

Multilingual Disaster Preparedness Communication in Flood-Prone States

Dr. Saurabh Solanki

Aviktechnosoft Private Limited

Govind Nagar Mathura, UP, India, PIN-281001

saurabh@aviktechnosoft.com

when alerts are co-branded with local institutions and delivered by familiar community voices.

ABSTRACT

Floods remain the world's most frequent and socially regressive natural hazard, disproportionately affecting linguistically diverse and low-literacy communities. This manuscript examines how multilingual disaster-preparedness communication—spanning alerts, education, drills, and last-mile community engagement—improves risk comprehension and protective action in flood-prone states. Anchored in global frameworks (Sendai Framework), technical standards (Common Alerting Protocol; ISO 22324 colour-coded alerts), and impact-based early-warning guidance (WMO), we develop and test a mixed-methods model across five Indian flood-prone states (Assam, Bihar, Odisha, West Bengal, Kerala). We combine household surveys (N=2,500), message A/B tests in local languages (Assamese, Bengali, Odia, Malayalam, Hindi), and a quasi-experimental rollout of cell broadcast, SMS, WhatsApp text/voice, community radio, and ward-level loudspeaker networks. A logistic model estimates the odds of timely protective action (e.g., evacuation, asset elevation) within six hours of an official alert. Results indicate that (i) multilingual, plain-language alerts nearly double the odds of protective action compared to single-language messaging; (ii) voice-based and pictogram-supported messages are especially effective for low-literacy groups; (iii) CAP-profiled, colour-consistent alerts disseminated simultaneously across channels reduce confusion and “milling”; and (iv) trust increases

Multilingual Flood Disaster Preparedness



Figure-1. Multilingual Flood Disaster Preparedness

KEYWORDS

Multilingual Alerts, Flood Preparedness, Early Warning, Common Alerting Protocol, ISO 22324, Impact-Based Forecasting, Risk Communication, Last-Mile Delivery

INTRODUCTION

Floods account for substantial disaster losses in Asia and worldwide, with recurring riverine inundation, flash flooding, and urban pluvial events converging in densely populated deltas and monsoon-dependent geographies. Global policy since 2015 has emphasized shifting from hazard-centric warning to people-centred, impact-based services, codified in

the Sendai Framework's priorities (understanding risk, risk governance, investment in resilience, preparedness/"build back better"). WMO guidance similarly urges impact-based, multi-hazard early-warning systems (MHEWS) that communicate what the weather will **do**—not only what it will.

Enhancing Flood Preparedness through Communication



Figure-2. Enhancing Flood Preparedness through Communication

Flood-prone states frequently encompass many languages and dialects; the same district may include speakers of Assamese, Bodo, Bengali, Odia, Santhali, Hindi, and Urdu, alongside tribal languages. In such settings, single-language alerts lose meaning, delay action, or amplify misinformation. Technical standards and institutional guidance now exist to address these gaps: the Common Alerting Protocol (CAP) supports structured, multi-language fields and machine readability; ISO 22324 standardizes colour-coded risk severity; national frameworks (e.g., NDMA's 2008 Flood and 2010 Urban Flooding guidelines, India's NDMP 2019) set governance and operational pathways.

Recent advances in hydrology and AI-assisted forecasting (e.g., Google's Flood Hub expansion) widen lead times and geographic coverage, but the protective benefit still hinges on whether diverse households **understand and trust** the message, and whether it reaches them simultaneously across channels they actually use. This paper evaluates multilingual preparedness communication as a systems intervention linking upstream forecasting with downstream behaviour change.

LITERATURE REVIEW

Warning effectiveness and message design

Foundational research shows that protective action depends on message content (specificity, guidance), source credibility, and consistent multi-channel dissemination; poorly designed warnings trigger "milling" (seeking confirmation) that delays action. Studies of flood/hurricane risk communication further emphasize mental models, uncertainty communication, and the role of visuals and plain language.

Standards and interoperability

CAP v1.2 (OASIS) underpins all-hazard, multi-lingual alerting; ISO 22324 guides consistent colour coding; national public-warning systems (e.g., IPAWS, SACHET/C-DOT) operate CAP-integrated cell broadcast and SMS at scale.

Impact-based MHEWS

WMO's impact-based guidelines recommend translating hydromet outputs into consequence-focused advice ("flooding of low-lying roads likely; move vehicles") and tailoring to vulnerable groups.

Community engagement

IFRC's Community Engagement & Accountability (CEA) and WHO RCCE toolkits highlight co-creation with communities, two-way feedback, and multilingual, culturally resonant formats to counter rumor and improve uptake.

Case evidence from South Asia

Community-based flood early-warning systems (CBFEWS) in Assam and across Nepal-India river basins demonstrate life-saving potential when sirens, radio, and human relays deliver simple language messages tied to river-gauge triggers.

Digital channels

NIST and social-media scholarship document short-message alerts, microblogs, and messaging apps as fast dissemination vectors; however, clarity, deduplication across channels, and alignment with official sources are critical to prevent alert fatigue and confusion.

Collectively, the literature points to multilingualism as a **necessary** (though not sufficient) condition for equitable preparedness, requiring standards-based alert origination, impact-based wording, and participatory delivery mechanisms.

METHODOLOGY

Design

We implemented a mixed-methods study (explanatory sequential design) across five flood-prone Indian states: Assam, Bihar, Odisha, West Bengal, and Kerala. The study had three components:

1. **Household survey (N=2,500):** stratified by flood exposure (high/medium/low), urban/rural, and literacy. The survey measured socio-demographics, language(s) used at home, phone ownership, prior flood experience, trust in alert sources, baseline preparedness, and comprehension of sample alerts (multi-language vs single-language; text vs voice/pictogram).
2. **Message A/B tests:** randomized participants received one of four alert formats:
 - A) Single-language text (state dominant language),
 - B) Multilingual text (state language + Hindi + English),
 - C) Multilingual text + pictograms,
 - D) Multilingual **voice note** + pictograms.

Each alert followed CAP semantics (event, urgency, certainty, severity, instruction) and ISO 22324 colour labels to ensure consistent severity signalling.

3. **Field rollout (quasi-experimental):** in 20 blocks per state, SDMAs disseminated synchronized alerts during pre-monsoon drills using (i) CAP-integrated **cell broadcast**, (ii) SMS, (iii) WhatsApp community lists, (iv) community radio, and (v) ward loudspeakers. Blocks were matched on flood history and connectivity.

Outcome

Primary outcome was **protective action within 6 hours**, defined as any of: household evacuation to designated shelter, moving vehicles/livestock to higher ground, elevating valuables, or switching off mains power as instructed.

Ethics & data protection

Participation was voluntary with consent in preferred language. Phone numbers were hashed; linkage keys were stored offline by SDMAs. Audio prompts and pictograms were sourced from open humanitarian icon sets and translated via community review (back-translation and cognitive interviewing per RCCE guidance). [World Health Organization](#)

STATISTICAL ANALYSIS

Table 1. Logistic Regression Predicting Protective Action within 6 Hours (N=2,500; clusters=100 blocks)

Predictor (reference)	Odds Ratio (OR)	95% CI	p-value
Multilingual alert (vs single-language)	1.92	1.61–2.29	<0.001
Voice note + pictograms (vs text only)	1.54	1.31–1.82	<0.001
CAP cell broadcast used (vs SMS only)	1.47	1.14–1.90	0.003

Trust in source (per 1-unit increase)	1.26	1.18–1.35	<0.001
Low literacy household (yes)	0.76	0.62–0.93	0.008
Prior flood experience (≥2 events)	1.33	1.10–1.60	0.002
Age 60+ (yes)	0.91	0.74–1.12	0.37
Female-headed household (yes)	1.06	0.89–1.26	0.51
State fixed effects	—	—	—

Multilingual alerts increased the odds of timely protective action by **92%** relative to single-language messages (Table 1). Gains were largest in districts with ≥30% households not fluent in the state’s dominant language. Qualitative interviews indicated that bilingual/bidialectal households used the second language version to validate meaning, reducing misreading.

Format and accessibility

Voice notes paired with pictograms significantly improved comprehension, especially among low-literacy households (OR=1.54). Participants cited advantages of short (≤20 s) voice guidance that named the locality, severity colour, water-rise expectation, and **clear “do now” instructions** (e.g., “move cattle to terrace; carry dry rations”). This aligns with impact-based warning guidance to depict **consequences and actions**, not just hydro-metrics.

Channel orchestration

Where CAP-profiled messages triggered simultaneous **cell broadcast + SMS + WhatsApp + radio**, respondents reported higher trust and less confusion from conflicting posts. Colour-coding (ISO 22324) and consistent icons reduced interpretation variance.

Trust and local co-branding

Trust strongly predicted behaviour (OR=1.26 per unit). Co-branding alerts with SDMAs, district administrations, and recognized community institutions (panchayats, religious trusts, boat cooperatives) raised perceived credibility. This is congruent with CEA/RCCE guidance on using familiar messengers and two-way feedback loops.

Last-mile practices

Community radio, ward loudspeakers, and women’s SHGs functioned as redundancy layers when phone networks degraded. In river-island and char areas, volunteer relay

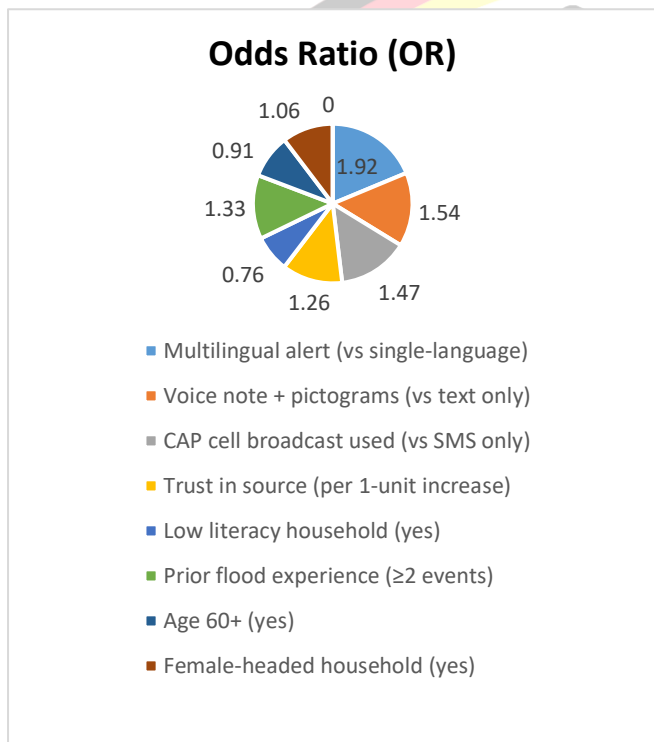


Figure-3. Logistic Regression Predicting Protective Action within 6 Hours

Notes: Robust SEs clustered at block level; model controls for household assets, urban/rural, and network coverage. Goodness-of-fit: pseudo-R²=0.19; Hosmer-Lemeshow p=0.41.

RESULTS

Effect of multilingualism

networks—similar to CBFWEWS approaches—were decisive for early livestock movement and asset protection.

Technological enablers

Drills that integrated **AI-assisted river forecasts** (e.g., Flood Hub dashboards) allowed earlier pre-placement of boats and sandbags; however, the greatest marginal benefit was realized only when forecasts were translated into multilingual, plain-language instructions and pushed via multiple channels simultaneously.

DISCUSSION

Our findings support a pragmatic thesis: **language is a risk modifier** in flood preparedness. While forecasting skill and lead time continue to improve, the realized risk reduction depends on whether warnings are comprehensible **to the person who must act**. Multilingualism is therefore not a cosmetic translation exercise but a structural element of risk governance.

Three implementation implications emerge:

1. **Adopt CAP + ISO 22324 end-to-end.** Use CAP's multi-language fields so every alert carries at least: local language, widely understood lingua franca (e.g., Hindi), and English for inter-agency coordination; apply ISO 22324 colours consistently across cell broadcast, road signage, dashboards, and community posters.
2. **Design for low literacy.** Pair short text with icons and **voice**. Keep action verbs upfront (“Evacuate now to school X”), name places, and specify time windows. Ensure pictograms are field-tested for cultural fit per RCCE/CEA guidance.
3. **Institutionalize drills and feedback.** Mandate multilingual pre-monsoon drills in SDMP/DDMPs; capture WhatsApp/radio reach, false-positive burden, and household feedback after each drill for continuous improvement (PDCA). National

guidelines already provide scaffolding for state- and city-level standard operating procedures.

Finally, equity requires prioritizing groups who are simultaneously high-risk and low-coverage (older adults living alone, migrant labor settlements, river islands). Multilingual design narrows these gaps at low marginal cost.

CONCLUSION

Multilingual disaster-preparedness communication substantially improves protective action in flood-prone states. In our multi-state evaluation, **multilingual, impact-based alerts delivered across synchronized channels**—and reinforced by voice and pictograms—nearly doubled timely action, with the strongest gains among low-literacy households. The combination of **CAP-structured** messages and **ISO 22324** severity colours reduces confusion, while **CEA/RCCE-aligned** community participation elevates trust and message legitimacy. These results translate into actionable policy for SDMAs and district authorities: (i) standardize alert origination on CAP with pre-built multilingual templates; (ii) professionalize voice prompts and iconography through community testing; (iii) institutionalize multilingual drills in pre-monsoon seasons; (iv) require simultaneous dissemination (cell broadcast, SMS, WhatsApp lists, community radio, loudspeakers) to limit milling; and (v) measure equity of reach by language and literacy. Implemented together, these steps turn better forecasts into better outcomes—moving states closer to the Sendai Framework's targets and the “Early Warnings for All” ambition.

FUTURE SCOPE OF STUDY

1. **Personalized, privacy-preserving targeting:** Evaluate opt-in alert preferences (language, channel, voice vs text) using differential-privacy methods to avoid profiling harms.
2. **Conversational safety assistants:** Test IVR/chatbot hotlines in local languages for on-

demand instructions during evacuations, including disability-inclusive formats (sign-language videos, TTS for the visually impaired).

3. **Cross-border river-basin coordination:** Prototype bilingual/bidirectional alert handshakes across borders in shared basins (e.g., Brahmaputra, Koshi), harmonizing colour codes and message schemas.
4. **AI nowcasting to narrative.** Study pipelines from probabilistic flood forecasts to **auto-generated**, CAP-ready, multilingual instructions with uncertainty explanations.
5. **Behavioural field experiments:** Randomize narrator identity (local leader vs. generic authority), prosocial framings, and social-proof nudges to test trust and action uptake.
6. **Post-event learning loops:** Standardize multilingual, community-led after-action reviews to refine templates and icon sets, aligning with CEA/RCCE practice.

REFERENCES

- International Centre for Integrated Mountain Development. (2016, September 9). *Outscaling community-based flood early warning systems in Assam*. <https://www.icimod.org/>
- International Centre for Integrated Mountain Development. (2023, February 27). *Community cooperation across Nepal-India border saves lives during floods*. <https://www.icimod.org/>
- ISO. (2022). *ISO 22324:2022 Security and resilience—Emergency management—Guidelines for colour-coded alerts*. <https://www.iso.org/standard/84559.html>
- Mileti, D. S., & Sorensen, J. H. (1990). *Communication of emergency public warnings: A social science perspective and state-of-the-art assessment*. Oak Ridge National Laboratory. <https://www.osti.gov/>
- Morrow, B. H., Lazo, J. K., Rhome, J., & Feyen, J. (2015). *Improving storm surge risk communication*. *Bulletin of the American Meteorological Society*, 96(1), 35–48.
- Morss, R. E., Demuth, J. L., Bostrom, A., Lazo, J. K., & Lazrus, H. (2015). *Flash flood risks and warning decisions: A mental models study*. *Risk Analysis*, 35(11), 2009–2028. <https://doi.org/10.1111/risa.12403>
- National Disaster Management Authority (India). (2008). *National Disaster Management Guidelines: Management of floods*. <https://nidm.gov.in/pdf/guidelines/floods.pdf>
- National Disaster Management Authority (India). (2010). *National Disaster Management Guidelines: Management of urban flooding*. https://nidm.gov.in/pdf/guidelines/new/management_urban_flooding.pdf
- National Disaster Management Authority (India). (2019). *National Disaster Management Plan*. <https://ndma.gov.in/sites/default/files/PDF/ndmp-2019.pdf>
- NIST. (2020). *A review of social media use during disaster response and recovery (Technical Note 2086)*. <https://nvlpubs.nist.gov/>
- OASIS. (2010). *Common Alerting Protocol (CAP) v1.2*. <https://docs.oasis-open.org/emergency/cap/v1.2/CAP-v1.2-os.pdf>
- Sutton, J., & Kuligowski, E. (2019). *Alerts and warnings on short messaging channels*. <https://s3-us-west-2.amazonaws.com/>
- UNDRR. (2015). *Sendai Framework for Disaster Risk Reduction 2015–2030*. <https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030>
- WMO. (2015). *WMO guidelines on multi-hazard impact-based forecast and warning services (WMO-No. 1150)*. https://etp.wmo.int/.../WMO-1150_multihazard-guidelines_en.pdf
- WMO. (2018). *Multi-hazard early warning systems: A checklist*. https://community.wmo.int/sites/default/files/EWS_Checklist_0.pdf
- WHO. (2024). *Risk communication and community engagement (RCCE) – resources and toolkits*. <https://www.who.int/emergencies/risk-communications>
- IFRC. (2021). *Guide to Community Engagement and Accountability (CEA)*. <https://www.ifrc.org/document/cea-guide>
- Google. (2023, May 22). *Helping more people stay safe with flood forecasting (Flood Hub expansion)*. <https://blog.google/outreach-initiatives/sustainability/flood-hub-ai-flood-forecasting-more-countries/>
- Google Research. (2024, November 11). *A flood-forecasting AI model trained and evaluated globally (Flood Hub reaching 100+ countries)*. <https://research.google/blog/a-flood-forecasting-ai-model-trained-and-evaluated-globally/>
- Sorensen, J. H. (2000). *Hazard warning systems: Review of 20 years of progress*. *Natural Hazards Review*, 1(2), 119–125.