

# Delivering Early Warning Systems for the Poorest

*From flood-vulnerable to flood-resilient communities*



Jodi Sugden, Practical Action, UK

Floods are the most common cause of weather-related disasters globally, causing billions of dollars' worth of damage and the loss of hundreds of thousands of lives. Flood early warning systems can significantly reduce the devastating impacts of floods on lives and livelihoods for the poorest and most vulnerable. To do so, they must be 'end-to-end', combining risk knowledge, risk monitoring, communication and dissemination, and the ability to respond. In 2016, the United Nations Office for Disaster Risk Reduction will produce guidelines that will shape how the Sendai Framework for Disaster Risk Reduction 2015–2030 is implemented around the world with regard to early warning systems. These guidelines must demand end-to-end systems that deliver actionable information to those most vulnerable to floods.



## Executive summary

Floods are the most common cause of weather-related disasters globally, causing billions of dollars' worth of damage and the loss of hundreds of thousands of lives (CRED and UNISDR, 2015; EM-DAT, 2016). It is inevitably the poorest who are hardest hit: they are more likely to live in vulnerable areas and less likely to have the skills or financial resources to protect themselves. Women are more likely than men to lose their lives and livelihoods (UNISDR, 2016).

In 2016, the United Nations Office for Disaster Risk Reduction will produce guidelines to shape how the Sendai Framework for Disaster Risk Reduction 2015–2030 is implemented around the world with regard to early warning systems, including Flood Early Warning Systems (FEWSs). It is critical that these guidelines demand *end-to-end* FEWSs that deliver *actionable* information to those *most vulnerable* to floods. An end-to-end FEWS has four components:

- risk knowledge;
- risk monitoring;
- communication and dissemination;
- the ability to respond.

All four are essential to move flood-vulnerable communities *from vulnerability to resilience*. From Vulnerability to Resilience (V2R) is a framework for analysis and action that describes four key vulnerability drivers:

- shocks and stresses;
- future uncertainty;
- livelihoods;
- governance.

This paper uses Practical Action's work with end-to-end FEWSs in Nepal and Bangladesh to argue that all four system components are essential if communities are to be empowered to protect their lives and livelihoods. Ensuring that all community members and government staff understand flood risk is critical for the system to function ('risk knowledge'). Risk warnings can affect the lives of thousands of people and therefore must be accurate ('risk monitoring'). The communication network ensures that all vulnerable people receive the warning in time ('communication and dissemination'). Finally, flood-vulnerable communities must be able to respond to the threat effectively and in time ('the ability to respond').

FEWSs must be locally owned to sustain resilience gains; this takes different forms in different countries. In Nepal, Practical Action has influenced national government to take ownership of the system. In Bangladesh, the FEWS becomes sustainable by enabling community members to run profitable businesses in return for their key role in communication. In both countries, participatory action planning engages and empowers the community.

Finally, this paper argues that while FEWSs are essential, governments and NGOs must also support people to adapt and diversify their livelihoods, building long-term resilience to floods.

## Introduction

Floods are the most common cause of weather-related disasters globally (CRED and UNISDR, 2015). Between 1980 and 2014, floods and hydrological landslides caused the deaths of 260,000 people and losses of US\$690 bn (EM-DAT, 2016). It is inevitably the poorest who are hardest hit: they are more likely to live in vulnerable areas and less likely to have the skills or financial resources to protect themselves. Gender intersects with poverty, resulting in women being usually more likely than men to lose their lives and livelihoods (UNISDR, 2016).

In 2016, the United Nations Office for Disaster Risk Reduction will produce guidelines to shape how the Sendai Framework for Disaster Risk Reduction 2015–2030 is implemented around the world with regard to early warning systems, including Flood Early Warning Systems (FEWSs). It is critical that these guidelines demand *end-to-end* FEWSs that deliver *actionable* information to those *most vulnerable* to floods. An end-to-end FEWS has four components:

- risk knowledge;
- risk monitoring;
- communication and dissemination;
- the ability to respond.

Each element is critical. To become flood-resilient, communities must have access to relevant knowledge, an effective monitoring system, resilient communication networks, and the capacity to respond promptly and effectively to flood events. Floods will always happen, but it is possible to stop them from becoming human disasters.

Implementing end-to-end FEWSs in flood-vulnerable communities is critical to reducing loss of life and to halting the steady decline in livelihoods that contributes to chronic poverty. FEWSs provide flood-vulnerable communities with 'lead time': a critical period between warning and flood in which they must move to safety. The longer the lead time, the safer and more effective this process is. With enough time, people can also move livestock and other assets. By empowering communities to respond effectively and rapidly, end-to-end FEWSs strengthen local economies and protect development gains.

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### Resilience

The ability of a system, community or society to pursue its social, ecological and economic development and growth objectives, while managing its disaster risk over time in a way that contributes to sustainable growth and helps to mitigate disaster risk. (Szoenyi, 2016)

FEWSs are too often associated with high-cost, high-technology interventions such as satellite monitoring. Gendered needs may be overlooked, exacerbating the vulnerability of women. Getting the message to those who need it, the 'last mile', is too often neglected. Communities may be given a loudspeaker, with no thought for their preparation or response. Such interventions are inadequate. Flood-vulnerable communities must move *from vulnerability to resilience*.

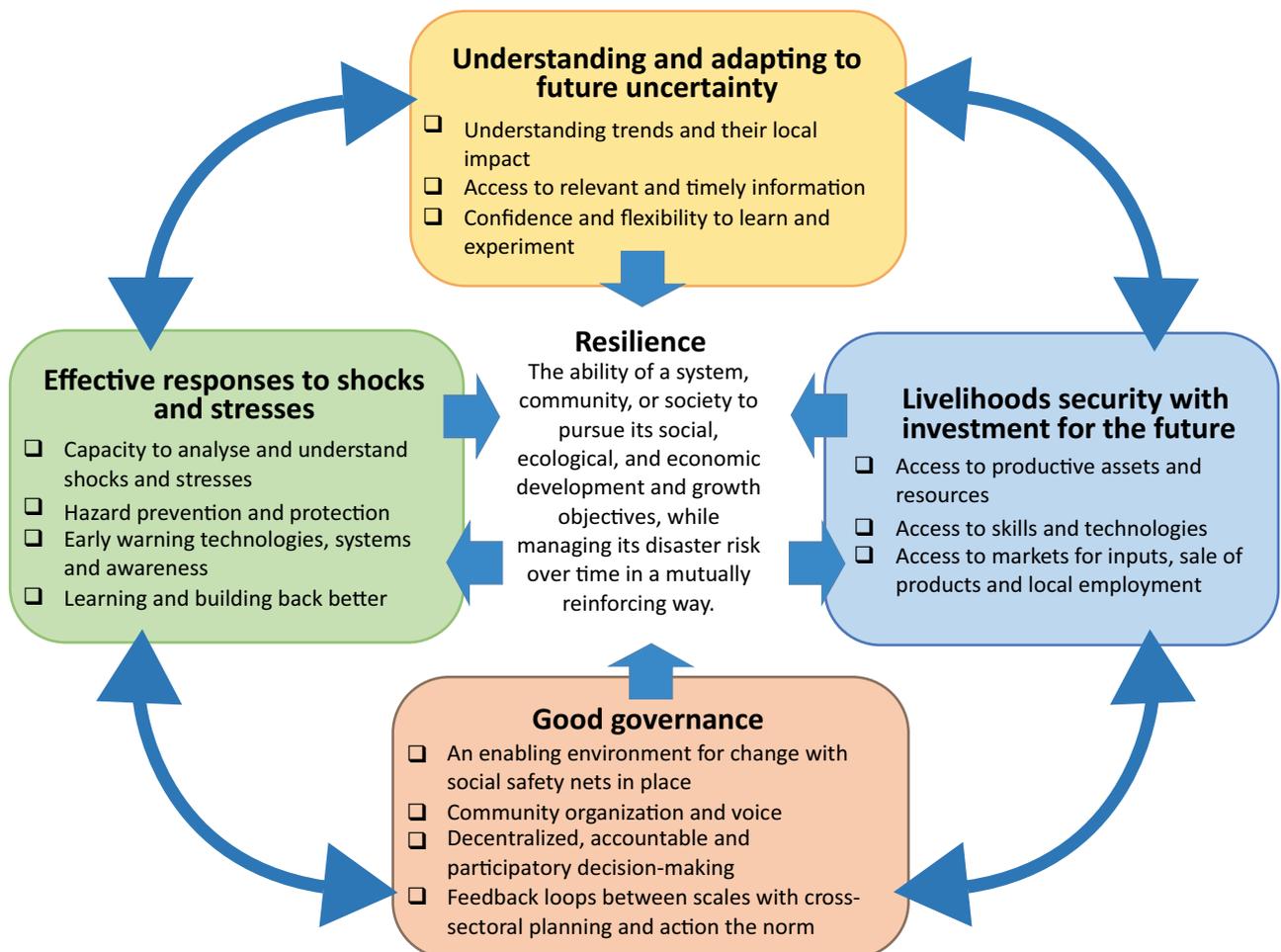
## From Vulnerability to Resilience: the V2R framework

Vulnerability is the degree to which a population is affected by hazards and stresses. The causes of vulnerability are multi-dimensional, including natural hazards such as earthquakes and socio-economic factors such as poor education or lack of savings. Vulnerability may be increased by broader trends such as climate or economic change, which are often not well understood. Poor people usually have weak access to and little influence over the institutions and policies that affect them, so are less able to address the underlying causes of their vulnerability.

V2R provides a framework for analysis and action to reduce vulnerability and strengthen the resilience of individuals, households, and communities. The framework sets out the key factors that affect peoples' vulnerability:

- shocks and stresses;
- future uncertainty;
- livelihoods;
- governance.

The V2R framework illustrated in Figure 1 shows how these factors are linked and provides a starting point for more integrated ways to build resilience.



**Figure 1** V2R framework  
Source: Pasteur and McQuistan (2016)

## From flood-vulnerable to flood-resilient in Nepal

Between 1992 and 2002 flooding and landslides caused nearly \$100 m in losses and a third of all disaster-related deaths in Nepal (DWIDP, 2007, 2011).<sup>1</sup> Practical Action recognized this devastating trend and in 2002 began working with flood-vulnerable communities. With Bhandara community we built a watch tower and siren that afforded the community a few minutes' lead time. This was enough for people to grab the legal documents needed to access post-flood relief and to reach higher ground. With support from the European Commission's Humanitarian Aid department, this system was improved and extended to more communities. Since 2013, Practical Action has collaborated with Zurich Insurance through the Zurich Flood Resilience Programme (ZFRP) to reach more people with more effective FEWSs. This global programme is also implemented in Peru and Bangladesh. In the Karnali basin of Nepal we now implement end-to-end FEWSs with 74 communities.

The following sections draw on Practical Action's work in Nepal to illustrate how each component of a FEWS is essential to protect lives, livelihoods, and hard-won development gains.

### Risk knowledge

Ensuring that all community members and relevant government actors understand flood risk is critical if all are to fulfil their roles in the FEWS.

Basic training to communities and local, district, and national government staff explains how FEWSs function and makes people's roles and responsibilities clear. For government staff this mostly relates to communication and warning dissemination; for community members, response roles are assigned to community volunteers.

Next the community is supported to map its capacities and the risks it faces. This integrates local experience of floods with expert knowledge of upstream developments such as new embankments and inundation patterns. The village map shows critical risk information, for example all households with pregnant women, and capacity information such as safe evacuation routes. This map is kept in the flood shelter and used during emergencies and for longer-term disaster risk reduction planning. It is updated every year before the monsoon season.

Finally an action plan is developed by the community that lays out necessary resilience-building activities. These may include: physical infrastructure such as emergency shelters; skills training, for example in first aid or alternative livelihoods; evacuation drills; or influencing local government to take action.

### Risk monitoring

The river level is monitored at the Department of Hydrology and Meteorology (DHM) gauge station at Chisapani, where the Karnali River enters the Terai plains. Manual and automatic monitoring adds reliability and redundancy if one method fails. Manual readings are taken by the gauge reader, three times daily under normal conditions, and every hour once the river level exceeds 9 m. This is supported by automatic radar readings relayed by internet directly to the DHM.

In Karnali this system gives downstream communities around three to five hours' lead time to move themselves, any community members that need assistance, and as many livestock and belongings as they can to a safe location. All communities report that loss of human life and belongings has greatly reduced since the FEWS was implemented. However, livestock, food stores, and other belongings are still frequently lost. This costs

households money that could otherwise be invested in healthcare or livelihoods. It is essential therefore that lead time be increased as much as possible.

Practical Action and the DHM have been working with Regional Integrated Multi-hazard EWS for South Asia and Africa to train DHM staff and other government agencies on FEWSs. If the system also measured rainfall in the upper basin, it could potentially increase lead time for communities. This year, with support from Practical Action, the DHM will pilot two methods of rainfall monitoring. One is an established 'rainfall-to-runoff' model, which uses basin characteristics such as slope and evaporation rate to estimate the river level from rainfall. The second is a probabilistic flood forecasting model that compares current and recent river level data trends against data from past floods. This forecasts the river level for the next five hours, potentially increasing lead time by one to five hours.

Risk warnings affect the lives of thousands of people and therefore *must* be accurate

Both models will be tested between 2016 and 2018. It is hoped that if one or both are effective the DHM will use them to increase lead time, reducing the devastating impacts of floods. Practical Action has already supported the DHM to upgrade 12 meteorology stations in the Karnali basin to provide automatic rainfall data. Whatever the system, it is essential that redundancy and reliability are built in by using more than one method. In the Karnali basin, risk warnings generated by one gauge station affect the lives of over 52,000 people and therefore must be accurate. Inaccurate warnings are incredibly dangerous; if the FEWS loses credibility, people may not respond to warnings, potentially leading to loss of life.

Different countries may address the core elements of FEWSs differently; Box 1 explains how the ZFRP in Peru implements rainfall monitoring in a locally appropriate way.

#### Box 1: Rainfall monitoring in Peru

In the city of Piura, Peru, not all floods are due to rising river levels; some are caused by heavy rainfall and poor drainage. Government rain stations are limited in number and the results they generate are not accurate for all communities. Practical Action has therefore trained local leaders to read community rain gauges and report rainfall data to the National Water Agency. This data contributes to a database of rainfall patterns, improving knowledge of local correlation between rainfall and floods. Leaders have also been trained to provide rapid warnings to the community and support emergency response.



Figure 2 A leader reads a community rain gauge in Piura  
Source: © Practical Action



**Figure 3** The Karnali gauge reader with a list of contact numbers for downstream communities  
 Source: © Practical Action

## Communication and dissemination

The communication network is the core of the FEWS and must be resilient. If the network breaks down, more lives and assets will be lost.

The Karnali gauge reader (see Figure 3) sits at the centre of a large communication network. This network is activated when the river crosses the ‘alert’, ‘warning’, or ‘danger’ levels. The gauge reader calls the District Emergency Operation Centre (DEOC), local radio stations, the police, the armed police, the army, and Community Disaster Management Committee (CDMC) coordinators in at-risk communities. The nearest communities are contacted first.

The police station contacts local police posts, who use megaphones to spread the message to communities they can reach in time. The DEOC contacts village development committees – the lowest level of government – in the affected areas, also informing the National Emergency Operation Centre. FM radio stations broadcast the warning regularly. The message reaches communities through multiple channels, thus increasing redundancy and resilience in the system.

The CDMC coordinator contacts the heads of each volunteer task force. The Early Warning Task Force is responsible for spreading the message using sirens, flags, or megaphones. In some villages, volunteers go house to house to make sure everyone receives the warning. Many people will phone friends and relatives in other communities.

One of the biggest challenges is keeping people’s phone numbers updated. In Nepal, people often buy a new SIM card instead of topping up to receive free credit. It is up to CDMCs and task force members to make sure that the gauge reader and others in their network have their most recent number. Practical Action manages a flood drill every year before the monsoon to make sure the system is up to date. This involves CDMCs, task forces, and other community members, as well as local and district government staff and the local police.

## The ability to respond

It is essential that those most vulnerable to floods can respond effectively and in time

Understanding risk and receiving a timely warning are not enough to prevent loss of life and livelihoods. It is essential that those most vulnerable to floods can respond effectively and in time.

Task forces play a key response role in end-to-end FEWSs. Each community has three: Early Warning, Search and Rescue, and First Aid, each comprising around five volunteers. Early Warning volunteers are responsible for making sure all community members receive the warning promptly, and are therefore also key to the communication network. Search and Rescue volunteers retrieve people stranded by flood waters, and First Aid volunteers manage any casualties or, in the worst case, fatalities. All volunteers know the risk and capacity map well and help to move the less able to safe shelter.

Each task force needs equipment such as sirens, lifejackets, bandages, and medicines. To keep this up to date and well-stocked, each CDMC manages a community emergency fund. Each household contributes 5 rupees (\$0.05) monthly. Some communities also

rent out the emergency shelter for events to raise money. The CDMC decides how this is spent; one granted 5,000 rupees (\$47) to two families made destitute. It can therefore also serve as a safety net for the community.

In the Karnali basin, many men migrate to India to work. Around 90 per cent of men return to the village only twice a year, for crop planting and harvest. This broadly reflects the proportion of male volunteers in our project villages – around one in 10. Representative participation of men and women helps to ensure that the needs of different groups are accounted for in response.

## Making FEWSs sustainable

There must be local ownership of FEWSs for resilience gains to be sustainable

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There must be local ownership of FEWSs for resilience gains to be sustainable. What this looks like on the ground will differ from country to country.

In Nepal there are costs associated with the FEWS that must be owned and absorbed by the government's DHM for the system to be sustainable. These include wages and mobile phone costs for the gauge reader, and maintaining and replacing equipment such as the radar.

At national level, flooding cannot compete for resources with infrastructure or health. At district level, it attracts a much higher priority due to the great physical and financial damage caused by floods in the Karnali basin. Unfortunately, district officer turnover rates are extremely high; they often move to new areas every 6–12 months. Until 2016, Practical Action had to approach the latest district officer before each year's monsoon to fund the repair of any broken equipment and the gauge reader's phone bills. Some officers would agree, some would not.

Practical Action has now successfully lobbied for the creation of a district-level FEWS management fund, mandated by the national government. No matter how often staff change they will be obliged to use this fund to maintain the Karnali FEWS. Furthermore, we have convinced the DHM to pay the principal gauge reader an extra 3,000 rupees monthly (\$28) for the four months of the monsoon season, increasing her incentives – and her financial resilience – considerably. Until recently, she was paid 200 rupees (\$1.90) per day, a very low wage considering the risks associated with manually checking the river level during monsoon rains and floods.

The four components of a FEWS – knowledge, monitoring, communication, and response – are the same regardless of the country in which the system is implemented. Specific details, however, vary by context, including how a FEWS becomes sustainable. Box 2 gives an example of how the ZFRP in Bangladesh has been made sustainable in a context that is quite different from that of Nepal.

Local ownership of FEWSs is not only about financial sustainability. Participatory action planning is essential to ensure the community is fully engaged with and empowered by the system. Banguan community in Nepal used their village risk map to successfully petition the local government not to build a road that would have inundated their village during the monsoon. Another community used theirs to plot the raised water pumps that provided safe drinking water during a flood, and to identify where more were needed. Community-managed emergency funds can be used to buy more lifejackets, further task force training, or as a social safety net for families who have lost everything. In this way, the community is empowered to manage its own FEWS.

## Box 2: FEWS in Bangladesh

While Nepal is mountainous and prone to flash floods, Bangladesh is flat and open, causing the monsoon floods to come on more slowly and last longer. Gauge readings can provide as much as three to five days' warning. Farmers may even have time to harvest their crops before leaving the village, and the information they need is slightly different.

In each of the communities Practical Action works in, one or two men and women have been provided with a computer, printer, and internet connection to set up businesses providing paid-for internet and printing services to their fellow villagers. In some villages this has been funded by Practical Action and in others by the Bangladeshi Government. This entrepreneur also accesses flood warning information online, and uses this to update local weather information boards using pictures and colour coding to describe the flood situation. Instead of needing the government to pay a wage, this FEWS becomes financially sustainable by enabling entrepreneurs to run their own business.



Figure 4 A FEWS entrepreneur in Bangladesh

Source: © Practical Action

## Beyond FEWSs

FEWSs must be combined with support to adapt and diversify livelihoods

End-to-end FEWSs are essential but insufficient to protect people's lives and livelihoods from recurring floods. To build long-term community resilience to floods, FEWSs must be combined with support to adapt and diversify livelihoods.

In Bangladesh, entrepreneurs also collect agricultural information from the agro-met website. With help from local agricultural extension agents, they translate this into clear, locally relevant advice posted on weather information boards. Farmers can find out when to plant, harvest, or when best to apply fertilizers to make crops more resilient to upcoming periods of drought or flood.

In several communities in Nepal 'Knowledge Nodes' have been built: libraries where women and men can access agricultural information and undergo training. They also provide weather information and forecasts for local farmers, enabling them to adapt their farming practices.

Farmer Field Schools provide more hands-on, practical training and are valuable forums for farmers to exchange ideas and to learn from one another. These are particularly

important for women farmers, who are less able to access government extension services due to cultural norms that prevent them from interacting with male extensionists or travelling far from home (FAO, 2010; Suvedi and McNamara, 2012).

Both services give farmers information on adaptation such as which food crops can be grown in sandy, previously flooded soils. Farmers' groups have been supported to register with the agricultural office. This gives them access to 50 per cent subsidized seed, including flood-tolerant rice varieties better adapted to survive flood events.

In many communities, CDMCs use their emergency funds to train people in alternative livelihoods. Practical Action has also sponsored training, including building improved cook stoves. During floods, traditional earthen stoves are destroyed. Those trained are able to make a living building stoves that use less fuel and create less smoke, leading to better long-term health outcomes, particularly for women. In several communities men and women have also been trained in masonry and household electrics, which generates income and helps people to rebuild after floods.

## End-to-end FEWSs and the V2R framework

End-to-end FEWSs alone do not achieve community flood resilience, but they do speak to each of the four aspects of V2R, as explained below and shown in Table 1.

Improving people's risk knowledge through training, and drawing out local knowledge and experience of floods reduces *future uncertainty* by improving understanding of flood trends and their impact. It helps people *respond to shocks and stresses* by increasing awareness of and building capacity to analyse those threats. It also provides a foundation for understanding how *livelihoods* should be adapted to be more flood-resilient.

Risk monitoring sits firmly under *response to shocks and stresses* in the V2R framework. It also reduces *future uncertainty* by improving access to relevant and timely information. It is of course intrinsically linked to the other aspects – without accurate and timely warning, investments in *livelihoods* and *good governance* will be wasted. On the other hand, a FEWS could embolden communities to invest in higher-risk livelihood activities that are potentially more profitable.

The communication network links local community organizations with government institutions, including district staff, the police, and the army. In the V2R framework, it enables people to *respond to shocks and stresses*. By ensuring access to relevant and timely information, it reduces *future uncertainty*. It also improves *governance*, by empowering communities to act and by supporting government staff to fulfil their responsibilities.

**Table 1** How end-to-end FEWSs address the V2R framework

		V2R component			
		Shocks and stresses	Future uncertainty	Livelihoods	Governance
FEWS component	Risk knowledge	✓	✓	✓	
	Risk monitoring	✓	✓		
	Communication and dissemination	✓	✓		✓
	Ability to respond	✓			✓

The ability to respond to floods clearly corresponds to *response to shocks and stresses*; community task forces help people be more prepared when other hazards strike, such as forest fires. By promoting decentralized and participatory decision-making for both women and men, and giving communities a stronger, better-informed voice, structures such as the CDMC and task forces clarify roles and responsibilities and therefore also strengthen *good governance*.

## Conclusion

Moving communities from vulnerability to resilience in the face of frequent catastrophic flood events means that governments, NGOs, and other development actors must work with every aspect of the V2R framework: shocks and stresses, livelihoods, future uncertainty, and governance. FEWSs have the potential to transform community flood vulnerability into community flood resilience – as part of broader resilience programmes. For this to happen all four components are essential: risk knowledge, risk monitoring, communication and dissemination, and the ability to respond.

The United Nations Office for Disaster Risk Reduction's position paper on early warning systems must demand investment in end-to-end FEWSs that deliver actionable information to those most vulnerable to floods.

## Note

1. Costs are based on Nepali Government estimates of costs due to floods, landslides, and avalanches ('water-related disasters'). Loss of life is based on only floods and landslides.

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## The Zurich Global Flood Resilience Programme

An increase in severe flooding around the world has focused greater attention on finding practical ways to address flood risk management. In response, Zurich Insurance Group launched a global flood resilience programme in 2013. The programme aims to advance knowledge and develop robust expertise and design strategies that can be implemented to help communities in developed and developing countries strengthen their resilience to flood risk.

To achieve these objectives, Zurich has entered into a multi-year alliance with the International Federation of Red Cross and Red Crescent Societies, the International Institute for Applied Systems Analysis in Austria, the Wharton Business School's Risk Management and Decision Processes Center in the US, and the international development non-governmental organization Practical Action. The alliance builds on the complementary strengths of these institutions. It brings an interdisciplinary approach to flood research, community-based programmes, and risk expertise with the aim of creating a comprehensive approach that will help to promote community flood resilience. It seeks to improve the public dialogue around flood resilience, while measuring the success of our efforts and demonstrating the benefits of pre-event risk reduction, as opposed to post-event disaster relief.

Jodi Sugden works with Practical Action on the Zurich Flood Resilience Programme. She supports the programme through research, analysis, knowledge capture, and communications.

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Front page photo: Community members in an emergency shelter in Nepal with capacity and risk maps © Practical Action

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