

# Nepal FbF Feasibility Study

## Highlights

- There are multiple hazards in Nepal which could benefit from the development of FbF systems.
- The hazard prioritized now is riverine flood due to the high impacts of floods in the Terai region, its alignment with the Nepal Red Cross Society strategic plan, and the ability to forecast negative impacts with sufficient lead time.
- It may also be possible to include a triggering model for flash floods which would provide a very short time period (3-6 hours) to complete no-cost actions.
- The recommended triggering model for riverine flood would be a multi-step trigger using multiple forecasts which are suitable at different lead times.
- There is a strong logic to acting early in anticipation of floods in the Terai region, primarily because road access to communities is immediately compromised during flood events. Nepal Red Cross Societies branch staff and volunteers have expressed frustration with having to 'sit on their hands' while affected populations are inaccessible.
- In previous years of extreme flooding the Nepal Red Cross Society has needed to employ expensive strategies to provide support to desperate people, such as the use of helicopters to air drop food to persons stranded on their roofs. As such, it is expected that a well developed and implemented FbF program for an extreme event would have a favourable cost-benefit ratio as opposed to action only in a response capacity.
- There is a strong FbF community of practice in Nepal with positive integration into government technical services, and opportunities to work closely together under the new ARRCC program.
- The Danish-funded pilot program for the 2018 monsoon season in one district of the Terai (Bardiya) did not trigger but the process of setting up the program has created multiple lessons learned and has established a strong understanding of the FbF concept within the Nepal Red Cross Society Disaster Management team at headquarters and throughout the branch in Bardiya.
- It is recommended that the process to write and validate an EAP for the DREF by FbA begin as soon as possible to be trigger-ready for the 2020 monsoon season.
- It is recommended that NRCS takes advantage of the work completed on the 2018 pilot to be trigger-ready for a small-scale FbF program in the 2019 monsoon season. If such a system was to trigger, it would reduce flood impacts and provide a valuable learning opportunity to feed into the development of an EAP to access funds from the DREF.
- There are multiple investments of Partner National Societies and the IFRC in Nepal that can be built off for the establishment of an FbF system, including the provision of data managers at the district emergency operations centres, and the PER process.
- There is a high level of heterogeneity within the flood prone area in terms of both vulnerability and preparedness. Developing a system that allows NRCS to select the communities expected to experience the most extreme river flooding conditions, and selecting actions suitable for communities with differing levels of preparedness and familiarity with NRCS, will be essential for the system's success.
- The ability to trigger effectively rests on strong integration with government system at all levels.
- Additional high potential opportunities to explore in future include the integration of the FbF system with social protection systems, and the inclusion of other hazards - mostly notably cold and heat waves.

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## Introduction

### About this report

This report outlines the findings of the feasibility study, which aimed to identify high potential applications of the FbF concept to reduce the impacts of hydro-meteorological disaster events. The study was conducted jointly by Meghan Bailey (RCCC), Ahmadul Hassan (RCCC) and Manish Dhungel (Danish Red Cross) with funding from Danish Red Cross and in-country support from the Nepal Red Cross Society (NRCS). In-country interviews and field visits to flood-prone areas were conducted Feb 11-21, 2019. This study builds off the work that has been done previously to set up the FbF pilot project in Bardiya District, and the work of other stakeholders furthering the FbF agenda in Nepal – most notably the World Food Programme (WFP) and Practical Action Consulting (PAC), in collaboration with the Nepal Department for Hydrology and Meteorology (DHM). The report was finalized in June 2019. It can be shared widely.

### Background

Forecast-based Financing (FbF) (also called Forecast-based Action/FbA) is a mechanism that uses climate and weather forecasts to trigger timely humanitarian action, before a

hazard hits the exposed population. These actions are automatically funded when the triggering forecast is released. This mechanism has been progressively developed since 2008. It began with several bilaterally funded pilot projects, which established an evidence-base for how to design and implement FbF systems. The lessons, best practices and recommendations from these projects led to the establishment of a central pool of funding as part of the DREF, whereby national societies can develop FbF Early Action Protocols (EAPs) to receive funding to implement activities in advance of an anticipated disaster. The development of EAPs of a sufficiently high standard to pass the validation process of the FbA by DREF mechanism offers a goal post in the development of FbF systems. This feasibility study is an early step towards developing an FbA by DREF EAP, which will likely include additional trialing of triggers and actions in the interim.

### FbF activities in Nepal to date

There has been considerable work undertaken in Nepal already. There is an established FbF working group including the World Food Programme, Practical Action Consulting, IFRC (working group hosts), the Nepal Red Cross Society and Danish Red Cross. There is a view to expand this working group to also include the Department of Hydrology and Meteorology (DHM). Although they are currently not part of the working group, all members of the working group have established relationships with DHM. The World Food Programme has been in the process of setting up an FbF system since 2015. They have formed close working relationships with the government hydrological and meteorological technical services to inform triggers and have completed a substantial mapping exercise of available vulnerability data. Their triggers were established jointly through a consultancy with Practical Action Consulting. Importantly, as World Food Programme do not have ongoing operational presence on the ground, their post-trigger actions are planned to be implemented by Red Cross branch staff and volunteers. They have established MoUs at branch level. The program has yet to be triggered. As will be highlighted later in the report, effective coordination with World Food Programme will be essential as both the Red Cross and WFP post-trigger activities will be completed by Red Cross chapter level staff and volunteers.

Through the Danish Red Cross's Innovation/Hum Grant, a pilot FbF program was established in Bardiya district for the 2018 monsoon season. As 2018 was not an extreme year for flooding, the programme rightly did not trigger. The establishment of the pilot offered multiple lessons learned which are thoroughly detailed in Danish Red Cross reports. The Nepal Red Cross chapter was heavily involved in the establishment of the pilot and now have a high level of understanding of the FbF concept, and operational constraints. The branch has an information management specialist seconded to the governmental district level emergency operations centre. This individual is heavily involved in monitoring the data coming in from observational stations (river level and rain gauges) which are relevant for flooding throughout the district. As such, the staff and volunteers have an above average awareness of flood monitoring and anticipating flooding conditions in their jurisdiction. The set-up of an Red Cross information management specialist seconded to the district emergency operations centre, and facilitating ongoing information sharing about flood risk both to the Red Cross chapter, and to the district chief operating officer who is responsible for issuing warnings, will be an important asset to any FbF system.

## Initial forecast analysis per hazard

Central to the feasibility assessment of an FbF system is the establishment of which disaster events, if any, can be anticipated with sufficient reliability in order to trigger pre-disaster action. In the initial days of this study, the following institutions were interviewed to related to trigger feasibility.

### Institutions interviewed as background for trigger assessment

Hazard	Government	NGO/PNS/UN	Scientific / Knowledge center
Flash flood	Meteorological Forecasting Division of Department of Hydrology and Meteorology under the ministry of Energy, Water Resources and Irrigation	Practical Action	ICMOD
River Flood	Hydrological Division and Forecasting Section, DHM	Practical Action WFP	ICMOD
Landslide	Meteorological Forecasting Division, DHM	Practical Action	
Drought	Meteorological Forecasting Division, DHM		ICMOD
Heat/cold wave	Meteorological Forecasting Division, DHM		

Based on these interviews the following situation analysis of currently available forecasts which could form the trigger in whole or in part for an FbF system was completed.

### Situation Analysis of Available Forecasts for FbF

Hazard	Forecast	Lead Time	Source
Flash flood	Real time precipitation monitoring and gauge to measure correlation used for forecast.  Upstream gauge monitoring and relation with the downstream gauge is able to forecast the flood in the downstream river basin.  This tool is still at research level. Both Practical Action and ICMOD are working to improve the lead time by adding a rainfall forecast.	3-6 hours	Practical Action ICMOD Meteorological Forecasting Division, DHM
River Flood	DHM flood have been forecasting	1-3 days	Hydrological Division and

	in the major river systems in Nepal from 2017 and calibrated in 2018. The MIKE 11 hydrodynamic flood model use for Koshi, West Rapti and Bagmati river basins and HEC HMS flood model are simulated in Karnali, Babai and Narayani river basin.		Forecasting Section, DHM
Landslide	Currently no forecasting is available. Research with international and local partners to develop a computational framework based on hydrology, geology and socio-economic factors funded by DFID.	Unknown	Practical Action Tribhuvan university
Drought	Global Season rainfall forecast	Months	Meteorological Forecasting Division, DHM  Ministry of Agriculture Development  FAO  ICMOD
Heat/cold wave	Nationally, a temperature forecast exists but not a heat/cold index. A heat/cold index would be required to anticipate the impacts of heat and cold waves as temperature alone is insufficient. The Climate Centre could support in the development of a heat index in the next phase of Climate Centre support for Nepal.	3-7 days	Meteorological Forecasting Division, DHM

## Hazard Analysis

Six hazard types were considered based on the historical impacts of the hazard, the ability to forecast it, the priorities of the Nepal Red Cross according to their strategic plan, which it is technically feasible to develop and impact-based forecast to trigger action, and whether meaningful action could be taken in the lead time afforded by an early warning. Note, although earthquakes are a major hazard in Nepal, it is not possible to forecast them in time and space, as they are based on seismic activity. The following matrix highlights the hazards considered (flood, drought, landslide, epidemic, cold wave, and heat wave).

	Can forecast the hazard?	Can currently forecast the impact?	Prioritized in NRCS strategic plan?	Technically feasible to make an IBF?	Meaningful early action to take?
Flood (riverine)	Yes (at certain timescales)	no	yes	yes	yes
Flood (flash)	Yes (at very short lead times)	no	yes	yes	yes
Drought	Yes (unsure of skill)	unsure	no	unsure	Unsure (not within Red Cross strategic advantage as primary impacts concern food security)
Landslide	In development	no	yes	unsure	yes
Epidemic	Some factors technically feasible	no	yes	Some disease types	yes
Cold Wave	Yes, but national forecasts are qualitative	no	no	yes	yes
Heat Wave	Yes, but national forecasts are qualitative only	no	no	yes	yes

Through this preliminary assessment, riverine flood emerged as the priority hazard for which to assess feasibility thoroughly. However, information on other hazards was collected at a lower intensity to support decision making as to whether FbF should be developed for additional hazards.

### Relevant information on non-prioritized hazards:

#### *Flash flood*

The impacts of flash floods are severe, frequently resulting in loss of life in the Terai, and the hazard has been prioritized by NRCS. Flash flood was not prioritized for the development of a full FbF system because of the very short lead time for FbF action (3-6 hours). This is primarily because the ability to release financing on this timescale to ground level is unlikely. However, certain no-cost actions, such as passing evacuation orders, would be feasible on this time scale. If systems were developed which could act rapidly enough to take advantage of 3-6 hour lead times, such actions could meaningfully reduce flash flood impacts, including loss of life. These no-cost actions could be included in a broader flooding EAP for areas prone to flash flooding. In practical terms, this would mean developing a flood EAP that includes both flash and riverine components, with no-cost actions outlined for flash flood and a more typical set of costed actions for riverine floods. The Climate Centre is currently involved in a flash flooding research program with NASA, which could provide

technical guidance in the development of flash flood triggers. However, the current feasibility assessment did not explore in detail what the capacity of any local actors are to be operating on timescales of this magnitude. It is likely that such a system would need to include multiple simulations to work out the ideal method of post-trigger operation. If there is an interest to pursue this option, technical support in this area can be provided by the climate centre in the next phase.

### *Drought*

Drought was not prioritized primarily because in comparison to other hazards in Nepal, it does not produce impacts requiring humanitarian intervention. Drought was not identified as a priority in the strategic plan of NRCS. Although WASH impacts associated with drought have been documented, drought impacts in Nepal tend to affect the food security and livelihood sectors, which is not the strategic advantage of NRCS. Apart from a seasonal forecast for rainfall (3-month lead time), there is no specific drought early warning product produced by the Department of Hydrology and Meteorology on which an FbF trigger could be based.

### *Landslides*

Landslides are of considerable interest for an FbF program. Landslides have been particularly harmful in the months and years following the 2015 earthquake. The quake destabilized the surface of many mountainous areas, making it more susceptible to landslides. There is currently a DFID funded research program under SHEAR examining the ability to anticipate landslides in Nepal. A team from international and local research institutes are now working to develop the computational framework based on hydrology, geology and socio-economic factors. The Nepal-based institutions are the NGO Practical Action and Tribhuvan University. This program includes the planned development of low-cost sensors by Imperial College London, which could contribute to a landslide early warning system. The results of the research program on landslides could produce a tool to anticipate landslides, which could in turn be operationalized for an FbF system. The research is currently underway. Results are expected, including an indication of both lead time and skill of any warning they are able to produce, in early 2020. At that time, the RCCC will review the results and will provide guidance as to whether FbF to address the impacts of landslides is feasible. NRCS would be well placed to engage in this space. NRCS has extensive experience with landslide response and some experience with landslide early warning systems, including small-scale community based approaches involving setting of alarm noises for people to evacuate (with a lead-time of a couple of minutes). The hazard is a priority area for NRCS.

### *Epidemics*

Multiple epidemics including dengue and cholera, which have links relationships to hydrometeorology are common to Nepal. The case load often increases in specific areas following flooding events or heavy rainfall requiring humanitarian intervention from NRCS. At present there is no early warning system for these public health issues. Should a system be developed that could anticipate an uptick in case loads as a result of weather conditions or other disaster impacts, an FbF system could trigger early action to reduce the impacts of epidemics. Appropriate actions would most likely come from the WASH sector, which is a high capacity area of the NRSC. As such, NRSC would be well-placed to implement an

epidemic FbF system should a warning system be developed. It is not possible at this time for the Climate Centre to help produce such an early warning system from scratch, as this would be a major scientific undertaking requiring considerable resources.

### Cold and heat waves

Currently only qualitative forecasts are available. These forecasts do not provide a probability of an event, but rather the meteorologists look at the model results and provide a qualitative indication of whether a heatwave or cold wave is likely. In order to use this forecast, we would need to evaluate whether, in the past, these qualitative indications have indeed lead to extreme events or not. Another option is to work with the meteorological providers to ensure that they provide a warning when a certain probability of a heatwave or cold wave is forecasted by these models, which would then give us a confidence in the probability of acting in vain and the frequency of the trigger. It is possible to complete this type of analysis with the view to develop an FbF system in future if there is a desire among stakeholders to do so. The Climate Centre is able to provide the technical support to develop a heat index for a cold and heat wave trigger. Currently there are major investments being made in India to be able to anticipate and understand the impacts of heat and cold waves. There is an opportunity to build off these investments as the Terai area would have very similar conditions. There are multiple health and WASH related actions, with a strong evidence base, which could be triggered in an FbF system for cold and/or heat wave. Cold waves within the Terai occur at the frequency and severity that would be suitable for the FbA by DREF mechanism. As temperature extremes affect the elderly and very young disproportionately, this hazard could be a high potential area to explore integration within the national social protection system (see section on social protection for more details). Globally there is increased interest in early action on heat waves, as they are strongly correlated with mortality. The hazard tends to be deprioritized because the deaths are not classified specifically as having been the result of a heatwave - rather they are classified as dehydration, high blood pressure, etc. As such they can be thought of as a 'silent emergency'. There is strong evidence that the frequency and severity of heat waves will increase as a result of global climate change.

## Flood Forecast Analysis

### Background: experience of the 2017 floods

During the 2017 flood, 17 people were reported to have died, and 337,000 people were affected, with 91,000 of those people temporarily displaced. At the time of the 2017 floods there was not an effective forecasting system. Based on this experience the Government of Nepal took initiative to strengthen the DHM flood forecasting system to reduce loss of life and property through the creation of the flood forecasting division with three sub-units. Previous to the 2017 flooding event, flood forecasting was the remit of a single unit. As such capacity as greatly improved within DHM and it remains an institutional priority. Likewise, in the 2018 strategic plan of the Nepal Red Cross Society, flood remains a top priority.

### Currently available flood forecasts

DHM started flood forecasting with a lead time of 3 days in the major six rivers system in Nepal. The model was calibrated in 2018. In Nepal, the six major rivers (Karnali, Babai, West Rapti, Narayani, Bagmati and Koshi) basins are modelled as shown in Figure 1.

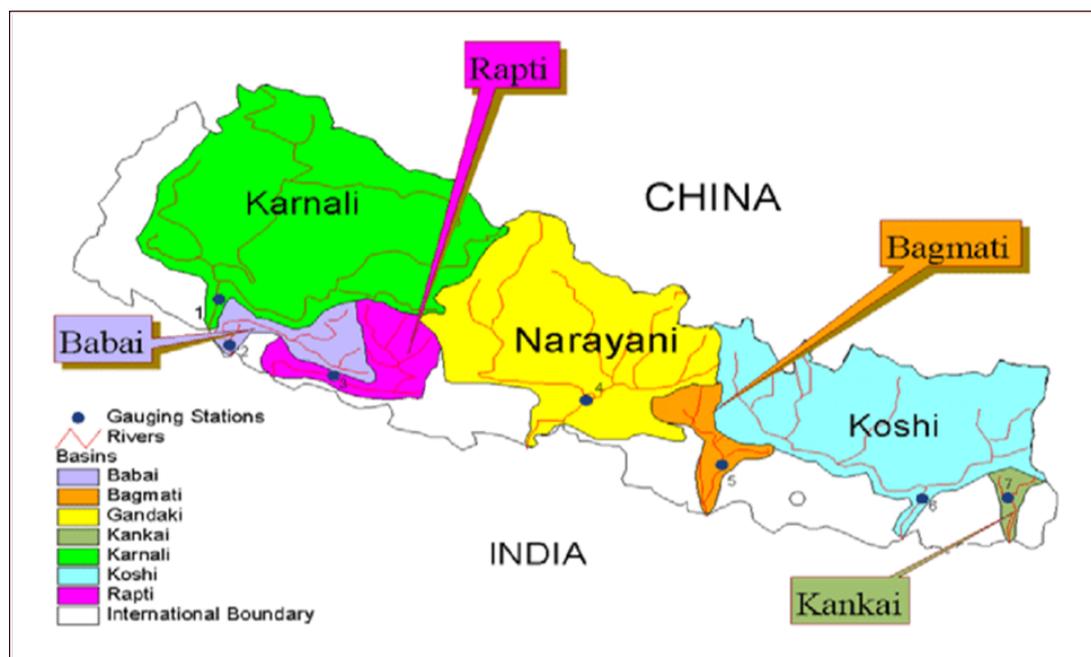


Figure 1: Location maps of six river basins in Nepal

There are two types of forecasting models which are used for these six major river basins. The MIKE 11 hydrodynamic flood model has been adopted for the three river basins i.e. Koshi, West Rapti and Bagma and the other three river basins adopted HEC HMS.

The initial flood model for the 3-day forecast assessment (reported by DHM) shows about 40 cm error between the river levels predicted and observed in the upstream, and 20 cm in the downstream. The error in the forecast is mostly in the small tributaries in the up steam basin and much less in the downstream relatively larger rivers. As such, the FbF system will focus on triggering based on the behaviours of the larger rivers. DHM is working to improve the forecast in the smaller rivers, hence currently these forecasts are not disseminated. For the purposes of understanding negative flood impacts, a 20cm error considerably reduces the utility of the 3-day forecast. On the contrary, the one day lead time forecast is within the acceptable range according to the DHM. In the minor rivers basins only one day lead time flood forecast was disseminated in year 2018, as the confidence is low for 2-3 days lead time.

The forecast message is prepared using available models - MIKE 11/HEC-HMS, GLOFAS and the model developed by RIMES. The DHM disseminates warnings with respect to danger levels. Danger levels are pegged on flood return periods (i.e. a 1 in 5 year flood) which correlate with specific known impacts (i.e. flow overtop a riverbank). If the forecast indicates conditions will surpass a specific danger level, a warning is issued.

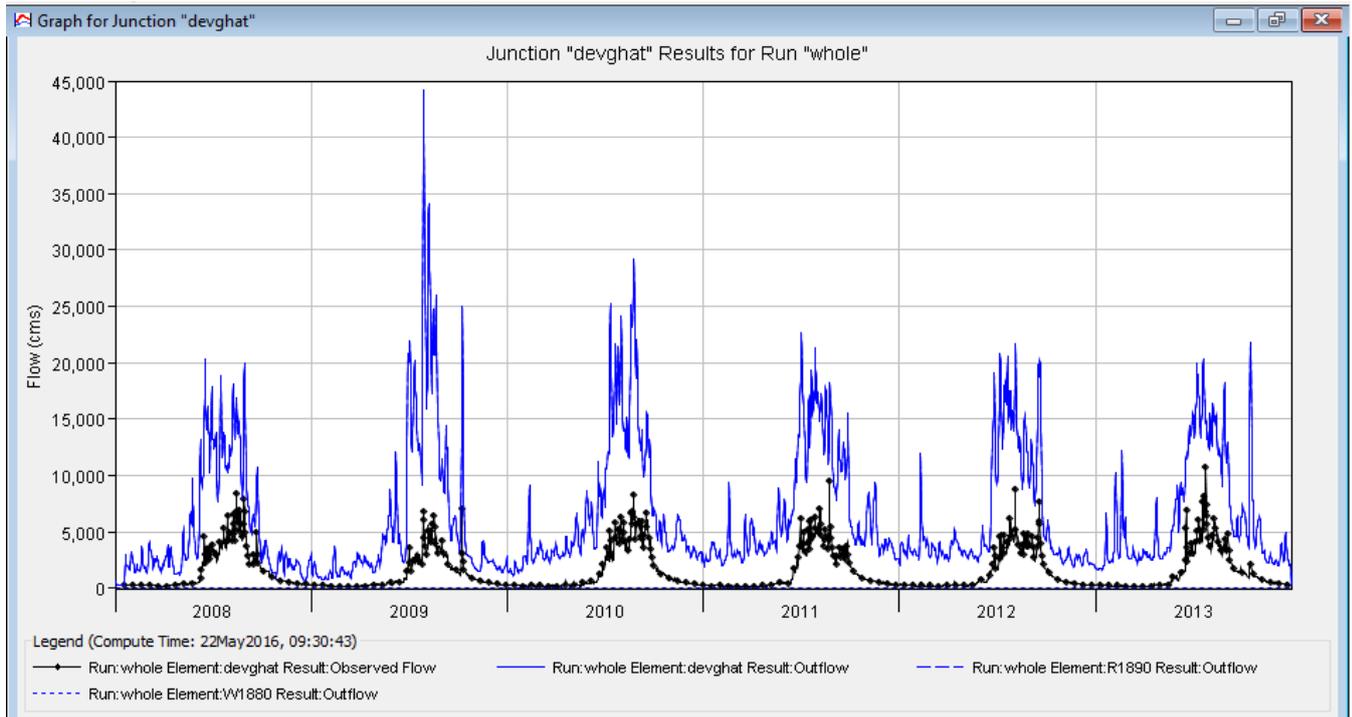
The DHM use a colour system to indicate risk level. The colour yellow represents the water reaching the level associated with a 1 in 2-5 year return period (the bank full level). The colour red (also referred to as the 'danger level') represents flood waters associated with a 1 in 5-8 year return period. At this level, rural roads typically become submerged in affected areas, cutting off access to communities, with only the major highways remaining sufficiently elevated. Highways become submerged (also called the highway top level) in flood waters associated with a 1 in 25-year return period. The 1 in 2-5 year (rural roads submerged) would be a sufficiently extreme anticipated event to trigger the FbA by DREF, if an EAP were to be developed.

### Suitability of available forecasts for FbF

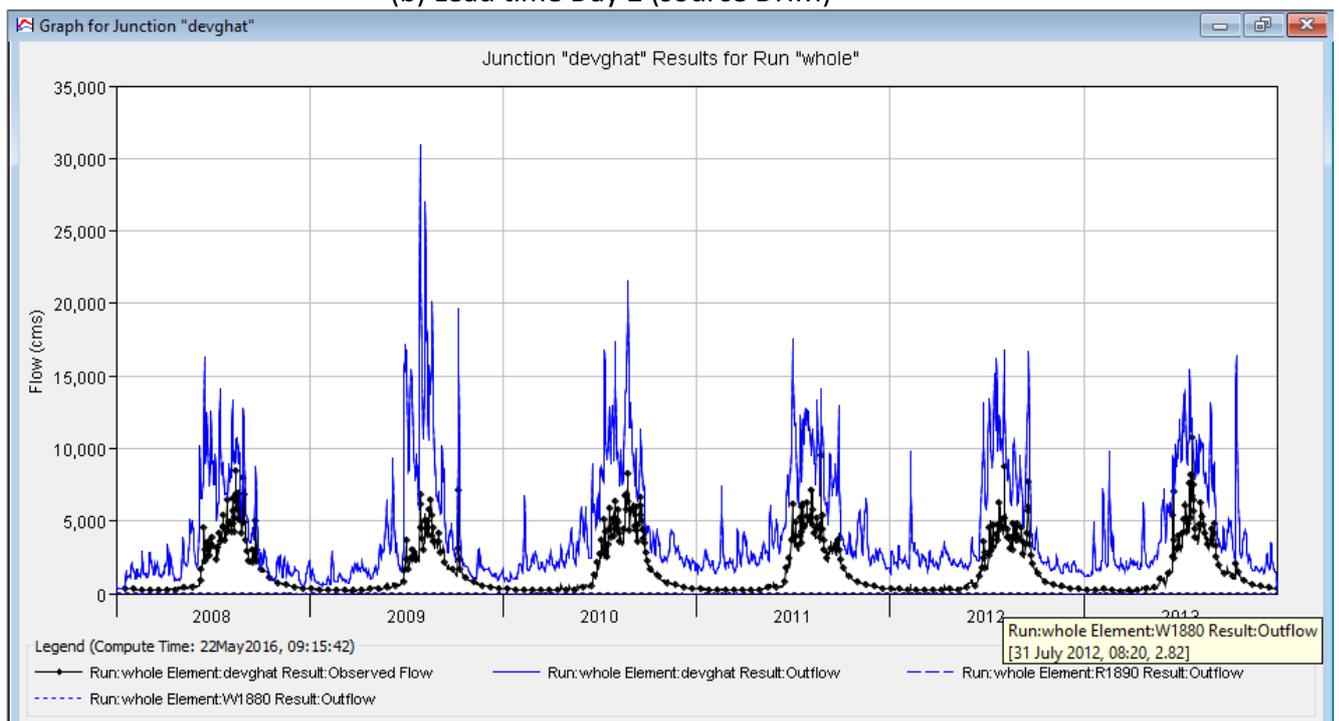
Central to the assessment of FbF feasibility is an assessment of how reliable the available forecasts are. This provides an indication of how frequently a trigger, based on a given forecast, might have a false alarm (type 1 error) or miss an upcoming event (type 2 error). These assessments are often looking at forecast 'skill', which is represented by a skill score. Such assessments can be sensitive as it involves critically examining the product produced by another organisation. However, it is not meant to be a critique, but rather an assessment of whether the forecast available is suitable for the very specific purposes of an FbF system, involving the disbursement of large amount of humanitarian funds. Fortunately DHM has been very open and collaborative with multiple stakeholders within the FbF community of practice, including the feasibility study team.

The model simulation results (produced by DHM) of forecasts from the year 2008 to 2013 with a lead time of 1-3 days are shown in Figure 2. There are 120 water level stations of which 90 stations are telemetric. 200 stations measure discharge, out of which 160 were used for the model. Figure 2 shows that the model was not able to simulate the peaks at a 3-day lead time. Result shows improvement for a 2-day lead time but the reliability is still insufficient for an FbF trigger as there would be too many missed events and false alarms to be able to confidently distribute funds. However, the forecast for a lead time of one day sufficiently matches the observed discharge rate indicating the forecast is able to identify most flooding events (with reliability varying slightly between major rivers).

(a) Lead time Day 3 (source DHM)



(b) Lead time Day 2 (source DHM)



c) Lead time Day 1 (source DHM)

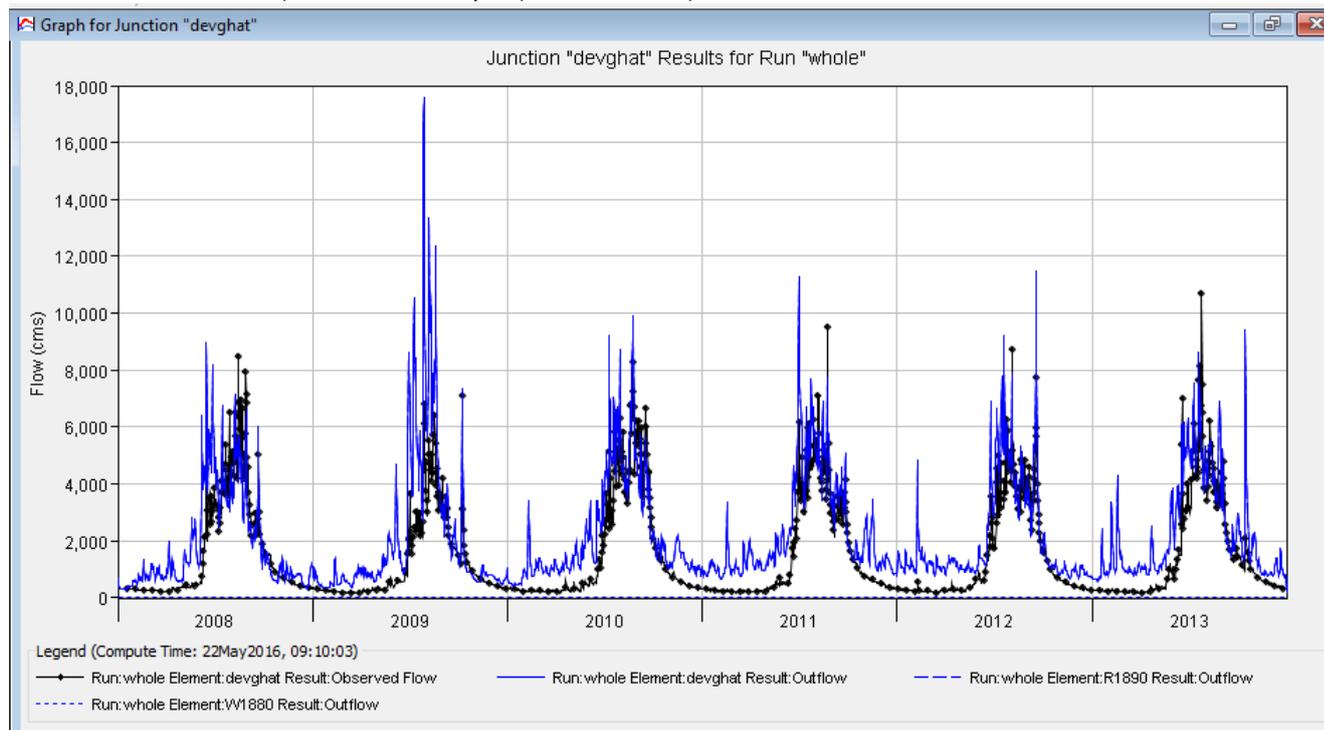


Figure 2: Model Simulation result. (a) Lead time 3 days, (b) lead time 2 days and (c) lead time 1 day. (source DHM)

Figure 2 shows that the forecast with one day lead time is better matched with the observed discharge data. A bias correction has been applied to the above figures by DHM using a statistical method to add the distribution of error to the initial value to produce a correlation between the forecast and the observation. After the bias correction, the results of the forecast output are improved for the one-day lead time forecast. Due to lack of access to the forecast and observed data, the skill analysis was carried using a presentation on the forecast by DHM. Assessment of the skill of forecasts was carried out using the direction of water flow (water will rise) and found that the model forecasted that the water would rise 9 times. Of those 9 times, the water rose as expected 5 times and did not rise 4 times, as shown in the following table. Hence, False Alarm Ratio (FAR) of flood forecast for one day lead time is about 0.44 (4/9). The skill will improve as the government considers the improvement of EWS a priority and puts direct resources towards it.

Forecast	Observe		
	Item	Rise	Fall
	Rise	5	4
Fall	3	6	

RIMES's assessment found that the Nash Sutcliffe coefficient (a statistical method for assessing the goodness of fit within hydrological models) varies river to river and found a variation between 0.53 and 0.7. In addition, they found very good agreement at Debganj on Narayani river. This means that the forecast is most reliable for the Narayani River.

In addition to the forecasts produced by DHM, there are other global models which can contribute to the trigger. The GLOFAS (Global Flood Awareness System) model has been

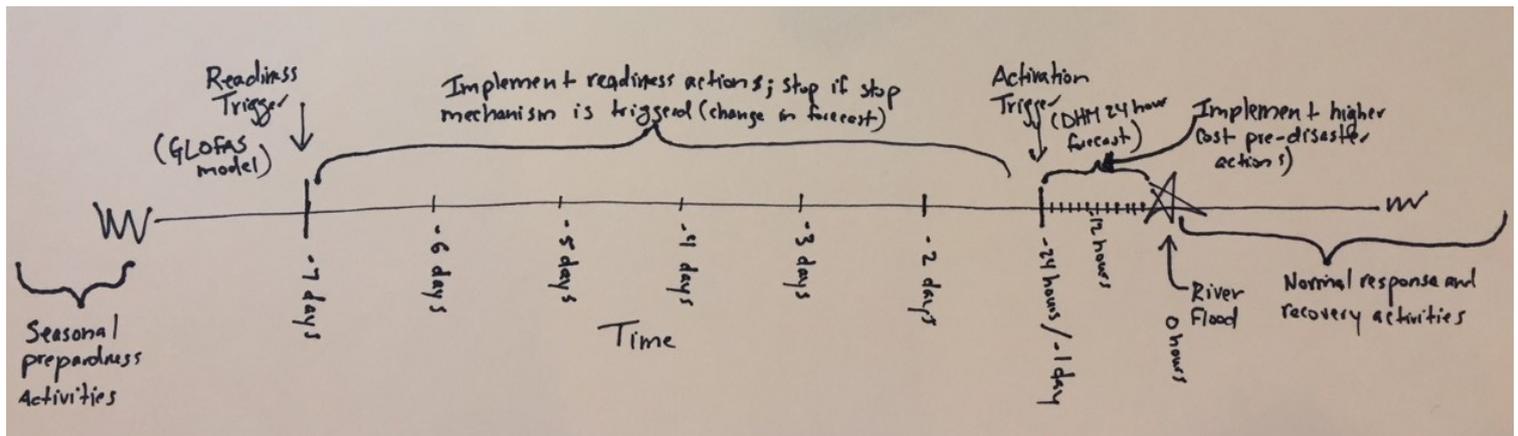
used in other FbF programs. The reliability of GLOFAS varies from place to place and as such a specific assessment was needed for the Terai region. DHM began using GLOFAS in 2015. They have calibrated the model with 25 observation station datasets. From 2018, GLOFAS has been producing a flood depth map with with 7 days lead time. DHM has been using this product but does not receive the raw or digital data, and as such could not provide data for this model to the study team. During the interview with ICIMOD, the technical specialists also felt confident to use the 1 day lead time, and not at longer lead times given the current forecast limitations. Given that the national forecasts beyond 1-day lead time currently is not sufficiently reliable for an FbF system, and given that a 1-day lead time limits what actions can be done, it is recommended that the GLOFAS model be used as a readiness trigger to initiate readiness actions at a 7 day lead time, which (assuming a stop mechanism is not initiated) would be followed by a 1 day lead time action trigger using the DHM forecast.

DHM made an analysis on rivers for their national forecast. The following sample of the analysis shows the forecast of the rivers and its Nash Sutcliffe coefficient which is shown in the chart below (note, a Nash Sutcliffe above 0.7 shows good skill):

Station	Nash Sutcliffe
KumalGaun (KaliG)	0.57
Kotagaun(KaliG)	0.58
Sisaghat(Madi)	0.48
Bimalnagar(Marsyan)	0.42
Kalikhola (Trishuli)	0.52
Devghat(Narayani)	0.76
Rajaiya( East Rapti)	0.1

Based on this analysis, FbF should be feasible with 1-3 days of lead time in the different large rivers of Nepal. The FbF project can provide further analysis to estimate the risk of false alarms, which will help select the lead-time of the trigger and integrate other global models as needed.

As was presented in the primary results of the feasibility study in-country, the recommended trigger system would look like this:



Note: a digital version of this will be prepared for the EAP. Time is written as it pertains to the anticipated disaster event. Zero (0) is the flood event, which we believe to be the time that rural roads cease to be accessible. Time before the event ranges from -7 days to -1 day. This shows from left to right: normal monsoon preparedness activities before -7 days. The GLOFAS model is used as a readiness trigger at -7 days to initiate readiness actions to be implemented between -7 days and -1 day. During this time period a stop mechanism could be initiated at any time if the forecasts being monitored indicate that the risk level has gone below the threshold, in which case activities would stop. If no stop mechanism is initiated, readiness activities continue until the activation trigger. The activation trigger is initiated by the DHM 1-day flood forecast at -1 day / -24 hours. After this trigger there is 24 hours to implement the high-cost pre-disaster actions before rural roads are no longer accessible. Following this period, if needed, normal response and recovery activities would be initiated.

## Flood Risk Analysis

### Vulnerability and Preparedness

During field visits, communities shared stories of very high water levels, going up to the tops of tall trees and just below the level of roofs. In some cases, ropes were tied between houses and trees to allow individuals to pull themselves through the water many feet above ground-level from treetop to roof make it to higher ground. In previous floods the Nepal Red Cross has made emergency distributions of foods to families stranded on roofs via helicopter drop. It is clear that floods in Nepal represent significant risk to human life, in addition to large-scale damage to property, and livelihoods. Further, the activities that have been taken in the past during extreme flooding events to access destitute, stranded families, have in some instances (e.g. the 2014 floods) included emergency distribution of food and non-food items dropped via helicopters to families stranded on rooftops. These actions are extremely high cost. As such, it is likely that an FbF system (implemented at scale) in anticipation of an extreme flooding event of this magnitude would have a favorable cost-benefit ratio.

There is a high level of heterogeneity between communities in terms of exposure to flood waters, their preparedness measures, the existence of elevated evacuation shelters, their knowledge and use of existing early warnings, and their familiarity and exposure to the

NRCS. The study team observed neighbouring villages with entirely different levels of community organisation. One village clearly had a long term relationship with NRCS, was in the process of building an elevated cement evacuation shelter, had individuals trained in search and rescue, was well aware of flood warning text messages, and has a community organisation with pooled funds into which households made contributions with a communally held bank account that could be accessed during emergency times, including during flood events. During the focus group discussion they mentioned multiple actions at both household and community level that they are already taking in the time period directly before a flood and while their roads and home are inundated, including moving the elderly, disabled, pregnant and young children to higher ground. During focus group discussions community members described road access being wiped out during flood events and thus they sent a small delegation or able-bodied persons to wade through the water to buy prepared foods and water to bring back to the broader community. These items in this instance were bought on credit and paid for later when they could access their communal bank account.

In contrast, the neighbouring community appeared to have a very low level of self organisation, including no communal loans and savings or contingency funds, no exposure to search and rescue training, little to no awareness of existing flood forecasting early warnings, and little connection to NRCS or any other external organisation. Admittedly the study team was only able to visit a small number of communities and so an analysis of vulnerability and exposure must be primarily informed by secondary sources and the experiential knowledge of NRCS and other stakeholders. However, the contrast between the two neighbouring communities was striking and demonstrated not only the heterogeneity of preparedness and organisation at community level but also highlighted two key challenges; Firstly, the challenge to design actions that would be suitable for communities with variable preparedness and self-organisation, and secondly, the importance of village-level targeting post-trigger so as not to exclude communities that are poorly networked with external organisations and with low levels of self-organisation if their vulnerability is comparatively high.

### Exposure

Exposure to flood waters within the Terai varies enormously. The most flood-prone districts and sub-districts are well understood by all parties. However, how exposure varies at village and household level is a significant gap. There appeared to be a belief held among stakeholders that proximity to the river bank was the primary characteristic of exposure - that the houses and villages closest to the river's edge were necessarily the most at risk of flood impacts. However, other factors are important indicators of exposure. In addition to proximity to rivers, elevation (which is often visually masked in the plains environment), position vis-a-vis the upstream-downstream, and the building of momentum of flood waters as they move across the landscape will be necessary to consider. Further, there are likely to be changes in vulnerability in future with the establishment of new large-scale water management infrastructure projects. There are multiple large projects in progress or at the planning stages throughout the Terai to better manage water. This will have a positive effect on reducing flooding in some areas and a negative effect on others. It will be important for NRCS to keep abreast of these developments and review all available documentation to understand which communities may have an increased risk - especially if

those communities have not typically been flood-prone and as such may have few internal coping capacities.

An impact-based FbF system is meant to be able to provide guidance on where to take action following a trigger. Given there is a such a high level of variability in both preparedness and exposure in the flood-prone districts, effective community-level targeting will be essential. A community mapping exercise using geo-location such as Open Street Map may be beneficial to understand the differing vulnerability. This would be an opportunity to mark which communities (A) have a functioning community organisation, (B) have a suitable evacuation shelter sufficient for their population, (C) whether there are elevated areas/homes which could provide temporary shelter, (D) have an elevated water source, (E) their elevation, and (F) whether their flood risk is likely to change in the next 1-5 years as a result of large water infrastructure projects.

### Danger levels

The work that has been done by DHM on flood danger levels thus far has focused on road submersion. Although there is likely to be some variation from road to road, broadly the first danger level of DHM is set at the flood level whereby it is expected that main rural roads will be submerged. This corresponds with a 1 in 2-5 year return period, which is also the minimum threshold for an FbA by DREF EAP. The submersion of roads is a logical threshold for FbF actions as it limits access to communities in need. The national society staff and volunteers at chapter level in Bardiya expressed frustration about 'sitting on their hands' waiting for water levels to recede before being able to support communities. Triggering and completing actions in advance of when rural roads become impassable has a clear logic. Given all of the above, it is recommended to use the same danger level as that used by DHM for river floods with a return period of 1 in 2-5 years. In practice this would mean triggering in anticipation of events of this magnitude or greater.

### Possibility to develop an Impact-based forecast (IBF)

IBF is quickly becoming the gold standard for severe weather warnings, although it has been implemented in very few low-income country contexts to date. IBF aims to go beyond forecasted what the weather will be, and instead forecasts what the weather will do (the impacts). Work has been initiated globally by the United Kingdom Meteorological Office (UKMO) and endorsed by the World Meteorological Organization (WMO). Initial discussions have already taken place between UKMO and Nepal stakeholders including DHM and WFP about the establishment of an IBF system in Nepal to produce robust severe weather warnings for multiple hazards, supported by the Asia Regional Resilience to a Changing Climate (ARRCC) programme. Development of an IBF system by the respective mandated authorities is an opportunity to enable FbF systems. The warnings produced by an IBF system could be used as the FbF trigger. The type of IBF which could be established in Nepal is nicely explained in this video focusing on the system in South Africa (<https://www.youtube.com/watch?v=uwpswXH2X9Y>).

At present, there are informal practices to integrate lots of data sources and experiential knowledge already happening. For example, multiple district-level stakeholders explained

looking at the outputs of the river gauge (which are presented in real-time on the government website: [http://hydrology.gov.np/#/river\\_watch?k=n4pc2t](http://hydrology.gov.np/#/river_watch?k=n4pc2t)) and looking at the rain forecast upstream, and qualitatively making a decision about expected flooding in the area based on their experiential knowledge of what happens when both those indicators are indicating high risk, at what point during the monsoon season, and for which communities (based on a tacit understanding of elevation and location as it pertains to local dykes, embankments and other structures affected the behavior of flood waters). Based on this, the police embedded within the district emergency operations centres are then informed of the elevated risk of flooding so that they can take action (not pre-defined). In this way, an informal IBF is already taking place in some areas of the Terai. A national level IBF would make the kind of calculations already happening mentally about which indicators produce impacts and where, and integrate this kind of thinking in a more standardized, empirically-grounded way, at higher scales, and for multiple hazards. The system would allow for a clear integration of vulnerability and exposure indicators to highlight where the most severe expected impacts will occur, which areas/elements are exposed to the hazards and who or what infrastructure is most likely to be affected given their vulnerability conditions.

Negotiations are currently underway to establish such a system in Nepal. A full system could be operational by 2022. In the meantime, forecasting the impact of floods in Nepal can still be done with sufficient vulnerability and exposure data, building off the informal work anticipating impacts that is already happening at district-level. To do this, FbF projects typically try and produce an impact curve which charts the damage produced by a hazard with the return period (extremity) of that hazard to more reliably set the threshold for action. An analysis to produce an impact curve will be completed by the Climate Centre for the FbA by DREF EAP in the coming year. There is insufficient time and access to data (at present) to complete such an analysis for the 2019 monsoon season, and as such it is recommended that the threshold be set at the bank full level, which is the current threshold used by DHM for flood alerts. Producing an appropriate impact curve to produce an impact-based FbF trigger for the coming years rests on close collaboration with WFP. WFP have already completed extensive work on vulnerability mapping through their Vulnerability Analysis Mapping (VAM) tool, and as such it does not make sense to try and do a separate piece of work on vulnerability. It will be important to collaborate closely with WFP to establish joint triggers and jointly integrate their vulnerability and exposure work into the multi-step flood forecasting system designed for the FbF program. This will also involve accessing or creating location data with the view to create a bespoke map of the Terai. Initial discussions with WFP indicate they are happy to engage, but outlining clear roles and responsibilities still needs to be done.

The Asia Regional Resilience to a Changing Climate (ARRCC) programme offers a unique opportunity to develop an FbF system that is co-produced and co-implemented by many national actors in Nepal with support from external partners, including RCCC and UKMO. The trigger level for the 2019 monsoon season will be set for one river basin using the existing danger level (bank full level, 1 in 2-5 year return period) set by the national government for issuing warnings, as this is a small pilot system designed primarily to gain knowledge on actions implementation and there is insufficient time to do additional trigger analysis. However, in the long term, a more sustainable, integrated approach is possible

under the ARRCC program. Specifically, this program will include IBF learning labs, through which key actors will be able to come together and co-design components of the IBF system, which ideally will also be the FbF triggering model in the long term.

### Jurisdiction for disseminating the forecast / early warning

The jurisdiction for disseminating warnings at district level rest with the Chief District Officer, who in turn is in close coordination and communication with high levels of government, including DHM headquarters. The FbF concept was explained to the Chief District Officer in Bardiya where the FbF 2018 pilot took place and where the 2019 trial is meant to take place. The feedback from the Chief District Officer was that an FbF system must maintain the integrity of the DHM forecast. In other words, the DHM forecast must remain intact and not altered. Further, Chief District Officer indicated that adding a layer of vulnerability and exposure data in addition to the hazard forecast would be acceptable. This is fine because we do not need to make any alterations to the 1-day forecast, which is sufficiently reliable for an FbF system. However, it will be important to make sure in all communications that the DHM 1-day forecast is the basis of the activation trigger. It is possible that presentations of the recommended triggering system, once the GLOFAS readiness trigger and the exposure and vulnerability data layers are added, will mask the underlying forecast used. It will be important that it remains visibly an applied use of the DHM output. Lastly, the recommended triggering system outlined on page 14 has not been presented to DHM either at headquarters or at district level. It will be important to present the recommended triggering system (-7 day GLOFAS model, -1 day DHM triggers etc) to get their feedback and approval so as not to overstep jurisdictions as it pertains to the dissemination of warnings / forecasts.

### Next steps for integrating the available forecasts and data into an FbF system

Note: these recommendations are for the development of an FbF by DREF EAP at national scale, and many of these steps are not necessary/feasible for the coming monsoon season. The study team recommends the following steps to integrate the available forecasts into an operational FbF system. It may be possible for some of these steps to be completed as part of the ARRCC program. This will need to be planned out with ARRCC stakeholders at a later date.

**Step 1:** Identify a climatologist or hydrologist in the government who can be the point person for FbF, and train the professional on the implementation procedures for the trigger, perhaps including a study visit to another country FbF project or a collaborating university.

**Step 2:** MoU with DHM to have access to the forecast digital data and advisory support. The RCCC hydrologist (Dr. Hassan) will collect this observation and forecast data from DHM. With support from technical expert from DHM and local university, the parties will jointly compute the skill of the forecast (vis-a-vis the impact limit).

**Step 3:** Through consultation with community-level stakeholders and the NS, confirm whether a 5-year return period (flooding of roads) is the appropriate impact level at which the community will need help at the time of disaster. Using historical data from the DHM, confirm the river levels that accord with this return period.

**Step 4:** Collect and organize the vulnerability data from WFP such that it is in a format which can be integrated with a hazard forecast, with support from RCCC.

**Step 5:** Develop the relation between hazard intensity against the impact from historic damage/impact data for different exposure levels. This should be developed in close cooperation and coordination between the department of disaster management and the Nepal Red Cross National Society, with technical support from the Climate Centre.

**Step 6:** Develop the model for triggering using the forecast, impact curve and vulnerability data. This model should show the potentially inundated roads, houses, and infrastructure at the trigger flood level and higher, so that the national society can see clearly where to take action when the trigger is reached.

**Step 7:** Complete national society capacity building at all the stages of the work mentioned in the above steps of trigger development. Note: capacity building for other aspects of the FbF system beyond the trigger are outline in the section on capacity building.

## Actions Analysis

One of the major lessons learned coming from the FbF projects that have been completed so far is the importance of selecting the best possible actions. At times in the earlier FbF projects, too little focus was placed on action selection as compared to the operationalization of the triggering mechanism. Ultimately, regardless of the skill of a triggering mechanism, if the actions that the trigger initiates are not very helpful for reducing the specific disaster impacts that are meant to be addressed, the FbF system will not help beneficiaries to reduce hazard impacts.

The selection of actions for any FbF system is an important one that must balance a number of considerations, including the effectiveness of a given action to reduce specific disaster impacts, the clear benefit in doing the action before the disaster rather than after the disaster, the ability for the national society and other partners to realistically complete the action after the warning but before the disaster hits (thus working very quickly), the suitability of the action for the local context, the experience/skills of locally engaged staff and volunteers to complete the specific action, the scalability of the action(s), and the complementarity of actions (if more than one is being implemented).

There is no perfect set of actions for any given context or capacity level. What is needed is a consideration of all the above factors, the development of a clear theory of change for each action selected, and a willingness to re-evaluate with each trigger in a transparent and critically reflexive manner, so that over time the system initiates the best actions possible.

More extensive exploration of potential actions to shortlist for the 2020 monsoon and onwards will be needed, especially if flash flooding is going to be added to the EAP on riverine/fluviat floods, as this would require an assessment of actions that could be completed within a few hours. For the 2019 floods, it is recommended that a paired down version of the actions identified for the 2018 pilot be used.

### Building off of the 2018 FbF pilot and pre-existing preparedness efforts

The 2018 pilot project afforded a valuable opportunity to explore potential FbF actions and also gauge responses by the pilot community and NRCS chapter to those actions. The set of actions for the pilot was comprehensive, with multiple arrangements in place such as pre-purchase agreements. The relevant NRCS chapter office was well-aware of what they would have done should they have a trigger. Equally the selected focus community was also well aware of what was expected and broadly ready to take action. The lessons learned coming out of the pilot are very well documented and the critical reflections of the implementing staff contained within the reports were helpful and informative to this study. Titles of those reports can be found in the annex of this report.

As is the case with many small-scale pilot projects with a pre-defined focal community, there are aspects of the post-trigger actions planned for the pilot that would be difficult to take to scale in a large FbF system. Most notably those are:

1. In the pilot there were a large number of different items requiring different pre-purchasing agreements in the adjacent market town to the flood prone area. Scaling this approach would mean creating these agreements for vendors in market towns over large areas of the flood prone regions of the Terai. This would incur a large overhead cost, which may in turn need to be re-done each season dependent on vendor availability. It is recommended that the number of pre-purchasing agreements be paired down to a number that is more manageable to take to scale. This would involve reducing the items included for distribution and also making those agreements in hubs that can service larger areas (ideally one per district).
2. The 2018 pilot selected a community as the focal community that has a high level of preparedness. Although it was not possible to do a comprehensive assessment as to how typical their level of preparedness was during the study mission, observations of other communities that were visited in neighbouring areas and conversations with local Red Cross staff and volunteers suggest that the pilot community's level of preparedness and internal organisation are much higher than average. Given that an FbF system operating at scale needs to be able to work in any community where the anticipated impact is highest, actions need to be suitable for communities with lower levels of preparedness. In principle, for FbF systems in all countries, the actions should be able to be completed within communities that have no pre-existing training or pre-existing relationship with the Red Cross.
3. The 2018 pilot included significant pre-trigger contact with the focal community, including an agreement that households would supply large bamboos to support the set up of evacuation shelters. Actions requiring extensive pre-trigger contact are difficult to scale because it would require that level of contact (and any pre-trigger agreements) to be done in virtually every community within the basis that is flood prone. This is because in an FbF system operating at scale, communities to receive support are not pre-selected, but rather selected at the time of the trigger when the

areas at highest anticipated risk become known (based on the forecast + exposure data + vulnerability data). For the context of this flood FbF program in the Terai, which will most likely use a 7 day readiness trigger, contact with the communities that receive support would begin at this 7 day readiness trigger. Anything before the 7 day readiness trigger would need to happen in every flood prone community in the basin, which is unrealistic and would incur significant cost.

There are multiple preparedness investments that have been made in the Terai which form a strong basis for an FbF system. Care should be made to ensure an FbF system capitalizes on all of these assets. The list of investments that have been made in this area is extensive and it was beyond the scope of this study to capture all of them. However, those that the study team became aware of that are highly relevant for FbF include:

1. The coordination of the District Emergency Operations Centre (DEOC), which works in close collaboration with radio stations and other media outlets to disseminate warnings. An FbF system could include pre-disaster messages which are disseminated in the same fashion.
2. The establishment of Information Management Officers seconded from the Red Cross to DEOC to support disaster monitoring. In addition to fostering very close collaboration between the government and the Red Cross at district level, these officers increase the capacity of the DEOC to monitor forecasts and hydro-meteorological observations and to anticipate disaster impacts.

### Feedback on actions and planned action implementation from the field

During the field visit there were a few feedback points made by residents of the FbF pilot community and chapter staff/volunteers that worth reiterating here:

1. It was communicated that there is insufficient provision for volunteers. The study team took this to mean insufficient budget for volunteer per diems specifically. This was expressed as a general point, but also pertaining to the FbF pilot. As such, it will be important to do a full costing, in advance of the pilot season, of how many volunteers are needed over how many days to complete all necessary actions of the FbF trigger, as well as any pre-season actions, and post-trigger impact evaluation activities.
2. It was communicated that there is a lack of clarity of what needs to be done by Red Cross chapter staff and volunteers post-trigger for WFP. It was expressed that they want to be ready to do what is expected of them and not to disappoint any parties. Further, there will also need to be clarity on what is expected of chapter staff and volunteers for activities of both the WFP and Red Cross FbF programmes, especially if they both trigger in the same areas at the same time (which is likely given there is a view to harmonise triggers). This will require strong coordination and pre-planning for lots of different post-trigger scenarios.
3. A concern about the use of unconditional cash was expressed. Specifically a concern about misuse of cash (spending on inappropriate things) and also that cash would encourage a mindset of dependence and discourage self-reliance. If cash is selected as a method to support households, these concerns will need to be addressed. Sharing the literature base on cash, or perhaps studies on cash use for FbF (for example Bangladesh or Mongolia) in a format that is accessible could assist in this

effort. New cash-focused programs beginning in Nepal such as the new ECHO-funded programme with cash components will also help raise awareness about the uses of unconditional cash.

4. The chapter staff and volunteers in Bardiya expressed a preference for FbF actions that focus on food, potable water and the provision of toilets.
5. It was communicated by members of the FbF pilot community that they were uncomfortable with the agreement for them to provide bamboo for the shelters. Although they understood the rationale, they worried that in the stress of evacuating themselves and their belongings that they would be too overwhelmed to do the harvesting.

### Actions short-listing

According to interviews, the primary barrier to supporting flood affected persons is access. Typically, the Red Cross chapter is aware that households and individuals are in need of support but are in one of the following scenarios:

- A. stranded in evacuation areas (official or unofficial) with little to no access to food, safe water, latrines, medicine and/or shelter
- B. stranded on their rooftops or in trees, but the water levels not rising or receding with little to no access to food, safe water, latrines, medicine and/or shelter
- C. stranded on their rooftops or in trees with water levels rising, requiring immediate search and rescue support

Additional analysis is needed to understand how correlated these scenarios are to the return periods of floods. However, given an FbF system would trigger for 1 in 5 year floods, or more extreme flooding events, all of these scenarios are possible following an FbF trigger. In the scenario C, which is the most extreme, this level of flooding is likely to be followed by a large-scale response effort. The selection of actions must bear in mind these different scenarios. It is possible that some actions would help beneficiaries in scenario A and B but be entirely useless in scenario C. The process of selected actions for the FbF system will require careful consideration of what actions would have the highest potential to reduce the likelihood of beneficiaries finding themselves in any of these scenarios post-flooding.

### Scale of intervention

While most FbF interventions have done interventions at the household level (e.g. providing cash or NFIs to households directly), it is not a given that all FbF interventions need to happen at household level. It is possible that an action could happen at an institutional level (e.g. providing equipment to volunteers), at a community level (e.g. providing a communal water purification unit, or providing communal supplies to an evacuation site) or at a broader level involving the wide-scale dissemination of messaging. During the field visits, it became clear that there are many village-level groups, such as village development groups, loans and savings groups, etc. It may be possible to provide supports at the group level, such as cash transfers to established community groups with bank accounts, to increase the coverage of the FbF intervention and build off the investments that have been made in establishing and maintaining these community structures. Action at the community level involves working out which areas are covered by a functioning group which could be given support. If a mapping of functioning community groups does not already exist, then a

mapping exercise might need to be undertaken to target at this level. Decisions about the scale of intervention is ultimately up to the local stakeholders.

#### Readiness and Immediate pre-disaster actions

If the suggested triggering model (-7 day readiness trigger and -1 day pre-disaster action trigger) is adopted, then two sets of complementary actions are needed. Readiness actions are meant to be lower cost, no regret actions which can be taken to get ready for a subsequent pre-disaster trigger when there is insufficient skill to be able to begin higher-cost actions with more lead time. Given there is a high level of uncertainty at this lead time, they should all be actions that the national society is comfortable taking in a false alarm scenario. In contrast, pre-disaster actions taken -24 hours before the disaster can be done with a higher level of certainty that the forecast is correct. These actions must be able to be reasonably completed in the time frame afforded by the forecast, which in this instance would be 24 hours. Note, that the -24 hour period pre-disaster could commence at any time of day, including in the middle of the night, on a public holiday etc, and so plans must be made that are suitable to fully take advantage of the 24 hours, regardless of the time of triggering.

The final selection of actions needs to be done by local stakeholders. This study can only make recommendations of which actions to consider based on interviews during the study, although some actions are likely to be essential for the functioning of the system (marked below). Actions recommended to be done following the readiness trigger (initiated at -7 day lead time and completed before -1 day) are as follows:

1. Activation of the CDMC (including the police, NDEOC, Red Cross and others) [essential]
2. Selection of villages/households to support, based on where the highest risk is indicated [essential]
3. Refresher training for plans of evacuation, search and rescue practices (and other types of trainings if relevant)
4. Volunteer visitation to areas highlighted by the trigger model as having the highest level of risk. During this time they:
  - a. Communicate the elevated risk, uncertainty of the forecast, plans (-24 hour activities) if a later forecast confirms the risk level
  - b. Identification of areas of high elevation based on the community mapping exercise or community perception / expert judgement
5. Volunteer visitation to safe areas to inspect it meets minimum criteria for a safe area (criteria to be developed, but must include a minimum elevation so as not to also be submerged in an extreme event)
6. Volunteers position basic supplies, based on needs, to safe areas [supplies to be determined, but should be very low cost at this stage]. This could include the installation of a temporary toilet (pending a review as to whether these can be procured and installed within the lead time).

Recommended immediate pre-disaster actions (initiated at -24 hour lead time to be completed before roads become inaccessible) are as follows:

1. Dissemination of warning via radio, loudspeaker, in person by volunteers, and/or SMS with clear guidance on the steps affected persons should take to reduce their risk
2. Distributions to households (items to be determined, but could include food, tarps, WASH items, cash).
3. Distribution of search and rescue essential items to volunteers in the area identified as having the highest risk.

## Capacity Assessments

### National Society Capacity

#### General

NRCS currently undergoing several changes. The society is wrapping up large scale response and recovery activities following the 2015 earthquake, which may result in a reduction of core staff at headquarters level. The number of PNS delegates is also planned to be reduced with several PNSs planning to coordinate with shared delegates. The long-standing head of disaster management has recently retired with a new staff person coming from the health sector to take his place. Although it is expected that this transition will be smooth, some of the institutional knowledge may be lost. In particular, the now retired head of disaster management was well-versed in the FbF concept, the pilot which was undertaken, and the lessons learned coming out of it. Going forward, the staff persons working on FbF will need to make sure the new senior level of the disaster management department is well engaged in the process.

Given a Preparedness for Effective Response (PER) process has recently been initiated, this documentation was used to assess general NS capacity, rather than doing a light-touch capacity assessment during the two-week mission to Nepal. A review of the DRCE report indicates many strengths relevant to FbF including good coordination between partners, timely deployment of volunteers, appropriate reporting, strong external communication, strong community engagement, and appropriate use and management of stocks and pre-positioned supplies. Weaknesses relevant to FbF include ill-defined scales at which to respond, lack of some procedures for internal response management, lack of safety and security policies to keep volunteers and staff safe, and little evidence of the use of early warnings for hazards to act proactively. These assessments were more thorough than the limited amount of capacity assessment which could be done as part of this study. The assessment results documented in the DRCE are largely commensurate with observations made during the mission.

#### Finance

During interviews with the finance department, they were very open to the FbF concept but expressed some concerns about how quickly funds could move from headquarters to district chapter level through the DREF mechanism. For the 2019 monsoon season this will not be a problem as the funds will be made available bilaterally through the Danish Red Cross, which currently keeps sufficient budget in-country. For the FbA by DREF (to be considered for later years), both IFRC and FbF-related staff at HQ will need to engage the

finance team in the decisions around how the funds will be managed.

There are many options acceptable to IFRC in this regard, including using funds held in-country which are later replenished.

### Technical Service Capacity

It was not possible to do a meaningful assessment of DHM's capacity, apart from a skill analysis of flood forecasts (discussed on page 9). However, the set up at district level (the issuance of warnings, data management, integration for Red Cross chapter to government emergency operations) appears highly conducive to an FbF system. ICIMOD (International Centre for Integrated Mountain Development) is also headquartered in Nepal, which is a valuable asset. ICIMOD and DHM have a strong collaboration.

### Capacity of the FbF Community of Practice

This project benefits from an established FbF community of practice. There is an FbF working group which meets regularly and multiple partners who have been involved in developing FbF systems, with staff who have attended FbF dialogue platforms. It is a strong foundation for the NRCS to begin larger scale forecast based work. Coordination will need to be prioritised for multiple aspects of the program - most notably the triggering modalities (forecast, danger level, integration in government systems) and the implementation of post-trigger actions (locations for each institution to support and the NRCS ground-level staff and volunteers to implement the actions). Additional MOUs may need to be developed to achieve these aims.

### Recommendations on areas for capacity building for stakeholders

The stakeholders of interest in this case would be primarily DHM (including counterparts at lower levels of government), local governments, NRCS and relevant partner national societies, relevant disaster management authorities (at all levels), and other members of the FbF working group including WFP and Practical Action.

1. Any party using the output of the FbF trigger must have the competencies to
  - a. understand and interpret the output (which will be a map with layers of hazard, exposure and vulnerability information) accurately with an understanding of the uncertainty inherent within it.
  - b. use the output to identify communities to target for early action. From this basis, apply additional targeting criteria (if any), to identify specific households which will be receiving forecast based support (for example, non-food items).
  - c. have the soft systems in place to be able to work very quickly during the lead time afforded by the warning. This may require dry-runs and other exercises to practice working at the speed required (including at headquarters level, such as the administration of finance etc.).
  - d. evaluate the impact of those actions in a rigorous way. The RCCC M&E specialist can support on some aspects of this as needed. Evaluating the

impact will be necessary for continually improving the EAP and for furthering the learning of the larger FbF community of practise.

2. Parties involved in the original design of the FbF triggering system must build the capacity to evaluate the trigger post-disaster, update the trigger as necessary for subsequent EAPs with minimal external support, and eventually develop triggers for additional hazards.
3. The Nepal Red Cross Society, IFRC, and supporting partner national societies should work together to build the core competencies that support the FbF system, including data preparedness, GIS skills, strong financial management, and capabilities associated with specific actions including cash readiness, WASH, health, and shelter-specific skills as well as building an understanding of the FbF concept and trigger model.
4. The early warning systems (EWS) in Nepal are highly variable district to district in terms of their functioning, reliability, use within their catchment areas and so forth. The weak EWSs need to be strengthened such that they provide the early warning service that the public is entitled to. This will require additional investment.
5. Access to safe evacuation shelters with sufficient sanitation provision and the capacity to shelter sufficient numbers of people, remains a major challenge. For extreme flooding events, there is no replacement for necessary shelter infrastructure. The FbF working group must continue to advocate for emergency shelter provision and make clear that FbF action will not replace the need for families to evacuate to safe areas in extreme events.

## Next Steps

### Plans for Monsoon season 2019

#### Rationale

Given the investment that was made in the 2018 FbF pilot, and the enthusiasm about FbF at both chapter and headquarters level, it is recommended that the national society implement an additional pilot for the coming season. Working in Bardiya District is recommended as the Red Cross chapter is already very familiar with FbF. There are more than 125 flood prone communities in Bardiya District.

#### Funding practicalities

The Danish Red Cross is able to bilaterally fund the post-trigger costs, if the programme triggers in the 2019 monsoon season. It was understood by the study team during the mission that there is sufficient funds held in country for an activation of this scale which can later be replenished. As such, the ability to make immediate transfers from outside Nepal is not needed. The practicalities of getting funding to Bardiya District immediately, if triggered, needs to be reviewed by the Danish Red Cross in country.

#### Design recommendations

As this will be a practice for how an FbF system would function at scale, it should not use a pre-defined community. Rather, it should be ready to take action in any of the 125 flood prone villages in Bardiya, where the trigger model indicates the highest risk. The number of villages that could be covered this season still needs to be determined. It is recommended that

this trial run covers approximately 500 households to gain experience working at scale based on a forecast. If there is a trigger, it is likely that the area highlighted as having the highest need will be larger than the program is able to support. Targeting criteria will need to be developed. If there are areas highlighted at highest risk that includes villages that the Red Cross has not previously worked with, it is recommended that those communities are included to gain practice working in areas without an established relationship with the chapter. The actions recommended for this season are the same as those outlined on page 23. A smaller set of actions may need to be prioritised for this season.

#### Additional data/information needed to set the trigger for 2019

1. The exact locations of the forecasting points from DHM for the selected basin (affecting Bardiya District), as well as the observation data for those locations. Ideally, this would be 10 years of observation data for these stations, but 5 years would be sufficient. It is possible that this data may need to be purchased.
2. Request the 2017 flood exposure map from DHM.
3. Request a topographic map of Bardiya to understand the elevation of communities as compared to roads, to identify which communities are below the road level.
4. Request to use WFPs VAM. This can be combined with the 2017 exposure map and topography map for the selected basin to guide village level targeting post-trigger.

#### Next steps to be trigger-ready for the 2019 Monsoon season

The following steps need to be completed. The RCCC can support remotely on all steps, as requested.

1. Set the trigger
  - a. Present the outlined trigger model to relevant stakeholders to get feedback and buy-in (NRCS, PNS, IFRC, DHM, WFP, PAC). This should ideally be done through the FbF working group.
  - b. Establish MoU with DHM (if not possible for this monsoon season, then definitely for the following seasons), including the agreement to provide real-time notification for when the FbF trigger has been reached to relevant individuals within the Red Cross and other partners.
  - c. Request additional data from DHM and WFP (outlined above)
  - d. Request support from WFP for vulnerability mapping (ideally get permission to use their VAM output).
  - e. Make a final decision on the trigger model based on feedback.
2. Define the scale of intervention (e.g. the number of beneficiaries)
3. Select the actions following both triggers and develop a theory of change for those actions
4. Make a post-trigger coordination plan with WFP if they intend to be operational for the coming monsoon season.
5. Make an outline of how the system will be evaluated (the trigger, actions) if the system triggers.
6. Arrange financing internally within Danish Red Cross for pre-trigger set-up activities, post-trigger costs in the eventuality that the system triggers.
7. Make a new contract and deliverables with RCCC for ongoing support.

## Proposed ongoing support from RCCC

Based on the study team's understanding of what the main support needs are, the areas of ongoing support are as follows:

1. Remote support to be trigger-ready for smaller scale bilaterally funded trigger for 2019 season
2. Remote support to develop the EAP for FbA by DREF through the design phase and all steps of the validation process. This could include in-country support, if needed.
3. Support for post-trigger impact evaluation to contribute to the ongoing learning within the FbF community of practice
4. Support the co-development of an Impact-Based Forecasting system with mandated authorities in Nepal and the UK meteorological office.

## Additional Opportunities

### Opportunities to address additional hazards in future

The study team found that the FbF programme should start with floods, but could include no-cost actions for flash floods. If the lead time for flash floods improves, costed actions for flash floods could be introduced. The lead time would need to increase to 24 hours or more. It is currently 3-6 hours.

The national society should maintain close contact with Practical Action to be aware of the research outcomes on the landslide forecasting system. If this system becomes operational, it would be possible to develop an FbF landslide programme.

FbF for heatwaves and cold waves could be viable in certain parts of the country. If there is interest among national stakeholders, this EAP could be developed quickly after the flood EAP has been finished.

### Opportunities to explore social protection in Nepal aligned with FbF

There is growing interest in the field of adaptive social protection, with an increasing appreciation that social protection is a valuable modality to support vulnerable people affected by natural hazards. The integration of FbF into social protection systems could be a valuable opportunity to reach vulnerable hazard-affected people. Also, given the experience of DRC and NRCS in supporting persons with disabilities, DRC and NRCS are well-placed to support in this area. During the field mission, a representative of UNICEF (which is a key partner in the implementation of social protection in Nepal) expressed an interest in integrating the triggering system developed into their internal protocol, but more discussions would need to take place. If there is interest among national stakeholders to explore further how the FbF system could be integrated into social protection systems in Nepal, this is an area where the RCCC could provide additional support. In particular, there would be a strong logic to integrating an FbF system for cold and heat waves with social protection systems that target the elderly, infants, chronically ill, and persons with disabilities in both rural and urban settings.

## Conclusion

There is high feasibility for FbF in Nepal. Nepal uniquely benefits from a pre-existing FbF community of practice. Riverine flood has been highlighted as the first hazard to address, but other hazards including flash floods and heat and cold wave have potential. While capacity needs to be built in some areas, the NRCS is well-positioned to implement an FbF program. If local partners are committed, it will be possible to develop an EAP of a sufficiently high standard so as to pass the validation process. An FbF system operating at scale in Nepal has the potential to substantially reduce disaster impacts before they are experienced.

## Annex

### Annex 1: Documents reviewed prior to the field study

- Forecast Based Finance Pilot Project Bardiya – Lessons Learned 2018
- Forecast Based Finance Discussion Paper (unofficial) 2018
- Flood Hazard Maps
- GIS Based Flood Hazard Mapping and Vulnerability Assessment of People Due to Climate Change: A Case Study fro Kanakai Watershed, East Nepal
- Nepal Flood Snapshot
- Standard Operating Procedures, Forecast Based Flood Preparedness, Bardiya
- Standard Operating Procedures, Forecast Based Flood Preparedness, Banke
- Standard Operating Procedures, Forecast Based Flood Preparedness, Dang
- Department of Meteorology and Hydrology Flood Bulletins
- WFP Pre-Intervention Survey
- Forecast based Financing and Emergency Preparedness for Climate Risks (FbF)
- Danish Red Cross Forecast based Finance Concept Note
- Danish Red Cross Forecast based Finance One Pager
- Department of Hydrology & Meteorology Hydrological Network of Nepal (Sept. 2015)
- Department of Hydrology & Meteorology Study of Major Weather Events
- Department of Hydrology & Meteorology List of Hydrology Stations
- NRCS VCAs (limited number translated into English)