

# FINAL PROJECT REPORT

## Technology Enabled Risk Information Systems and Inclusive Early Action in South Asia

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Strengthening Inclusive Disaster Risk Governance for Climate Resilience in Asia (SIDRRA)



Sweden  
Sverige



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ACTION**

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## Abbreviations and Acronyms

| Abbreviation | Full Form                                                                       | Abbreviation | Full Form                                                                                       | Abbreviation | Full Form                                                              |
|--------------|---------------------------------------------------------------------------------|--------------|-------------------------------------------------------------------------------------------------|--------------|------------------------------------------------------------------------|
| AIDMI        | All India Disaster Mitigation Institute                                         | AMARC        | World Association of Community Radio Broadcasters                                               | ASHA         | Accredited Social Health Activist                                      |
| BMD          | Bangladesh Meteorological Department                                            | BP           | Best Practice                                                                                   | CAP          | Common Alerting Protocol                                               |
| CBEWS        | Community Based Early Warning System                                            | CDMC         | Community Disaster Management Committee                                                         | C DOT        | Centre for Development of Telematics                                   |
| CPP          | Cyclone Preparedness Programme                                                  | DEOC         | District Emergency Operations Centre                                                            | DHM          | Department of Hydrology and Meteorology                                |
| DN           | Duryog Nivaran                                                                  | DRG          | Disaster Risk Governance                                                                        | DRM          | Disaster Risk Management                                               |
| DRR          | Disaster Risk Reduction                                                         | EOC          | Emergency Operations Centre                                                                     | EW2EA        | Early Warning to Early Action                                          |
| EW4All       | Early Warnings for All                                                          | EWS          | Early Warning System                                                                            | FbF          | Forecast based Financing                                               |
| GEDSI        | Gender Equality, Disability and Social Inclusion                                | GLOF         | Glacial Lake Outburst Flood                                                                     | HF           | High Frequency                                                         |
| ICT          | Information and Communication Technology                                        | ILO          | International Labour Organization                                                               | IMD          | India Meteorological Department                                        |
| IVR          | Interactive Voice Response                                                      | MOFAGA       | Ministry of Federal Affairs and General Administration                                          | MOFE         | Ministry of Forests and Environment                                    |
| NDMA         | National Disaster Management Authority                                          | NDRF         | National Disaster Response Force                                                                | NDRRMA       | National Disaster Risk Reduction and Management Authority              |
| NEOC         | National Emergency Operations Centre                                            | NbS          | Nature based Solutions                                                                          | NIUA         | National Institute of Urban Affairs                                    |
| NRLM         | National Rural Livelihoods Mission                                              | O&M          | Operations and Maintenance                                                                      | ODI          | Overseas Development Institute                                         |
| OHCHR        | Office of the United Nations High Commissioner for Human Rights                 | OPD          | Organisation of Persons with Disabilities                                                       | OSDMA        | Odisha State Disaster Management Authority                             |
| PAC          | Practical Action Consulting                                                     | PEOC         | Provincial Emergency Operations Centre                                                          | PWD          | People With Disabilities                                               |
| SACHET       | National Disaster Alert Portal of India                                         | SDMA         | State Disaster Management Authority                                                             | SDRF         | State Disaster Response Force                                          |
| SHG          | Self Help Group                                                                 | SHIELD       | Solutions for Heat and Water Stress Interconnected through Early and Locally Driven Development | SIDA         | Swedish International Development Cooperation Agency                   |
| SIDRRA       | Strengthening Inclusive Disaster Risk Governance for Climate Resilience in Asia | SMS          | Short Message Service                                                                           | SOP          | Standard Operating Procedure                                           |
| ULB          | Urban Local Body                                                                | UNCRPD       | United Nations Convention on the Rights of Persons with Disabilities                            | UNDP         | United Nations Development Programme                                   |
| UNDRR        | United Nations Office for Disaster Risk Reduction                               | UNESCO       | United Nations Educational, Scientific and Cultural Organization                                | UN Women     | United Nations Entity for Gender Equality and the Empowerment of Women |
| VHF          | Very High Frequency                                                             | WMO          | World Meteorological Organization                                                               |              |                                                                        |

## Executive Summary

South Asia's early warning systems have come a long way. Forecasting infrastructure, national disaster management institutions, emergency operation centers, and mobile-based alerts have expanded meaningfully over the past two decades. India, Bangladesh, and Nepal now have substantially stronger technical early warning capacity than they did a decade ago. The formal architecture, from the India Meteorological Department and OSDMA to Bangladesh's Cyclone Preparedness Programme and Nepal's Department of Hydrology and Meteorology, has been professionalized, resourced, and in some cases recognized internationally. These are genuine achievements, and this report builds on them.

And yet preventable losses continue. People still die in cyclones for which accurate warnings were issued well in advance. Street vendors still face life-threatening heat exposure even when advisories are circulated through government platforms. Communities in river basins still lose livestock, standing crops, and livelihoods to floods that were predicted days earlier with reasonable accuracy. Coastal fishers may still put to sea during deteriorating weather because a warning was not trusted, not understood, or not linked to a meaningful instruction about what to do.

This is the central puzzle the SIDRRA Phase II exploratory study set out to examine. The problem is not primarily a technology problem. South Asian early warning systems have generally not failed because forecasting models are unavailable or because communication platforms do not exist. They weaken because warning information is not always converted into trusted, locally meaningful, inclusive, and institutionally backed protective action for the households and workers most exposed to risk. That conversion from alert to protective action is a governance challenge, not only a technology challenge.

The report's main analytical contribution is to show that the warning-to-action gap is not caused by a single weakness in technology, institutions, or community behaviour. It is produced by a set of linked governance failures that appear repeatedly across different hazard and country contexts. These recurring failures are summarised below.

| Recurring governance failure        | How it weakens early action                                                                                                                           |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| One-way broadcast systems           | Warnings are sent out, but there is limited confirmation that communities received, understood, trusted, or acted on them.                            |
| Inaccessible messaging              | Warnings often do not sufficiently account for language, literacy, disability, gender, mobility, age, connectivity, and livelihood constraints.       |
| Weak trust layer                    | Official or anonymous alerts may be delayed or discounted unless they are reinforced by trusted local actors.                                         |
| Unclear decision triggers           | Forecasts and alerts do not always activate predefined institutional responsibilities, thresholds, resources, or accountability.                      |
| Weak horizontal coordination        | Communities, frontline workers, SHGs, volunteers, and local institutions often lack formal mechanisms to coordinate laterally during warning periods. |
| Livelihood-constrained early action | Informal workers, fishers, farmers, vendors, and other exposed groups may understand warnings but lack the financial or practical ability to act.     |

These governance failures do not operate separately. They compound along the warning-to-action chain. A warning may reach a phone but not the person most at risk. It may be understood but not trusted. It may be trusted but not

linked to transport, shelter, cash, work flexibility, livestock protection, caregiver support, or institutional authorization. This is why the report argues that technology-enabled early warning becomes effective only when it is supported by trusted local relay, accessible message design, clear decision authority, two-way feedback, horizontal coordination, and practical early action support.

This report is an applied learning product for Duryog Nivaran and its regional network. It draws on fourteen structured evidence notes, practitioner validation from Practical Action Bangladesh and Practical Action Nepal, and desk synthesis across India, Bangladesh, Nepal, and wider South Asian literature. The report offers a warning-to-action governance diagnostic, ten South Asia-transferable best practice cards, a transferability matrix, actor-specific governance and investment recommendations, and a clear statement of evidence limitations and future research needs. A separate companion concept note has also been developed to translate the study's findings into a possible future investment pathway for DN/SIDRRRA.

| Core Output                      | What This Report Provides                                                                                                         | Confidence Level     |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|----------------------|
| Governance diagnostic            | Assessment of six recurring governance failure points where the warning-to-action chain weakens                                   | Evidence-informed    |
| Best practice cards              | Ten cards combining technology/channel choice, governance condition, and inclusion design note                                    | High to moderate     |
| Transferability matrix           | Assessment of which practices can be adapted across selected South Asian contexts                                                 | Moderate, analytical |
| Recommendations                  | Actor-specific governance and investment guidance                                                                                 | Evidence-informed    |
| Evidence architecture            | Structured synthesis of fourteen evidence notes, practitioner validation inputs, and secondary literature                         | Moderate to high     |
| Research gaps and future inquiry | Identification of evidence gaps on migrants, informal workers, disability inclusion, feedback systems, and field validation needs | Evidence-informed    |
| Companion concept note           | Separate future investment pathway for a South Asia inclusive early action readiness facility                                     | Conceptual           |

The practical message is straightforward. The next generation of early warning investment in South Asia should not focus only on faster alerts, better platforms, or wider digital dissemination. These remain important, but they need to be matched with the governance layer that converts information into inclusive protective action. This includes trusted community relay systems, accessible and action-oriented message formats, predefined decision triggers, structured feedback mechanisms, horizontal coordination protocols, recurrent operations and maintenance, and livelihood-compatible early action support.

# 1. Introduction

South Asia faces some of the most complex and intersecting disasters and climate risks on the planet. Cyclones, riverine floods, flash floods, heatwaves, landslides, glacial lake outburst floods, droughts, coastal surge, and urban flooding interact with dense settlement, informal livelihoods, seasonal migration, poverty, gender inequality, disability, and deeply uneven infrastructure. In this environment, early warning is not simply a technical service delivered by specialized government agencies to passive populations. It is a public governance function, one that determines whether the most exposed and least resourced households have the information, time, authority, and support to protect lives and livelihoods before disaster strikes.

The following map orients the reader to the geographic context of this study, showing the three primary study countries, the specific case lens locations, and the major hazard zones across which the evidence base was developed.

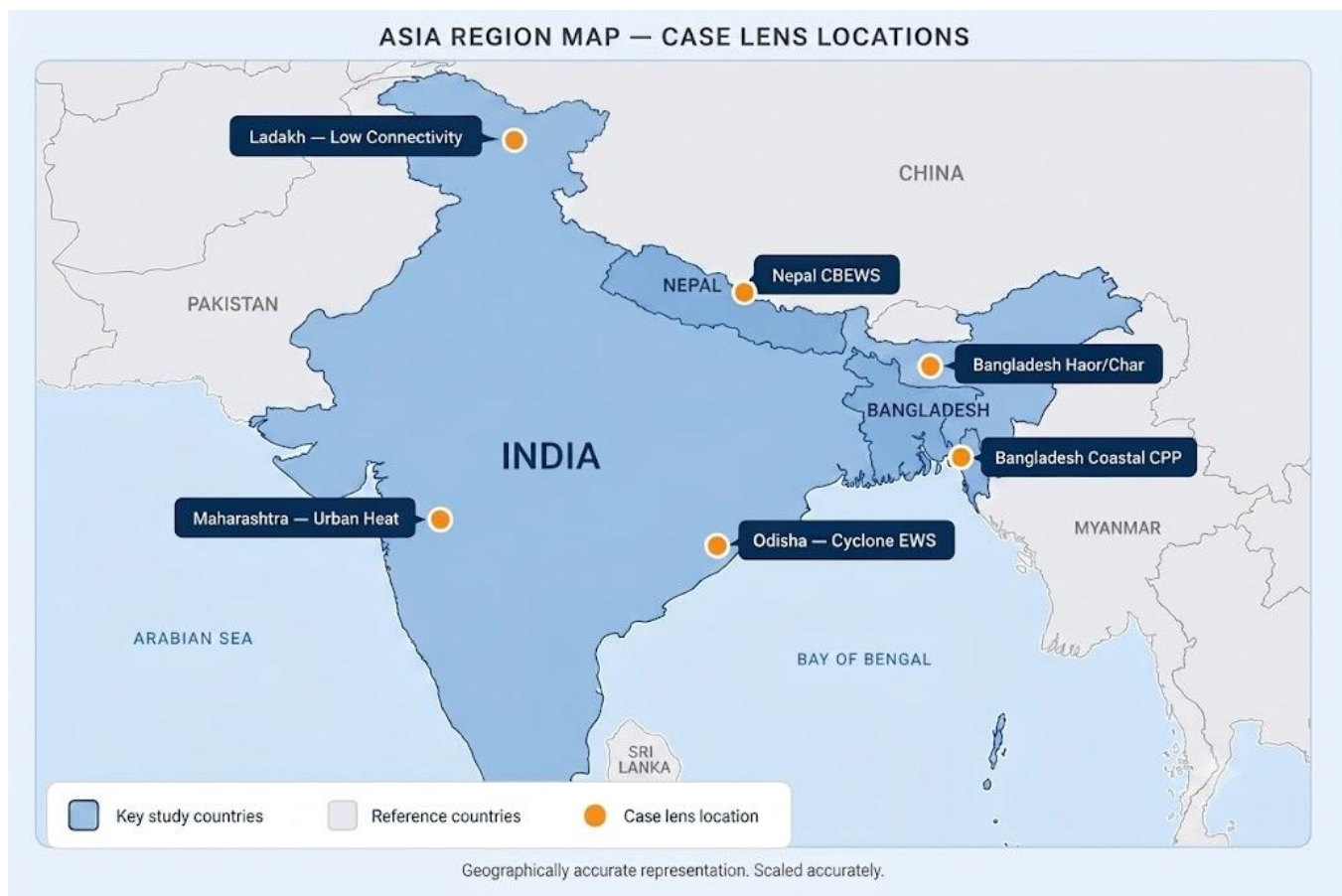


Figure 1: Regional map showing case lens locations and primary hazard zones.

South Asia's progress on early warning infrastructure over the past two decades is real and should not be dismissed. India's cyclone track record is one of the clearest stories of EWS investment paying off. The 1999 Odisha super cyclone killed approximately 10,000 people. Cyclone Phailin<sup>i</sup> in 2013, which was of similar intensity and affected similar geography, killed fewer than 50 people, in part because of dramatically improved forecasting, mass evacuation, and community preparedness. Bangladesh's<sup>ii</sup> Cyclone Preparedness Programme has reduced cyclone mortality by orders of magnitude since the 1970 cyclone that killed an estimated 300,000 people. Nepal has built community-based flood EWS across multiple river basins with evolving linkages to anticipatory action and Forecast based Financing. These are not marginal improvements.

And yet a persistent and well-determined gap remains between alert issuance and protective action, particularly for the most exposed groups. The study frames this gap through a governance lens. Warnings must be locally meaningful and not just technically accurate. They must be reinforced through trusted channels, not only broadcast through official ones. They must be linked to predefined institutional decisions and community action protocols, not left as information for individuals to act in isolation. They must be connected to the material resources like transport, shelter, cash, community support that make early action possible for households without options. And they must enable communities to report what is happening on the ground back to institutions, not only receive information flowing one way.

### RESEARCH QUESTION

What kinds of technology-enabled, locally trusted, inclusive, and governance backed risk information systems can help South Asian communities move reliably from receiving early warnings to taking early action including for those currently excluded from or underserved by existing systems?

## 2. Study Scope and Use of Results

### 2.1 Purpose and Positioning

This study was designed to identify practical, transferable, and governance relevant lessons on how early warning systems can become more inclusive, accessible, trusted, and action oriented across South Asia. It does not produce a general disaster risk reduction review, a technical audit of forecasting systems, a full field evaluation, or a statistically representative household survey. Its focus is deliberately narrow: the specific governance and design conditions that determine whether warning information becomes protective action and whether that action reaches the most exposed communities.

The study is positioned as an exploratory synthesis, proportionate to its time bound, desk led design, and intended to generate usable learning and a clear future direction for Duryog Nivaran and its regional network. It is designed to be advocacy ready: the evidence is presented in a form that can be used for peer learning, policy engagement, and fundraising, not only for internal research purposes.

The positioning is also deliberate because the central gap in early warning systems across South Asia is not only the availability of forecast data or communication technology. In many contexts, warnings are generated and disseminated, but the institutional, social, and behavioral conditions required for early action remain weak. The study therefore examines the interface between technology and governance: how warning information is translated, trusted, localized, acted upon, and fed back into decision making systems. This makes the report especially relevant for actors who are interested not only in improving alert systems, but in strengthening the full warning-to-action chain.

By focusing on transferable practices rather than isolated project examples, the study aims to support DN/SIDRRA partners in adapting lessons across different hazard contexts, institutional settings, and community realities. The findings are therefore presented as practical building blocks: diagnostic insights, best practice cards, transferability considerations, and a concept note on future investment pathways. This structure allows the report to serve both as a learning product from SIDRRA Phase II and as a foundation for future regional programming, donor engagement, and policy dialogue on inclusive early warning to early action.

## 2.2 Geographic and Thematic Coverage

The study covers early warning to early action systems across selected South Asian contexts, with primary attention to India, Bangladesh, and Nepal. Within India, the study draws on case lenses from Odisha (cyclone EWS, SHG women relay networks, coastal mangrove linked risk communication), Maharashtra (urban heat action, water stress, informal workers, ULB coordination), and Ladakh (low connectivity and remote community communication). Bangladesh contributes learning on the CPP, Forecast-based Financing mechanisms, volunteer networks, trusted intermediary architectures, and the adaptation of coastal models to inland flood contexts. Nepal contributes community based EWS experience across multiple river basins, anticipatory action mechanisms, index-based flood insurance, and local disaster governance structures.

## 2.3 Intended Users and Applications

| Intended User                             | How Results Can Be Applied                                                                    |
|-------------------------------------------|-----------------------------------------------------------------------------------------------|
| DN/SIDRRA network                         | Policy advocacy, peer learning products, donor engagement conversations                       |
| Practical Action country offices          | Country level adaptation of best practice cards and transferability matrix                    |
| National/state DRM institutions           | Governance review, SOP strengthening, feedback mechanism design                               |
| Donors and funders                        | Investment case for the governance layer around EWS technology                                |
| Civil society and community organisations | Programme design guidance for inclusive risk communication systems                            |
| Future research teams                     | Evidence gaps: migrants, disability inclusion, two-way feedback, livelihood compatible action |

## 3. Methodology and Evidence Architecture

### 3.1 Research Design

The study adopted a desk led exploratory synthesis approach, strengthened through structured programme informed evidence notes and targeted practitioner validation. This design was selected because the SIDRRA Phase II assignment was time bound (four months, January to May 2026), budget constrained (USD 10,500 gross, approximately USD 9,030 net after Sri Lanka withholding tax) and intended to generate actionable learning rather than produce a full field research output with primary data collection. The methodology combined four evidence streams in a layered architecture.

## THE FOUR LAYERS OF RESEARCH DESIGN

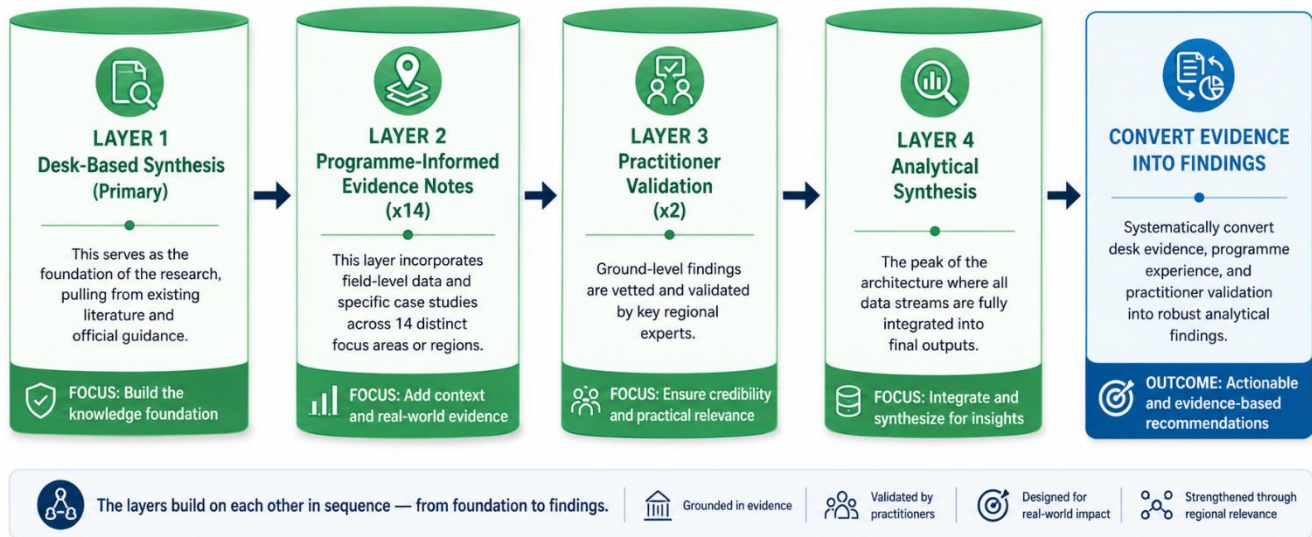


Figure 2: Evidence architecture showing the four research streams feeding the analytical synthesis.

### 3.2 Five Analytical Themes

All evidence was reviewed against five analytical themes representing the governance points where warning information most commonly weakens before becoming protective action. These themes were identified through the initial desk review and refined through the evidence note synthesis process. Together, they allow the study to move beyond a narrow assessment of alert delivery and examine the conditions that determine whether warnings are received, understood, trusted, acted upon, and improved through feedback. They also help surface where exclusion enters the system, whether at the point of message access, local interpretation, institutional decision making, or the availability of resources needed for early action. This thematic structure therefore provides the analytical bridge between global early warning system architecture and the practical realities of last mile risk communication in South Asian contexts.

| Theme                               | Core Question                                                                           | Why It Matters for This Study                                                               |
|-------------------------------------|-----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Accessibility and usability         | Does the warning reach different users in appropriate formats, languages, and channels? | Exclusion at receipt stage means governance failure before any other link is tested         |
| Trust and credibility               | Do people believe the warning and act on it? Which intermediaries strengthen trust?     | Technically accurate warnings are worthless if recipients discount or ignore them           |
| Institutional decision triggers     | Are warnings linked to clear decisions, SOPs, thresholds, and accountability?           | Without predefined authority to act, officials hesitate even when warnings are strong       |
| Two-way feedback and accountability | Can communities and frontline actors send information back to institutions?             | One-way systems are broadcast infrastructure; two-way feedback is governance infrastructure |
| Inclusion barriers and enablers     | Are women, PWD, elderly, migrants, and informal workers designed into the system?       | Exclusion from EWS design concentrates risk precisely where exposure is highest             |

### 3.3 Evidence Confidence Framework

Because the study is exploratory and desk led, findings are presented with a confidence indicator. This prevents overclaiming while preserving important insights that require further testing or validation.

| Level       | Meaning                                                                                               | Application in This Report                                              |
|-------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|
| High        | Supported by multiple credible sources and/or direct practitioner validation                          | Basis for core findings and primary recommendations                     |
| Moderate    | Supported by credible secondary evidence and programme informed insight, requiring further validation | Used with careful wording and specific caveats about context dependence |
| Provisional | Important issue identified but evidence limited or highly context specific                            | Presented as an area for future inquiry, piloting, or targeted research |

### 3.4 How to Read This Report

This report uses a layered analytical structure to move from evidence synthesis to practical recommendations. The structure is deliberately sequenced so that the reader can first understand the evidence base, then the warning-to-action problem, then the diagnostic findings, and finally the transferable practices and governance recommendations.

The report uses four main analytical layers –

First, the study is anchored in the four globally recognized pillars of effective early warning systems: risk knowledge, monitoring and forecasting, dissemination and communication, and preparedness and response capability. These pillars provide the standard early warning system architecture against which the South Asian evidence is assessed.

Second, the report applies five governance themes to examine why warnings may weaken before becoming protective action: accessibility and usability, trust and credibility, institutional decision triggers, two-way feedback and accountability, and inclusion barriers and enablers. These themes are used to look beyond whether warnings are issued and examine whether they are received, understood, trusted, acted upon, and improved through feedback.

Third, the report identifies six recurring bottlenecks that interrupt the warning-to-action chain across different hazard and country contexts. These bottlenecks help organize the main findings and show where technology, institutional systems, and community-level coordination need to work together.

Fourth, the report translates the diagnostic findings into ten best practice cards and a South Asia transferability matrix. These are intended to support DN/SIDRRA partners, civil society actors, local governments, and disaster risk management institutions to adapt the study findings to different geographies, hazards, and institutional contexts.

In this sense, the report does not present themes, pillars, bottlenecks, and best practices as competing categories. They perform different functions within the same analytical sequence: the pillars provide the global EWS architecture, the themes provide the governance lens, the bottlenecks identify where the chain breaks, and the best practice cards suggest how those breaks can be addressed.

*The analysis in Sections 4 to 8 draws on three linked evidence streams: secondary literature and global EWS frameworks, structured evidence notes prepared under the SIDRRA Phase II study, and practitioner validation inputs from Practical Action Bangladesh and Practical Action Nepal. To improve transparency, the report uses source cues within the body of the text, such as “the Odisha evidence note indicates” or “the Bangladesh*

*practitioner validation highlighted”. Annex A provides the evidence classification, including the geography, analytical contribution, confidence level, and caveat for each evidence note and validation input.*

*All figures, tables, and synthesis visuals in this report are author-generated unless otherwise stated. Some visual layouts were developed with support from AI-enabled design tools and subsequently reviewed, edited, and finalized by the authors. The analytical content, interpretation, evidence synthesis, and final wording remain the responsibility of the authors.*

## 4. Regional Context: Early Warning to Early Action in South Asia

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South Asia has made significant progress in strengthening early warning systems over the past two decades. Investments in hydrometeorological monitoring, cyclone forecasting, national and state disaster management institutions, emergency operation centers, public alert platforms, community-based preparedness systems, and local volunteer networks have improved the region’s ability to anticipate and communicate disaster risks. India’s cyclone preparedness experience, Bangladesh’s Cyclone Preparedness Programme, and Nepal’s community-based flood early warning systems all show that early warning investments can reduce loss of life when they are supported by institutional preparedness, trusted local relay, and community-level action.

At the same time, the region continues to face a persistent warning-to-action gap. Accurate warnings do not always translate into timely protective action, especially for households and workers who face social, economic, mobility, language, disability, livelihood, or connectivity barriers. This gap is not explained only by limitations in forecasting or alert technology. It is shaped by whether warning information is locally understandable, trusted, accessible, linked to clear decisions, supported by practical action options, and reinforced through accountable institutions and community networks.

The evidence reviewed for this study suggests that the warning-to-action gap is most visible after a warning leaves the technical forecasting system and enters the social and institutional space where people must decide whether and how to act. A forecast may be technically sound, but the message may not reach the person most at risk. It may reach the right household but in a format, language, or channel that is not usable. It may be understood but not trusted. It may be trusted but not linked to transport, shelter, cash, work flexibility, livestock protection, or institutional support. In such cases, the warning system has not failed at the point of forecast generation; it has weakened during conversion from information to protective action.

*The regional framing in this section draws on the study’s structured evidence notes from India, Bangladesh and Nepal, practitioner validation inputs from Practical Action Bangladesh and Practical Action Nepal, and secondary references on early warning systems, cyclone preparedness, community-based flood early warning, public alert systems, urban heat risk, disability-inclusive early action, and community-level risk communication. The evidence base is classified in Annex A.*

This report therefore treats early warning as a governance chain rather than only a communication event. The chain begins with risk knowledge and hazard monitoring, but it only becomes meaningful when warning information is converted into locally relevant, trusted, inclusive, and feasible early action. This framing is consistent with the study’s evidence base, including the structured evidence notes, practitioner validation inputs from Bangladesh and Nepal, and secondary literature reviewed under the SIDRRA Phase II assignment.

The following figure presents the warning-to-action governance chain used in this study. It shows the main points at which a technically valid warning may weaken before it becomes protective action, and highlights why excluded groups often experience multiple barriers at the same time.

Figure 3: Warning-to-action governance chain showing key nodes, failure points, and excluded groups. Source: Author-generated based on desk synthesis, evidence notes, practitioner validation inputs, and the study's analytical framework.

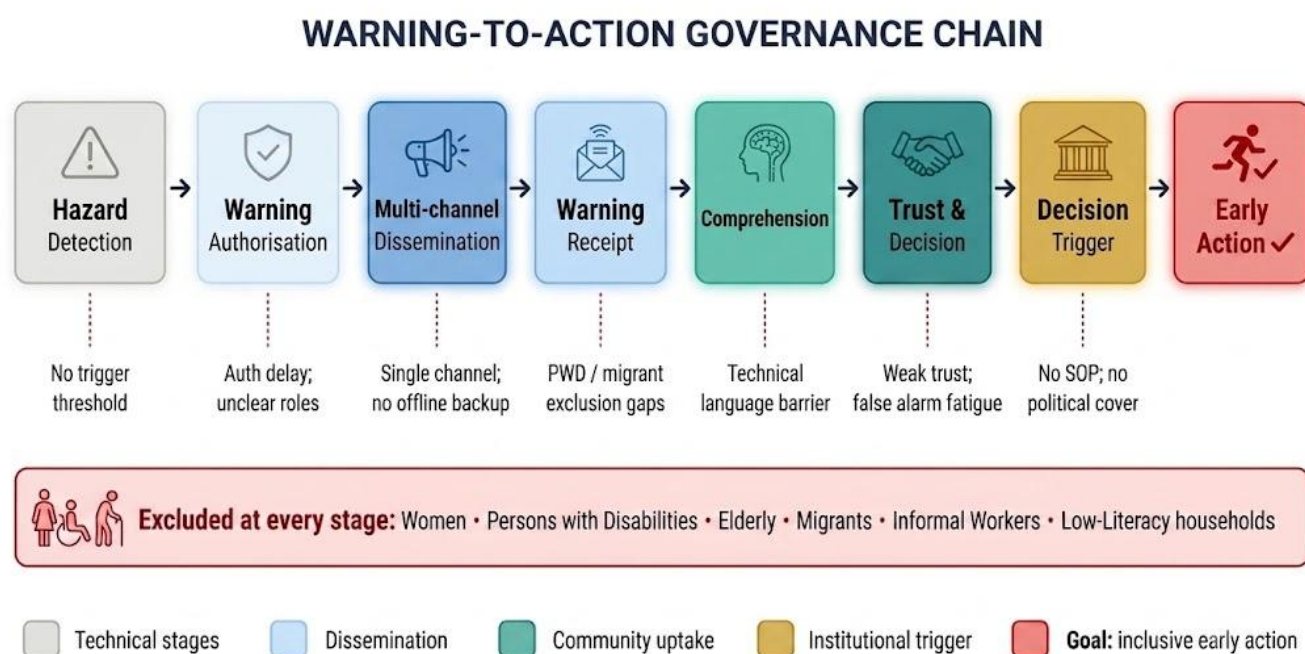


Figure 3: The figure should be read as a conversion pathway. Its purpose is not to suggest that every early warning system fails at every point, but to show where failure can occur when technology, institutional authority, local trust, inclusion design, and practical preparedness do not align. The same warning may move successfully through one part of the chain and still fail for specific groups if the final message is inaccessible, the action instruction is unclear, or the household lacks the resources needed to act.

The chain highlights recurring points where governance investment, coordination design, and institutional commitment can make a decisive difference. It does not suggest that the chain breaks in exactly the same way in every context, but it shows that similar types of failure recur across different hazards, geographies, and institutional settings. This consistency is important because it means targeted, cross-contextual solutions are possible.

#### 4.1 Regional Progress and Remaining Governance Gaps

The country and context snapshots below are not intended to provide a full comparative assessment of national early warning systems. They summarize the main strengths and unresolved governance gaps that are relevant to this study's focus on inclusive early warning to early action. The emphasis is on what the selected evidence base shows about trust, accessibility, institutional triggers, two-way feedback, horizontal coordination, and inclusion.

The table below synthesizes the main strengths and unresolved governance gaps emerging from the evidence notes, practitioner validation inputs, and secondary sources reviewed for each context. It should be read as a qualitative synthesis rather than a formal comparative ranking.

| Country / Context | Documented Strengths                                                          | Persistent Gaps for This Study                                                     |
|-------------------|-------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| India (Odisha)    | Strong cyclone forecasting at 48 to 72hr lead times; mass evacuation culture; | Inland and tribal community coverage; disability and migrant inclusion; post event |

|                     |                                                                                                                                                                                              |                                                                                                                                                                                                       |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     | OSDMA institutional capacity; hybrid warning pathways combining official and community channels; established SHG infrastructure                                                              | feedback mechanisms; horizontal peer coordination between communities                                                                                                                                 |
| India (Maharashtra) | Urban resilience programming; SHG and ULB networks; SHIELD/NbS experience; Heat Action Plan frameworks in select cities                                                                      | Heat action plans remain patchy; informal workers excluded from most warning pathways; ULB coordination with informal sector weak; livelihood compatible action designs absent                        |
| India (Ladakh)      | Government presence improving; satellite connectivity expanding; NDRF and SDRF coverage                                                                                                      | Extreme low connectivity during events; offline first design absent; seasonal isolation not addressed; local relay systems underdeveloped; O&M capacity weak                                          |
| Bangladesh          | CPP: one of the world's most sophisticated communities based EWS; formal gender parity in volunteer architecture; Forecast based Financing emerging; strong trust and reach in coastal areas | CPP primarily coastal; haor/char and inland flood contexts significantly under adapted; horizontal between community coordination mainly informal; disability inclusion in CPP design remains limited |
| Nepal               | Strong CBEWS in riverine contexts across multiple basins; anticipatory action linkages developing; index-based flood insurance piloted; local disaster governance improving under NDRRMA     | Primarily institutional cascade rather than fully horizontal; multi hazard evolution still early; GEDSI design vs. practice gap; mountain GLOF contexts less developed than riverine                  |
| Wider South Asia    | Shared hazard profiles enabling transferability; DN/SIDRRA regional network for peer learning; growing Sendai Framework accountability                                                       | Governance systems differ significantly; transferability requires deliberate adaptation; low connectivity and remote contexts chronically underinvested across the region                             |

## 5. Warning to Action Diagnostic

This section presents the main diagnostic findings of the study. It examines where the early warning system weakens after technical risk information is produced and before protective action is taken by households, communities, frontline institutions, and local authorities.

The diagnostic is organized around the four globally recognized pillars of effective early warning systems: risk knowledge, monitoring and forecasting, dissemination and communication, and preparedness and response capability. These pillars provide the standard structure for assessing an early warning system. However, this study applies an additional governance lens to each pillar, using five analytical themes: accessibility and usability, trust and credibility, institutional decision triggers, two-way feedback and accountability, and inclusion barriers and enablers.

This two-layer approach is important because a technically functioning early warning system may still fail to produce inclusive early action. A forecast may be accurate, but the warning may not be accessible to people with disabilities, migrants, informal workers, elderly people, or low literacy households. A message may be disseminated quickly but not trusted locally. A hazard threshold may be crossed, but officials may hesitate if authority, SOPs, and accountability are unclear. Community actors may observe changing risk conditions but have no structured channel to report this information back to emergency operations centers or local authorities.

The diagnostic therefore does not assess early warning performance only by weather forecasts are issued or alerts are disseminated. It examines whether the warning chain is capable of producing locally understood, trusted, inclusive, and feasible action. The findings draw on the structured evidence notes, practitioner validation inputs from Bangladesh and Nepal, and secondary sources reviewed under the SIDRRA Phase II study. The detailed evidence classification is provided in Annex A.

### FOUR EWS PILLARS × FIVE GOVERNANCE THEMES – DIAGNOSTIC HEATMAP

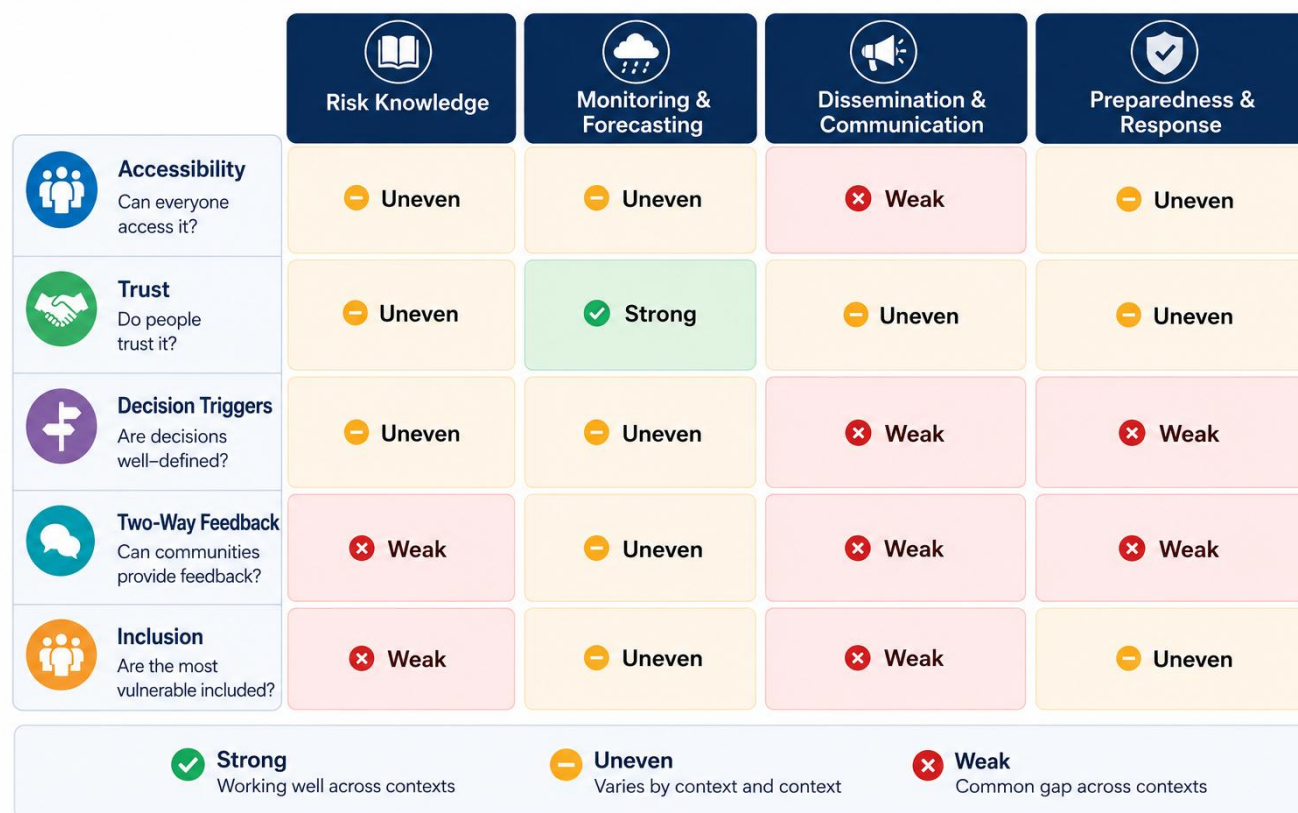


Figure 4: Diagnostic heatmap showing the four EWS pillars assessed against five governance themes.

Source: Author-generated based on desk synthesis, structured evidence notes, practitioner validation inputs, and the WMO four-pillar early warning framework.

The diagnostic shows that the most persistent gaps are not concentrated in forecasting alone. Across the evidence reviewed, weaknesses are more visible where technical warnings need to become locally usable messages, where official alerts require trusted interpretation, where decision thresholds must activate predefined action, and where excluded groups need accessible channels and practical support to act. This is why the study places particular attention on dissemination, communication, preparedness, response capability, and the governance arrangements that connect them.

## 5.1 Pillar One: Risk Knowledge

Risk knowledge refers to the systematic understanding of hazard, exposure, vulnerability, and capacity. It is the foundation from which warnings are generated, and preparedness actions are planned. Across India, Bangladesh, and Nepal, risk knowledge has improved through hazard mapping, vulnerability assessments, community risk mapping, climate risk analysis, and local disaster planning. However, the evidence reviewed for this study indicates that risk knowledge often remains stronger at national, state, or district level than at the household and frontline level where early action must take place.

A critical observation from the evidence notes is that risk knowledge must be held simultaneously at multiple governance levels to be actionable. National or district level flood hazard maps describe which areas are exposed to which intensity of flooding. That information is necessary but not sufficient. Household level risk knowledge and understanding that your specific plot, livelihood, mobility constraint, or disability type places you in a particular danger zone is qualitatively different from a district level hazard map. The former is actionable. The latter is not. Systems that hold risk knowledge only at the institutional level cannot translate warnings into individually relevant action instructions. Co generated community risk knowledge, regularly updated and locally owned, is the foundation from which accessible warnings can be built.

*Evidence from the Odisha, Maharashtra, Ladakh, Bangladesh, and Nepal lenses suggests that risk knowledge becomes actionable only when it is localized and periodically updated with community participation.*

## 5.2 Pillar Two: Monitoring and Forecasting

This is the pillar where South Asian investment has been most concentrated and where improvement is most visible. India's IMD now provides high skill cyclone track forecasts at 48-to-72-hour lead times with reasonably reliable intensity predictions. Bangladesh Meteorological Department and Nepal's DHM have expanded their hydromet station networks and improved real time monitoring. Community based gauge readers and local water level monitoring in Nepal's CBEWS work add an important community level monitoring dimension that technical systems alone cannot provide.

The governance gap at this pillar is not primarily in the forecasting itself. It is in the linkage between forecast data and action ready trigger thresholds. A forecast says the Karnali River will reach 4.2 meters at a named gauge station within 18 hours. But what action does that trigger? For whom? Authorized by which official? With what deadline for initiation? In the absence of predefined and institutionally endorsed trigger thresholds, even excellent forecasting data accumulates in systems and dashboards without producing protective action. Officials receive information and wait for confirmation, for higher authority, for the event itself to confirm the forecast, and the window for early action closes.

*Secondary evidence and practitioner validation indicate that South Asia has made visible progress in forecasting capacity, particularly for cyclones and floods, but that the operational gap often lies in linking forecast thresholds to predefined action.*

## 5.3 Pillar Three: Dissemination and Communication

This is where the evidence is most richly documented and where governance failures are most clearly and consistently identified. The evidence notes on CAP/SACHET, community radio, disability inclusion, SHG-led relay, and informal workers all point to dissemination as the point where technology, trust, language, accessibility, and local action instructions intersect most strongly.

Given the exploratory and qualitative nature of this study, the diagnostic is presented through recurring gap areas rather than through a formal country ranking or quantitative performance score. The table below summarizes the common dissemination and communication gaps identified across the evidence base and the groups most affected by each gap.

| Diagnostic Area | Common Gap Observed                                                                                     | Most Affected Groups                                                 |
|-----------------|---------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| Warning receipt | Phone dependent or single language systems exclude remote, low literacy, or low connectivity households | PWD, elderly, low literacy, non-smartphone users, remote communities |

|                         |                                                                                                           |                                                                                                |
|-------------------------|-----------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|
| Comprehension           | Color coded alerts and technical classifications not meaningful at household level without interpretation | Low literacy users, non-local language speakers, informal workers, new migrants                |
| Trust                   | Anonymous official alerts are frequently discounted until confirmed by a trusted local actor              | Migrants, new settlers, socially isolated households, communities with low institutional trust |
| Decision triggers       | Officials delay when institutional authority or SOP accountability is unclear                             | All groups, but this is worst for those without independent self-protection options            |
| Feedback                | Community reporting channels informal, personal, or absent; EOC monitoring of community information rare  | Women, PWD, informal workers, migrant communities                                              |
| Horizontal coordination | Systems vertical by design; peer to peer relay between communities rarely mandated or tested              | Upstream/downstream communities, isolated hamlets, inter ward urban populations                |
| Inclusion design        | Inclusion typically added after core system design rather than built in from the beginning                | All excluded groups but disability inclusion is the most systematically absent                 |

## 5.4 Pillar Four: Preparedness and Response Capability

The fourth pillar connects the warning system to the institutional and community response capacity that makes early action possible. Even the most accessible, trusted, and well triggered warning is insufficient if the household at risk has no transport to the cyclone shelter, no cash to preposition assets, no shelter that can accommodate a person using a wheelchair, no mandate to stop work and evacuate, or no mechanism to report what is happening. Preparedness and response capability is where warning systems must connect to wider social protection, anticipatory finance, local governance, and community organisation and where the boundary between EWS and broader disaster risk governance most clearly dissolves.

Early action is most reliable where preparedness is institutionalized: simulation drills are conducted annually before hazard seasons, SOPs are tested under realistic conditions, shelter capacity is mapped and updated, evacuation routes are known and practiced, and vulnerable households are identified and registered before an event. Bangladesh's CPP is the strongest South Asian example of this integration at community level. Nepal's Community Disaster Management Committees represent a promising but unevenly resourced and capacitated equivalent at the local government level.

*Practitioner validation from Bangladesh and Nepal, along with the Odisha and Maharashtra evidence notes, suggests that early action is most reliable where preparedness arrangements are pre-agreed, locally practiced, and linked to practical resources such as shelter, transport, work adjustment, cash, or community support.*

## 6. Key Bottlenecks and Enablers

The bottlenecks identified by this study are not isolated problems. They interact across the warning-to-action chain. A message may reach a device but not the person who needs it. It may reach the right person but in an inaccessible format. It may be accessible but not trusted. It may be trusted but not linked to transport, shelter, cash, work flexibility, or institutional support. When multiple gaps occur together, the warning may technically be delivered but still fail to produce protective action.

This section does not repeat the full diagnostic presented in Section 5. Instead, it identifies the recurring bottlenecks that most consistently interrupt the movement from warning information to early action. Each bottleneck is presented as a practical governance failure, followed by the enabling condition that would help address it.

The bottlenecks presented in this section are derived from a cross-reading of the structured evidence notes, practitioner validation inputs, and secondary literature. They represent recurring failure points observed across different hazard, geography, and institutional contexts, rather than findings from a single country or programme.

Where donors and governments fund only the technology layer, through better apps, more sensors, or faster alert platforms, the warning-to-action chain may still remain weak if the governance layer is not addressed. Because the governance layer that determines whether technology translates into inclusive protective action has not been addressed. Understanding these bottlenecks is important for investment decisions.

### **Bottleneck 1: One Way Broadcast Architecture**

One recurring structural problem identified across the evidence base is that systems have been designed around one way information movement: from institution to community. Alerts are issued; reception is assumed. There is rarely a systematic mechanism to confirm that a warning was received, understood, or acted upon. Communities cannot report changing local conditions such as a blocked evacuation route, a gauge already above danger level, a stranded household or a local shelter that is already full, back into the system in a structured and monitored way.

The post-event feedback evidence note indicates that many EWS arrangements reviewed for this study are stronger at sending information out than at learning from communities in real time during active warning periods. The practical enablers for two-way feedback are not technically complex where IVR feedback lines, WhatsApp escalation pathways to EOC duty officers, community reporting desks with assigned monitoring responsibility. The governance barrier is assigning someone with clear authority and accountability to monitor and respond to incoming community information during warning events, not only to issue alerts.

*Evidence base: Post-event feedback and accountability notes, CAP/SACHET desk note, community radio note, and practitioner validation inputs on community-level reporting and feedback.*

### **Bottleneck 2: Inaccessible Messaging**

Inaccessibility in EWS is not one problem while it is a cluster of distinct problems that compound. A warning delivered only through SMS fails households without mobile phones. A color-coded alert fails low literacy users. A text only alert fails people with visual impairments. An audio only alert fails people with hearing impairments. A warning in Hindi fails Odia speaking fishing communities. A message formatted for a smartphone screen fails a feature phone user in rural Ladakh. A warning issued on a Tuesday afternoon fails seasonal migrant workers who are in transit between states and outside the household registration system through which warnings travel.

The disability inclusion evidence note is among the sharpest in the study: across several reviewed contexts, warning systems appear insufficiently designed with accessible formats as a primary requirement. Sign language interpretation of broadcast alerts, audio friendly message formats, simple pictorial warnings usable by low literacy households, formats accessible to persons with visual impairments, and caregiver notification protocols for persons with cognitive or mobility impairments are all available, documented solutions. The governance gap is not in the technology. It is in the design process. Accessibility requires co-design with organisations of people with disabilities before deployment, not adaptation after the system is built.

*Evidence base: Disability-inclusive EWS desk note, informal workers heat warning note, community radio note, and evidence on language, literacy, disability, and connectivity barriers.*

### **Bottleneck 3: Weak Trust Layer**

Trust is not a soft issue at the margins of EWS effectiveness. It is the mechanism by which warning information is converted into the decision to act. The evidence across all study contexts is consistent: an official or anonymous alert that is not reinforced by a trusted local actor, i.e., an SHG leader, a community health worker, a CPP volunteer, an imam who knows the community, a schoolteacher, a market committee head, is frequently discounted, delayed, or acted upon by only a fraction of the households it should reach.

Trust operates at multiple levels simultaneously. Trust in the technical accuracy of the forecast: do people believe the IMD or DHM forecast is reliable? Trust in the institutional source: does this government alert reflect genuine danger or is it bureaucratic precaution? Trust in the messenger: is this person known to me, embedded in my community, accountable to me? Trust in the instruction: if I evacuate now, will the shelter actually be there, will it be safe, will I be able to return? In Bangladesh, CPP volunteers who live within the communities they serve are the critical trust bridge across all these levels. Their physical presence in the community during a warning event is moving door to door, using loudspeakers, personally persuading reluctant household members which is irreplaceable by any technology.

*Evidence base: Odisha cyclone EWS note, Odisha SHG and women-led relay note, Bangladesh CPP practitioner validation, Nepal CBEWS practitioner validation, and community radio evidence note.*

#### **Bottleneck 4: Unclear Institutional Decision Triggers**

When district, block, or local level officials receive a warning but have no Standard Operating Procedure specifying what action they are authorized to initiate and by when, institutional delay is structurally inevitable. The political economy compounds this: an official who initiates mass evacuation and the event turns out less severe than forecast faces public criticism, disruption of livelihoods, loss of institutional credibility, and sometimes formal accountability for the costs. An official who waits and the event is severe has more political cover, the standard of care shifts from anticipatory to responsive.

Pre-defined threshold-based trigger protocols are linked to named officials, specific action requirements, explicit no regret language and clear legal protection for anticipatory decisions directly address this bottleneck. Nepal's index-based flood insurance mechanism provides a practical example from the study's evidence base: triggers are defined before the season, tied to measurable parameters (river gauge levels, forecast probability thresholds), and linked to a pre-committed financial response. The decision question is resolved before the event, not during it, removing the political and institutional hesitation that delay creates.

*Evidence base: Nepal practitioner validation, index-based flood insurance evidence, Maharashtra heat and water risk reflection, and wider EWS governance literature.*

#### **Bottleneck 5: Weak Horizontal Coordination**

This is one of the study's most distinctive analytical contributions, and it emerged consistently across the evidence notes rather than being anticipated in the original analytical framework. Early warning governance has been designed primarily as a vertical system: technical information flows from forecasting agencies through institutional hierarchies to communities at the bottom. But protective early action which is particularly in contexts of riverine flooding, urban heat, and agricultural drought, also depends critically on horizontal coordination: between neighboring communities who share upstream downstream flood exposure, between frontline workers who serve overlapping or adjacent geographic areas, between SHG networks that span multiple hamlets, and between informal sector workers and municipal authorities during urban heat events.

The horizontal coordination evidence note identifies a crucial dynamic: peer networks often hold information that formal systems do not. A neighboring community may know that the settlement downstream has no mobile signal during monsoon flooding. An SHG leader may know which households in the hamlet have members with mobility constraints who will need evacuation support. A market vendor association may know which migrant worker dormitory has no access to official warning channels. Without a mandate and mechanism for lateral information

relay, this knowledge stays local, informal, and inaccessible to the formal response system. With one, a predefined community to community relay protocol, an SHG federation communication tree, a VHF radio network linking volunteer teams across adjacent geographic units and it becomes part of the protective system.

*Evidence base: Horizontal coordination cross-cutting analytical note, Odisha SHG relay notes, Maharashtra SHG-ULB coordination note, Bangladesh CPP practitioner validation, and Nepal CBEWS validation.*

## Bottleneck 6: Livelihood Constrained Early Action

For a significant proportion of the population in urban South Asian contexts the daily wage earners, construction workers, sanitation workers, transport workers, market vendors and domestic workers, the instruction to 'avoid going out during a heatwave' or 'leave the area before the cyclone arrives' is not an instruction they can follow without additional support. Their livelihood depends on being present. A day not worked is income not earned, often with downstream consequences for household debt, food security, and children's schooling. A warning that tells them what the hazard is without giving them a livelihood compatible action pathway is not an early warning system for them. It is an information service that they receive but cannot act on.

The informal workers evidence note introduces the precise formulation the report adopts: 'livelihood compatible early action.' This requires not just issuing advisories but designing enabling conditions: shifting work timing during the hottest hours without income loss, providing shaded rest points and water access at vending locations, coordinating with employer associations and market committees, and connecting warning systems to social protection mechanisms that can provide a minimum income floor during heat events that make outdoor work impossible. This is the most provisionally evidenced area in the study and the evidence for effective delivery models is thin, but the problem is clearly identified and its scale in South Asian cities is significant.

*Evidence base: Informal workers and street vendors heat warning note, Maharashtra urban heat and water risk reflection, Odisha coastal mangrove and risk communication note, and anticipatory finance literature.*

### SUMMING UP

Taken together, these bottlenecks show why early warning systems cannot be strengthened only through faster dissemination or better technology platforms. The practical task is to identify which part of the warning-to-action chain is weakest in a given context and then match the response accordingly: accessible communication where messages are not usable, trusted relay where warnings are not believed, SOPs where authority is unclear, feedback systems where local information does not travel upward, and livelihood-compatible support where households cannot act without economic loss.

## 7. Evidence from Case Lenses and Practitioner Validation

*Source base for this section: This section draws on fourteen structured evidence notes and two practitioner validation inputs. The evidence notes cover Odisha cyclone EWS, Maharashtra urban heat and water risk, Odisha coastal mangrove-linked risk communication, Odisha SHG and women-led relay, Maharashtra SHG-ULB coordination, Ladakh low-connectivity risk communication, India CAP/SACHET and cell broadcast systems, community radio and offline warning channels, disability-inclusive early warning systems, informal workers and heat warning, horizontal coordination, and post-event feedback and accountability. The practitioner validation inputs were provided by Practical Action Bangladesh and Practical Action Nepal. The full evidence classification is provided in Annex A.*

This section synthesizes insights from the fourteen structured evidence notes and two practitioner validation inputs. The purpose is not to present full case studies, because the study's desk-based design does not support that level of depth. Instead, it identifies what each context specifically and distinctively teaches about the warning to action chain, and what that teaching transfers to other South Asian contexts. The evidence has therefore been used as a set of analytical lenses, not as a collection of standalone country or programme descriptions. Each lens helps test a different part of the study's core argument: that early warning systems succeed when technology, trust, institutional authority, community relay, and inclusion design work together. The practitioner validation inputs from Bangladesh and Nepal were especially important in grounding the desk synthesis in operational experience and preventing over generalization from secondary literature alone.

The case lenses were read comparatively rather than descriptively. Each context was examined for the specific governance function it illustrates within the warning to action chain. Odisha helps explain the value of hybrid warning pathways and repeated community reinforcement. Maharashtra brings out the challenge of translating heat advisories into livelihood compatible action for informal and outdoor workers. Ladakh highlights the importance of offline first design in low connectivity and remote geographies. Bangladesh demonstrates how trusted volunteer systems can institutionalize community level relay at scale, while Nepal shows how community-based flood early warning systems can connect hydromet information, local monitoring, and anticipatory finance. Taken together, these lenses help move the analysis beyond country examples and towards transferable design principles on trust, accessibility, decision triggers, feedback, and local ownership.

| Case Lens                                  | Main contribution to the warning-to-action analysis                                                                                                                                            | Transferable lesson for South Asia                                                                                                                                                               |
|--------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Odisha cyclone early warning systems       | Shows how formal alerts become more actionable when reinforced through local institutions, panchayats, volunteers, SHGs, media channels, and neighbor-level confirmation.                      | Hybrid warning pathways are stronger than single-channel dissemination, but residual inclusion gaps remain for inland, tribal, migrant, fisher, elderly, and disability-affected households.     |
| Maharashtra urban heat and water risk      | Highlights that heat advisories require a different action logic from cyclone or flood warnings because many exposed groups cannot stop work without livelihood loss.                          | Early warnings must be linked to livelihood-compatible action, including shade, water access, adjusted work timing, municipal coordination, school protocols, and support for informal workers.  |
| Ladakh low-connectivity risk communication | Demonstrates why mobile-first and internet-dependent systems are insufficient in remote, dispersed, and climate-vulnerable mountain contexts.                                                  | Offline-first design, local ownership, basic O&M capacity, sirens, radio, physical relay, and community drills should be treated as primary design requirements in low-connectivity geographies. |
| SHG and women-led relay systems            | Shows that women's collectives and SHG networks can function as trusted social infrastructure for warning interpretation, household preparedness, and identification of vulnerable households. | SHGs and women-led networks should be formally recognized, trained, and included in local disaster management plans, rather than used informally during active events.                           |
| CAP, SACHET and cell broadcast systems     | Clarifies the value of national alert platforms for speed, scale, and geographic targeting, while also showing their limits in relation to comprehension, trust, accessibility, and feedback.  | Digital alert platforms are necessary but not sufficient. They need to be complemented by local language formats, action-oriented messages, trusted intermediaries, and feedback pathways.       |

|                                                   |                                                                                                                                                                                                            |                                                                                                                                                                                                                             |
|---------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Community radio and offline warning channels      | Shows the value of locally trusted, low-literacy-friendly, low-connectivity communication that can operate during power or network disruption.                                                             | Community radio should be integrated into official warning protocols as a local risk communication institution, not treated only as a fallback channel.                                                                     |
| Disability-inclusive early warning systems        | Establishes that accessibility cannot be added after the system is designed. Warning formats, evacuation plans, shelter access, caregiver protocols, and feedback processes must be co-designed with OPDs. | Disability inclusion requires co-design, pre-season testing, accessible formats, household mapping, and post-event review involving persons with disabilities and their organisations.                                      |
| Bangladesh Cyclone Preparedness Programme         | Provides a mature example of a hybrid model where national triggers are combined with trusted community volunteer execution at scale.                                                                      | Structured volunteer networks, gender-balanced architecture, mosque and market amplification, and door-to-door relay offer transferable principles, though action packages must be adapted beyond coastal cyclone contexts. |
| Nepal community-based flood early warning systems | Shows how hydromet information, community monitoring, local institutions, and anticipatory finance can be linked in riverine flood contexts.                                                               | Community-based EWS works best when connected to institutional cascades, local monitoring, trigger thresholds, and livelihood protection mechanisms such as index-based insurance or anticipatory action.                   |

*Source: Author synthesis based on structured evidence notes, practitioner validation inputs from Practical Action Bangladesh and Practical Action Nepal, and evidence classification provided in Annex A.*

The synthesis shows that no single case lens provides a complete model for inclusive early warning to early action. Odisha contributes learning on hybrid warning pathways, Maharashtra on livelihood-compatible action, Ladakh on offline-first design, Bangladesh on trusted volunteer architecture, and Nepal on community-based flood warning linked to institutional systems and anticipatory finance. Taken together, these lenses support the report's central argument that technology-enabled early warning becomes effective only when it is embedded in trusted, accessible, locally governed, and action-oriented systems.

## 7.1 Odisha; Hybrid Warning Architecture and the Limits of Success

**Source base:** *Odisha Cyclone EWS Evidence Note, Odisha SHG and Women-Led Warning Relay Note, Odisha Coastal Mangrove and Risk Communication Note, and secondary literature on Odisha cyclone preparedness.*

Odisha is one of South Asia's clearest examples of how strong political will, substantial institutional investment, and repeated event learning can substantially improve disaster outcomes over time. The improvements since the 1999 super cyclone are real, well documented, and internationally recognized. OSDMA's institutional capacity, the mass evacuation culture among coastal communities, the multi hazard EWS infrastructure, and the network of cyclone shelters represent genuine achievements of sustained investment and governance commitment over more than two decades.

The Odisha evidence note identifies the critical and transferable insight: Odisha's strength is the repeated local reinforcement of warnings, not only the formal alert itself. Cyclone warnings move formally from IMD through OSDMA to district administration, blocks, and panchayats. But at household level, people receive and act on warnings through what the evidence terms a 'hybrid warning pathway': television and radio alerts, WhatsApp groups among community members, personal mobile calls between neighbors, SHG leader notifications, volunteer mobilisation, panchayat public address systems, and the social pressure of seeing neighbors prepare and evacuate.

The technical alert provides an authoritative signal; the social relay provides the locally trusted interpretation and the action instruction.

Crucially, even in this relatively strong system, residual gaps persist at a scale and consistency that cannot be dismissed as edge cases. Inland and tribal communities in western Odisha face very different warning architectures than coastal communities and receive substantially weaker coverage. Fishers already at sea when warnings are issued face connectivity and authority challenges. Households with members who have mobility impairments face evacuation barriers that are well documented but poorly addressed. Seasonal migrant workers who have temporarily relocated outside their registered household are largely outside the formal warning system during active events. The lesson from Odisha is not that it is a system to replicate wholesale, but that hybrid dissemination architecture, mass evacuation culture, and administrative clarity can move the system substantially forward while inclusive design for the most exposed groups remains the unfinished and urgent work.

## 7.2 Maharashtra; Urban Heat and Action Linked Advisory Design

**Source base:** *Maharashtra Urban Heat and Water Risk Reflection, Maharashtra SHG-ULB Local Coordination Note, informal workers and street vendors heat warning evidence note, and secondary literature on heat action planning.*

Maharashtra's experience with urban heat and water stress illustrates a dimension of EWS design that cyclone focused analysis tends to underweight. Heat risk does not produce a single dramatic warning and evacuation moment. It builds gradually over days or weeks, arrives without a geographically defined impact boundary, and affects people whose livelihoods require them to remain in precisely the conditions that put them at risk. An outdoor construction worker, a sanitation worker, a street vendor, a school student walking to class, these people cannot self-protect through evacuation. They need a different kind of early action: modified work schedules, shaded rest points, accessible hydration, employer and authority coordination.

The Maharashtra evidence note introduces the formulation that travels into this report's policy argument: 'action linked advisory.' A useful heat advisory tells a specific person, i.e., a street vendor, a construction worker, a schoolchild, an elderly person in a tin roof settlement on what to do, when to do it, and where to access protective resources. A useless heat advisory tells them it is 42 degrees and advises them to stay hydrated. The gap between these two is not in the accuracy of the temperature forecast. It is in the governance commitment of urban local bodies to translate forecast data into specific protective actions: water kiosks at vending locations, temporary shade structures, shifts in school timing, modified schedules for municipal outdoor workers, market closure coordination, heat emergency helplines that actually function.

## 7.3 Ladakh; Offline First as Primary Design Principle

**Source base:** *Ladakh Low-Connectivity Risk Communication Note, community radio and offline warning channel note, and wider literature on low-connectivity and mountain risk communication.*

Ladakh represents a design frontier that is increasingly relevant as climate change intensifies hazard risk in mountain and remote contexts across South Asia and globally. Extreme low connectivity, sparse and dispersed settlement, harsh terrain, seasonal road closures, and extreme temperature ranges mean that mobile networks, smartphone-based alerts, internet dependent platforms, and any technology infrastructure requiring stable electricity are unreliable as primary warning channels. Offline first is not a fallback design option in such contexts. It is the only viable primary design principle.

The Ladakh evidence note documents that the most effective risk communication mechanisms in such contexts are VHF and HF radio networks, hand operated sirens with specific codes for different hazard levels, physical relay systems through community runners or mounted couriers, community notice board updated before hazard seasons, and prepositioned preparedness kits at designated community assembly points. What distinguishes effectively from ineffective offline first systems in these contexts are not the hardware. It is local ownership. A siren that no one in

the community knows how to operate or maintain after the installation team departs is not a functioning early warning system. Regular simulation drills, local operations and maintenance training, and a formally designated community member with responsibility for system readiness are as important as the hardware investment.

## 7.4 SHG Women Led Relay, The Formalization Gap

**Source base:** *Odisha SHG and Women-Led Warning Relay Note, Maharashtra SHG-ULB Local Coordination Note, and practitioner insights on trusted community relay systems.*

The Odisha SHG and women led relay evidence note identifies a governance resource that exists across South Asian contexts at significant scale but is frequently used informally rather than being structurally embedded in official warning systems. Women's Self-Help Groups are particularly the large networks of SHGs linked to NRLM in India and equivalent programmes in Bangladesh and Nepal are already maintain regular contact with member households, conduct weekly or monthly savings meetings, manage microcredit disbursements, and coordinate community activities. They are trusted social infrastructure, reaching into households that formal government systems frequently cannot. In a warning event, they can function as relay points that translate, verify, reinforce, and personalize official messages within hamlets and households.

The critical condition which the evidence note states carefully is that SHG led communication requires prior orientation and formal recognition to be effective. Without training in how to interpret specific alert levels, clear message templates, pre agreed action guidance ('SHG action cards' for different hazard levels), and formal recognition within panchayat or district disaster management plans, SHG members may relay partial information, hesitate to advise full evacuation, or communicate warnings in ways that generate uncertainty rather than protective action. The governance move required is not to use SHGs informally at the last minute when an event is already developing. It is to embed their role formally in local disaster management plans, train them before hazard seasons, test that training in simulation drills, and give them institutional standing and accountability.

## 7.5 CAP, SACHET, and the Technology Governance Interface

**Source base:** *India CAP, SACHET and Cell Broadcast Desk Note, NDMA/SACHET platform references, C-DOT CAP Integrated Alert System reference, and wider literature on public warning systems.*

India's Common Alerting Protocol and SACHET platform represent important national level technology investments in rapid, geo targeted public warning dissemination. Cell broadcast architecture<sup>iii</sup> which can deliver messages to all devices in a defined geographic area regardless of whether they are locally registered or have a local SIM, represents a significant improvement in warning speed and scale over traditional SMS based systems that depend on network operator cooperation and subscriber databases. The investment is warranted, the technology is well suited to the Indian context, and its continued development should be supported.

The CAP/SACHET<sup>iv</sup> evidence note identifies, however, a consistent governance gap that the technology itself cannot close: the pathway from alert issuance to protective action at the household level depends on several conditions that CAP/cell broadcast does not address. Messages must be in a language and format the recipient can understand. They must contain a practical action instruction, not only a hazard classification or a color code. The device must be charged, accessible to the person at risk (not only the household's primary phone holder, who may be a male adult away at work), and capable of receiving the specific alert format. And the recipient must trust the source enough to act rather than discount the message as institutional noise. CAP solves the speed and scale problems. It does not solve the comprehension, trust, accessibility, or feedback problems. A complete EWS architecture needs both.

## 7.6 Community Radio; Trusted, Local, and Chronically Undervalued

**Source base:** *Community Radio and Offline Warning Channel Note, UNESCO references on community radio and disaster resilience, and wider evidence on local-language risk communication.*

Community radio<sup>v</sup> occupies a distinct and important niche in the EWS communication architecture that receives far less attention than it deserves in South Asian policy discussions. It is local programming that reflects community geography, seasonal rhythms, and local language and dialect. It is trusted where stations have been developed with strong community engagement rather than imposed from above, they carry genuine community authority. It is accessible and it does not require a smartphone, a data connection, or literacy. It is resilient, battery powered receivers function during power outages and network disruptions. And it is multi directional while community radio stations can receive and relay community generated information, not only broadcast official alerts.

The community radio evidence note identifies three conditions under which it is most effective in EWS contexts: when it is genuinely community operated rather than state relayed, meaning the station has editorial independence and local credibility; when it maintains regular DRR programming across the year rather than only activating during emergencies; and when it is formally connected to official early warning systems through a designated alert relay protocol so that official warnings are received, contextualized, and relayed promptly. The governance risk is that community radio is treated as a channel of last resort for non-literate audiences rather than as a primary community communication institution that deserves formal structural integration into the EWS architecture.

## 7.7 Disability Inclusive EWS; The Co Design Imperative

**Source base:** *Disability-Inclusive Early Warning Systems Desk Note, UNCRPD Article 11, UNDRR guidance on gender-responsive and disability-inclusive early warning and early action, and OPD-centred inclusion literature.*

The disability inclusion evidence note is one of the most analytically important in the study, not for what it reveals about solutions but for what it reveals about how EWS design processes typically operate. Systems are designed usually by technical agencies without disability expertise or representation and then translated for accessibility as an afterthought. Warning messages are issued, then someone asks whether a sign language version is available. Shelters are designated, then someone notes there are no accessible routes or toilet facilities. Evacuation systems are planned, then someone asks whether households with members using wheelchairs are registered and supported.

This sequencing systematically disadvantages people with disabilities, and the design flaw is not correctable by translation after that fact. Inclusive EWS<sup>vi</sup> design for persons with disabilities requires co design from the beginning of the system design process: involvement of organisations of persons with disabilities in the development of message templates, simulation of warning scenarios with diverse disability groups in different household contexts, household level mapping of people who need evacuation assistance, caregiver network integration in community warning plans, accessible shelter designation and certification, and post event feedback collection that specifically solicits disability perspectives. In South Asian contexts where disability prevalence is significant and where PWD face compounding vulnerabilities related to mobility, communication access, and social isolation, excluding this group from EWS design represents a fundamental and correctable governance failure.

## 7.8 Bangladesh CPP; The Hybrid Model

**Source base:** *Bangladesh Practitioner Validation Note provided by Tamanna Rahman, Bangladesh Cyclone Preparedness Programme references, Bangladesh Red Crescent Society materials, and literature on community-based cyclone preparedness.*

The practitioner validation from Tamanna Rahman at Practical Action Bangladesh provides the study's most detailed and analytically precise examination of a mature, large-scale community based early warning and preparedness system. The Bangladesh Cyclone Preparedness Programme operational across coastal districts for decades, structured around ward level volunteer units with formal institutional links to Bangladesh Meteorological Department and local government, and reaching millions of people through its volunteer network is the strongest reference in South Asia for how trusted intermediary networks can be institutionalized at scale.

The validation input introduces an important analytical framing that the report adopts across its analysis: CPP is best described as a hybrid model, a top-down trigger, horizontal execution<sup>vii</sup>. The activation signal comes from national meteorological alerts moving through a structured institutional cascade from BMD through national and district level to the CPP network. But once the warning reaches the last mile, implementation depends entirely on horizontal social coordination: door to door warning delivery by volunteers who live in the same communities they serve and are known and trusted there, mosque loudspeaker amplification coordinated with local religious leaders, market closure coordination with traders, resource pooling between households, and peer to peer persuasion of household members reluctant to evacuate or comply with protective instructions.

The validation also introduces critical caveats that prevent the report from overclaiming CPP's performance. CPP's formal gender parity architecture requiring both men and women volunteers in every ward level unit is a genuine structural achievement. However, formal participation in volunteer rosters does not automatically translate into equal operational participation during high stress warning events. Women's frontline engagement can decline during nighttime evacuation scenarios, severe storm conditions, and contexts where mobility restrictions, safety concerns, care responsibilities, or lack of protective equipment create barriers to full participation. The transferable lesson is that gender parity in volunteer architecture must be backed by enabling conditions: safety arrangements specific to night operations, dedicated protective equipment for women volunteers, childcare sensitive deployment design, and formal recognition and compensation that does not disadvantage women members.

On transferability beyond coastal Bangladesh, the validation is instructive. CPP's core institutional and community logic, structured volunteer networks, formal gender architecture, redundant communication channels, household level relationship between volunteer and community members can inform inland flood contexts in haor areas and char areas, but the specific action package must be redesigned. In haor contexts, early action may prioritize anticipatory crops and livestock protection over evacuation. In char areas, prearranged boat mobilisation and temporary elevated land relocation matter more than fixed shelter systems. The volunteer logic and horizontal execution model are transferable. The specific action content must be contextualized to the hazard profile and community livelihood systems.

## 7.9 Nepal CBEWS: Institutional Cascade with Community Last Mile

**Source base:** *Nepal Practitioner Validation Note provided by Dharam Updety, Practical Action documentation on flood early warning systems in Nepal, index-based flood insurance materials, and secondary literature on Nepal's flood EWS governance.*

The practitioner validation from Dharam Updety at Practical Action Nepal provides the study's most detailed examination of community based EWS in a riverine and mountain context, drawing on a substantial programme record spanning multiple river basins, i.e., Karnali, Babai, West Rapti, Kankai, Kamala, Aurahi, Melamchi Indrawati and institutional partnerships with DHM, NDRRMA, MOFE, MOFAGA, and local governments.

The validation introduces an important nuance that prevents the study from presenting Nepal as a fully horizontal EWS model: Nepal's CBEWS architecture is primarily a structured institutional cascade rather than a codified village to village horizontal relay system. DHM generates weather and flood forecast information; warnings move through NDRRMA, NEOC, PEOCs, and DEOCs before reaching local governments and communities. At local level, CDMCs, grassroots structures, and community members disseminate through sirens, mobile messaging, community radio, and interpersonal communication. Horizontal spread occurs at the community level neighbors warn each other, volunteers relay messages laterally, but this is generally informal and context dependent rather than formally mandated as a peer-to-peer relay protocol. Nepal should be presented as a model of strong community last mile mechanisms within an institutional cascade, not as a fully horizontal peer to peer system.

On anticipatory action and the linkage between EWS and livelihoods, the Nepal validation provides the study's most concrete and precisely evidenced example. In collaboration with Global Parametrics, Shikhar Insurance Company, and Stonestep, Practical Action Nepal developed<sup>viii</sup> an index-based flood insurance mechanism for farmers in flood prone river basins. The 2022 monsoon pilot covered 935 farmers through 12 cooperatives<sup>ix</sup> holding 27 group

policies, with an insured sum of approximately NPR 14.25 million across approximately 134 hectares of paddy cultivation. Risk polygons were defined by government agencies; triggers were linked to flood risk thresholds rather than assessed individual losses. This is not Forecast based Financing in the strict humanitarian technical sense the validation is careful about that distinction, but it demonstrates clearly that EWS trigger data can be connected to prearranged disaster risk finance that protects livelihoods before loss occurs, not only activates emergency response after.

## 8. Best Practice Cards for Inclusive Early Warning to Early Action

The ten best practice cards translate the diagnostic findings into practical design principles. They are not presented as standalone project models or technology recommendations. Each card combines three elements: the communication or technology channel, the governance condition required for that channel to work, and the inclusion design feature needed to ensure that excluded groups are not reached only as an afterthought.

The cards are intended to support adaptation by DN/SIDRRA partners and other practitioners. They should therefore be read together with the transferability matrix in Section 9 and the evidence classification in Annex A. The purpose is not direct replication, but informed adaptation across different South Asian hazard, geography, and institutional contexts.

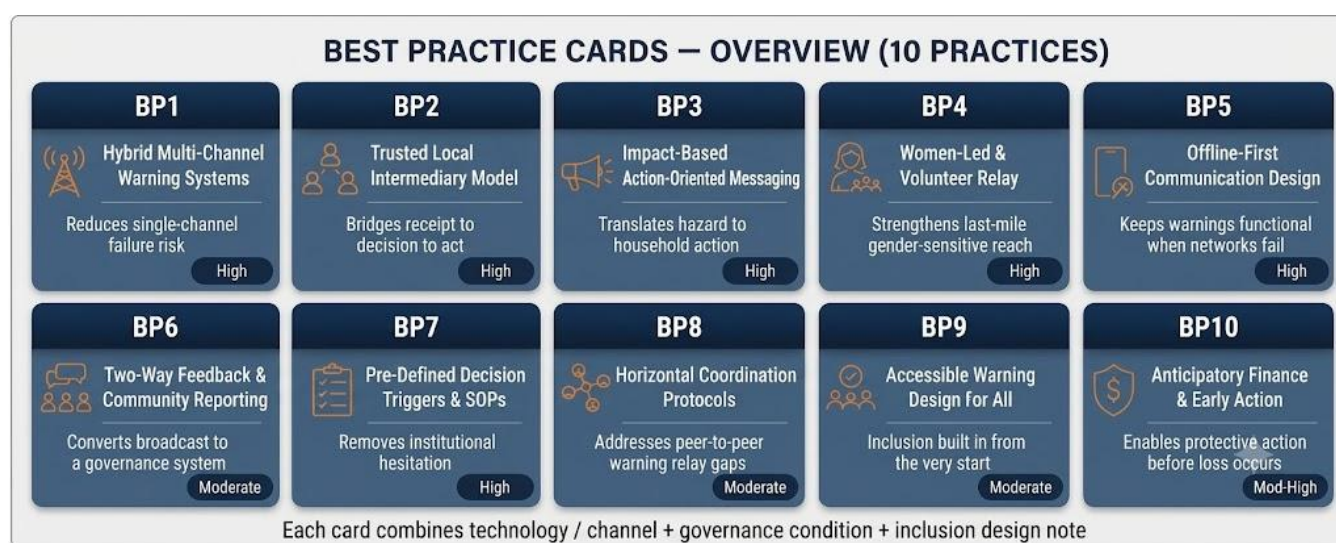


Figure 9: Overview of ten best practice cards for inclusive early warning to early action

### BP1: Hybrid Multi Channel Warning Systems

#### Evidence confidence: High

**Problem addressed:** Reduces dependence on any single technology or communication channel. In South Asian contexts, single channel dependence creates systemic fragility at the worst possible moment: mobile networks fail during severe cyclones; power outages cut loudspeaker systems; internet connectivity collapses in remote areas during flash floods. A system designed around one channel will fail precisely when it is most needed. Hybrid architecture ensures that at least one channel reaches each household type across each geographic and connectivity context.

**Technology and channel:** SMS, IVR, WhatsApp group alerting, community radio, hand operated loudspeakers and megaphones, sirens with defined codes for different hazard levels, visual flag systems, door to door volunteer relay, faith institution amplification. Channels should be layered in order of connectivity dependency and cell

broadcast at the lowest connectivity requirement, internet dependent smartphone applications at the highest so that as connectivity degrades during an event, lower connectivity channels pick up the communication load.

**Governance conditions:** District or local warning SOP must specify which channel activates at which hazard level, by which named authority, within which timeframe. Channel activation must follow predefined protocol it cannot depend on real time decisions by officials who may be unavailable or overwhelmed during an active event. Regular simulation drills must test each channel layer, including the offline components specifically.

**Inclusion design note:** Every channel layer must be assessed against the seven excluded groups: women household members who may not hold the family phone, persons with disabilities who cannot use standard audio or visual formats, elderly people without smartphones, migrants without local SIM registration, low literacy users who cannot interpret text alerts, low connectivity communities without reliable mobile coverage. Community radio and volunteer relay are typically the strongest channels for excluded groups and should be treated as primary channels rather than fallback options.

## BP2: Trusted Local Intermediary Model

### Evidence confidence: High

**Problem addressed:** Bridges the critical gap between receiving a warning and believing it strongly enough to act on it immediately and fully. Official and anonymous alerts are frequently discounted or delayed until confirmed by a trusted local voice. This is not irrational. Communities have experience of false alarms, of official warnings that were precautionary rather than indicative of actual danger, and of past events that were less severe than forecast. Trust in a locally embedded intermediary who shares the community's risk and whose judgment is informed by local knowledge provides a qualitatively different signal than an official broadcast.

**Technology and channel:** SHG leaders with pre-season training and action card templates; ASHAs, Anganwadi workers, community health volunteers with formalized warning relay roles; CPP volunteers with defined ward level coverage responsibilities; imams, pastors, and other faith community leaders with access to loudspeaker infrastructure; market committee heads who can coordinate trader behaviour; local government frontline workers with community relationships.

**Governance condition:** Trusted actors must be formally recognized and trained as part of the warning system included in district disaster management plans, given specific role clarity, provided with simple action card templates for each hazard level, formally connected to the official alert chain through a designated communication link, and included in simulation drills that test their specific relay function. They should not be activated informally at the last minute when an event is already developing.

**Inclusion design note:** The trusted intermediary network must include women who can reach women headed households and household members with restricted mobility; persons who can communicate in local dialects spoken by minority language groups; intermediaries who can communicate through accessible formats including audio description for persons with visual impairments and visual or written formats for persons with hearing impairments.

## BP3: Impact Based and Action Oriented Messaging

### Evidence confidence: High

**Problem addressed:** Translates hazard information into practical household and livelihood action instructions. Most South Asian warning messages describe what the hazard is: wind speed, rainfall quantity, flood level, temperature without specifying what the person at risk should do, by when, and with what priority. A warning that says 'Very severe cyclone expected, maximum wind speed 200 km/h, landfall in 36 hours' tells a coastal fisher what is coming. It does not tell them whether to return to shore immediately, where to secure their boat, where to take their family, or which shelter to go to.

**Technology and channel:** Predesigned message templates that specify expected impact by location, timing, and affected group type, combined with a clear action instruction for each group. Different templates for different hazard levels and different geographic zones. Templates developed jointly by hydromet agencies, disaster management institutions, and community representatives including excluded groups, tested with community members before hazard season deployment.

**Governance condition:** Hydromet agencies and disaster management bodies need a pre agreed impact messaging framework that has been locally tested and is ready to activate at different alert levels. The governance condition is an inter-agency agreement on message content, format, authorization pathway, and language versions that can be activated immediately when a warning threshold is reached not negotiated during an active event.

**Inclusion design note:** Message templates must include livelihood specific instructions for farmers, fishers, vendors, informal workers, and migrant workers; disability accessible formats tested with OPDs; and locally tested language and dialect versions. Messages should be tested with community members from excluded groups before hazard season to verify that action instructions are clear and actionable.

## BP4: Women Led and Community Volunteer Relay Systems

### Evidence confidence: High

**Problem addressed:** Strengthens last mile reach and gender sensitive early action. Women's SHGs and community volunteer networks can function as trusted information relay points that reach households particularly women, children, elderly people, and persons with disabilities that official channels systematically miss. In many South Asian contexts, the household member who receives the mobile phone alert is an adult male who may be away from home during a hazard event, leaving women and children without direct warning receipt.

**Technology and channel:** SHG and SHG federation networks with designated relay responsibilities; CPP style formally structured volunteer units with gender parity requirements; women community health workers and ASHA workers with EWS relay training; women's market and trader associations with communication infrastructure. In Bangladesh, CPP's formal requirement for women volunteers in every ward level unit is the strongest South Asian institutional reference for gender inclusion in community EWS architecture.

**Governance condition:** Women led relay systems require formal training before hazard seasons, safety arrangements specifically designed for night time warning events when mobility restrictions are most severe, role clarity in local disaster management plans, financial recognition and compensation for volunteer time that does not disadvantage women members, protection from gender based risks that arise during emergency mobilisation, and monitoring of whether women volunteers are actually deployed during active events.

**Inclusion design note:** This best practice is specifically designed for gender inclusion. The critical caveat from the Bangladesh validation is that formal gender parity in volunteer rosters does not automatically produce equal operational participation. Enabling conditions: safety, equipment, childcare, recognition are as important as the formal design.

## BP5: Offline First and Low Connectivity Communication Design

### Evidence confidence: High

**Problem addressed:** Ensures that warnings remain functional when internet and mobile networks fail which is precisely when they are most likely to fail, as the intensity of a weather or flood event disrupts the infrastructure that warnings depend on. For communities in permanently low connectivity areas, offline first is not a contingency plan. It is the only viable primary design requirement. Investment decisions that treat digital channels as primary

and offline systems as backup produce precisely inverted resilience: strong performance in routine conditions, catastrophic failure at the moments of greatest need.

**Technology and channel:** VHF and HF radio networks with designated operators and regular maintenance schedules; manually operated sirens with standardized codes for different hazard levels; battery powered megaphones for village level relay; flag based danger signal systems for visual warning over distances; physical runner relay protocols for hamlets without radio coverage; community notice boards updated before hazard seasons; locally trained community gauge readers who monitor water levels independently of the formal network.

**Governance condition:** Offline first systems require recurrent operations and maintenance budgets not only capital investment for installation. Communities need training in equipment operation and basic maintenance. Simulation drills must specifically test the offline components, not only the digital architecture. Local ownership, including formal community designation of O&M responsibility and accountability is as important as the hardware. Donor programmes that fund hardware installation without O&M budgets produce decaying systems.

**Inclusion design note:** Offline first design is particularly critical for excluded groups: elderly people without smartphones, persons with disabilities who depend on audio or physical relay, remote communities without mobile coverage, and households without grid electricity. These groups are simultaneously the most likely to be excluded from digital warning channels and the most exposed to hazard risk.

## BP6: Two Way Feedback and Community Reporting Systems

### Evidence confidence: Moderate

**Problem addressed:** Converts the EWS from a broadcast infrastructure into a governance system. The defining characteristic of a broadcast system is that information flows one way. The defining characteristic of a governance system is that information flows in multiple directions and that feedback changes decisions and actions. Communities during active warning events hold information that institutions need: local gauge levels rising faster than predicted, blocked evacuation routes, households that have not responded to evacuation calls, shelters that have reached capacity, local bridges or roads that have become impassable.

**Technology and channel:** Hotlines with 24-hour staffing during active warning periods; IVR feedback options in multiple local languages; WhatsApp escalation pathways to designated EOC duty officers with defined response protocols; community reporting structures linked to local government EOC monitoring; a designated EOC feedback desk with assigned monitoring responsibility and clear authority to initiate action based on community reports.

**Governance condition:** The most demanding governance condition in this best practice: someone with clear authority and accountability must be assigned to monitor incoming community reports and take defined action during warning periods. Collecting reports without responding to them erodes trust more rapidly than having no feedback channel at all. Communities that report flooding and receive no response will not report again. Feedback integration into SOPs is essential. After action reviews must assess whether feedback was received, monitored, and acted upon.

**Inclusion design note:** Feedback channels must be accessible to excluded groups: audio and IVR options for non-literate users, locally available access points for people without personal phones, and specific inclusion of women's groups, OPD associations, and informal worker associations in the feedback network design.

## BP7: Predefined Decision Triggers and Standard Operating Procedures

### Evidence confidence: High

**Problem addressed:** Removes the institutional hesitation that delays early action after warnings are received as this is one of the most consequential governance failures identified by the study identifies across all contexts. The gap between a warning reaching an official and an official initiating a protective action is structurally produced by

the absence of predefined authority, pre-committed resources, and pre agreed accountability. Without these, officials face an asymmetric incentive structure: acting early on a warning that turns out to be overstated produces criticism and cost; waiting produces political cover. Pre-defined triggers remove this asymmetry by resolving the decision question before the event.

**Technology and channel:** Threshold based trigger protocols linked to named forecast products, gauge levels at named stations, forecast probability thresholds, wind speed classifications, heat index thresholds specified for different types of action at different threshold levels. Named officials with specific action responsibilities. Pre-defined evacuation or preparedness actions that initiate automatically at defined thresholds. Explicit no regret language provides legal and administrative protection for anticipatory decisions that precede events of less than forecast severity.

**Governance condition:** Requires administrative and political endorsement that predefines authority and not only technical specification of thresholds. Decision makers at district and local government level must have documented, formally approved, legally protected authority to initiate specific actions at specific trigger points, without needing to seek further authorization during an active event. This is the governance precondition that all trigger-based systems depend on.

**Inclusion design note:** Decision trigger SOPs must include specific provisions for excluded groups: prepositioned transport for persons with disabilities, livestock protection support for farming households, asset security arrangements for informal workers without fixed property, and shelter access protocols for migrants and informal workers not registered in household-based systems.

## BP8: Horizontal Coordination Protocols

### Evidence confidence: Moderate

**Problem addressed:** Addresses the systematic gap in peer-to-peer warning relay between communities, between wards, and between frontline teams. Warning systems are designed and resources for vertical information flow. But protective early action, particularly in riverine flood contexts, urban heat events, and pastoral drought situations depends on horizontal coordination that the formal system does not mandate or resource. An upstream community that observes water levels rising at a dangerous rate should have a formal mechanism to warn the downstream community, not rely on an individual volunteer's judgment to make a personal phone call.

**Technology and channel:** Community to community relay protocols with named responsible persons in each community; upstream downstream notification agreements formalized in local disaster management plans; SHG federation communication trees spanning multiple villages or wards; inter ward coordination protocols for urban heat events linking health facilities, markets, and informal settlements; VHF radio networks connecting volunteer teams across adjacent geographic units; simulation drills that specifically test lateral relay rather than only vertical response chains.

**Governance condition:** Horizontal coordination requires formal recognition in district and local disaster management plans. Without a mandate, it remains informal and therefore unreliable. Bangladesh CPP demonstrates horizontal coordination in practice at scale. The governance move is to formalize and test what currently often happens informally turning it from a chance outcome of good community relationships into a designed and accountable component of the system.

**Inclusion design note:** Horizontal networks are particularly important for excluded groups who fall outside formal communication chains: migrants in informal settlements not included in household registration, persons living at community boundaries, households at the end of information chains. SHG federation networks and OPD associations can serve as inclusion focused horizontal relay layers.

## BP9: Accessible Warning Design for Excluded Groups

### Evidence confidence: Moderate

**Problem addressed:** Builds disability inclusion, gender accessibility, and language accessibility into EWS from the beginning of the design process rather than translating or adapting after the main system architecture is established. The study finds consistently that accessibility is treated as an add on in South Asian EWS: a sign language version of an existing message format, a local language version of a national template, a wheelchair ramp added to a shelter designated without disability assessment. These adaptations are better than nothing. They are substantially less effective than inclusive design from the start.

**Technology and channel:** Audio and pictorial warning formats for non-literate users; local language and dialect versions of all primary warning messages; sign language interpretation for television and radio emergency broadcasts; caregiver notification protocols for persons with mobility, cognitive, or communication impairments who may not receive or be able to act on warnings independently; OPD involvement in message design, format testing, and post event accessibility review; accessible shelter routing information.

**Governance condition:** Co design with OPDs, women's groups, and local language communities is a governance condition, not an optional enhancement. The formal inclusion requirement must be specified in EWS design and review processes, with documented responsibility for preseason accessibility testing and post event accessibility audit. This means EWS commissioning and evaluation processes must include accessibility criteria from the first design specification.

**Inclusion design note:** This best practice is entirely about inclusion. Every excluded group has different accessibility requirements; no single format solution works for all. The governance principle is that accessibility must precede deployment<sup>x</sup> it cannot be retrofitted after the system is in operation.

## BP10: Anticipatory Finance and Early Action Linkages

### Evidence confidence: Moderate High

**Problem addressed:** Connects warning triggers prearranged financial responses that enable households to take protective action before loss occurs protecting livelihoods and assets, not only lives. Without pre-committed finance, a well-functioning trigger-based warning system may be received, trusted, and understood by the household at risk and still does not result in protective action because the household lacks the cash to pre-position livestock, rent transport for evacuation, protect stored crops, or stop work without income replacement. The warning system without anticipatory finance does not fail; it succeeds at the information step and fails at the action step.

**Technology and channel:** Forecast based cash transfers<sup>xi</sup> linked to specific forecast thresholds and targeting criteria; index based flood and crop insurance with parametric triggers tied to government risk polygon definitions and gauge station thresholds; anticipatory food and non-food item pre-positioning by humanitarian and government actors before forecast events; micro credit or savings group emergency access mechanisms; shock responsive social protection programmes with drought, flood, or heat triggered disbursement protocols.

**Governance condition:** Requires predefined triggers linked to forecast products, prearranged financing commitments from government, humanitarian, or insurance sources, clear and auditable targeting criteria, and institutional accountability for timely disbursement before loss occurs, not in response to loss. Governance complexity is highest in this best practice. Nepal's index-based flood insurance pilot demonstrates that this is feasible at community scale; the architecture requires sustained institutional commitment and preseason financial preparation.

**Inclusion design note:** Anticipatory finance targeting must explicitly include women SHG members with financial autonomy over disbursements, PWD inclusive criteria that capture mobility constrained households, and informal workers whose livelihood losses from early protective action are not captured by asset-based targeting. Cash transfer design should account for gender dynamics in household financial control.

## 9. South Asia Transferability Matrix

Transferability is not a binary property of the best practice. A practice that demonstrates strong evidence of effectiveness in coastal Bangladesh during cyclone season cannot simply be transplanted to Ladakh during glacial lake outburst flood season or to an urban Maharashtra neighborhood during a summer heat event without deliberate contextualization. The transferability matrix is designed to help DN/SIDRRRA partners make evidence informed adaptation decisions: identifying which minimum enabling conditions must be present before a practice can realistically function, and which elements of a practice are context independent governance principles versus context specific operational design choices.

|                                                                                          | Odisha<br>(context) | Maharashtra<br>(context) | Ladakh<br>(context) | BGD Coastal<br>(context) | BGD Haor<br>(context) | Nepal Riverine<br>(context) | Nepal Mountain<br>(context) |
|------------------------------------------------------------------------------------------|---------------------|--------------------------|---------------------|--------------------------|-----------------------|-----------------------------|-----------------------------|
|  BP1    | Direct              | Direct                   | Direct              | Direct                   | Direct                | Direct                      | Direct                      |
|  BP2    | Direct              | Direct                   | Adapt               | Direct                   | Direct                | Direct                      | Adapt                       |
|  BP3    | Direct              | Direct                   | Adapt               | Direct                   | Adapt                 | Direct                      | Adapt                       |
|  BP4    | Direct              | Direct                   | Adapt               | Direct                   | Adapt                 | Direct                      | Adapt                       |
|  BP5   | Adapt               | Adapt                    | Direct              | Adapt                    | Direct                | Adapt                       | Direct                      |
|  BP6  | Adapt               | Adapt                    | Adapt               | Direct                   | Adapt                 | Adapt                       | Adapt                       |
|  BP7  | Direct              | Adapt                    | Adapt               | Direct                   | Adapt                 | Direct                      | Adapt                       |
|  BP8  | Adapt               | Adapt                    | Adapt               | Direct                   | Direct                | Adapt                       | Adapt                       |
|  BP9  | Direct              | Direct                   | Adapt               | Direct                   | Adapt                 | Direct                      | Adapt                       |
|  BP10 | Adapt               | Adapt                    | Adapt               | Adapt                    | Adapt                 | Direct                      | Adapt                       |

 **Direct** — minor adaptation needed
  **Adapt** — significant adaptation required

 Transferability matrix based on analytical assessment — field validation recommended before scaling

Figure 10: South Asia transferability matrix showing ten best practices across seven contexts.

### 9.1 Reading the Transferability Matrix

'Direct' means the best practice can be adopted with minor adaptation the governance logic, technology architecture, and inclusion design are relevant with modest contextualization to local hazard profile, community structure, and institutional arrangements. 'Adapt' means significant redesigning of the operational content is required, though the underlying governance principle and inclusion logic remain valid. The matrix does not include a 'Redesign' category because the study's evidence base does not support confident judgements about which practices are not viable in any given context only that require substantial adaptation effort.

### 9.2 Minimum Enabling Conditions

Before attempting to adapt any best practice from this study to a new context, DN/SIDRRA partners should assess whether six minimum enabling conditions are present. Where they are absent, the first investment should be in creating the enabling conditions, not in deploying the practice itself.

| Minimum Condition                            | Why It Matters                                                                                                                                                     | Practical Assessment                                                                                                                                                            |
|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Trusted local relay layer                    | Technology delivers messages. Trusted actors convert warnings into protective action. Without them, technically excellent alerts are systematically discounted.    | Is there an existing trusted community institution that can be formally integrated into the warning chain, the SHG, volunteer network, health worker, faith leader?             |
| Clear local ownership and O&M responsibility | Without a formally designated institution with budget and capacity, systems decay after installation. Capital without recurrent funding produces decaying systems. | Is there a local institution with formal designation, recurrent budget, and technical capacity to own the practice after the implementing agency exits?                         |
| Inclusive message design, pretested          | Warnings designed for the average household will fail for excluded groups, who are also the most exposed. Testing before hazard season is the minimum standard.    | Have warning messages been tested with women's groups, OPD representatives, local language speakers, and low literacy community members in the relevant geographic context?     |
| Pre-defined decision triggers                | Alerts without predefined action thresholds produce institutional hesitation rather than early action. The trigger framework must precede the warning event.       | Is there a named official with documented authority to initiate specific actions at specific forecast thresholds, without needing further authorization during an active event? |
| Two-way feedback mechanism                   | Without feedback, systems cannot improve, and community trust erodes. Communities that report and receive no response stop reporting.                              | Is there an assigned team with responsibility to receive, verify, and act on community reports during warning periods?                                                          |
| O&M financing beyond capital grant           | Sirens, radio equipment, gauge stations, and alert platforms all require recurrent maintenance. Capital investment produces rapidly decaying systems.              | Is there a confirmed recurrent budget line, not only a one-time installation grant, for system maintenance, annual training, and preseason simulation drills?                   |

## 10. Governance and Investment Recommendations

The recommendations in this section are evidence developed, actor specific, and focused on governance arrangements rather than technology procurement. They avoid generic calls for better platforms or faster alerts. The underlying principle is consistent: the most important investment for South Asian EWS over the next five years is not in the technology layer, which has already received substantial and growing attention, but in the governance layer that determines whether technology translates into inclusive protective action.

### 10.1 National and State Disaster Management Institutions

The primary recommendation for national and state DRM institutions is to move from alert dissemination accountability to warning to action accountability. The current performance measurement framework for most South Asian national EWS focuses on inputs number of alerts issued, forecast accuracy, dissemination speed rather than outcomes: did warnings produce protective action, for whom, and within what timeframe? Reorienting

performance accountability toward outcomes requires defining warning to action metrics, investing in post event learning reviews that systematically document community experience of warnings, and establishing inter agency accountability frameworks that link hydromet agencies to DRM institutions to local government.

The second primary recommendation is to mandate national standards for impact-based messaging and multi-language warning formats, co-developed with community representatives, OPD networks, and informal sector organisations. Such standards should specify minimum requirements for what a warning must communicate (hazard, specific location, timing, expected impact, action instruction) and should require accessible format versions. The governance condition for this recommendation is political endorsement at the national level and operational integration into the alert issuance workflow of all relevant agencies.

## 10.2 District and Local Authorities

The first recommendation for district and local authorities is to create and resource district level EWS feedback cells with specific responsibility to receive, verify, and act on community reports during active warning periods. The governance gap at district level is not usually the absence of information channels district officials often receive significant informal information during events but the absence of a structured, staffed, and formally accountable mechanism to process that information and convert it into field action. A designated EOC feedback desk during warning periods, linked to field SOPs, and with authority to initiate specific actions based on community reports addresses this directly.

The second recommendation is to conduct district level warning to action readiness audits before each hazard season. A readiness audit asks seven questions: Who currently receives warnings at the community level? Who is trusted to translate them locally? Who decides when action is initiated? Who is systematically left out of current warning pathways? Who can currently report back to institutions? Who coordinates between neighboring communities? Who has authority to initiate horizontal relay? The answers to these questions reveal the specific governance gaps in a district's warning architecture and they cannot be answered from institutional data alone; they require engagement with community members, frontline workers, and local government staff.

## 10.3 Local Governments and Frontline Systems

The primary recommendation at local government and frontline level is to formally integrate SHGs, community volunteers, health workers, teachers, religious leaders, and market committee heads into warning SOPs with preseason training, role clarity, and simulation. The trusted intermediary network already exists in most South Asian communities at significant scale. The governance move is to make that network formal including it in local disaster management plans, providing pre-event training, supplying action card templates for different hazard levels, and testing its function in simulation drills before the hazard season.

The second recommendation is to establish and test horizontal coordination protocols between neighboring communities and frontline teams. Local governments at ward or panchayat level are best positioned to mandate community to community relay agreements and ensure they are tested in drills. Upstream downstream notification agreements for riverine flood contexts, inter ward coordination protocols for urban heat events, and SHG federation communication trees for rural areas are all operationally straightforward and significantly under implemented across the region.

## 10.4 Technology Providers and ICT Platforms

Design multi-channel, low connectivity, and accessible warning systems from the beginning of the design process, not as late accessibility add ons. The study's consistent finding is that accessibility and redundancy are not features to be added after the core system is built. Platform procurement and design requirements must include mandatory accessibility standards: offline functional fallback modes, local language APIs, audio format capability, and minimum contrast and font size standards for visual alerts. These requirements should be specified in government procurement contracts for EWS platforms and evaluated in the commissioning assessment.

## 10.5 Civil Society and DN/SIDRRA Network

The primary recommendation for DN/SIDRRA and its civil society network is to develop and publish an annual South Asia Inclusive Early Action Readiness Report, a brief, evidence based assessment that tracks governance quality across the warning to action chain in key contexts, identifies the most transferable practices and innovations in the current year, documents the most significant investment gaps, and names the specific governance improvements needed. This kind of sustained, annual advocacy product builds the evidence base for DN's donor engagement and policy influence over time.

The second recommendation is to develop a structured South Asia peer learning platform and not an annual conference, but an ongoing facilitated exchange among practitioners working on EWS governance at the community and local government level across India, Bangladesh, Nepal, Sri Lanka, and Pakistan. The platform should produce practical co learning products: adaptation guides, SOP templates, post event learning summaries, and field documentation of what worked and what did not.

## 10.6 Donors and Funders

The primary recommendation for donors and funders is to deliberately fund the governance layer around technology: trusted relay networks, training and simulation drills, feedback mechanisms, SOP development and testing, recurrent O&M budgets, and anticipatory finance mechanisms. The investment gap in South Asian EWS is not in hardware or platforms. It is in the human and institutional infrastructure that determines whether technology translates into inclusive protective action for the households most exposed to risk. Community volunteer networks, SHG EWS training, disability inclusive message design, local feedback desk staffing, and anticipatory finance trigger protocols are all substantially underfunded relative to their demonstrated impact potential.

### PRACTICAL ENTRY POINT

The most actionable first step for any actor at any level is a local warning to action readiness audit asking seven questions: Who receives the warning? Who translates it locally? Who is trusted? Who decides? Who is left out? Who reports back? Who coordinates horizontally? The answers reveal the specific governance investment needed and should determine the technology selection, not the other way around.

### FUTURE INVESTMENT PATHWAY FOR DN/SIDRRA

The future investment pathway emerging from this study has been developed separately as a concept note for DN/SIDRRA. This has been done to preserve the analytical flow of the research report while still translating the study's findings into a practical programme development opportunity. The concept note draws directly from the diagnostic findings, best practice cards, transferability considerations, and governance recommendations presented in this report, and outlines how DN/SIDRRA could take forward a South Asia focused inclusive early action readiness facility.

# 11. Limitations and Areas for Further Research

This study was designed as a time bound exploratory synthesis. Its limitations are structural to the design choice made by the project team in consultation with Duryog Nivaran, not failures of execution. They are stated here clearly because they shape the realistic scope of the recommendations and define the research agenda that a future phase should address.

| Limitation                                                      | Implication for Report Claims                                                                                                                                                                       | Recommended Next Step                                                                                                                                                                          |
|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No primary community level data                                 | Findings cannot claim the authority of representative household survey data or statistically validated field assessments. They represent analytical synthesis of secondary evidence.                | Future phase should include targeted community validation in 2 to 3 risk geographies per country, with explicit inclusion of excluded groups in data collection design and analysis.           |
| Uneven evidence on migrants and informal workers                | Available EWS literature substantially under documents the warning experience of mobile, seasonal, and informal populations. This is an evidence gap, not a sign that they are well served.         | Commission a focused study on warning access and early action constraints among migrant and informal worker populations in at least two South Asian urban contexts.                            |
| Limited disability inclusive EWS evidence in South Asia         | Policy commitments to disability inclusion in DRR are strong across the region. Documented operational examples of inclusive EWS design and post event accessibility audit are substantially fewer. | Partner with OPD networks in at least three DN member countries to co design accessible warning tools and conduct post event accessibility audits following the next significant hazard event. |
| Rapidly evolving technology landscape                           | CAP, cell broadcast, AI enabled monitoring, and digital early warning platforms are changing faster than desk synthesis can track. Specific platform assessments may be outdated.                   | Update the technology evidence base through structured practitioner review with IMD, BMD, DHM, and technology platform operators before any large-scale technology investment design.          |
| Transferability assessments are analytical, not field validated | The transferability matrix is structured analytical judgement based on the evidence synthesis. It has not been evaluated through field adaptation and evaluation.                                   | Test 3 to 4 adaptation decisions from the matrix in the first phase of any follow-on programme, with documented learning before scaling.                                                       |

## CLOSING REFLECTION

The main lesson from this exploratory study is not technically complicated. Early warning systems become effective reliably, equitably, and at scale when information, trust, institutional authority, community resources, and accountability mechanisms all meet at the last mile simultaneously. Technology can accelerate and scale that meeting. It cannot substitute for the governance and social systems that make it possible. The governance layer is the investment gap. For DN/SIDRRRA and its network positioned at the intersection of community level evidence and regional policy influence it is also the most powerful opportunity.

## Annex A: Evidence Classification

| Evidence Note / Validation Input                    | Geography / Lens                                                             | Core Analytical Contribution                                                                                                                                                                                                                                                                                                            | Confidence and Caveat                                                                                                                                                                  |
|-----------------------------------------------------|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Odisha Cyclone EWS Evidence Note                    | Odisha coastal and cyclone prone districts                                   | Shows how Odisha's cyclone warning system works through a hybrid pathway combining formal alerts, state and district systems, panchayats, SHGs, volunteers, shelters, media, and neighbor level reinforcement. It is especially useful for analysing trust, local interpretation, mass evacuation culture, and residual inclusion gaps. | Strong as desk based and programme informed evidence. Specific district level claims should be treated as moderate unless locally validated.                                           |
| Maharashtra Urban Heat and Water Risk Reflection    | Akola, Jalgaon, Nanded Waghala and comparable small or medium urban contexts | Demonstrates that heat and water stress warnings require a different action logic from cyclones or flood warnings. The key contribution is the idea of action linked advisories connected to shade, water access, school protocols, work timing, municipal coordination, and livelihood realities.                                      | Moderate to strong as programme informed evidence. Should not be presented as a formal evaluated Maharashtra model.                                                                    |
| Odisha Coastal Mangrove and Risk Communication Note | Odisha coastal, estuarine and mangrove linked communities                    | Connects coastal EWS with livelihood decisions, ecological risk awareness, fisher communication networks, asset protection, creek movement, embankment risk, women's household preparedness, and local ecological observations.                                                                                                         | Moderate. Useful for livelihood sensitive and ecology aware warning design, but coastal communities should not be treated as uniform.                                                  |
| Odisha SHG and Women Led Warning Relay Note         | Odisha rural and community programme contexts                                | Shows how SHGs and women's collectives can act as trusted local relay points for warning interpretation, household preparedness, identification of vulnerable households, and upward feedback on household level needs.                                                                                                                 | Moderate to strong as programme informed evidence. SHGs should be presented as complementary social infrastructure, not as a substitute for formal disaster management responsibility. |
| Maharashtra SHG ULB Local Coordination Note         | Akola, Jalgaon, Nanded Waghala and SHIELD / NULM / ULB coordination contexts | Highlights the governance bridge between urban local bodies, SHGs, ward actors, schools, vendors, and community networks. It supports the argument that urban early warning is credible only when linked to visible municipal service delivery and ward level coordination.                                                             | Moderate. Should be framed as programme informed learning, not as a fully institutionalized municipal EWS model.                                                                       |
| Ladakh Low Connectivity Risk                        | Ladakh and comparable                                                        | Provides the low connectivity lens for the study. It shows why mobile first systems are insufficient in remote, dispersed and fragile                                                                                                                                                                                                   | Moderate. Use as a comparative low connectivity lens, not as                                                                                                                           |

|                                                       |                                                                          |                                                                                                                                                                                                                                                                                            |                                                                                                                                                                 |
|-------------------------------------------------------|--------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Communication Note                                    | remote mountain contexts                                                 | geographies, and why offline first, hyperlocal and community anchored warning systems are required.                                                                                                                                                                                        | a claim that Ladakh has a fully documented formal EWS model.                                                                                                    |
| India CAP, SACHET and Cell Broadcast Desk Note        | India national and state EWS technology systems                          | Clarifies the value and limits of CAP, SACHET and cell broadcast systems. It supports the report's core technology argument: digital alert platforms improve dissemination speed and scale, but do not automatically solve comprehension, trust, accessibility, feedback, or early action. | Moderate to strong as desk-based technology evidence. Avoid claiming universal household level impact without separate verification.                            |
| Community Radio and Offline Warning Channel Note      | India and South Asia, with community radio and hybrid communication lens | Shows how community radio can convert official warnings into trusted, repeated, local language and low literacy friendly communication. It also supports the offline first, hybrid channel, rumor correction, and two-way feedback arguments.                                              | Moderate. Stronger where a specific station or network is validated. Community radio should not be presented as universally available or sufficient on its own. |
| Disability Inclusive Early Warning Systems Desk Note  | India and South Asia disability inclusion lens                           | Establishes that disability inclusion is not only a message format issue. It requires accessible warnings, caregiver protocols, household mapping, accessible transport, shelter access, OPD participation, and post event review.                                                         | Moderate. Strong for design principles, but country or state specific claims should be validated through OPDs or disability practitioners.                      |
| Informal Workers and Street Vendors Heat Warning Note | Urban India and Maharashtra type heat and livelihood contexts            | Introduces the concept of livelihood compatible early action. It shows that informal workers may understand heat warnings but cannot act without income sensitive options such as shade, water, adjusted working hours, vendor representation, and heat health referral.                   | Moderate. Avoid assuming all informal workers are organized or reachable through associations.                                                                  |
| Horizontal Coordination Cross Cutting Analytical Note | Cross cutting across India, Nepal, Bangladesh and programme contexts     | Develops one of the study's most distinctive arguments: warning systems need horizontal relay and coordination, not only vertical dissemination. It highlights peer to peer, ward to ward, SHG to SHG, fisher network, school cluster, and frontline worker coordination.                  | Moderate. Strong conceptually and supported by programme logic. Do not claim formal horizontal SOPs exist unless directly evidenced.                            |
| Post Event Feedback and Accountability Note           | Cross cutting across disaster and climate risk contexts                  | Strengthens the report's feedback and accountability lens. It shows that early warning systems should not end at alert issuance, but should include community reporting, post event learning, inclusion audits, SOP revision, and follow up tracking.                                      | Moderate to strong as cross cutting synthesis. Phrase carefully: feedback often exists informally but is weakly structured.                                     |

|                                                         |                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                             |
|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bangladesh Practitioner Validation Note, Tamanna Rahman | Bangladesh CPP, coastal cyclone preparedness, FbF / early action and transferability                | Provides strong validation on CPP as a hybrid model with top-down trigger and horizontal execution. It contributes evidence on gender balanced volunteer architecture, trusted intermediaries, mosque and market level amplification, low tech redundancy, and coastal to inland transferability.                                                                             | Strong as targeted practitioner validation for Bangladesh interpretation. Specific numerical claims should be verified through official CPP / BDRCS sources before publication.             |
| Nepal Practitioner Validation Note, Dharam Uprety       | Nepal CBEWS, flood and multi hazard risk, anticipatory action, local governance and transferability | Provides strong validation on Nepal's community centred and institutionally linked EWS. It adds nuance on CBEWS as a formal institutional cascade with strong community last mile systems and contributes practical learning on index-based flood insurance, local government engagement, GEDSI responsive programming, and transferability to Terai and floodplain contexts. | Strong as targeted practitioner validation for Nepal interpretation. Basin specific figures and activation claims should be treated as practitioner reported unless independently verified. |

## Annex B: Reference Section

- Project documents and SIDRRA Phase II source materials**  
SIDRRA Phase II approved application form, signed subgrant agreement, approved workplan, approved budget, inception report, progress update, internal evidence notes, and practitioner validation inputs from Practical Action Bangladesh and Practical Action Nepal.
- Global early warning and disaster risk governance frameworks**  
World Meteorological Organization. *Multi Hazard Early Warning Systems: A Checklist*.  
[https://community.wmo.int/sites/default/files/EWS\\_Checklist\\_0.pdf](https://community.wmo.int/sites/default/files/EWS_Checklist_0.pdf)  
United Nations. *Early Warnings for All*.  
<https://www.un.org/en/climatechange/early-warnings-for-all>  
UNDRR. *Sendai Framework for Disaster Risk Reduction 2015 to 2030*.  
<https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030>
- India early warning and public alert systems**  
SACHET, National Disaster Alert Portal, National Disaster Management Authority.  
<https://sachet.ndma.gov.in/>  
C DOT. *CAP Integrated Alert System*.  
[https://www.cdor.in/cdotweb/web/product\\_page.php?catId=9&lang=en&pId=49](https://www.cdor.in/cdotweb/web/product_page.php?catId=9&lang=en&pId=49)  
National Disaster Management Authority. *Heat Wave Guidelines and Preparedness*.  
<https://ndma.gov.in/heat-wave>
- Odisha cyclone preparedness and disaster risk management**  
World Bank. *Cyclone Devastation Averted: India Weathers Phailin*.  
<https://www.worldbank.org/en/news/feature/2013/10/17/india-cyclone-phailin-destruction-preparation>  
UNDP and Government of Odisha. *Disaster Risk Management Effectiveness in Responding to Cyclone Phailin in Odisha*.  
<https://ndmindia.mha.gov.in/ndmi/images/pdf/PhailinReport-UNDP-Odisha.pdf>
- Bangladesh Cyclone Preparedness Programme**  
Bangladesh Red Crescent Society. *Cyclone Preparedness Programme*.  
<https://bdracs.org/cyclone-preparedness-programm-cpp/>

Humanitarian Practice Network. *Capitalizing on the Cyclone Preparedness Programme to Build Community Resilience in Bangladesh*.

<https://odihpn.org/en/publication/capitalising-on-the-cyclone-preparedness-programme-cpp-to-build-community-resilience-in-bangladesh/>

**6. Nepal community based early warning systems and anticipatory action**

Practical Action Publishing. *Flood Early Warning System in Practice: Experiences of Nepal*.

<https://practicalactionpublishing.com/book/2807/flood-early-warning-system-in-practice-experiences-of-nepal>

Practical Action. *Index Based Flood Insurance*.

<https://practicalaction.org/knowledge-centre/resources/index-based-flood-insurance-june-2025/>

ODI. *The Governance of Nepal's Flood Early Warning System*.

<https://odi.org/documents/6047/12904.pdf>

**7. Disability inclusive and gender responsive early warning**

OHCHR. *Convention on the Rights of Persons with Disabilities*.

<https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-persons-disabilities>

UNDRR. *Gender Responsive and Disability Inclusive Early Warning and Early Action*.

<https://www.undrr.org/publication/gender-responsive-and-disability-inclusive-early-warning-and-early-action-pacific>

UN Women. *Gender Responsive Early Warning Systems and Early Action*.

<https://wrd.unwomen.org/sites/default/files/2022-07/Tool%2017%20-%20Gender-responsive%20Early%20Warning%20%26%20Early%20Action%20-%2015072022.pdf>

**8. Community radio and inclusive risk communication**

UNESCO. *Early Warning Systems*.

<https://www.unesco.org/en/disaster-risk-reduction/ews>

UNESCO. *Community Radio for Disaster Resilience*.

<https://www.unesco.org/en/articles/community-radio-disaster-resilience-sids-unesco-workshop-empowers-local-teams>

**9. Urban heat, informal workers, and livelihood compatible early action**

ILO. *Working on a Warmer Planet: The Impact of Heat Stress on Labour Productivity and Decent Work*.

[https://www.ilo.org/sites/default/files/wcmsp5/groups/public/%40dgreports/%40dcomm/%40publ/documents/publication/wcms\\_711919.pdf](https://www.ilo.org/sites/default/files/wcmsp5/groups/public/%40dgreports/%40dcomm/%40publ/documents/publication/wcms_711919.pdf)

NIUA. *Cool Cities Knowledge Hub*.

<https://niua.in/c-cube/niua-cool-cities-knowledge-hub>

## Annex C: Footnotes

<sup>i</sup> The comparison between the 1999 Odisha super cyclone and Cyclone Phailin is widely used to illustrate the impact of improved forecasting, evacuation, and preparedness systems in Odisha. See World Bank, *Cyclone Devastation Averted: India Weathers Phailin*. Link: <https://www.worldbank.org/en/news/feature/2013/10/17/india-cyclone-phailin-destruction-preparation>

<sup>ii</sup> For Bangladesh's Cyclone Preparedness Programme model, see Bangladesh Red Crescent Society, *Cyclone Preparedness Programme*. Link: <https://bdracs.org/cyclone-preparedness-programm-cpp/>

<sup>iii</sup> For India's CAP based Integrated Alert System and its pan India operationalization, see C DOT, *CAP Integrated Alert System*. Link: [https://www.cdor.in/cdotweb/web/product\\_page.php?catId=9&lang=en&pId=49](https://www.cdor.in/cdotweb/web/product_page.php?catId=9&lang=en&pId=49)

<sup>iv</sup> India's SACHET platform is part of the Common Alerting Protocol based Integrated Alert System implemented under NDMA for official geo targeted disaster alerts. Link: <https://sachet.ndma.gov.in/>

<sup>v</sup> UNESCO recognizes community radio as an important local communication mechanism for disaster preparedness and emergency information, particularly where locally trusted and accessible communication

channels are needed. Link: <https://www.unesco.org/en/articles/community-radio-disaster-resilience-sids-unesco-workshop-empowers-local-teams>

vi Article 11 of the UN Convention on the Rights of Persons with Disabilities requires protection and safety of persons with disabilities in situations of risk and humanitarian emergencies, including natural disasters. Link: <https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-persons-disabilities>

vii The Bangladesh Cyclone Preparedness Programme is a long-standing institutional arrangement for community based cyclone preparedness and warning dissemination through trained volunteer networks. Link: <https://bdrccs.org/cyclone-preparedness-programm-cpp/>

viii Practical Action has documented Nepal's flood early warning systems as community based, people centered systems linking national hydromet information with local monitoring, communication, and preparedness structures. Link: <https://practicalactionpublishing.com/book/2807/flood-early-warning-system-in-practice-experiences-of-nepal>

ix For Nepal's index-based flood insurance pilot and its linkage with flood early warning and risk transfer, see Practical Action, *Index Based Flood Insurance*. Link: <https://practicalaction.org/knowledge-centre/resources/index-based-flood-insurance-june-2025/>

x UNDRR highlights the importance of gender responsive and disability inclusive early warning and early action systems, including accessible warning practices and response mechanisms. Link: <https://www.undrr.org/publication/gender-responsive-and-disability-inclusive-early-warning-and-early-action-pacific>

xi The Anticipation Hub provides global documentation on anticipatory action, forecast based financing, and pre-arranged financing linked to forecast triggers. Link: <https://www.anticipation-hub.org/>