PRACTICAL ACTION AND EARLY WARNING SYSTEMS

Practical ACTION

Transforming lives
through ingenuity

PRACTICAL ACTION AND EARLY WARNING SYSTEMS

Practical Action: Transforming lives, inspiring change

Practical
ACTION

About Practical Action

We are an international development organization putting ingenious ideas to work so people in poverty can change their world.

We help people find solutions to some of the world's toughest problems. Challenges made worse by catastrophic climate change and persistent gender inequality. We work with communities to develop ingenious, lasting and locally owned solutions for agriculture, water and waste management, climate resilience and clean energy. And we share what works with others, so answers that start small can grow big.

We're a global change-making group. The group consists of a UK registered charity with community projects in Africa, Asia, and Latin America, an independent development publishing company and a technical consulting service. We combine these specialisms to multiply our impact and help shape a world that works better for everyone.

Practical
ACTION
PUBLISHING

CONTENTS

SUMMARY AND RECOMMENDATIONS

Summary

Early warning provides an opportunity for people to take action to save lives and livelihoods, reducing the impacts of rapid onset disasters. For an early warning system to be truly effective, we must take a holistic and people-centred approach to ensure that timely, accurate, reliable, and understandable information reaches everyone in the right way for them to take action. This publication outlines the key elements of an effective early warning system; explains why these elements are so important and what considerations need to be taken for each; and explores how Practical Action is incorporating these elements into our early warning systems work.

Recommendations

1. **Take a holistic, people-centred approach:** For an early warning system (EWS) to be effective we must address all elements to ensure that timely, accurate, reliable, and understandable information reaches everyone in the right way for them to take action.

2. **Understand risk:** We need to understand the risks affecting communities, including hazards, exposure, vulnerabilities, and coping capacities. We need to collaborate with those at risk and those responsible for reducing risks to develop this knowledge, and help with preparedness and risk reduction planning and management.

3. **Undertake evidence-based monitoring and warning:** We need to monitor environmental conditions and issue warnings in a scientifically robust, low-cost, contextually appropriate, scalable, and sustainable way.

4. **Communicate effectively:** In order for warnings to reach everyone at risk, they must be accessible, tailored, clear, understandable, useful, and actionable.

5. **Develop response capacities:** Clear preparedness plans, training, education, and resources are needed in advance of a disaster. In this way, stakeholders will be confident in their roles and responsibilities, information shared, and action taken efficiently and effectively in response to early warning before a disaster occurs.

6. **Address cross-cutting issues:** While undertaking all of these recommendations, we need to ensure that the development and implementation of the EWS involves local communities and marginalized people; considers gender perspectives and cultural diversity; develops effective governance and institutional arrangements; and takes a multi-hazard approach.

We need to collaborate with those at risk and those responsible for reducing risks

Introduction to early warning systems

Early warning is integral to disaster preparedness, which is central to building the resilience of households and communities to disaster. Early warning systems (EWS) provide information before a hazard occurs (e.g. flood, cyclone, landslide). This provides an opportunity for people to take action in order to save lives and livelihoods, reducing the impact of the hazard event. EWS vary widely across hazard types, contexts, and spatial scales. They have different lead times, levels of complexity, capacities to forecast, and a variety of end-users; there is no 'one-size fits all' EWS. The focus of this publication is on rapid onset hazard EWS.

Early warning is integral to disaster preparedness

EFFECTIVE GOVERNANCE AND INSTITUTIONAL ARRANGEMENTS

INVOLVEMENT OF LOCAL COMMUNITY

A MULTI-HAZARD APPROACH

RISK KNOWLEDGE

- Hazard
- Exposure
- Vulnerability

RESPONSE CAPABILITY

- Plans
- Practice
- Resources

MONITORING AND WARNING

- Observation
- Analysis
- Trigger

DISSEMINATION AND COMMUNICATION

- Access
- Understanding
- Action

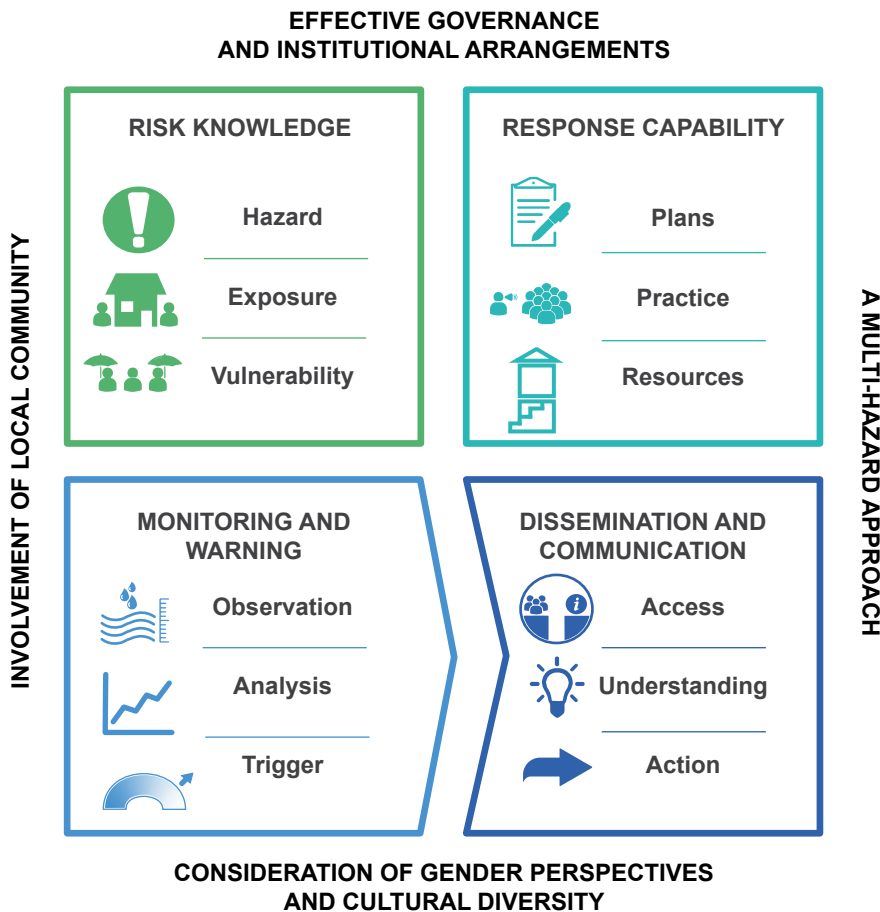**CONSIDERATION OF GENDER PERSPECTIVES AND CULTURAL DIVERSITY**

Figure 1 Elements of an effective EWS. This diagram provides a useful way of framing these complex systems in order to understand the different elements that make up an effective EWS
Source: adapted from World Meteorological Organization (2017)

For an EWS to be truly effective, we must consider all elements of the system (illustrated in Figure 1) and take a holistic approach to ensure that timely, accurate, reliable, and understandable information reaches everyone in the right way for them to take action. We must learn and continually adapt to improve the systems to ensure no one is left behind.

What has Practical Action done?

Practical Action has been working to develop EWS in our partner countries for over two decades. The work has evolved over time as technology and science has evolved, but has always taken a holistic approach and placed people at the centre of that approach.

See Practical Action (2016) for more information.

RISK KNOWLEDGE

Risks from natural hazards arise from a combination of:

- the physical hazard (e.g. flood water location);
- exposure of people and assets to that hazard (e.g. people located in areas next to rivers where flood waters reach); and
- their vulnerabilities and coping capacities at a particular location (e.g. a person's ability to prepare for, respond or adapt to, and recover from a flood event).

In order to reduce these risks, we need to:

Understand: Collect information on each of these components and understand how they interact and may cause increased risks for some.

Inform: Collaborate with stakeholders to share this information so that all are aware of the risks and the opportunities to take action to reduce those risks.

Act: Work with those at risk and those responsible for reducing risks to minimize the impacts of disasters. We need to develop preparedness and risk reduction plans and management strategies that can be readily put into action.

Conducting risk assessments can help to:

- identify the location of vulnerable groups, critical infrastructure, and assets;
- design appropriate evacuation strategies including evacuation routes and safe areas; and
- ensure warning messages reach the most vulnerable.

We must learn and continually adapt to improve the systems to ensure no one is left behind
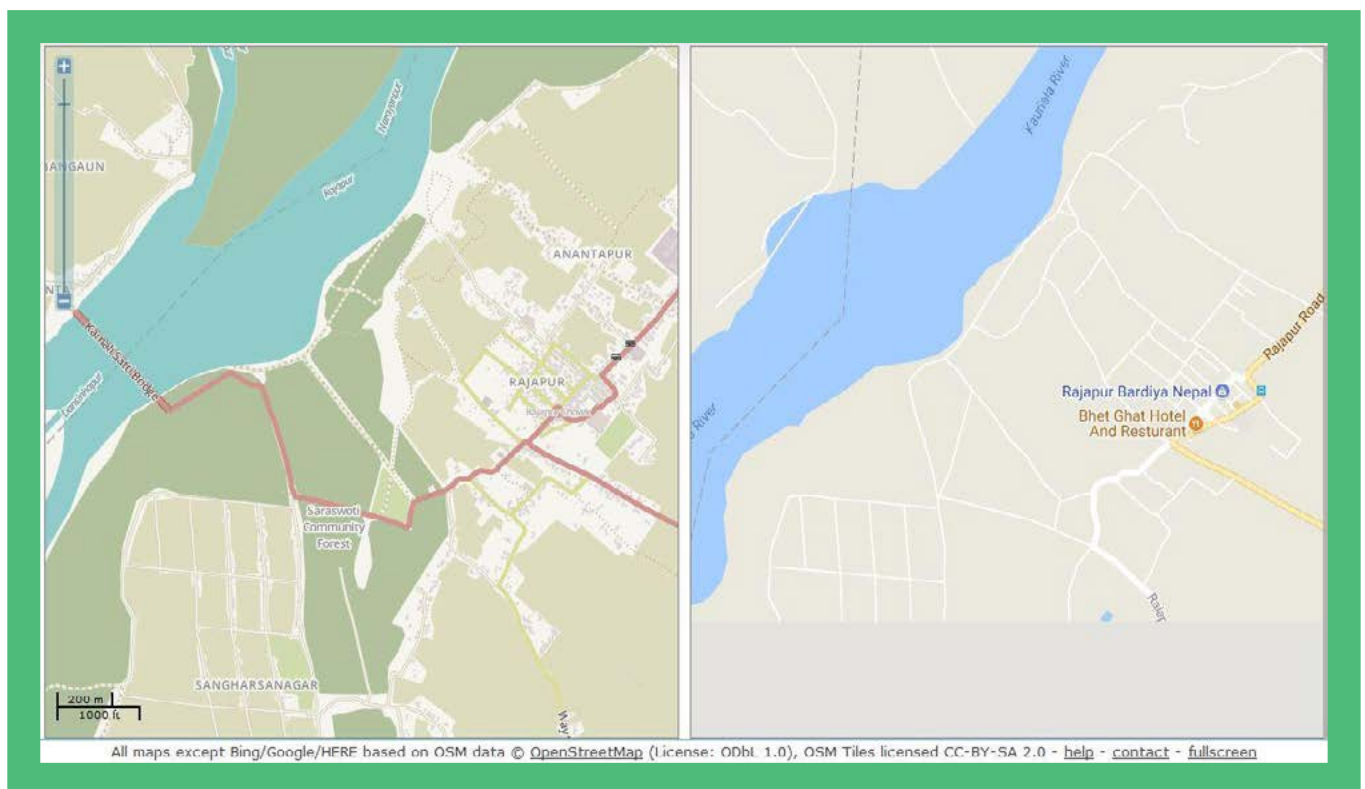
Figure 2 Rajapur municipality and surrounding communities in lower Karnali basin, Nepal, shown in OpenStreetMap (left, grey dots indicating individual buildings) and Google Maps (right) as of September 2017

MONITORING AND WARNING

Monitoring of conditions such as river levels and rainfall is an important part of any early warning system. By monitoring environmental conditions, we can understand weather and hydrological patterns that took place when hazards occurred, and forecast when a hazard is likely to occur again in the future, as illustrated in Figure 3.

Historical data on previous hazards

Statistical model predicting likelihood of hazard occurring based on environmental conditions

When environmental conditions match 'thresholds' for likely hazard occurrence, issue warning

Historical data on environmental conditions

Continually collect data on environmental conditions
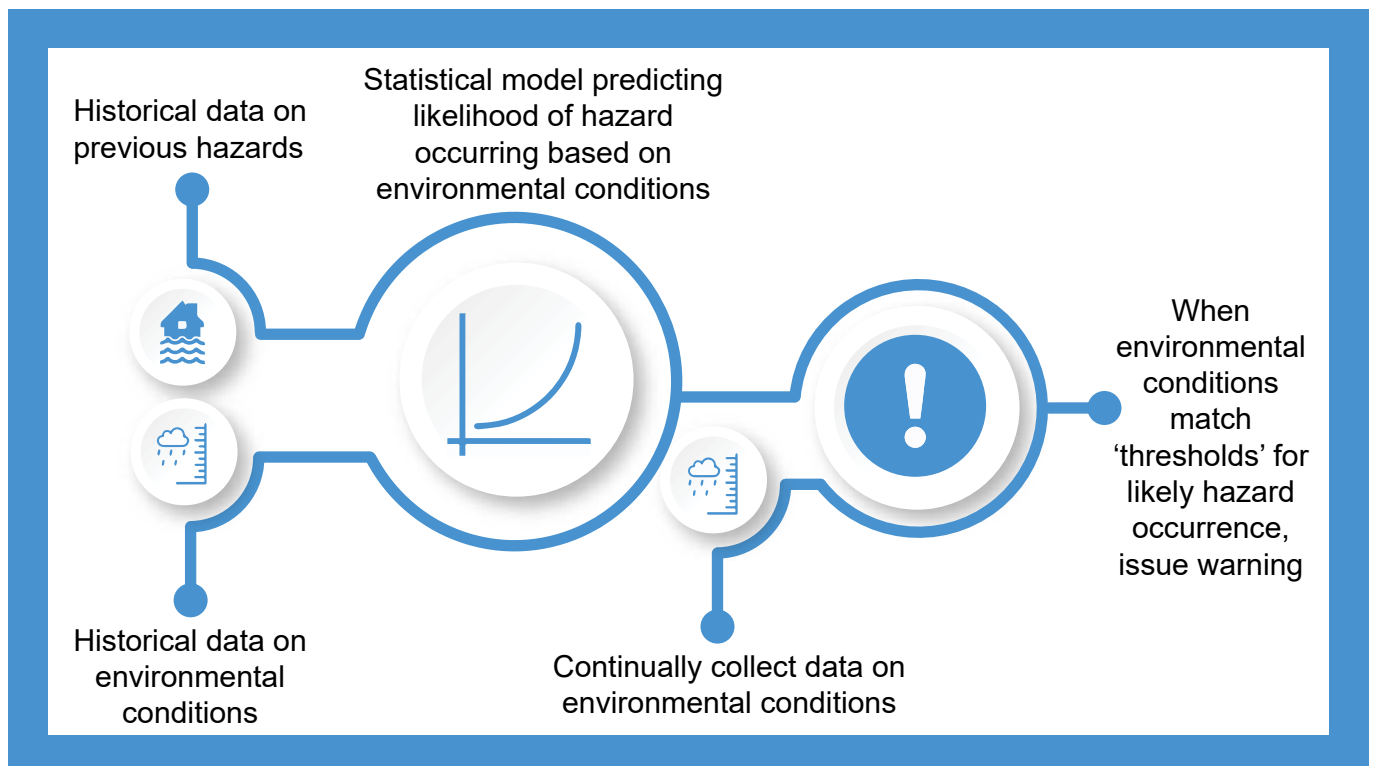
Figure 3 Historical data helps us to understand the types of conditions that increase the likelihood of a hazard event; combining this with data about current conditions means we can identify when a hazard is likely to occur and can issue a warning

There are several points to take into consideration when developing monitoring and warning methods. Methods should be:

Scientifically robust: Data collection and analysis methods should be based on evidence-based science, to ensure the warnings are accurate, timely, and reliable.

Low-cost: Solutions that are low-cost mean that the technology can be accessible to as many as possible, and can be maintained in the long term.

🔍 **Appropriate**: The most appropriate solution for the specific context should be evaluated and prioritized, building on and respecting existing community practices, capacities, needs, and processes.

🔗 **Scalable**: Solutions that are scalable can inspire others to apply the solution in their contexts, reaching more people and yielding more learning and insights about how to develop EWS that leave no one behind.

♻️ **Sustainable**: Monitoring stations should be able to collect data and contribute to an operational EWS after project funding has ended. Working with communities and national actors can ensure that solutions are embedded in long-term systems.

Early warning information ensures people get the right information in the right way

---

Monitoring and warning and Practical Action

Using open-source technology to develop local solutions: In Peru, Practical Action has been providing monitoring stations for early warning of mudslides and flash floods. The stations are low-cost, community-led, and issue real-time warnings to the local area.

Improving weather monitoring: In Bangladesh, we have installed one automated weather station in the remote coastal area of the Satkhira District. This station is now owned and operated by the Bangladesh Meteorological Department, feeding into the national EWS to generate more accurate and localized weather information.

Improving river monitoring: Practical Action has been working with the Nepal Department of Hydrology and Meteorology (DHM) for more than 10 years to help improve monitoring of river levels across Nepal. We provide advice to the DHM and other local stakeholders, assess existing hydro-meteorological stations, conduct feasibility assessments to identify where best to place monitoring stations, develop and install low-cost, community-managed monitoring stations, and pilot innovative technology and science for the DHM to implement.

For further information, see Practical Action (2018, 2020a, b).

DISSEMINATION AND COMMUNICATION

In order for early warning information to help people to act before a disaster, effective dissemination and communication of warning messages are critical. This ensures people get the right information in the right way in order to act in advance of hazards. Barriers still remain in the communication of early warnings to authorities, communities, and individuals worldwide.

Our dissemination and communication must be:

Accessible: We need to ensure warnings reach everyone at risk, including the most vulnerable and marginalized. Dissemination channels and formats need to be carefully considered and respond to the different needs that different people have.

Clear: We need to make sure warning information is clear for users, considering appropriate languages, levels of literacy, accessibility for people with sensory impairments, and avoiding technical jargon.

Understandable: We need to check that the risks and warnings are understood by those receiving them.

Useful: We need to make sure the information provided is appropriate to needs and enables people to take action.

Trusted: We need to develop and maintain trust in the source of the information and the information itself.

Dissemination and communication and Practical Action

Local communication: Practical Action has been working to establish local and appropriate means of disseminating warnings to those at risk using a variety of approaches including loudspeakers, local brigades and 'resilient agents', digital boards, and community-managed bulletins.

Improving access to information: In Bangladesh, we have developed a Disaster Alert app through the Zurich Flood Resilience Alliance. The app is used by Practical Action and the Ministry of Disaster Management and Relief to disseminate early warning messages along with other services before, during, and after disasters.

Reaching more people: In Nepal, we have been working with the DHM and telecom providers to send mass push SMS warning messages to mobile phones in areas at risk. Similarly, in Bangladesh Practical Action sends out push voice messages and advisories to community members' mobile phones. This method ensures that a large number of people receive warning messages as quickly as possible, maximizing the time available to take action.

Ensuring information is clear: Practical Action has been working with the government authorities in Bangladesh and Nepal to develop clear and consistent warning messages to ensure the information provided is understandable, for example, using non-technical language.

Reaching everyone: We have conducted research in East Africa and Nepal to analyse and understand flows of information and decision-making and early action. Through this work we have identified barriers and bottlenecks in dissemination and communication strategies, and developed recommendations for improvements to the system to ensure forecast information is accessible and actionable by everyone at risk.

For further information, see Lambert et al. (2019) and Budimir et al. (2020).

We have identified barriers and bottlenecks in dissemination and communication strategies

RESPONSE CAPABILITY

National and community response capabilities also need to be coordinated and coherent

It is important that, given accurate, timely, and understandable warning information in advance of a disaster, people are able to respond and take action. The focus here is to build capacity to respond to early warning information. Preparedness plans, training, education, and resources are needed so that people can respond before a disaster rather than after it occurs. National and community response capabilities also need to be coordinated and coherent.

We need to consider:

Planning: An understanding of local and national knowledge and capacities is needed. Plans to respond to warning information need to be developed in advance and should be regularly updated.

Practice: People need to be aware of and familiar with preparedness plans. They need to know what to do in response to early warning information and be ready to react. Regular drills can help to prepare communities.

Resources: People need to have sufficient resources to respond, including having a safe location, a safe route to the location, and any other resources to enable them to take action.

Barriers: Barriers to taking action need to be identified in advance and measures taken to address them within the planning stages.

Response capability and Practical Action

Community and household response capacity building: Practical Action works with communities to develop preparedness plans, identify safe evacuation routes, improve access to evacuation facilities, prepare resources for evacuation, practise evacuation scenarios, and develop the capacity of first responders.

National and district preparedness planning: Practical Action works with government authorities and other civil society actors in regular preparedness planning at central and regional government level, including pre-monsoon planning.

Decision making in complex environments: Practical Action has been working with forecasters, responders, and disaster management authorities in Bangladesh and Nepal to develop Standard Operating Procedures which provide clear guidelines for what early action to take, when, and by whom in the case of a likely hazard event.

Increasing lead times: In Nepal, we have been piloting a low data probabilistic approach to flood forecasting with the DHM. The novel approach has extended the amount of time communities could have to prepare by up to 5 hours, and has since been rolled out across major river basins in Nepal.

Post-event analysis: As a member of the Zurich Flood Resilience Alliance, Practical Action has conducted post-event analysis studies in Malawi, Zimbabwe, Nepal, and Peru looking at how the system performed in flood events, and what needs to be improved.

Forecast-based early action: Practical Action has been piloting the use of increasingly accurate and reliable weather forecast information to inform early response and risk reduction in Nepal, working to improve responses to disasters by taking action before they occur.

For further information see Flood Resilience Portal (n.d.) and Smith et al. (2017).

Practical Action works with communities to develop preparedness plans

CROSS-CUTTING THEMES

A local, 'bottom-up' approach to early warning systems strengthens local capacities

In order to ensure EWS work effectively, operate smoothly, and reach everyone, several cross-cutting themes also need to be considered: involvement of local community, consideration of gender perspectives and cultural diversity, effective governance and institutional arrangements, and a multi-hazard approach.

Involvement of local community

Early warning systems need to be inherently and actively people-centred. Without the involvement of local authorities and communities at risk, early warning systems are unlikely to respond appropriately to community needs and capacities, and responses to warning information are unlikely to protect people, households, and communities from disasters. A local, 'bottom-up' approach to early warning, with the active participation of local communities, including marginalized groups, enables engagement in and contribution to the system, ensuring reduced vulnerability and leveraging and strengthening of local capacities.

What has Practical Action done?

Practical Action's work is based on consciously putting people at the centre of early warning systems. We work with communities and individuals at risk, considering the entire system and developing awareness of risks. We collaborate with local members of communities and civil society as leaders, gauge readers, and holders and distributors of knowledge, to develop locally owned preparedness plans.

For further information, see Practical Action (2016).

Consideration of gender perspectives and cultural diversity

Marginalized people (i.e. those who are marginalized on the basis of age, sex, disability, race, ethnicity, religion, migration status, socio-economic status, place of residence, and sexual orientation and gender identity) are often those most overlooked by early warning systems, and require special consideration and focused attention to ensure they are not left behind.

Marginalized people are often those most overlooked by early warning systems

---

What has Practical Action done?

Practical Action has made a commitment to being gender sensitive and becoming gender transformative.

Practical Action has conducted several studies investigating gender in disaster risk reduction (DRR) and EWS in Peru, Nepal, and southern Africa. As a result of the studies, Practical Action developed a series of recommendations for gender sensitive and transformative EWS. We developed a novel methodology for hearing the perspectives of those most marginalized whose insights and experiences may be missing from traditional data collection techniques – and consequently from DRR planning and strategy.

See Brown et al. (2019a, b; 2020) for more information

Gender aware: Explicitly acknowledge, assess, and document the ways in which disasters and EWS impact different gender groups in different ways.

Acknowledge: Explicitly acknowledge gendered impacts

Vulnerability: Understand how gender impacts on vulnerability

Assess: Undertake gender analysis

Participation: Understand how gender impacts on participation

Examine: Examine gendered assumptions (including stereotypes and cisnormativity)

Dissemination: Understand how gender impacts on dissemination

Listen: Make proactive efforts to hear from marginalized gender groups

Response: Understand how gender impacts on response

Intersectionality: Understand how intersectional vulnerabilities exacerbate gendered vulnerabilities

Power and Decision-making: Understand how gender impacts on decision making

Gender sensitive: Adapt project actions (across all areas of the EWS, with proactive consideration of participation, power and decision-making) to improve the effectiveness of EWS for marginalized and vulnerable gender groups.

Gender transformative: Design policies, approaches and actions to ensure the EWS works effectively for people of all genders. Consider how all aspects of the EWS (including participation power and decision making) can support the reduction of gender-based inequalities.

Figure 4 Gender early warning system checklist

Effective governance should encourage both vertical and horizontal communication

Effective governance and institutional arrangements

Well-developed governance through robust frameworks and supported by a long-term commitment to early warning systems is necessary to support development and sustainability of sound EWS. Effective governance should encourage both vertical and horizontal communication and coordination between early warning stakeholders.

> **What has Practical Action done?**
>
> Practical Action works across local, national, and global stakeholders, with a range of actors including community members, civil society, and government authorities, enabling dialogue and sharing of needs and opportunities. Practical Action has also developed a methodology for empowering community members to participate in national conversations on climate information services and forecast information.
>
> See Lambert et al. (2019) and Meechaiya et al. (2019) for more information.

Multi-hazard early warning systems are rare

Multi-hazard approach

Where possible, early warning systems should link all hazard-based systems to provide better holistic understanding of forecasted hazards that may occur within similar timescales and that have complex impacts (e.g. a cyclone occurring after a volcanic eruption). However, multi-hazard early warning systems that are truly integrated across hazards are rare, and in many of the developing countries, the focus is to initially develop reliable, accurate, and robust single hazard early warning systems.

> **What has Practical Action done?**
>
> Landslides are inherently complex hazard events, by nature triggered by other hazards (e.g. intense rainfall or earthquakes) and often causing subsequent hazards (e.g. blocking a river causing an outburst flood). Practical Action has been working with partners in India and Nepal to advance knowledge of developing regional and slope scale landslide early warning systems in developing country contexts where there is typically less data to inform forecasting and early warning.
>
> For further information, see SHEAR (2019a, b).

FURTHER READING

Further reading

Brown, S., Budimir, M., Sneddon, A., Lau, D., Shakya, P., and Upadhyay Crawford, S. (2019a) *Gender Transformative Early Warning Systems: Experiences from Nepal and Peru*, Zurich Flood Resilience Alliance, Practical Action Publishing, Rugby, UK.

Brown, S., Budimir, M., Sneddon, A., Lau, D., Nizama, J., Ordoñez, M., Upadhyay Crawford, S. (2019b) *Missing Voices: Experience of Marginalized Gender Groups in Disaster in Nepal*, Zurich Flood Resilience Alliance, Practical Action Publishing, Rugby, UK.

Brown, S., Budimir, M., Sneddon, A., Clements, R., and Upadhyay Crawford, S. (2020) *Gender and Age Inequality of Disaster Risk*, UN Women and UNICEF, Geneva.

Budimir, M., Donovan, A., Brown, S., Shakya, P., Kumar Gautam, D., Uprety, M., Cranston, M., Sneddon, A., Smith, P.J. and Dugar, S. (2020) 'Communicating complex forecasts: an analysis of the approach in Nepal's flood early warning system', *Geoscience Communication* 3: 49–70 <http://dx.doi.org/10.5194/gc-3-49-2020>.

Flood Resilience Portal (no date) 'Post-Event Review Capability' [online] <https://floodresilience.net/perc> [accessed 11 June 2020].

Lambert, K., Allen, M., and Blumenstock, A. (2019) *Participatory Climate Information Services Systems Development: Methodology Guide*, Learning Agenda on Climate Services in Sub-Saharan Africa: Climate Information Services Research Initiative (USAID), Mercy Corps, Washington, DC.

Laurien, F., Keating, A., Mechler, R., Etienne, E., Velev, S., Szoenyi, M., McQuistan, C., Ianni, F., and Campbell, K. (2019) *Lessons Learned from Measuring Flood Resilience*, IIASA Working Paper WP-19-007, IIASA, Laxenburg, Austria.

Meechaiya, C., Wilkinson, E., Lovell, E., Brown, S., and Budimir, M. (2019) *Governance of Nepal's Flood Early Warning System: Opportunities Under Federalism*, BRACED, London.

Practical Action (2016) *Delivering Early Warning Systems for the Poorest: From Flood-Vulnerable to Flood-Resilient Communities*, Resilience in Practice Briefing 2, Practical Action Publishing, Rugby, UK.

Practical Action (2018) *Pilot Early Warning System for Debris Flow and Floods*, Practical Action Publishing, Rugby, UK.

Practical Action (2020a) *Monitoring Rainfall for Flood Early Warning: Peru's Ingenious Solutions*, Practical Action Publishing, Rugby, UK.

Practical Action (2020b) *Monitoring Rivers for Flood Early Warning: Nepal's Ingenious Solutions*, Practical Action Publishing, Rugby, UK.

Science for Humanitarian Emergencies & Resilience (SHEAR) (2019a) *Landslide EVO: Citizen Science for Landslide Risk Reduction and Disaster Resilience Building in Mountain Regions* [pdf] <https://practicalaction.org/wp-content/uploads/2019/07/LANDSLIDE-EVO-fact-sheet.pdf> [accessed 11 June 2020].

SHEAR (2019b) *LANDSLIP: LANDSLide multi-hazard risk assessment, Preparedness and early warning in South Asia: Integrating Meteorology, Landscape and Society* [pdf] <https://practicalaction.org/wp-content/uploads/2019/07/LANDSLIP-fact-sheet.pdf>[accessed 11 June 2020].

Smith, P., Brown S., and Dugar, S. (2017) 'Community-based early warning systems for flood risk mitigation in Nepal', *Journal of Natural Hazards and Earth System Sciences* 17: 423–37 <http://dx.doi.org/10.5194/nhess-17-423-2017>.

Wei, L., Dugar, S., Thapa, G., and Brown, S. (2018) *Participatory Digital Mapping: Building Community Resilience in Nepal, Peru and Mexico*, Practical Action Publishing, Rugby, UK.

World Meteorological Organization (2017), *Multi-hazard Early Warning Systems: A Checklist: Outcome of the first Multi-hazard Early Warning Conference*, World Meteorological Organization (WMO) 1st Multi-hazard Early Warning Conference, 22 to 23 May 2017; Cancún, Mexico <https://library.wmo.int/index.php?lvl=notice_display&id=20228#.X5max4j7SUm> [accessed 28 October 2020]

Practical Action and Early Warning Systems

Early warning provides an opportunity for people to take action to save lives and livelihoods, reducing the impacts of rapid onset disasters. For an early warning system to be truly effective, we must take a holistic and people-centred approach to ensure that timely, accurate, reliable, and understandable information reaches everyone in the right way for them to take action. This publication outlines the key elements of an effective early warning system; explains why these elements are so important and what considerations need to be taken for each; and explores how Practical Action is incorporating these elements into our early warning systems work.

Big change starts small