World Vision Bangladesh), and insurance companies (Pragati Insurance, PKSF). These interviews sought to deepen understanding of the political, financial and technical barriers to scaling up FbA, including existing technical capacity in forecasting climate-related hazards in Bangladesh.

The research took an action-oriented approach, using analysis and stakeholder engagement as a means of furthering awareness, learning and action on FbA. A workshop to discuss initial findings held in July 2018 brought together forecasters, humanitarian agencies and government representatives. This was followed by discussions on a working group and future action plan with members of the START Fund network in Bangladesh during their workshop in October 2018. A working group was established through this research, made up of NGOs and hydro-meteorological services representatives, with support from the START Fund Bangladesh. The working group will seek to engage UN agencies, national NGOs and government disaster management bodies, as well as those working in relevant areas such as social safety nets, sovereign risk transfer, insurance and micro-finance. Initial tasks for the group include agreeing a nationally-owned definition, language, evidence and narratives for FbA.

A Theory-Based Impact Assessment (TBIA) methodology was also developed to assess the impact of an FbA pilot and hence determine if these kinds of actions would be suitable for scaling up in Bangladesh. The TBIA examined the BDRCS's provision of cash assistance based on a flood forecast in Bogura District in northern Bangladesh. Originally designed for the START Network's Drought Risk Financing Facility (DRF), the TBIA assesses the impact of a pre-disaster cash transfer by testing whether or not the intervention led to real change by following steps in a chain of logic derived from the project's Theory of Change (TOC). If no change is found in any one of the links, this implies that the logic chain had broken down and that any changes in people's lives cannot be automatically attributed to the project actions. Conversely, if changes can be found for every link in the impact chain, then a conclusion about the contribution of the intervention to overall change is compelling. The TBIA approach (which we refer to as a 'learning study') can be used to generate learning and reflection on whether, and which, actions are valuable for FbA. The study was conducted on a small scale, and focused only on some of the benefits that might be achieved by using an anticipatory and forecast-based intervention as opposed to a conventional humanitarian response. To make this comparison, researchers developed hypothetical scenarios based on the evidence gathered.

Eight graduate research assistants were trained in Dhaka, and qualitative research was undertaken in Khazla, Khamalpur and Bhandabari 6 and 7 villages in Bogura District from 5–11 June 2018, one year after the flood event being discussed. A total of 50 households were interviewed, 30 of which received the BDRCS cash transfer and 20 of which did not, either because they were not present in the area at the time of the transfer, or because they did not qualify in a needs-based assessment. Focus Group Discussions were held in each village, and key informant interviews were conducted across the research area with local officials and BDRCS volunteers. Interviewees were not asked to specify how they had spent the grant money, but rather how they used whatever resources they had available.[1] The analysis looked at how far a shortage of money had played a role in limiting people's preparations. As a result, interview questions were almost the same for transfer beneficiaries and non-beneficiaries of the BDRCS cash transfer.

[1] This is because the transfer was simply an additional resource to a household, and there is no reason to distinguish money from the transfer from any of their other income sources.

2 Institutional and stakeholder challenges in scaling up FbA

Scaling up FbA will require greater engagement by state institutions and stakeholders responsible for formulating and implementing disaster risk management in Bangladesh. This entails extending the breadth of response and institutional integration beyond what has occurred in pilot FbA projects to date. This section describes the institutional arrangements for DRM in Bangladesh, and the challenges involved in altering policies, mandates and guidelines in order for different agencies and actors to respond to a forecast.

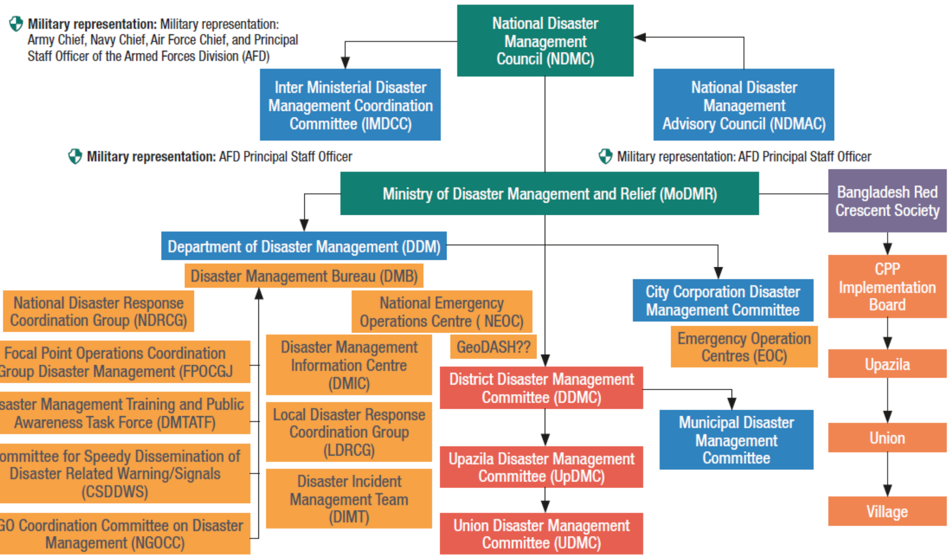
2.1 Disaster policy framework and structure

In recognition of the importance of disaster prevention and management, the Ministry of Relief was renamed the Ministry of Disaster Management and Relief (MoDMR) in 1992. The MoDMR has responsibility for coordinating national disaster management efforts across all agencies. While planning and execution responsibilities are vested in a variety of sectoral agencies, MoDMR has an overall coordinating and facilitating role as Secretariat to the National Disaster Management Council (NDMC) (see Figure 3). Headed by the Prime Minister, the NDMC provides overall direction for disaster management, including disaster risk reduction, mitigation, preparedness, response and recovery.

Bangladesh has a well-established policy framework for tackling disasters and climate change. The Disaster Management Act of 2012 provides the legal basis for disaster management in the country, underpinning the National Plan for Disaster Management (NPDM), the National Disaster Management Policy (NDMP) and the Standing Order on Disasters (SOD), together providing the institutional framework for government regulation of disaster management. These are supported by international frameworks including the Sendai Framework for Disaster Risk Reduction 2015–2030, the Asian Regional Plan for Disaster Risk Reduction and the Sustainable Development Goals (SDGs). Long-term sectoral plans under the government's Seventh Five Year Plan (2016–2020) integrate disaster risk reduction measures into different sectors of the economy, and the government's Vision 2021 document calls for integrating DRR into all development plans and projects. The NPDM (2016–2020) has a strong emphasis on anticipation and DRR, and created the Disaster Management Fund as a dedicated financial resource for activities at all levels. The approach to planning is guided by the core aim of achieving resilience.

The SOD, first issued by the MoDMR in 1997, were revised in 2010 and are currently in another phase of revision. They provide the formal mandates, roles and responsibilities for disaster management before disasters, in the warning phase, in relief and in rehabilitation. Overall coordination for disaster-related activities at the national level is led by the National Disaster Management Council (NDMC) and Inter-Ministerial Disaster Management Coordination Committee (IMDMCC). Coordination at District, Upazila and Union levels is the responsibility of the respective local Disaster Management Committees (DMCs).

Figure 3 National emergency coordination structure



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Source: xxxx

2.2 Institutional change and mandates for FbA

Formal government mandates can present challenges to scaling up early action, as their rules of procedure and legal regulations may influence their ability to finance and take different actions. While pre-disaster actions are now commonly worked into the practices of disaster ministries, the same may not be true for other government ministries and agencies (Coughlan de Perez et al., 2015). However, while often slow to change, these mandates are not fixed, as shown by the renaming of the Ministry of Relief as the Ministry of Disaster Management in 1992, and its subsequent merger with the Ministry of Food in 2002.

Interviewees pointed to two critical factors driving institutional and normative changes: first, the drastic reduction in deaths following the introduction of the Cyclone Preparedness Programme; and second, the influence of global practice, including the shift towards prevention and preparedness initiated under the International Decade of Natural Disaster Reduction in the 1990s, and the Hyogo Framework for Action (2005–15), which interviewees believed had helped underpin a significant normative shift in government responsibilities with regard to anticipatory action in tackling disasters. The legal underpinnings of disaster management in Bangladesh through the Disaster Management Act and Policy also provide a mandate for both anticipatory DRR activities and disaster response. In part, the institutional barrier lies in deciding whether FbA falls into the former, the latter or a new category. Some stakeholders expressed concern that FbA may represent a new category and therefore may not be mandated under existing legal structures.

Nevertheless, the existence of some FbA actions suggests potential for scaling up within existing institutional structures. First, the revision of the SOD in 2010 set out the formal responsibilities of different government bodies (central, district and local) and officials during the 'warning phase', defined as 'The period from the issuing of an alert or public warning of an imminent disaster threat to its actual impact, or the passage of the threat and the lifting of the warning' (MoDMR, 2010: 4). Mandated actions include pre-positioning relief supplies and establishing information-sharing and coordination mechanisms. Food stocks and relief infrastructure are placed on standby, and funds are released to local authorities at Union Parishad level. Second, a significant FbA mechanism has long been in operation under the Bangladesh Cyclone Preparedness Programme, which defines triggers for preparedness and evacuation based on levels of cyclone alert issued by the Bangladesh Meteorological Department (BMD) (see Section 3.4). As a result, the concept of FbA is easier to understand and communicate in Bangladesh than it might be elsewhere.

In a note of caution, however, interviews suggest that allocations of flood relief stocks and funds are politicised, while the SOD do not define the threshold triggers for declaring a 'warning phase'. Interviewees noted that such preparatory actions are in reality largely mobilised once flooding has begun, and many local government authorities are not well resourced or have the capacities for disaster management. As a result, activities are usually prioritised once disaster impacts are evident.

The SOD are currently being revised, while the drafting process for the next NDMP will start in 2019. Both of these processes provide opportunities for advocacy around FbA in Bangladesh, and for working with the government in developing the evidence base. Discussion in the workshops for this research suggests that advocacy could build on the evidence base to generate shared policy narratives among the FbA community of practice, foster a network of FbA champions, widen government involvement in and experience of FbA pilot activities and organise the formal submission of recommendations for the SOD and NDMP by an FbA working group.

2.3 Stakeholder interests and incentives

2.3.1 Altering perverse incentives

Scaling up FbA would entail a fundamental restructuring of existing interests and incentive structures within government agencies, and for the stakeholders within them. As political economy analysis tells us, change can often be co-opted by politically and economically powerful groups to suit their own interests, rather than in the interest of reducing risk for vulnerable or marginalised groups (Marino and Ribot, 2012). In Bangladesh, Alam et al. (2011) argue that climate change adaptation planning has reflected the disciplinary interests of a small inner circle of advisers, while Sovacool and Linnér (2016) illustrate how projects under the country's National Adaptation Plan of Action have enabled elites to capture land and reinforced class and ethnic hierarchies.

The promise of post-disaster funding is known to generate perverse incentives. These include the potential for externalising and passing on the costs of risky activities to others (Mechler et al., 2015). For example, households can locate in flood-prone areas in the knowledge that government relief efforts will mean they will not individually bear all the costs of future flooding. Disaster relief can thereby actively disincentivise investment in prevention and early action, as the places that suffer the highest incidence of disasters tend to receive more assistance through relief, rehabilitation and reconstruction efforts.

These factors can frustrate policy advances that promote anticipatory action, with government agencies remaining geared more towards disaster response. While the policy framework makes provision for anticipatory actions through disaster risk reduction and emergency preparedness, the political significance of emergency response in Bangladesh creates strong incentives for those working within it. Indeed, the long history of disaster-related impacts and humanitarian assistance has to some extent normalised the response function of the government as part of its duty to its citizens.

Interviewees noted that response efforts in Bangladesh receive greater political support as initiatives are more visible and linked more directly to disaster impacts than anticipatory action. This is driven in part by politicians who are keen to ensure that they are able to assist their constituents when disaster strikes, with patterns of relief on the ground reinforcing the patron–client networks that dominate Bangladesh governance (Lewis and Hossain, 2017). Interviews highlighted that this response function is also driven by citizens' expectations. Evidence from the United States and India suggests that voters prioritise post-event response, with politicians held accountable for disaster relief but not preparedness (Healy and Malhotra, 2009; Cole et al., 2012).

Attempts to scale up FbA will therefore depend on the ways that they challenge and alter these established patron–client relationships. The incentives provided by the existing approach to relief, rehabilitation and recovery will influence decision-making on which early actions are taken. For example, flood-affected householders reportedly do not prioritise rebuilding their houses immediately because assistance for doing so relies on a damage assessment that occurs later in the response cycle. Such perverse incentive structures may equally determine the effectiveness of FbA approaches that target infrastructure strengthening before a forecasted shock. The local power structures similarly affect incentives and decisions, as illustrated in the importance attached to paying off debt to creditors before a forecasted flood hits (see Section 4).

Unlike crisis response, FbA requires actions to be targeted at a predetermined set of actors. Interviewees noted that this process of pre-targeting will similarly be prone to bias based on patron–client networks, rather than objective need. This applies particularly to the selection of beneficiaries, as is seen in the targeting of social safety net programmes in Bangladesh (Coirolo et al., 2013). The threat to these established networks of mutual cooperation may be one of the political barriers to scaling up FbA, but equally a shift towards FbA could be a tool of reform to break these perverse incentives by making targeting and delivery more transparent, equitable and needs-based. As the power structures governing people's access to political and economic opportunities in Bangladesh become more multifocal and flexible (Lewis and Hossain, 2017), this may provide an opportunity to advance a more rights-based approach to disaster support.

2.3.2 An institutional home for FbA

Both interviewees and workshop participants noted the influence of the Rohingya crisis in Myanmar in altering the incentives of the humanitarian community in Bangladesh following the rapid increase in refugees from August 2017. The huge scale of the challenge has resulted in an expansion both in the number of humanitarian workers and in international funding, with over $417 million generated through the UN appeal since 2017 (OCHA, 2018). Humanitarian funding to Bangladesh in both 2017 and 2018 was ten times higher than the average annual amount from 2000–2016. While not seeking to downplay the importance of responding to the crisis, a number of interviewees noted that the sheer scale of the refugee crisis has meant that international agencies have a reduced appetite and capacity for humanitarian work away from this region.

Nevertheless, managers of the refugee camps have taken on elements of FbA. The assessments of both IOM, UNHCR and ADPC (2018) and GFDRR (2018) provided different scenarios of monsoon intensity and their impacts. These helped mobilise early preparedness activities to strengthen homes against wind and rain, to improve drainage systems, roads and retaining walls, and to construct stairways to enable safe access. They also prompted the installation of improved weather stations to help with local forecasting.

The impact of the Rohingya crisis on the prospects for scaling up FbA in Bangladesh highlights the wider need to consider the most appropriate institutional home for such efforts. Developing FbA based on humanitarian capacities and with these organisations may enable it to link to support provided during and after crises – while at the same time acknowledging that FbA is synergistic to, rather than a replacement for, response actions – but interviewees felt that FbA should also work more closely with DRM actors and organisations. The incentive structures for these are more likely to be geared towards anticipation and building local capacity to plan and implement actions. This touches on wider international debates around linking the humanitarian and development communities (Peters et al., 2015).

The research also revealed an element of competition between agencies as potentially detrimental to scaling up FbA. Numerous organisations have attended FbA-related meetings and shown interest in the possible Anticipation Financing Window of the START Fund. This competition has sometimes manifested itself in a reluctance to share information on approaches or working documents. While this may relate to internal organisational politics, greater openness is more likely to foster learning and the course correction that is needed as FbA is scaled up. Indeed, scaling up finance for FbA may help to reduce the intensity of competition.

2.3.3 Tackling perceptions of failure from ‘acting in vain’ in FbA

One of the major barriers cited by interviewees to scaling up FbA was what the terminology calls ‘acting in vain’, and what some interviewees called ‘failure’: when early actions are taken but the hazard predicted in a forecast does not materialise, and assistance is delivered in advance to people who are then not directly affected by the hazard. This was cited as a particular concern for idiosyncratic risks like flash floods (where a household’s experience is typically unrelated to its neighbours), as well as for cyclones, where affected locations are harder to predict with accuracy or with long lead times.

Many interviewees dismissed concerns around acting in vain by justifying early action with a narrative of ‘no regrets’, meaning that spending on people and places that are poor and climate-vulnerable anyway can enhance resilience to future shocks. Workshop discussions also highlighted the importance of FbA in tackling indirect impacts of weather extremes on livelihoods, markets, water and food security, health, employment opportunities, transport and communications. For floods, for example, these wider impacts are still felt by those nearby even if their households are not inundated.

The appetite for accepting such risk varied across stakeholders consulted for this research, from those with little or no concern about delivering to people not directly affected at one end, to those at the opposite end who felt that the potential for failure was such that it rendered FbA impractical or unjustifiable. A common concern among representatives of international NGOs and bilateral agencies was the risk of accidentally delivering assistance to households that are not classed as vulnerable. This risk of a perceived failure to deliver targeted assistance to those most affected by disasters has implications for accountability and perceived misallocation of limited resources.

Disaster managers in Bangladesh were less concerned about this risk, arguing that effective targeting of poor and vulnerable beneficiaries in advance would not constitute failure because they needed government assistance from a development perspective. However, other interviewees raised the issue of ensuring that any action in vain was able to pass the government's audit systems.

The research findings presented above offer some counter-narratives to these concerns, suggesting that FbA can be useful for building resilience, even if targeting is inaccurate, and can tackle the indirect impacts felt by those close to the disaster. The research also suggests that FbA needs to be presented as part of the suite of approaches for risk management, rather than as replacing existing relief mechanisms.

2.4 Policy narratives on FbA for different stakeholders

One of the principal ways that practitioners, bureaucrats and policy-makers articulate and make sense of complex realities is through simplified stories or scenarios, known as policy narratives (Roe, 1991). Although such narratives can be misleading, they can also be extremely powerful (Leach and Mearns, 1996). They can be vital in communicating evidence, convincing policy-makers of problems and debating the range of potential solutions. Counter-narratives can also emerge that support certain interests or priorities, often linked to the status quo in the face of disruptive change.

One important step towards scaling up FbA is to generate policy narratives that stakeholders are able to buy into and support. These can vary depending on the stakeholders in question. There are lessons here from past step changes in tackling disasters in Bangladesh, including reductions in disaster-related mortality attributed to the distribution of Oral Rehydration Solution for diarrhoeal disease or the implementation of the coastal Cyclone Preparedness Programme (Chowdhury et al., 1997; Habib et al., 2012). This creation of the organisational and legal frameworks for disaster management in the 1990s was ground-breaking for a low-income country. Similarly, Bangladesh is considered to have benefited from wider development shifts, including increased remittances, which have improved resilience capacities (Mohapatra et al., 2009).

For FbA to be scaled up in Bangladesh. these narratives will need strengthening and will need to become more focused on specific types of early action and hazard types. Elements of a strong FbA narrative were identified by stakeholders in this study but are also prevalent in the literature. These include:

- The ways in which the existing humanitarian system already uses forecasts to trigger preparedness actions (Coughlan de Perez et al., 2015).

- Protecting development and poverty reduction progress from disaster losses (Hallegatte and Rozenberg, 2017).
- FbA as part of a suite of approaches for risk management, rather than a replacement for existing mechanisms.
- The cost-effectiveness of early action (Mechler, 2016; also see Section 5).
- Co-benefits of early action even in the absence of disaster events (Surminski and Tanner, 2016).

3 Flood and cyclone forecasting: institutions, generation and dissemination

The availability, accuracy and skill of forecasts is paramount to the development of effective actions leading up to extreme weather events. This section outlines the institutional responsibilities and models used for generating forecasts for floods and cyclones in Bangladesh. It also touches on flash floods and riverbank erosion forecasting, which are less well developed. The current predictive skill and accuracy of flood and cyclone forecasting is therefore explored here as being more immediately appropriate for FbA applications. This section describes the generation and dissemination processes for forecasting information. A summary of the skill and accuracy in the forecast models, where available, can be found in Annex 1.

3.1 Flood forecasting

Situated within the government's Water Development Board, the Flood Forecasting and Warning Centre (FFWC) was created in 1972 to enhance the flood disaster management capacity of national agencies and communities. The Centre has been supported over time by a variety of international organisations, including UNDP/WMO, DANIDA and USAID. FFWC provides forecasts for around 60% of flood-affected areas in the country, but crucially does not forecast over coastal regions due to the strong tidal influence on river height. The Centre collects hydrological monitoring data from 90 water level and 59 rainfall stations across the country. Gauge data for water levels and rainfall are currently collected via telephone, though there are plans to collect this by real-time telemetry. Satellite imagery is also used to provide precipitation estimates and to estimate upstream water levels from India.

Two forecasts are produced: a five-day-ahead deterministic forecast and a probabilistic medium-range forecast up to ten days prior (see Figure 4). The DHI MIKE-II hydrodynamic modelling system is used to simulate river routing and initial conditions of river height are taken from FFWC observations, while current and 24-hour outlooks at the international boundary are provided by the Indian Meteorological Department. For the five-day forecast, the model uses precipitation forecasts from the Weather Research and Forecasting Model (WRF) through the Global Forecast System (GFS). Two WRF forecasts are used: a three-day outlook from the Bangladesh Meteorological Department (BMD) and a five-day simulation run at FFWC. To produce the ten-day forecast, 51 members of the ECMWF ensemble prediction system are used to drive the MIKE-II model (Webster et al., 2010).

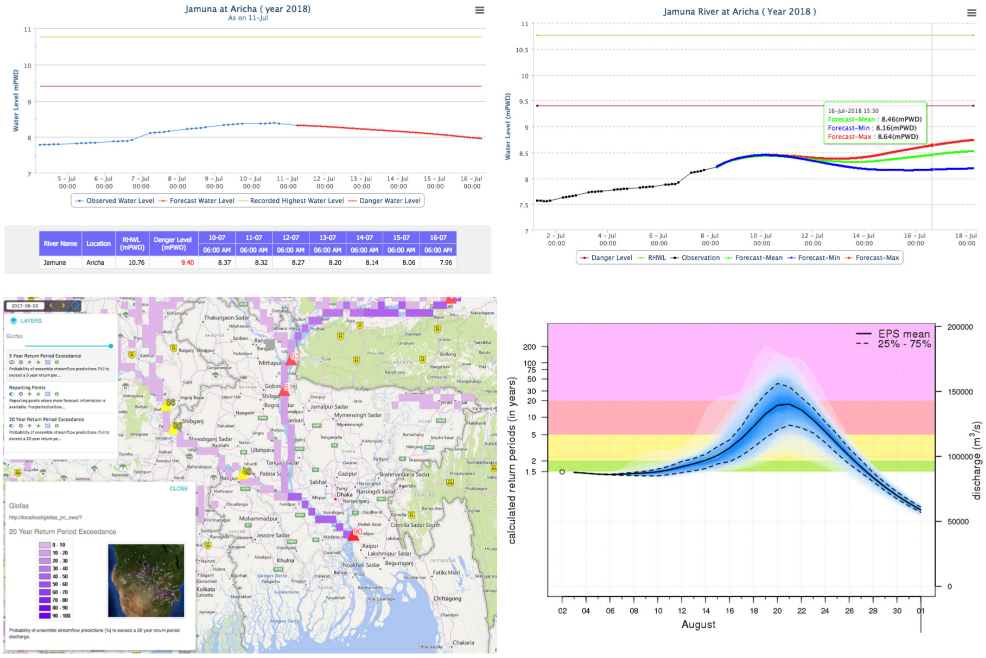
Longer-range streamflow forecasts from the GloFAS are also considered at the FFWC. Currently, GloFAS provides daily streamflow forecasts up to 30 days ahead. An example is shown in the bottom row of Figure 4 during the 2017 floods in Bangladesh. The GloFAS system, developed jointly by the European Commission and ECMWF, couples state-of-the art weather forecasts with a hydrological model to provide a global outlook of river flooding. The driving weather forecast comes from the operational ECMWF Ensemble Prediction System (ENS), which simulates runoff using the land surface model HTESSEL, and is coupled to the river routing model LIS-FLOOD. GloFAS forecasts may be accessed through a web-mapping platform (www.globalfloods.eu).

FFWC alerts are issued when a pre-defined danger level is crossed. This is defined for each station: where an embankment is present, the level is one metre below the top of the embankment, and where an embankment does not exist, the level is defined as the 1 in 2.33-year return period river height level (Sazzad Hossain, pers. comm.). The level is designed to represent a general danger level for the area and may not be accurate at smaller scales, where locations may flood below the danger level, or may not flood above the danger level. The water level status is then reported relative to this danger level, whereby:

- Normal Level = more than 50cm below Danger Level
- Warning Level = below Danger Level within 50cm
- Food = at and above Danger Level
- Severe Flood = more than 1m above Danger Level

FFWC does not currently make a specific forecast for urban flooding, which is exacerbated in Bangladesh due to drainage congestion. In practice, forecasts of heavy rainfall from the Weather Research and Forecasting Model are used for urban flood forecasting. This may limit the potential for scaling up FbA in urban areas, which is becoming increasingly important given high levels of rural to urban migration in Bangladesh.

Figure 4 Forecast outputs



Source: Top row: an illustration of the forecast output of the FFWC for the Jamuna River from the deterministic (left) and probabilistic system (right).
Bottom row: an example of the Global Flood Awareness System (GloFAS) viewer for 2017 flooding forecasts initialised on 1 August: left shows the probability of a 1 in 20-year flood in purple; right shows a forecast hydrograph at the mouth of the Meghna river.

3.2 Tropical cyclone forecasting

An annual average of 3.5 tropical cyclones are generated during the pre- (March–May) and post- (October–November) monsoon seasons over the Bay of Bengal (Sobel and Pillai, 2018). The mandate for cyclone and storm surge warning is held by the BMD, and specifically the specialised Storm Warning Centre (SWC). When a cyclone is detected in the Bay of Bengal, SWC forecasters monitor its movement from the formation stage until landfall, looking at its position, speed, the maximum sustained wind, strong wind areas and track. SWC also runs two weather prediction models to guide forecasts, but issued forecasts are limited to text warnings only at a lead time of less than 72 hours, and no quantitative track or intensity forecast is provided (Choudhury, 2014).

SWC warnings are issued for different danger levels related to a specific threshold in the speed of the rotating wind within the cyclone: these are shown in Table 1 (Habib et al., 2012; Choudhury, 2014; Roy et al., 2015). Each stage is initiated with at least a certain lead time, and if the wind speed crosses the specified threshold then cyclone warning flags are hoisted in ports, cyclone shelters, public buildings, community centres and local government organisations in coastal areas. One, two or three flags are hoisted according to caution, danger or great danger, as described in Table 1. BMD also runs a storm surge model to forecast surge height at the time of landfall. However, it has not been assessed due to limited observation stations.

Table 1 Alert level thresholds used at the Storm Warning Centre

Warning level	Minimum lead-time	Wind speed threshold	Message frequency

Alert	36 hours	Wind speed reaches 50km/h	A single warning message
Warning	24 hours	Between 51–61km/h	A single warning message
Danger	18 hours	Above 61km/h	30-minute update
Great Danger	10 hours	Above 89km/h	15-minute update

Source: Roy et al., 2015. Wind speed threshold indicates the speed of the rotating wind within the tropical cyclone at its current location.

Several factors affect SWC cyclone forecast quality in Bangladesh (Roy et al., 2015):

- Infrequent data updates from the Bay of Bengal.
- Lack of in-house meteorological expertise to produce forecasts, specifically for tropical cyclones at SWC.
- Lack of computing capacity to run advanced numerical atmospheric models.
- Lack of forecast benchmarking techniques, limiting meteorologists' ability to verify the accuracy of the predictions and include the precision level in the warning message.

The Regional Specialized Meteorological Centre (RSMC), operated by the India Meteorological Department, also produces forecasts for Bay of Bengal tropical cyclones. Computational capacity at RSMC is higher than SWC, and the RSMC produces track and intensity forecasts up to five days ahead. Note that, although developments in weather predictability have made ten- or 15-day-ahead forecasts possible in some cases, tropical cyclone forecasts for Bangladesh are limited by the natural physical constraint imposed by the small size of the Bay of Bengal. As Bay storms cannot move far without reaching land, the time from genesis to landfall tends to be significantly shorter than five days, hence landfall forecasts for such storms cannot be made with more than five days' lead time.

3.3 Riverbank erosion and flash flooding forecasting

Riverbank erosion is a regular phenomenon in Bangladesh due to its location in the delta of three large rivers: the Ganges, the Brahmaputra and the Meghna. These highly dynamic rivers have widened significantly over the last 50 years, with the erosion of large areas of floodplain leading to landlessness and homelessness. Structural interventions to tackle erosion are expensive, and Bangladesh has looked to non-structural measures complemented by erosion prediction and warning systems. From 2005, prediction activities were funded by the Jamuna-Meghna River Erosion Mitigation Project (JMREMP) and the EMIN project of the Bangladesh Water Development Board (BWDB) and Water Resources Planning Organization (WARPO), and from 2008 by UNDP.

Since 2004, the Centre for Environmental and Geographic Information Services (CEGIS) has been making predictions of bank erosions and morphological changes of the Jamuna, Ganges and Padma rivers, using time-series satellite images, GIS and remote sensing techniques. According to CEGIS reports, the results show a ‘reasonably good match’ with actual occurrences.[2] In 2018, CEGIS forecast severe river erosion at 29 points in the Jamuna, Ganges, Brahmaputra and Padma river basins in Kurigram, Bogura, Rajbari and Shariatpur districts. The prediction results are presented annually in national workshops; the reports are distributed to local stakeholders but are not publicly available. These forecasts are not yet formally integrated into the government BWBD mandate or procedures. The NGO BRAC has recently begun purchasing this data to create dissemination materials to inform vulnerable communities about the extent and possibility of erosion.

Flash floods occur predominantly in north-eastern Bangladesh, triggered particularly by high-intensity rainfall in the neighbouring Indian catchments in the states of Meghalaya and Tripura. Flash flood events in the region in 2017 affected 850,000 households and 212,000 hectares of agricultural land. Forecasting has been complicated by the need for quantitative rainfall forecasts at the level of small basins and from cross-border sources. In recent years, BMD has established eight automated data collection stations in the north-east that can provide continuous data with short time intervals, and there are plans to upgrade all existing manual hydrological stations. Since 2016, IWM/FFWC have been developing an experimental flash flood forecasting early warning system, with an online website showing forecast and observed data for sites across the north-east.

Forecasts of flash floods in the north-east have potential future FbA application because even warnings of 24 or 48 hours can provide time to harvest post monsoon ‘boro’ rice early (even before complete maturity). This way, farmers can rescue at least part of their crop, although there may also be losses associated with acting in vain. The growth of Rohingya refugee camps has also brought into sharper focus the inadequacy of forecasting systems for flash floods in high-risk areas of the south-east. Camps currently use a crude early-warning system based on rain gauges, but there is limited predictive capacity.

3.4 Flood and cyclone forecasts dissemination

Dissemination of forecasts in Bangladesh is largely determined by information suppliers rather than the needs of end users. This reflects the more science-based disciplinary focus of many of those within forecasting institutions, while also maintaining a distance from decision-making and politics around response options. The development of scaled-up FbA approaches in the country would potentially require forecast data that is more tailored to triggers and early action procedures.

FFWC forecasts are freely available on the website,[3] which is updated twice daily, and bulletins are shared via an email list of more than 600 recipients, including government ministries, offices (central and district level), the media, development partners, research organisations and NGOs. Whenever the forecast river stage crosses the danger level, the relevant field offices and key officials are informed through mobile SMS. Interactive Voice Response (IVR) was first used in July 2011 through Teletalk, and since 2015 all mobile operators have been using IVR. Social media is not yet widely used, though in mid-2018 FFWC made available a mobile application providing flood forecasts to users on smartphones.

During the 2007 and 2008 seasons, ten-day experimental FFWC forecasts were communicated to Union Parishads via a planned cell phone network and a series of flag alerts (Webster et al., 2010). In each Union, government personnel and village

[2] For more information, see http://www.cegisbd.com/LandmarkProj?prjsl=6
[3] See www.ffwc.gov.bd

leaders were trained to understand and interpret the forecast in terms of local references and landmarks, so that the expected degree of inundation could be readily and unambiguously expressed to the villagers. Warnings are sent via SMS to a network of flag stations, and designated chairmen then wave the flag corresponding to the warning level, based on probabilistic forecast with ten-day lead-time. The warnings are also sent to partner NGOs and volunteers at Union Parishad levels, who disseminate them to the community using microphones, flags and door-to-door communication. Following these warnings, local NGOs, government agencies and community-based organisations prepare evacuation and response plans. Households and individual people also take their own measures to prepare for the predicted flood.

Communities were particularly interested in when the flooding would occur, what height the flood level would reach and for how long the level would be exceeded. The ten-day lead-time of the forecasts was deemed to be sufficient for people to make agricultural adjustments and decisions, to suggest to agricultural dealers to hold off on the sale of seeds and pesticides and to offer advice to farmers, fishermen and agricultural dealers. With a forecast of an impending flood at 7–10 days, the following actions were possible, which would not have been possible with a 2–3-day forecast:

- Identification of evacuation assembly points with adequate communication and sanitation facilities.
- Protection of fisheries by the placement of nets.
- Suggestions made about harvesting crops early or delaying planting.
- Families advised to store about ten days' worth of dry food and safe drinking water (as relief would not be forthcoming until at least seven days after the advent of a flood).
- Securing of cattle and poultry, crop seed and portable belongings in safe locations, such as on road embankments.
- Plans made for rapid deployment of manual and mechanised boats for evacuation from river islands.

A cost–benefit analysis of these forecasts estimated average savings for each household involved in fisheries at $130, and in agriculture $190; protection of livestock gave savings of $500 per animal and savings of $270 per household were made through protection of household assets (Webster et al., 2010). Mobile-based warnings are trusted and understood (Cumiskey et al., 2015), but effective responses to them are limited by a lack of boats, poor road quality, lack of manpower, lack of safe storage places and limited financial support.

When a tropical cyclone threatens Bangladesh, the BMD issues a Special Weather Bulletin consisting of warnings of severe weather associated with the cyclone. This is sent to all concerned ministries, NGOs and other organisations, local administrations, maritime and river ports and the media. While the mandate for warnings lies with BDM, response and evacuation is the responsibility of the Department for Disaster Management (DDM). The government, under the Cyclone Preparedness Programme, and the BDRCS also respond to cyclone forecasts and warnings (Sobel and Pillai, 2018). Frequent contact is maintained between BMD and national radio and television stations, depending on the severity of the storm. The DDM also uses different mobile network-based systems: Cell Broadcasting System, Interactive Voice Response and SMS.

Evaluations suggest that warning information reaches most of the people who need it: during cyclones Sidr and Mahasen, for example, at least 83% of people in at-risk areas received warnings and were able to understand them despite misinterpreting technical terms like 'forecasted movement direction', 'time of landfall' and 'surge height' (Roy et al., 2015). However, in both cases less than half of the population effectively evacuated following the warnings, largely because they mistrusted the forecasts and felt they needed to remain to protect their property. Future FbA actions could work to upgrade cyclone preparedness by protecting, moving or adapting shelters to accommodate their assets.

Figure 5 Value for money of FbA: three dimensions from cash transfers in Bangladesh

3.5 Towards impact-based forecasting for FbA

In scaling up FbA efforts in Bangladesh, one area of significant potential identified by stakeholders was in the development of impact-based forecasts. Current forecast and warning systems are limited in geographical reach, while data on exposure and vulnerability is not comprehensive (Fakhruddin et al., 2015). As a result, flood warning thresholds can be imprecise as to the specific areas likely to be affected (Sai et al., 2018).

For hazard forecasts to enable action, warnings need to be contextualised and translated into expected risks (the probability of suffering losses as a result of the hazard): in other words, assessing what any particular warning level might mean in terms of impacts on a household, local government, NGO or business in any given area. One emerging way of helping this translation is through so-called 'impact-based forecasting', which focuses on the consequences of the hazard rather than forecasting only its type and severity. These techniques are in their infancy in Bangladesh, and the approach would mark a radical change in how forecast information is produced and communicated. Impact-based forecasts require access to a wide range of new data, potentially using crowdsourcing and big data, behavioural and livelihood information and information on the resilience of infrastructure and services (Rogers and Tsirkunov, 2013). They also necessitate a demand-led rather than supply-led approach, with users of the forecast driving the requirements and formats for information that match their needs and levels of understanding.

Developing impact-based forecasts for FbA at scale would require much closer collaboration between the national meteorological and hydrological services and other government agencies and actors involved in understanding risk and vulnerability. This will require 'a rethink of the structure of the organization and the way it operates, an expansion of training to strengthen capacity both within the National Meteorological Hydrological Services and with partner organizations and users, and new operational partnerships' (CMA/GFDRR, 2016). Interviewees suggested that this could draw on experience from the climate change adaptation community in particular, where meteorological models have been combined with vulnerability data to create longer-term assessments of climate change impacts. One important initial institutional step towards scaling up impact-based approaches in Bangladesh would be for the national forecasting and disaster management bodies to agree joint responsibility for developing and issuing impact-based warnings. Without this, incentive structures will continue to drive supply-led approaches to forecasting.

4 Learning on impact and value for money: case study evidence

4.1 Background to the FbA pilot and evaluation in Bogura

There is a strong intuitive argument for the benefits of early and forecast-based response. However, there have been few empirical studies testing how far using forecasts and carrying out early actions are indeed more effective and efficient than existing response-based humanitarian efforts. This section summarises two complementary analyses of FbA pilot interventions in Bangladesh. The first uses this example to test a learning methodology developed for the START network. The second highlights the Value for Money (VfM) aspects (based on core findings of the ongoing BDRCS evaluation of this pilot exercise: Gros et al., forthcoming 2019). Together, they provide indicative learning about the processes of FbA and what is needed to understand the VfM dimensions, rather than an evaluation of all aspects of the impact of the project.

The German Foreign Ministry has funded the Bangladesh Red Crescent Society and the German Red Cross (GRC) to pilot the use of an FbA payment mechanism in Bogura District that enables early action based on credible flood forecasts and risk analysis. Flooding is an annual event in villages along the Jamuna river, a tributary of the huge Brahmaputra, and displaces large numbers of people. In 2015, 2016 and 2017, FbA systems were established and tested, along with cash transfers of approximately $60 each to between 1,039 and 1,700 households, based on vulnerability criteria that were refined over time. These pilots were implemented to test the FbA system; future interventions will be triggered using a new, impact-based forecast approach designed to deliver payments before unusually serious flooding – i.e. a one-in-ten-year flood event. In 2017 (the first year in which funds were disbursed when flooding was significantly more severe than normal), payments were received three or four days before the population in four targeted villages was forced to move to dykes and other areas of higher ground. The floods displaced a larger number of people and, more importantly, for a much longer period than the average before flood waters receded.

4.2 Theory-based Impact Assessment: learning study of the Bogura pilot

This section summarises the results of a learning exercise carried out to test the START Network's Drought Risk Financing (DRF) facility learning framework (Levine and Gray, 2017), and assesses the difference which making emergency cash transfers based on flood forecasts had on their impact for families affected by the floods in 2017. The methodology (described in Section 2.4) involves examining a set of assumptions within the project's logic chain or Theory of Change.

4.2.1 The logic chain

The logic chain for the Bogura pilot included the assumptions that:

- **Link 1:** Scientists can accurately predict a flood in Bogura around a week before it arrives.
- **Link 2:** Combined with a vulnerability and exposure analysis conducted in advance (based on disaster impact analysis at the household level), this allows for reliable prediction of a crisis for identified population groups.
- **Link 3:** The flood forecast (combined with the vulnerability and exposure analysis) can trigger a payment which, with adequate preparedness, can reach people before the potential flood arrives.
- **Link 4:** Receiving a payment before the flood allows people to prepare for it, or respond to its immediate impacts, in ways that would not have been possible had they not received the payment.
- **Link 5:** Because people were able to prepare for the flood differently, or to respond more quickly to its first impacts, they endured less loss and suffering.

There is an additional assumption that, if the logical chain is realised in full, then the payment will have been cost-effective (i.e. there is full VfM – as represented in Link 6b, below). This cost-effectiveness can be judged in two ways:

- **Link 6a:** The costs of making the payment are significantly lower than the losses or suffering that have been avoided (i.e. the VfM of the transfer itself); and
- **Link 6b:** The additional costs of using a forecast-based system are significantly lower than the losses or suffering avoided by the fact of having made the transfer before the flood, in other words compared to what would have been achieved if the transfer had been made after the flood had arrived (i.e. the VFM of using a forecast-based approach).

Since this learning exercise was undertaken within the framework of a broader study on scaling up forecast-based early action that already looked at forecasting capabilities, the TBIA did not examine the first two causal links or assumptions in the chain above. Instead, the research focused on links 3–5, from which the analysis of 6a and 6b is also drawn.

4.2.2 The learning study results

Link 3: The flood forecast triggers a payment which, with adequate preparedness, reaches people before the flood arrives.

This was quickly established. In 2017, payments reached households 3–4 days before they had to move, and people were able to use the money for flood preparations. However, many people reported that receiving the money over a week before having to move would have been preferable – perhaps because prices started to rise in advance of the flood – although current models do not permit longer lead-times without far more significant uncertainty. Further research would be necessary to establish exactly how large this additional benefit would be.

Link 4: Receiving a payment before the flood allows people to prepare for it in ways that would not have been possible had they not received the payment.
The receipt of a cash grant enabled people to take greater levels of action to prepare for and cope with the flood (e.g. buying more food stocks), though even people who did not receive the grant carried out similar types of actions. Preparations were differentiated due to living conditions, particularly between people living on the river bank and those living on the islands. Households within the flood catchment area (i.e. between the river and the protective dykes) prepare for floods in the following ways:

- **On the river bank:** moving to the dyke and constructing a temporary shelter of bamboo, corrugated iron and plastic sheeting. They typically spent BDT 1,000 and BDT 1,500 on shelter materials.
- **On the islands:** people moved into safe buildings (e.g. schools), and constructed raised storage for their possessions ('lofts'). The costs of these constructions were slightly higher, partly because of the need to pay for river transport for materials: typically, around BDT 2,000.
- People stockpiled food, including dried pre-cooked food (rice), because of the difficulties of cooking while displaced. Food remained available during the flood, but people knew that prices would rise (see below). People who received the cash grant tended to buy more food in advance, typically spending BDT 1,000–2,000, against the BDT 500–1,000 typical for non-beneficiaries.
- Many people bought livestock feed.
- Many people had to take out loans in order to make these preparations (discussed further below).
- People who received the grant tended to save around a third of the money (BDT 1,500–2,000) for anticipated future needs, such as healthcare (as sickness increases during floods). Many also spent part of the money on repaying loans and on school fees. Some used part of the money to invest in livestock, since prices fall significantly during flooding.

In the sample interviewed for this study, while those receiving the grant were able to undertake preparations on a larger scale (e.g. buying larger amounts of food), these preparations that were not substantially different in nature from those of non-beneficiaries – i.e. all people prepare for flooding in some way, even if they have not received additional cash to do so.[4] The advantages of the grant being received before the flood therefore lay in being able to stockpile more food or livestock feed when it was cheaper, and having to borrow less (for example, to pay for boat transport to protect livestock and goods). Understanding how the local economy functioned during the flood thus turned out to be key to understanding the project's impact, and how best to design any future support for flood-affected people in Bogura.

There were significant increases in the prices of basic commodities, river transport and loans. It was impossible for this study to determine how far the rise in food prices was due to increased costs for traders, or to the market simply exploiting favourable conditions (i.e. a huge rise in demand). It is difficult to interpret the rise in the cost of borrowing as anything other than opportunistic. There were also

[4] The BDRCS project intended to target people by levels of vulnerability or poverty, so in theory the beneficiaries would have been poorer and the grant increased their ability to prepare for floods (relative to non-beneficiaries). However, the interviews we conducted with non-beneficiaries and beneficiaries did not substantiate this: we found that the impact of the grant was independent of people's wealth status. Rather, the impact lies in the use of the additional resources, which is described in this section.

significant decreases in the price of livestock. This appears to be have been caused by traders taking advantage of people's difficulties in keeping animals alive, and thus their willingness to accept any price they could get out of desperation. Prices for livestock began to fall several days before the flood arrived, when people's fear for their animals had already set in (although it was difficult to obtain reliable information on food price changes throughout the year).

In summary, the TBIA found that prices changed in the following ways before flooding occurred:

- Food prices rose by between 30% and 40%.
- Interest rates on loans from landlords and individual moneylenders (i.e. not micro-finance) often doubled, from 5% to 10% per month.
- River transport prices were between twice and ten times normal rates.
- Livestock prices fell by around 30%.

Loans

Many people had to take out loans to finance their flood preparations. Those who could do so borrowed from relatives, without interest. This seems to be a small minority, but further quantitative research would be needed to establish this. A minority approached the formal financial sector (Grameen Bank) for short-term loans. People did not find Grameen Bank easily accessible for urgent loans, because of the lengthy process required to set up a loan. There appeared to be some distrust of the formal financial system, which, apart from institutions specifically set up to service the poor, is inaccessible to most residents in the villages studied. The majority used the informal sector for borrowing, both in normal life and for flood preparation. Often, money was borrowed from landlords, and people faced difficulties in paying back these loans.

In general, interest rates were much higher than with Grameen Bank or other institutions in the formal sector, with most people reporting having to pay 5% per month (80% APR). Some, but not all, reported that interest rates rose before the flood, with some having to pay up to 10% per month (214% APR). It appears that fewer transfer beneficiaries had to borrow money, and those who did took out smaller loans. However, the research methodology was purely qualitative, and no quantitative conclusions can be drawn without follow-up work. Respondents quoted loan sizes of between BDT 1,000 and 10,000, but most were typically in the range BDT 4,000–5,000. This was much lower than the loans found by the BDRCS/GRCS evaluation.

Savings

Only two respondents said they used their own savings to prepare for a flood. Some had ceased to save in preparation for the floods due to the regularity of the BDRCS cash distributions in the two preceding seasons. The prevalence of borrowing supports the finding that few people can finance flood preparation from their own resources. Even from the evidence of how the grant money was spent, it appears that most people would prefer to invest any disposable cash, for example by buying small livestock, especially as their price falls.

Flood forecasts and preparation

Only a small minority of respondents admitted to using formal flood forecasts, and very few made decisions based on them. The vast majority used their own experience to predict the arrival of the flood, believing that it was quite obvious when the waters began rising and not seeing the importance of hearing that they were from the radio. Some listened to public megaphone alerts.

Preparations did not change depending on the severity of the flood. The number of people displaced by floods is similar each year, and only rises slightly when floods are more severe. The main impact of severe floods is the length of displacement, which can increase from around three weeks to up to three months. However, if people believed that they would be displaced within a few days, they took the same preparations whether the floods would be severe or not. Whether this is because there are no other preparatory measures that they could take or because they do not pay attention to, or do not rely on, flood forecasts is a question that would require further research. The limiting factor does not appear to be cash resources. When interviewees were asked how they would use the money if a larger payment were made, almost all said they would make the same preparations, with any additional money being spent for non-flood purposes, mainly livestock purchases.

Targeting

This learning exercise did not investigate targeting or any other aspect of the implementation of the programme. It is worth reporting, though, that a small percentage of people, all non-recipients of the cash grant, depended on local charity in and around the community during the flood. These were possibly households who had moved to the district after population registers and targeting for the programme had been completed.

Link 5: Because people were able to prepare for the flood differently, they endured less loss/suffering

Interviewees who had received cash were able to take actions at a higher degree/scale to prepare for the flood (such as stockpiling larger amounts of food), compared to those who had not, although the types of actions taken were similar. The financial benefits to households are calculated below.

Link 6: Making a forecast-based, early transfer provides value for money

Impact is the difference between what happened with a particular kind of intervention and what would have happened without it. Making the right comparison, or finding the right counterfactual, is the critical first stage. The benefit of using flood forecasting to give people an early grant cannot be assessed by looking at the difference the grant made to beneficiaries: they would have been $60 better off even if the money had been given after the flood. To establish the impact of being forecast-based, or giving money before the flood, it is necessary to compare the outcome with the (hypothetical) situation of people having been given a late grant, i.e. after the flood arrived. The government, which does not use forecast-based triggers, was able to deliver in-kind assistance around 1–2 weeks after people had been displaced. It is reasonable to assume that BDRCS/GRC could have done the same with their cash grants. Three different hypothetical scenarios and the outcomes are described in Box 1.

Box 1 VfM comparisons of cash transfers based on evidence from interview

Scenario 1: VfM comparison of forecast-based payment against an unpredictable reactive (or late) payment.

The impact of the grant will vary depending on people's circumstances. To calculate the added value of a forecast-based payment we make the following assumptions about all households, based on evidence from the interviews:

- The household spent BDT 3,500 of the grant on flood preparations. BDT 1,500 was kept for later needs and not spent before the flood.
- The household had no other source of savings/funds, and could not borrow from friends or relatives without interest.
- The household borrowed BDT 2,000 at 10% interest per month (i.e. the highest market rate) to make preparations at their own expense.
- The household stockpiled food to the value of BDT 1,500 less than if it had received the grant. In other words, the household had to buy BDT 1,500 more food at the later, higher price than if it had received the grant.
- A household receiving the grant some two weeks after the flood could use the money to repay the loan it had taken out (BDT 2,000), to buy the food that it had not been able to stockpile in advance (BDT 1,500) and then to re-establish the same cash reserve (BDT 1,500) for other needs, as if it had received the grant before the flood.

The cost to the household of the grant coming after the flood can now be calculated. The main difference to its economic welfare are the cost of the loan, repaid within the first month if the flood arrived, and the additional cost of having to buy food at a higher price.

Interest for one month on 2,000 BDT @ 10%	= 200 BDT
Additional cost of food at higher price = 1,500 BDT x 30%	= 450 BDT
Added value of FbA compared to post-disaster cash assistance* 13% of transfer value	= 650 BDT or

Note: The study did not look at the additional cost to the project of using FbA, and therefore a full project VfM cannot be established. The costs of setting up an FbA mechanism are dependent on scale, and further research is needed on the cost-effectiveness of doing so at different scales.

Scenario 2: VfM comparison of forecast-based payment against a predictable late payment

In establishing scenario 1 of a late grant, it was assumed that households behaved as if they did not know that they would receive a grant, or did not feel they could rely on it. Scenario 2 posits that, if households knew they were likely to receive a grant two weeks after a flood, their behaviour based on the forecast might be different: it would be economically preferable to take out a larger loan and buy more food in advance, knowing that they would be able to repay the loan within a month (food prices rise by 30%, but the loan would not cost more than 10%).**

Based on these assumptions, the impact of FbA is now lower. Households would behave as if they had received the grant early, borrowing the money needed to take the earlier actions (BDT 3,500), and waiting to receive the grant to establish a reserve pot of BDT 1,500. The cost to the household of a predictable grant coming after the flood can now be calculated. The only difference to the economic welfare of the household is the cost of the loan, which can now be repaid within the first month.

Interest for one month on 3,500 BDT @ 10% = 350 BDT. This is 7% of the transfer value.

A third possible counterfactual should also be considered:

Scenario 3: VfM comparison of forecast-based payment against an automatic earlier payment

According to local respondents, the number of people displaced annually is similar to the number displaced by a 1-in-5 or 1-in-10-year flood event. Because the informants did not say that they would make any different preparations for a normal or for a severe flood, the purpose of using FbA to make an anticipatory payment for a 1-in-5 (or 1-in-10)-year flood needs to be considered. If the difference in normal and severe floods lies in duration and damage caused, these do not need to be addressed by payments in advance, if it is the case that households cannot use the grant to make preparations that would help them avoid those more severe losses. If a payment were to be made as a social safety net measure on an annual basis during the flood season, then the impact could be greater. If a payment were made ten days before the flood, rather than three, households would be able to stockpile food before prices had begun to rise.

Reliable information was not obtained on how much lower prices were 7–10 days before the flood, but it is possible that prices had already risen by around 10% in the three days before displacement. Households might thus benefit more if a social protection measure were used, rather than a forecast-based response. This raises further questions about the costs of responding comprehensively in a country where millions live at risk of floods and existing social safety net coverage is low relative to needs (World Bank, 2006; Coirolo et al., 2013).

Additional savings for households could be around BDT 150 for riverbank residents (an additional 3% of the value of the transfer) and BDT 250–300 (5–6%) for inhabitants of the islands.

** Note that this value represents the additional impact of a cash grant being forecast-based, i.e. before the flood displacement. The TBIA does not assess the impact of the cash grant itself. See Gros et al. (forthcoming, 2019) for information on the impact of the cash grant itself. The 'added value of FbA' refers to the total value of making the response forecast-based, instead of having the same response, but reactively (and in this case unpredictably).*

***This scenario assumes that households could be confident enough in the grant* *arriving to take out a larger loan. However, the forecast could be wrong, and no flood means no grant, so people would have taken out a loan unnecessarily and would not have received a grant to pay it back. In this scenario, the risk of acting in vain is passed on to households rather than humanitarian actors, and therefore does not address a key objective of FbA.*

4.2.3 Further lessons

The DRF guide (Levine and Gray, 2017) recommends using a mixed methods approach to impact assessment. Qualitative questioning can reveal key issues that need further follow-up, often using quantitative methods. This was not possible in this learning exercise because of resource constraints. Several questions can be identified which could now be researched in a targeted way with a short questionnaire for a larger sample, to help fill some evidence gaps. For example, the evaluation by Gros et al. (forthcoming, 2019) found that many people invested part of the grant in protecting their livestock from the flood. These and other potential benefits need further investigation, including:

- **Loans:** What percentage of households borrowed money, how much, from whom and at what interest rates? What percentage of households had access to interest-free loans?
- **Livestock:** What percentage of households owned livestock? What percentage invested in livestock protection, and how much did they spend? What percentage sold animals before or during the flood, and how many lost livestock? Did grants lead to greater investment in livestock protection and lower livestock mortality?
- **Stockpiling:** More precise quantification for a larger sample of the money invested in stockpiling food and how long the food lasted.

The study also suggests some lines of enquiry around other ways to help mitigate the impacts of flooding in Bogura. Apart from the direct damage to assets, households suffered as a result of increased ill-health, disruption to education and unfavourable market conditions (high prices for food, low prices for livestock). Further study would be needed to establish how far market problems are a result of difficult conditions for market actors, and how far they are a result of unequal power relations in imperfect markets (i.e. exploitation). If this were better understood, mitigation measures might be possible, either working with traders and other actors involved in value chains to improve business continuity during floods (market DRR), or measures to increase competition in the market, perhaps by supporting more organised or collective action by those with a relative lack of power in the market.

The TBIA is clearly a useful methodology for analysing the different steps in an FbA project and can help ensure that the intended outcomes of early action are realistic. Carrying out this kind of assessment of forecast-based actions versus post-disaster response actions can also help practitioners understand how and where it would be valuable to scale up forecast-based actions, and which types of actions to support.

4.3 VfM analysis of the Bogura pilot from evaluation results

An assessment of VfM can also be made based on the evaluation of early action in Bogura (see Gros et al., forthcoming, 2019). The evaluation assesses the impact of the cash transfer, comparing a sample of 390 responses from people who received the cash transfer ahead of the flood, and a control group who did not, including propensity score matching to ensure that people of similar conditions are compared to each other. Conclusions cannot be drawn about the benefits of the forecast, as the sample does not compare those with a forecast-based cash transfer to those who received a transfer without a forecast, but the case study is nonetheless useful in illustrating the types of benefits that can arise, how they might be measured and how a VfM analysis could be applied. The results suggest that the forecast-based cash transfer had a statistically significant effect on outcomes, including that FbA-assisted households were less reliant on loans from moneylenders, ate more and better food and reported positive psychosocial outcomes.

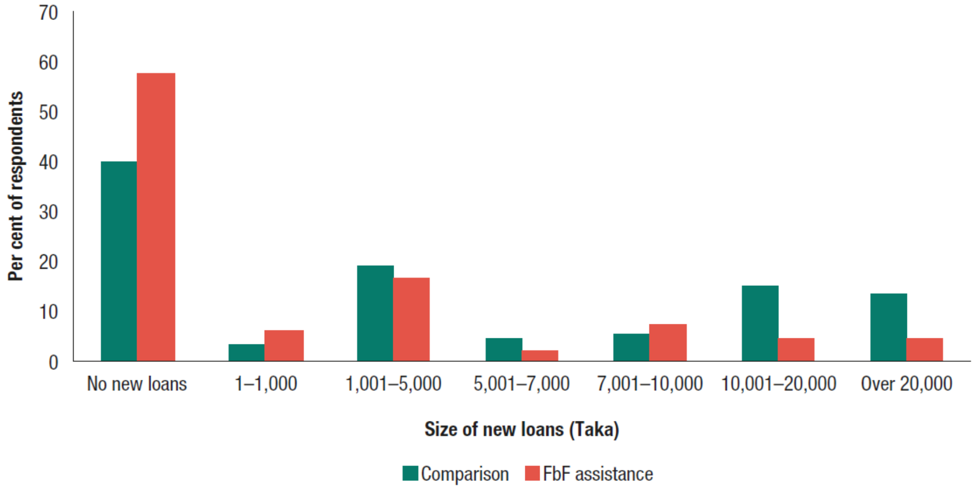
This section examines some of the VfM implications of the data from these preliminary evaluation findings.

4.3.1 VfM from reduction in loans

According to the findings from the post-flood survey undertaken by the BDRCS in Bogura, 58% of FbA-assisted households indicated that they did not need to take out any new loans, compared to 40% in households that did not receive forecast-based cash assistance. Comparison households were also three times more likely to have taken out large loans of over BDT 10,001 and BDT 20,001, respectively. Households that did not receive FbA cash assistance were more than four times as likely to borrow from banks at interest rates usually ranging from 20% to over 35%, depending on the total loan amount and the repayment schedule. They were also more than twice as likely to take out loans from private moneylenders at potentially even higher interest rates.

The data from the survey provides an estimate of the amount of interest paid on loans. The survey presents the data according to the percentage of respondents who took out a loan within a certain band (see Figure 6). This data is used to calculate the weighted average loan size, across the full population of respondents, by aggregating the probability of someone taking out a certain size of loan. Table 2 presents the weighted data calculations and the average weighted loan size for the full set of respondents, divided between the FbA early transfer group and the comparison group.

Figure 6 Loan size among FbA and non-FbA recipients



Source: Data from BDRCS survey.

Table 2 Average weighted loan size among survey respondents

Loan size, BDT (US$)	FbA – % of respondents taking loan	FbA weighted average	Comparison group – % of respondents taking loan	Comparison weighted
No loan	57.5%	n/a	n/a	n/a
1–1,000 ($6)	6.30%	$0.38	3.40%	$0.20
1,001–5,000 ($30)	16.70%	$5.01	19.00%	$5.70
5,001–7,000 ($71)	2.30%	$1.63	4.60%	$3.27
7,001–10,000 ($101)	7.50%	$7.58	5.20%	$5.25
10,001–20,000 ($177)	4.60%	$8.14	14.90%	$26.37
Over 20,000 ($237)	4.60%	$10.90	13.20%	$31.28
Weighted average loan size		$33.64		$72.08
Interest paid @ 20%		$6.73		$14.42
Interest paid @ 35%		$11.77		$25.23

The weighted average loan size effectively takes the average loan size but then weights it across the entire population. In other words, if 16.7% of people take out a loan worth $30, that is equivalent to a weighted average of $5 per person across the entire population (16.7% multiplied by $30). This is then added across all loan sizes to calculate the weighted average loan size across the full population and for all loan sizes. The analysis suggests a weighted average loan size of $34 for FbA-assisted households, and $72 for comparison (i.e. non-assisted) households. At interest rates of 20% and 35%, FbA-assisted households pay between $7 and $12 in interest, whereas comparison households pay between $14 and $25, representing a saving of between $7 and $11 on interest payments per person. There is also the possibility that people are not able to pay back their loan/interest and turn to negative coping strategies. While it is not possible to measure and monetise the impact of this, the above calculations can be used as a proxy for the cost of debt, regardless of an individual's response to that debt.

4.3.2 VfM against improved food/nutrition intake

FbA respondents reported that they spent the majority of their cash transfer on food. The data further indicates that FbA households were eating more and better-quality food. The control group was over three times more likely to have had to skip meals or reduce meal sizes more than ten times (28%), compared to only 8% of households in the intervention group. The quality of food was significantly lower for the control group, with 95% of respondents indicating that their household was forced to eat rice for an entire day, compared with 71% of the FbA group.

While it is not clear whether similar effects would be found when comparing the intervention group with a control group that also got a cash transfer but without a forecast, it is nonetheless useful as an illustration. It is highly plausible that a cash transfer given at different times during a flood would be spent largely on food. The difference in value between cash given at different points in time can most readily be found by looking at the 'real' value of that cash – in other words, the amount of food and other items that can be bought with a given amount of cash in the market. As goods become scarce, and prices go up due to the crisis, the value of a 5,000 BDT cash transfer will change. Good market data can allow a VfM assessment to quantify the value of that cash at different points in the crisis.

While an earlier cash transfer can enable people to buy food and other supplies at lower prices, it also have its own inflationary effect on the market, and this should be incorporated into the analysis to ensure that the benefits of early cash are not overstated.

4.3.3 VfM from psychosocial outcomes

The Bogura study indicates that households that received the cash transfer had significantly better psychosocial outcomes. Those that did not receive cash were 20% more likely to say that they constantly felt miserable or unhappy after the flood, and were 14% more likely to have felt anxious or depressed in the previous seven days. While it is not possible to monetise the benefits of these psychosocial outcomes, it is nevertheless critical to ensure that these qualitative findings are weighted equally. A person's sense of agency and empowerment plays a critical role in their ability to cope with a crisis, and therefore these types of impacts are foundational to a more resilient outcome.

4.4 Insights for future impact and VfM analysis

The case study from Bangladesh presented above offers useful insights into some of the practicalities of analysing the impact and VfM of FbA. These will be important in making the case for scaling FbA in the future.

Calculating full costs and benefits

Data limitations usually prevent calculation of the full Benefit to Cost Ratios. Even in cases where more data is available, it may not be appropriate or possible to fully quantify the results of a VfM study for FbA. If only partial data is available, this will only give an incomplete picture, and there is a risk that quantitative results are used without full acknowledgement of the data limitations surrounding them.

How early is early?

Does forecasting allow us to intervene far enough in advance of a crisis to see measurable effects? In the case of the BDRCS study, even with only a few days' lead-time the researchers were able to distinguish statistically significant effects of a forecast-based cash transfer arriving between three and seven days ahead of the traditional government response. Ideally, for the purposes of this report, the statistical sample would have compared a cash transfer provided 3–7 days ahead of the flood peak to a cash transfer provided once the peak had been reached. In fact, the focus of the analysis was to compare an early cash transfer using a forecast to no transfer at all, hence the results do not tell us anything about the added value of a forecast-based transfer. Nonetheless, the findings are useful because they do suggest that differences in impact can be detected with a well-planned monitoring, evaluation and learning framework in a rapid-onset context where the window for measuring impact is very narrow.

In scaling up FbA, a critical question lies in whether the cost of the forecast itself provides value for money, or whether the same effect can be obtained by providing a regular and predictable early action without the forecast, especially in areas prone to repeated cyclical disaster events. Even more importantly, would the benefits be greater because the response is being undertaken with a greater lead time before a crisis? This point is particularly relevant in the context of cyclical versus non-cyclical events. In a context where highly cyclical events are predictable and regular, it is possible that action can be taken well in advance without a forecast, and bring about positive impacts. This has to be offset against the scale of that transfer – not knowing where flooding will hit could require an early response without a forecast to target a large population, and hence be costly at scale. In other words, do people get the maximum benefit from a cash transfer provided weeks in advance of a crisis, or does the addition of a forecast-based trigger mean that they are able to put that cash to better use in mitigating the impact of the event? Teasing out the difference in impact for different timings could be difficult but would be very informative evidence when considering the potential and cost implications of scaling up FbA.

Should we be assessing the impacts of early action, the use of a forecast or both?

The BDRCS study, presented here, is useful as an example of how we can collect data on changes in impact (both reductions and potential increases) within a very short time frame. However, it tells us little about the benefit of a forecast-based response, as it compares the early cash intervention with no intervention at all. If we want to measure the impact specifically of the forecast, we need to compare the costs and benefits of taking early action with a forecast against the costs and benefits of taking early action without one.

Any VfM analysis of FbA must place equal weight on both qualitative and quantitative outcomes

There is a temptation with VfM to focus on the quantifiable benefits, because the value proposition of monetised costs and benefits can be so compelling and easy to understand for advocacy purposes. However, there is a real risk that benefits that are not quantified are not given the same level of recognition, even though they can be some of the most important. The case study from Bangladesh highlights the different areas of benefit that were statistically significant in the sample studied. While the benefits, as mentioned above, are not directly relevant to a forecast, they do highlight the significant and positive effect of an early cash transfer on the psychosocial outcomes of those most affected.

5 Conclusions and key findings

Key findings from this study are summarised below, followed by a set of recommendations in Section 6, which draw on these findings and form the basis for an action agenda to be discussed and agreed by FbA stakeholders in Bangladesh.

5.1 Institutional and stakeholder challenges

There is a solid institutional basis for FbA in Bangladesh; government policy and guidelines incorporate anticipation through DRR, and the SOD define some responsibilities and actions based on warning periods. However, these thresholds are generally not defined relative to forecast data.

Despite progress with DRR, incentive structures at national and local level are still skewed towards relief activities, often tied up with the relationships of political patronage that dominate the governance landscape in Bangladesh. These structures present a challenge to new approaches to managing disaster risks. Political influences on the selection of FbA actions and target beneficiaries could be similar to those that bear on existing government disaster response. Nevertheless, a shift towards FbA could be a tool of reform to break these perverse cliental incentives by making targeting and delivery more transparent, equitable and needs-based. As the power structures governing people's access to political and economic opportunities in Bangladesh become more multifocal and flexible, this provides an opportunity to advance a more rights-based approach to disaster support.

The risk of acting in vain emerged as a major perceived barrier among stakeholders to scaling up FbA, with government representatives particularly wary of the implications of failure and accountability for delivering early action when forecasts turn out to be inaccurate. Findings from the learning study component of this research help to counter some of the concerns around delivering early action in areas not directly affected by disasters, and the importance of the indirect impacts of disaster events, such as market price changes and reduced employment options when neighbouring areas are hit.

In addressing barriers to FbA, one important step is to generate simplified policy narratives that others are able to buy into and support. This research suggests that these narratives should build on the humanitarian system's existing use of forecasts to trigger preparedness actions; emphasise the protection of development progress in Bangladesh; present FbA as part of the suite of approaches for risk management, rather than replacing existing mechanisms; and provide figures to support the cost-effectiveness of early action.

5.2 Forecasting and targeting challenges

The system for forecasting riverine floods is well developed, with accuracy up to ten-day lead-times permitting early action, although models are limited in scope and do not cover southern Bangladesh because of the difficulties in modelling tidal influences. Flood predictions in any given location also need to be calibrated with historical data and against the nearest gauges for FbA applications. There may be future potential for FbA to deal with riverbank erosion as seasonal forecasts are reportedly fairly accurate. While forecast-based cyclone preparedness actions are already significant in Bangladesh, the inaccuracy of forecasting outside short lead-times leaves a limited window for early actions beyond refining existing preparedness and evacuation plans.

Dissemination of forecasts in Bangladesh is largely in technical formats that do not match local levels of technical expertise, do not match the needs of decision-makers and, with the exception of the Cyclone Preparedness Programme, are not linked to established triggers for action. FbA therefore provides an impetus for improving climate services in Bangladesh and ensuring that they are linked to decision-making contexts, bringing forecasters together with experts in exposure, vulnerability and risk reduction. Impact-based forecasting approaches have the potential to assist FbA by creating forecasts of the probability of disaster impacts. These impacts could be to a sector, infrastructure, household, local government, NGO or business in a given area.

5.3 Impacts and VfM of FbA

The impact assessment of the Bogura pilot highlighted the need to understand the impacts of possible actions in greater detail to inform decisions around which early actions to take and the technical procedures for doing so. Effective actions should be prioritised over speed of delivery. For cash transfers, this means understanding what people need and how they prioritise spending, how the local market and lending conditions change during a flood episode and how and at what point people start investing in longer-term resilience (such as purchasing productive assets).

While the level of preparatory actions taken was higher among recipients of the grants, the study found that the types of action taken were not substantially different from those taken after the flood hit by people who did not receive the grant. Outside the (possibly significant) psychosocial benefits of acting early, the value for money that we could calculate of early spending was largely related to food purchases before prices spiked and reducing the costs of borrowing by allowing people to pay down debts or borrow before interest rates increased. Understanding these price dynamics is crucial when considering FbA approaches at household scale and designing market-oriented approaches.

People’s behaviour was influenced by the degree of certainty around when and whether a grant would arrive or not for a given level of hazard. This is as important as the amounts transferred, or the mechanisms for doing so. For cyclical floods in high-risk areas, there may be a case for delivering a social safety net annually, rather than forecast-based actions based on less frequent hazards.

The study also served as a reminder that there are often multiple peaks in hazards such as flooding. The Bogura cash transfer was implemented for the first peak, but most people did not spend it all upfront because they knew that there was likely to be another peak flood later in the season.

6 Recommendations: an action agenda for scaling up FbA

This final section sets out areas where FbA is being taken forward in Bangladesh, and recommendations for future action. Based on the research interviews, analysis and outcomes of the dissemination workshops, we propose some next steps for scaling up FbA through convening and knowledge-sharing, evidence and policy influence.

6.1 Convening and knowledge-sharing

Despite improvements in forecasting techniques and examples of early action in Bangladesh, the community of practice in the country is still nascent. To date, meetings of interested stakeholder agencies to discuss FbA have usually been ad hoc and convened to share findings from a particular scoping or pilot exercise.

Workshops under this research have led to the formation of an FbA working group, initially comprising NGOs and hydro-met services representatives, with facilitation support from the START Fund Bangladesh. Next steps for this group include the inclusion of UN agencies, national NGOs and government disaster management bodies. The group also needs to bring in perspectives from those currently outside the community of practice, including policy analysis, forecasting, climate services, climate adaptation, risk analysis, beneficiary targeting, safety nets, cash transfers, sovereign risk transfer, insurance and market analysis.

The working group will develop a more regularly programmed meeting schedule and maintain a directory of organisations and individuals with expertise and interest in relevant fields. An initial task for the group is to agree a nationally owned definition, language and narratives for FbA. The process of definition can itself help to stimulate debate, communication and awareness-raising on FbA.

6.2 Evidence-based policy

Stakeholders engaged in this research process highlighted the need for a stronger evidence base, along with better narratives that simplify FbA in the national context. Early evidence suggests that these narratives should build on existing forecasting and early warning-based activities in the country; emphasise the use of forecasts to reduce human suffering and protect assets; and counter perceptions about the risks of acting in vain and the reallocation of relief resources.

In general, this research suggests that more experience-based evidence and learning is still required to determine any scaling up of FbA. This requires a commitment to fund and implement further piloting exercises with explicit components related to shared learning and evaluation. Of particular interest will be those pilots that engage government agencies and that tackle major forecastable hazards, such as heatwaves, cold snaps, river bank erosion, flooding and cyclones.

The national evidence base on FbA is evolving as pilot initiatives generate lessons and adjust and readjust their approaches. The working group will produce a regular synthesis of key thematic lessons and challenges in planning, financing, implementing and evaluating FbA. The group will regularly share findings nationally and internationally, including via online sites such as the IFRC-managed platform on forecast-based financing (www.forecast-based-financing.org) and at regional meetings on forecast-based finance.

While the MoDMR officials consulted in this study were receptive to the concept, the government has yet to formally recognise FbA as part of its disaster management portfolio. Engaging government agencies in pilot exercises, fostering champions and field-based experience were all cited by participants in the research as important priorities. Opportunities for policy dialogue on FbA include the ongoing revision of the SOD and drafting process for the revised NDMP from 2019.

Weather and climate forecasting needs improving in Bangladesh, beyond just addressing technical or capacity constraints, to link dissemination with risk management decision contexts. The FbA community will seek to work with national hydro-met service providers, particularly on impact-based forecasting. This dialogue process will also provide an opportunity to engage government agencies in discussions on nationally appropriate risk assessments, triggers and forecast-based actions.

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Annex 1 Skill and accuracy of forecasts

FFWC river forecasts for the slower-rising Brahmaputra are generally more accurate than forecasts for rivers more prone to flash flooding such as those in the Meghna catchment in the northeast. Verification of the accuracy of FFWC's forecasts is provided in annual reports published on the FFWC website, where river height forecasts at multiple leads are compared with observations, and accuracy is quantified in terms of the mean absolute error (MAE) and the r-squared value. Respectively, these indicate the average size of river height forecast errors, and the overall correlation with observations. Criteria have been defined to create a categorical index to rank forecasts from very poor to good. Sixty-five per cent of stations rank as Good or Average at one-day lead; only 2% reach this level at five-day lead.

More verification of the FFWC forecasts has been carried out in several separate studies over the years. Under the Community Based Flood Information System pilot project of the Ministry for Water Resources, analysis of HR and FAR was carried out for stations at Singdair, Bhalkutia, Tebaria and Boro Boinya, for data covering the period 2004 to 2007. HR and FAR for 48-hour forecasts of direction (rising or falling) and of danger level crossing were calculated: for direction, HR varied between 57–70%, and FAR from 26–51%. For danger level crossing events results were much worse, with HR between 5–17% and FAR from 0–36%. Later, HR and FAR for Goalondo station have been calculated for 2008 for the ten-day forecast, finding HR for threshold crossing decreasing from 60% at 48 hours to 25% at nine days, and FAR increasing from 40% to 70%.

Most recently, the German Red Cross evaluated the 2014 FFWC deterministic forecast at the nearby station to the FbF pilot project, Sariakandi (Hassan and Neussner, 2016). HR for three-, five- and seven-day forecasts was 84%, 53% and 20%. FAR for the three-day forecast was reported as 21%. The three-day forecast trigger is used in the pilot, suggesting that, if an action is triggered based on this forecast, one would expect roughly four out every five events successfully hit, with one miss. Over the long term, one out of every five warnings would be a false alarm.

It should be noted that all verification of the ten-day probabilistic forecast has treated it as an deterministic model, by taking the ensemble mean forecast. Doing so loses potential information: if instead the whole ensemble is included, actions can be tailored to probabilities. By carrying out probabilistic verification (e.g. ROC curves), a range of HR and FAR can be calculated at a single lead-time, allowing the user to calibrate action triggers to different probability threshold exceedances depending on the need for a minimum HR or sensitivity to a maximum FAR. Indeed, multiple triggers at the same lead-time may be selected based on different probability thresholds.

In addition, verification scores are likely to change over time as precipitation input forecasts improve, and assessment of more recent performance is necessary to gain a reliable picture of expected HR and FAR. Analysis of HR and FAR is not routinely carried out for all FFWC forecast stations for recent years. However, FFWC evaluation can be used as a guide to other stations and lead-times where we might expect HR and FAR to be comparable, better or worse than Sariakandi (since skill scores co-vary). Care must be taken as a single verification score cannot capture the full behaviour of a forecast system. However, if the HR and FAR for the FbF pilot at Bogra is acceptable, this gives an idea of which locations and lead times are likely to be supported by forecasts with acceptable HR and FAR.

This summary is provided in Figure A1, for both the five-day deterministic system and the ensemble mean of the ten-day probabilistic system. This indicates that stations such as Jagir, Kamarkhal, Jamalpur and others are likely to have comparable or better skill than the forecast for the FbF pilot study, even at lead-times longer than three days, while stations Markuli, Sureswar and Sheola are unlikely to have sufficient skill on which to scale-up FbF. It should be noted that the deterministic and probabilistic systems have different skill values at the same lead-time due to different precipitation forecast input and model setup. Indeed, the r^2 value for Sariakandi is actually higher for a five-day forecast from the ensemble mean of the probabilistic system than it is for a three-day forecast from the deterministic system, and the seven-day forecast from the ensemble mean of the probabilistic system has comparable skill to the three-day forecast. Overall, comparing five-day deterministic forecasts with the ensemble mean of the five-day probabilistic forecast reveals higher skill for nearly all stations, suggesting that this system is superior, at least at longer lead-times.

Figure A1 Accuracy of FFWC forecasts during 2016

2016 FFWC river height forecasts: r-squared value

	5-day deterministic system					Ensemble mean of 10-day probablistic system		
Station	**1 day**	**2 day**	**3 day**	**4 day**	**5 day**	**5 day**	**7 day**	**10 day**
Jagir	1.00	0.99	0.97	0.94	0.90	0.93	0.92	0.86
Kamarkhali	0.94	0.87	0.86	0.86	0.85	0.94	0.88	0.65
Jamalpur	0.95	0.89	0.86	0.84	0.80	0.89	0.84	0.77
Gorai Rly Bridge	0.93	0.85	0.83	0.82	0.80	0.93	0.84	0.63
Tongi	0.97	0.90	0.84	0.76	0.68	0.89	0.84	0.73
Sariakandi	**0.93**	**0.85**	**0.83**	**0.79**	**0.73**	**0.88**	**0.82**	**0.68**
Demra	0.96	0.89	0.83	0.76	0.68	0.86	0.79	0.70
Kazipur	0.99	0.94	0.87	0.75	0.60	0.84	0.75	0.64
Hardinge Br	0.91	0.82	0.80	0.79	0.78	0.89	0.78	0.55
Bahadurabad	0.93	0.84	0.81	0.78	0.72	0.85	0.76	0.61
Mymensingh	0.95	0.87	0.82	0.78	0.74	0.75	0.69	0.65
Serajganj	0.92	0.82	0.81	0.77	0.72	0.84	0.76	0.58
Goalondo	0.93	0.84	0.83	0.81	0.78	0.86	0.67	0.37
Aricha	0.92	0.82	0.81	0.79	0.76	0.89	0.70	0.38
Baghabari	0.92	0.84	0.83	0.81	0.79	0.84	0.63	0.28
Elashinghat	0.93	0.86	0.84	0.82	0.79	0.78	0.57	0.25
Sunamganj	0.98	0.94	0.87	0.81	0.74	0.58	0.40	0.29
Bhagyakul	0.93	0.85	0.65	0.62	0.58	0.83	0.69	0.41
Narsingdi	0.69	0.62	0.56	0.49	0.41	0.89	0.83	0.70
Naogaon	0.94	0.86	0.79	0.70	0.62	0.59	0.37	0.06
Sylhet	0.97	0.89	0.80	0.71	0.63	0.37	0.22	0.09
Mohadevpur	0.93	0.82	0.74	0.64	0.51	0.57	0.31	0.07
Dhaka	0.38	0.74	0.32	0.22	0.16	0.78	0.78	0.70
Bhairab Bazar	0.68	0.44	0.39	0.23	0.12	0.67	0.71	0.77
Narayanganj	0.61	0.78	0.38	0.28	0.13	0.68	0.57	0.36
Sherpur-Sylhet	0.63	0.58	0.52	0.46	0.44	0.42	0.27	0.07
Sheola	0.90	0.71	0.57	0.47	0.39	0.12	0.04	0.00
Sureswar	0.62	0.49	0.37	0.23	0.10	0.27	0.14	0.15
Moulvi Bazar	0.20	0.13	0.05	0.02	0.01	0.02	0.00	0.03

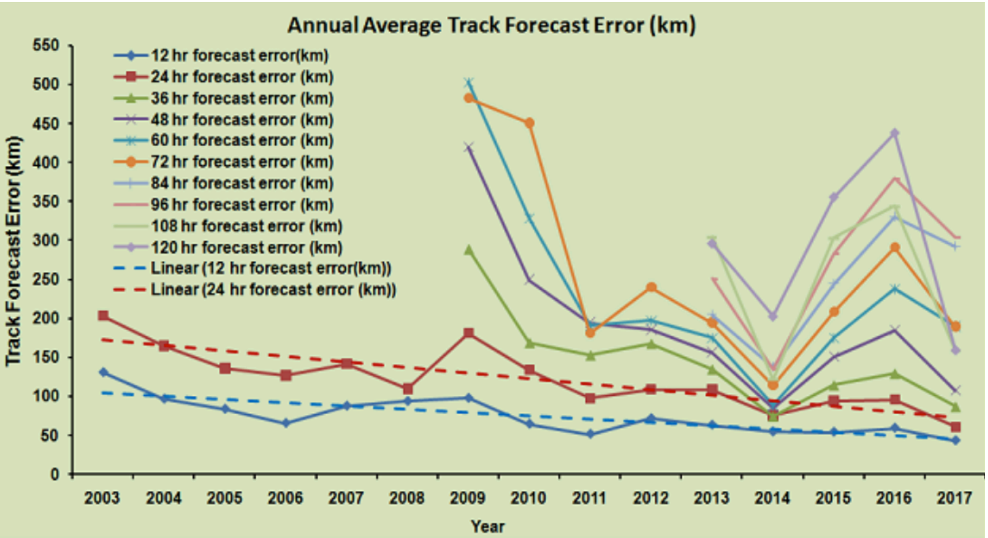
Notes: r2 values are shown for days 1–5 of the five-day deterministic system and the ensemble mean value of day five, seven and ten of the ten-day probabilistic system. The verification for the station used in the GRC pilot, Sariakandi, is highlighted. Stations are ranked by their mean r2 value at all lead-times and cells are coloured green or red where the score is better or worse than forecasts for Sariakandi at a three-day lead. Data shown for the subset of stations in the FFWC annual report 2016 where verification statistics are available for both the five-day and ten-day system. See the FFWC annual reports for deterministic data presented on a map (see www.ffwc.gov.bd/images/annual16.pdf). It should be noted that r2 values is a broad performance metric of river height forecasts, and is not necessarily a good indicator of extreme event forecasts.

Source: FFWC.

Before using these forecasts in an FbF setting, a full probabilistic skill analysis should be carried out on the ten-day probabilistic system across all data available, to obtain a clearer idea of the expected HR and FAR for forecasts of danger-level crossings. Similarly, longer-term 30-day and seasonal outlooks provided by GloFAS should be treated with caution until a full verification is carried out, as long-range precipitation forecasts over the region can be of poor quality (e.g. Kim et al., 2012; Johnson et al., 2017). While links between the predictable climate signals such as ENSO and the Asian summer monsoon have been made, the link between ENSO and flooding is complex (Emerton et al., 2017).

For tropical cyclones, the lack of track and intensity forecasts from BDM prohibits quantitative verification, and public trust in forecast warnings is not high (Roy et al., 2015). However, verification of RSMC tropical cyclone forecasts is provided on the website (http://www.rsmcnewdelhi.imd.gov.in). This shows that the RSMC tropical cyclone track predictions are accurate and are improving over time (Figure A2). Forecasts 12h / 24h ahead are generally accurate to within 50/100km. 72 hour forecasts may be accurate to within 200km, with increasing error on forecasted position at longer lead times. The error of long lead track forecast also shows high year-to-year variability at long lead times, which may indicate that some instances may be more predictable than others. Predicting this forecast uncertainty in advance is not possible in the deterministic system currently in use, however a full probabilistic system may be able to provide this information.

Figure A2 Tropical cyclone track error of Regional Specialized Meteorological Centre forecasts over time



Source: http://www.rsmcnewdelhi.imd.gov.in.

Annex 2 Considerations for VfM assessments of FbA

There is widespread agreement that taking action before disasters occur can reduce impacts and suffering, as well as generating significant co-benefits (Mechler, 2016; Tanner et al., 2015). In enhancing the case for scaling up FbA, however, the additional challenge is in demonstrating the value of using a forecast to trigger pre-specified early actions over and above the value of conventional risk management. In enhancing the case for scaling up FbA, the additional challenge is in demonstrating the value of using a forecast to trigger pre-specified early actions over and above the value of conventional risk management.

Three possible comparisons can therefore be made in assessing VfM of FbA (see Table A1), based on action versus inaction, anticipation versus reaction, and forecast versus non-forecast-based action. A conventional VfM analysis of FbA weighs the benefits of a project against its cost, to ascertain the overall effectiveness of any intervention. Learning on FbA therefore needs to understand whether the forecast resulted in different outcomes compared with a similar set of interventions provided without a forecast (assumed to be late).

Table A1 Assessing VfM of FbA approaches

Factor	Comparator 1		Comparator 2	Example
Action	Taking no action	vs.	Action to reduce impacts and suffering	Assessing the impact of any humanitarian, DRR or climate adaptation action
Anticipation	Anticipatory early action	vs.	Post-disaster action	Assessing disaster preparedness action against relief actions
Forecast	Forecast based early action	vs.	Early action without forecast	Assessing forecast-based cash transfers against regular safety net payments

In order to assess the additional value of using a forecast, the impact of early action with a forecast should be compared to a scenario where a comparable set of activities are triggered without a forecast. The basic components include:

- **Assessment of costs.** What is the additional cost of implementing early action using FbA? This should include the cost of implementing a forecast system, as well as the full cost associated with the interventions planned under each scenario. It should consider both fixed and variable costs over the lifetime of the project.

- **Assessment of benefits.** The benefits of early action would typically be measured in terms of the avoided losses that arise for affected populations as a result of that early action – for example reductions in losses to income, assets, loss of life and injuries or school disruption. Implementing agencies may also realise savings on the cost of response through early action. In order to assess the benefits, the impact of the disaster event on those affected needs to be measured for those that receive an intervention using a forecast, and those that receive an intervention without the forecast. The difference between the two is the benefit of the forecast-based approach. There may be additional co-benefits of anticipatory action, but data precluded their assessment in this study.

Collecting data to document the impacts of early action requires that some level of assessment is undertaken to compare the effects of a disaster on households that received early action using a forecast, and those that did not. However, the depth and breadth of analysis can vary significantly, along with the degree to which evidence is assessed qualitatively and quantitatively.

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ODI
203 Blackfriars Road
London SE1 8NJ

+44 (0)20 7922 0300
info@odi.org

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