

Strengthening Disaster Risk Reduction through Inclusive, Participatory and Culturally Responsive Communication

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ABSTRACT

Background: Disaster risk reduction (DRR) increasingly depends on effective communication to translate scientific risk information into preparedness, protective action and resilient recovery. Despite advances in hazard monitoring and early warning technologies, persistent communication gaps, particularly the “last-mile” problem, continue to limit community-level effectiveness. **Objectives:** This study examines the evolution of communication and people-centred approaches across the Yokohama Strategy, Hyogo Framework and Sendai Framework; identifies communication gaps in early warning and disaster preparedness; assesses the relevance of visual and non-verbal communication; and examines the role of communication in psychosocial support, recovery, trust and community resilience. **Methods:** A qualitative research design was adopted, combining policy analysis with a targeted thematic synthesis of secondary literature. The three major international DRR frameworks were comparatively analysed, including descriptive word-frequency analysis of science-and-technology and participatory terminology. Peer-reviewed literature primarily published between 2010 and 2022 was reviewed thematically across early warning, disaster education, psychological first aid and post-disaster recovery. **Results:** The findings reveal a growing technical orientation in international DRR governance without a proportionate strengthening of operational communication mechanisms. Science- and technology-related references increased from 10 in Yokohama and 9 in Hyogo to 21 in Sendai. Major weaknesses include last-mile warning failures, inadequate integration of scientific and local knowledge, text-dominated communication, insufficient attention to visual and non-verbal modalities, and opaque recovery communication. Effective DRR communication requires transparency, trust, inclusion, cultural relevance, two-way participation and institutional coordination. **Conclusion:** Communication should be institutionalized as a cross-cutting and measurable pillar of DRR. Integrating visual, multilingual, culturally appropriate and participatory communication with scientific and local knowledge can strengthen preparedness, response, psychosocial support, recovery and sustainable community resilience.

Keywords: Disaster Risk Reduction, Risk Communication, Early Warning Systems, Community Resilience, Sendai Framework

INTRODUCTION

Disasters have become an increasingly complex global development challenge, imposing substantial human, social and economic costs while disproportionately affecting vulnerable populations. Rapid urbanisation, environmental degradation, climate change and growing exposure to hazards have intensified disaster risks and made effective disaster risk reduction (DRR) an essential component of sustainable development. In response, the Sendai Framework for Disaster Risk Reduction 2015-2030 was adopted in March 2015 as the successor to the Hyogo Framework for Action 2005-2015. It established four Priorities for Action, seven global targets and a set of standardized indicators for monitoring progress (Aitsi-Selmi et al., 2015). More importantly, the Framework marked a conceptual shift from managing disasters after their occurrence towards understanding and reducing the

underlying conditions that create risk. It also placed people, communities, resilience, health and well-being at the centre of disaster governance rather than focusing primarily on physical infrastructure (Maly & Suppasri, 2020). Although participatory and people-centred approaches have long been emphasized in international DRR policy, translating these principles into effective practice remains uneven (Poterie & Baudoin, 2015). Within this context, communication constitutes a fundamental but frequently underestimated component of DRR. Early warning systems, preparedness education, psychosocial first aid and recovery programmes can achieve their intended purposes only when information is accessible, understandable, trusted and translated into appropriate action. Thus, the effectiveness of disaster governance depends not merely on generating accurate information but also on ensuring that information reaches diverse populations in meaningful and culturally appropriate forms.

Despite significant advances in hazard monitoring, forecasting and communication technologies, important gaps remain between the production of risk information and its interpretation and use by communities. Early warning systems, for example, frequently experience a “last-mile” problem in which technically accurate warnings fail to reach people in forms that encourage timely protective behaviour (Marchezini, 2020). Conventional top-down communication approaches may treat communities as passive recipients of expert knowledge while inadequately recognizing local knowledge, social networks and community trust (Baudoin et al., 2016). The limited integration of scientific and local knowledge can therefore create a disconnect between technically sound warnings and actual preparedness and response (Hermans et al., 2022; Rollason et al., 2018). Similar communication gaps are evident in disaster education and psychosocial support, particularly for migrants, people with low literacy and socially marginalized groups. Static, text-dominated educational approaches may overlook visual and non-verbal forms of communication, while psychological first aid depends substantially on interpersonal interaction, empathy and non-verbal attunement (Arneson et al., 2017; Tagliacozzo & Magni, 2016). Communication is equally important during recovery, when inadequate transparency, delayed information or exclusion from decision-making can deepen distrust and generate secondary social conflict. Against this background, the present study examines communication as an enabling condition across the disaster management cycle. It addresses three interrelated questions: where and why existing DRR communication systems fail; how visual and non-verbal modalities can address limitations of conventional verbal communication; and how communication influences recovery and may either reduce or intensify secondary harm. Drawing on qualitative policy analysis of the Yokohama Strategy, Hyogo Framework and Sendai Framework, together with a targeted synthesis of scholarly literature on early warning, disaster education, psychological first aid and post-disaster recovery, the study develops a conceptual framework positioning effective, inclusive and trusted communication as a cross-cutting foundation of successful disaster risk reduction.

LITERATURE REVIEW

The previous findings on disaster risk reduction (DRR) increasingly recognizes communication as a fundamental determinant of whether risk knowledge is translated into preparedness and protective action. Fakhruddin et al. (2020) argue that even highly sophisticated forecasting and early warning technologies can become ineffective when warnings are not communicated clearly, promptly and in forms that enable people to understand and act upon them. In the authors’ view, risk communication is therefore not an auxiliary activity but a critical component of people-centred disaster preparedness and response. Marchezini (2020) similarly observes that although the Sendai Framework gives considerable importance to early warning systems, the means through which warnings reach and influence communities remain insufficiently developed. This literature points particularly to the persistent “last-mile” problem, whereby technically accurate information fails to produce appropriate action because of weaknesses in accessibility, trust, local interpretation and institutional coordination. Recent scholarship further emphasizes that communication should move beyond one-way transmission of expert information towards dialogue and collaboration among governments, scientific institutions and communities. A review of 194 studies found that participatory and collaborative communication approaches are increasingly important for linking awareness, preparedness and action, although long-term risk communication remains underdeveloped across many hazard contexts.

A closely related body of literature emphasizes the importance of integrating scientific knowledge with local and indigenous knowledge. Hermans et al. (2022), through a review of research on early warning systems, demonstrate that local communities possess valuable knowledge concerning environmental indicators, hazard patterns, coping strategies and risk communication. The authors argue that effective early warning requires integration of local and

scientific knowledge rather than privileging one knowledge system over another. Their review also identifies institutional barriers, power differences and inadequate translation between knowledge systems as major constraints to meaningful integration. A broader systematic review by Hermans and colleagues similarly shows growing recognition of local and indigenous knowledge within DRR, although its incorporation into formal policy and practice remains relatively embryonic. Recent research on multi-hazard early warning systems reinforces these concerns, identifying fragmented institutions, inconsistent terminology, inadequate recognition of existing community-based warning practices and insufficient integration of top-down and bottom-up approaches as continuing weaknesses. Taken together, the literature suggests that the effectiveness of DRR communication depends not simply on technological capacity but on trust, inclusion, cultural relevance, local participation and institutional coordination. However, comparatively less attention has been given to communication across the entire disaster cycle, particularly the role of visual and non-verbal communication in disaster education and psychosocial support and the consequences of communication failures during recovery. The present study therefore extends existing scholarship by conceptualizing communication as a cross-cutting enabling condition linking early warning, preparedness, psychosocial assistance and recovery within the broader framework of the Sendai Framework.

OBJECTIVES

The present study aims to critically examine the role of communication as a fundamental enabling condition for effective disaster risk reduction (DRR) within the Sendai Framework for Disaster Risk Reduction 2015-2030. Specifically, the study seeks to: (i) assess the evolution of communication, participation and people-centred approaches across the Yokohama Strategy, Hyogo Framework and Sendai Framework; (ii) identify major communication gaps in contemporary DRR instruments, particularly the last-mile failures of early warning systems; (iii) examine the potential of visual and non-verbal communication to improve disaster education and psychosocial support, especially for vulnerable and low-literacy populations; (iv) analyse how communication influences trust, inclusion and community participation during disaster recovery; and (v) develop a conceptual framework demonstrating how transparent, inclusive, culturally appropriate and two-way communication can strengthen preparedness, response, recovery and resilience throughout the disaster management cycle.

MATERIALS AND METHODS

The present study adopted a qualitative research design based on policy analysis and a targeted synthesis of theoretical and empirical literature on disaster risk communication and disaster risk reduction (DRR). The study relied entirely on secondary materials, including international policy frameworks, scholarly articles, review studies and relevant policy analyses, with no primary data collection. Three major international DRR policy documents, the Yokohama Strategy and Plan of Action for a Safer World (1994), the Hyogo Framework for Action 2005-2015, and the Sendai Framework for Disaster Risk Reduction 2015-2030 were purposively selected for detailed textual analysis to examine the evolution of communication, participation and people-centred approaches. A descriptive word-frequency analysis was also undertaken to compare references to science and technology with participatory and people-oriented terminology across the three frameworks. In the second phase, peer-reviewed English-language literature published primarily between 2010 and 2022 was thematically reviewed, focusing on early warning systems, disaster education and psychological first aid. The analysis identified recurring communication gaps, including last-mile warning failures, text- and language-based limitations, inadequate integration of local knowledge and insufficient attention to non-verbal communication. The third phase involved conceptual synthesis of evidence concerning communication, trust, inclusion, transparency and conflict-sensitive recovery. Findings from different literature streams were triangulated to develop an integrated framework positioning effective communication as a cross-cutting enabling condition throughout the disaster management cycle.

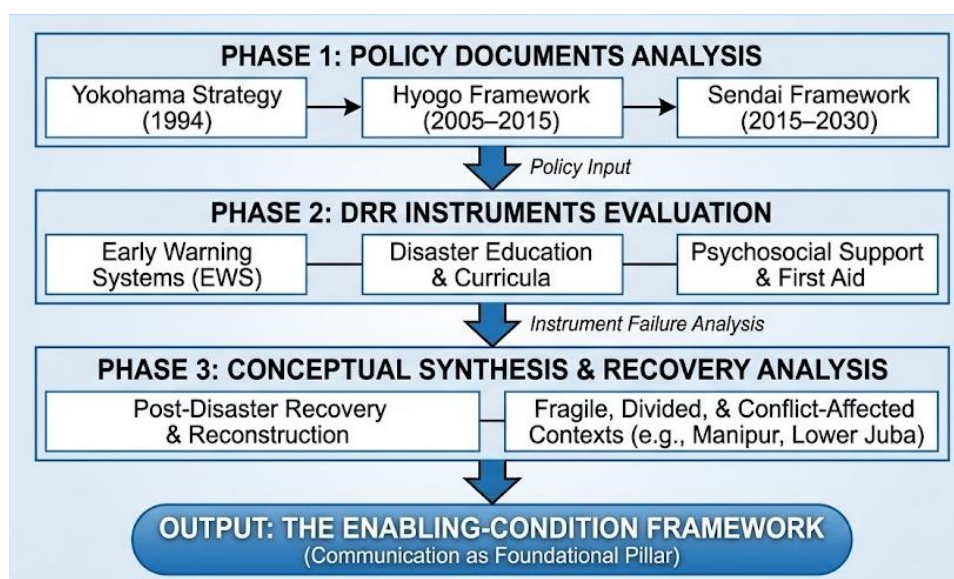


Figure 1. Three-phase analytical design of the study
ANALYSIS AND RESULTS

The analysis reveals that the evolution of international disaster risk reduction (DRR) governance has been accompanied by a significant strengthening of scientific and technological orientation, but this progress has not been matched by comparable operational development of participatory communication. Comparative analysis of the Yokohama Strategy (1994), Hyogo Framework (2005–2015) and Sendai Framework (2015–2030) demonstrates a clear transition from post-disaster response towards preparedness, prevention and people-centred risk governance. As summarized in Table 1, Yokohama introduced participation into international DRR discourse, Hyogo institutionalized preparedness and risk reduction, while Sendai further codified the agenda through four Priorities for Action, seven global targets and 38 indicators. However, the descriptive word-frequency analysis indicates an important asymmetry: science- and technology-related references occurred 10 times in Yokohama, 9 times in Hyogo and increased to 21 times in Sendai, whereas participatory language remained comparatively less specific regarding implementation mechanisms, resources and accountability.

Table 1: Three generations of international DRR frameworks

Framework	Year	Orientation	Key codification
Yokohama Strategy and Plan of Action for a Safer World	1994	Emergency response- Managing disasters as events; information as a technical input to response	Introduced people-centered participation into international DRR discourse (Poterie & Baudoin, 2015)
Hyogo Framework for Action	2005–2015	Shift from response to preparedness and risk reduction	Institutionalized the expectation that states identify, assess, and reduce risk in advance
Sendai Framework for Disaster Risk Reduction	2015–2030	People-centered risk governance; managing systemic conditions of risk	Four Priorities for Action, seven global targets, 38 monitoring indicators (Aitsi-Selmi et al., 2015)

This pattern, illustrated in Figure 2, suggests that the technical architecture of DRR has become increasingly sophisticated, while the communicative architecture required to convert technical knowledge into community-level action remains comparatively weak. In the authors' view, this represents a fundamental implementation gap: a framework may be strongly codified at the institutional level but cannot become genuinely people-centred unless communities are enabled to understand, interpret, question and act upon risk information. Thus, communication should be regarded not merely as a supporting activity but as an operational bridge between international DRR commitments and community resilience.

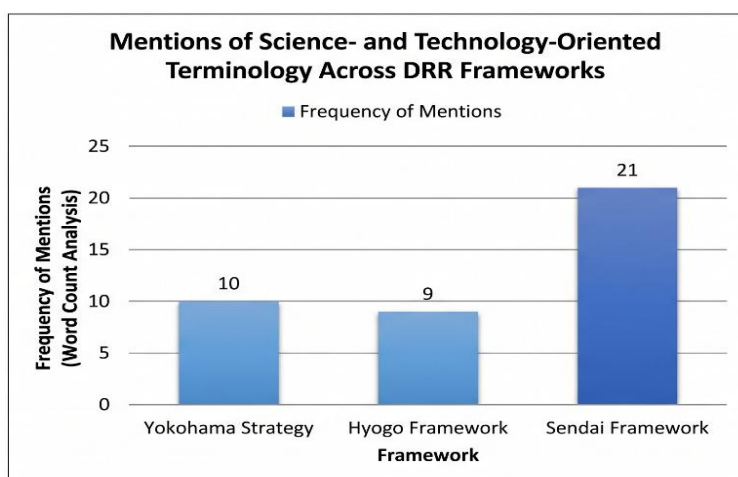


Figure 2: Science and technology-oriented terminology mention across the three DRR frameworks

The thematic analysis of DRR instruments further identifies communication failures at several critical points. Early warning systems demonstrate the clearest example of the “last-mile” problem. As shown conceptually in Figure 3, substantial improvements in hazard detection, forecasting and technological dissemination have not eliminated the gap between receiving a warning and understanding and acting upon it. Evidence reviewed by Budimir et al. (2020), Baudoin et al. (2016) and Hermans et al. (2022) indicates that technical warnings frequently fail because they are not sufficiently translated into locally meaningful messages, trusted by communities or connected to clearly understood protective actions. Institutional fragmentation further weakens the warning chain when forecasting, communication, evacuation and emergency-response responsibilities are divided among agencies. The analysis therefore suggests that connectivity or message dissemination should not be equated with effective communication. Disaster education presents a parallel limitation. Conventional curricula remain heavily dependent on written materials, lectures, posters and rehearsed drills, potentially excluding migrants and populations with limited literacy or different linguistic backgrounds. Evidence from visual communication studies indicates that pictorial and scenario-based communication can improve comprehension and motivate protective behaviour, although visual symbols must be culturally tested rather than assumed to have universal meanings (Hare et al., 2012; Blee & Mak, 2012; Banerski et al., 2020). Table 2 summarizes a proposed visual safety language based on red for danger or prohibition, yellow for caution, blue for mandatory action and green for emergency facilities. The analysis further demonstrates that psychological first aid depends substantially on non-verbal communication, including posture, eye contact, facial expression, vocal tone and interpersonal distance. As represented in Figure 4, preferences regarding family presence during difficult communication also vary across cultural contexts, demonstrating that effective psychosocial communication must be culturally sensitive rather than based solely on standardized verbal scripts. The findings of the present analysis indicate that visual literacy and non-verbal competence should be incorporated explicitly into disaster education and psychosocial-support training.

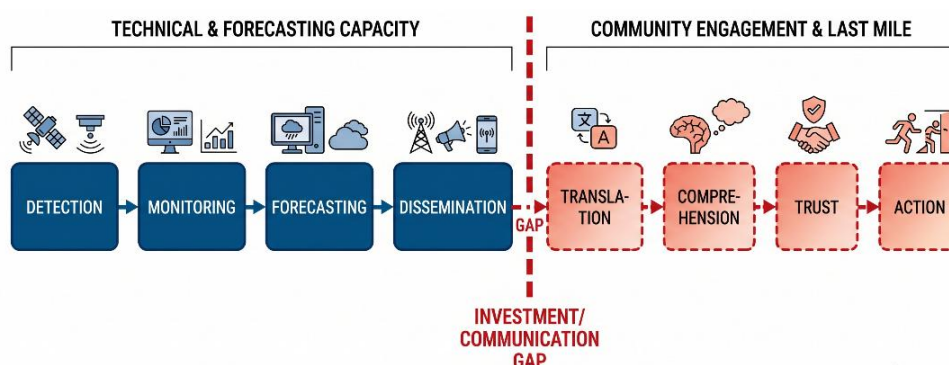


Figure 3: The early warning "last mile" chain. The Decisive gap sits between forecast receipt & protective interpretation (Budimir et al., 2020)

The third analytical dimension concerns disaster recovery, where communication failures can transform an already damaging event into a source of prolonged distrust and secondary conflict. The synthesis indicates that recovery programmes depend on transparent information regarding resource allocation, housing, compensation, reconstruction, eligibility and institutional decision-making. When information is delayed, inaccessible, inconsistent or perceived as partisan, affected populations may interpret the communication deficit as exclusion or discrimination. Figure 5 illustrates the resulting “negative trust factor”, whereby institutional opacity creates an information vacuum that allows rumours, grievances and competing narratives to expand, thereby weakening confidence in authorities and obstructing collective recovery. The literature reviewed by Arneson et al. (2017), Tagliacozzo and Magni (2016), Rakow et al. (2003) and Rice and Jahn (2019) collectively supports the view that resilience is not solely a material or infrastructural outcome but is also produced through continuous communication, participation and social interaction. The findings therefore converge on three overarching requirements for effective DRR communication: transparency, particularly regarding uncertainties and decisions; inclusion, especially of marginalized and locally knowledgeable groups; and conflict sensitivity, ensuring that communication does not reinforce existing social divisions. Triangulation across policy analysis, early-warning research, disaster education, psychosocial support and recovery literature strengthens the consistency of these findings. The overall result is a conceptual framework in which communication functions as the enabling condition connecting risk knowledge, preparedness, protective action, psychosocial assistance and recovery. In this interpretation, the principal weakness of contemporary DRR is not the absence of technical knowledge but the insufficient translation of that knowledge into trusted, accessible and actionable communication at community level.

Table 2: Visual safety language color legend

Color	Meaning
Red	Danger and prohibition
Yellow	Caution
Blue	Mandatory action
Green	Emergency facilities (first aid stations, fire exits)

DISCUSSION

The findings of the present study demonstrate that communication represents a critical but insufficiently institutionalized dimension of contemporary disaster risk reduction (DRR). The comparative analysis of the Yokohama Strategy, Hyogo Framework and Sendai Framework shows a progressive transition from disaster response towards prevention, preparedness and people-centred risk governance. However, the increase in science- and technology-oriented terminology, from 10 references in Yokohama and 9 in Hyogo to 21 in Sendai, contrasts with the relatively limited operational detail concerning participation and community communication. In the authors’ view, this asymmetry indicates that international DRR governance has developed a strong technical architecture without establishing an equally strong social and communicative architecture. This finding is consistent with Poterie and Baudoin (2015), who emphasized the persistent difficulty of translating participatory commitments into operational practice, and with Maly and Suppasri (2020), who identified the people-centred orientation of the Sendai Framework as both its major conceptual contribution and an important implementation challenge. The present study therefore argues that technological sophistication alone cannot guarantee effective risk reduction. Accurate forecasts, sophisticated monitoring systems and standardized indicators acquire practical value only when communities can understand, trust and translate them into appropriate action. The persistent “last-mile” gap identified in early warning systems strongly supports this interpretation. As noted by Marchezini (2020) and Fakhruddin et al. (2020), communication failure frequently occurs not at the stage of hazard detection

but between the dissemination of technical information and its local interpretation and behavioural use. The authors' view is that DRR policies should consequently treat communication as a core institutional capacity rather than as a supplementary activity undertaken after technical systems have been established.

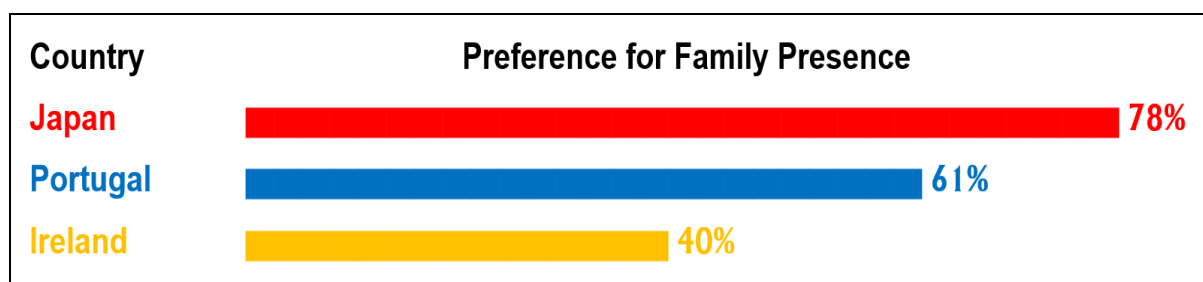


Figure 4: Family-presence preference when receiving difficult news, by country

The findings further suggest that effective communication must be inclusive, culturally appropriate, multidimensional and sustained throughout the disaster cycle. The difficulties associated with integrating scientific and local knowledge identified by Baudoin et al. (2016), Hermans et al. (2022) and Rollason et al. (2018) indicate that communities should not be regarded merely as passive recipients of expert warnings. Local knowledge, social networks and community experience can substantially influence whether risk information is believed and acted upon. Similarly, the analysis of disaster education indicates that reliance on text-based curricula may disadvantage people with low literacy, migrants and linguistically diverse populations, whereas appropriately designed visual communication can improve comprehension and facilitate protective behaviour. However, as the authors emphasize, visual communication should be culturally tested and contextualized rather than assumed to possess universally identical meanings.

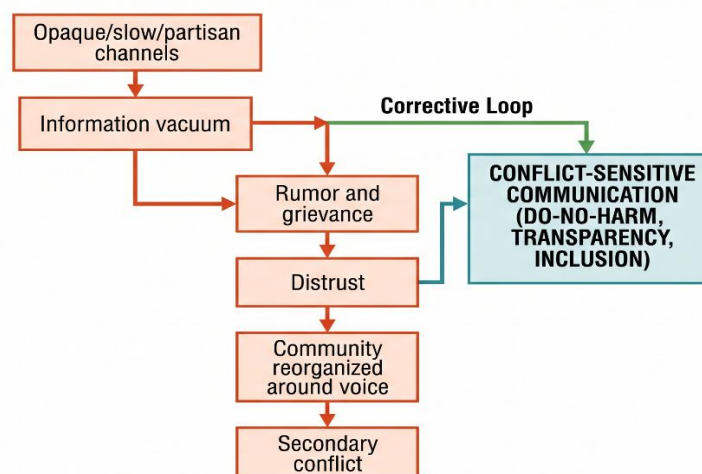


Figure 5: The negative trust factor pathway

The findings concerning psychological first aid extend this argument by showing that communication is not restricted to spoken or written language; body posture, eye contact, facial expression, vocal tone and interpersonal distance can influence perceptions of empathy and trust. In the authors' view, these non-verbal competencies deserve greater attention in psychosocial preparedness and responder training. Most importantly, the recovery analysis demonstrates that communication can either strengthen resilience or contribute to secondary harm. Delayed, opaque or exclusionary communication regarding compensation, housing, reconstruction and resource distribution can create an information vacuum in which rumours and grievances flourish, thereby weakening institutional legitimacy. This supports the broader argument of Rice and Jahn (2019) that resilience is partly a communicative accomplishment. Accordingly, the authors propose that transparency, inclusion, two-way participation, cultural sensitivity and conflict-sensitive communication should be integrated across early warning, preparedness, response, psychosocial support and recovery. Since the present study is based entirely on secondary

literature and policy documents, its conclusions are conceptual rather than empirically causal; nevertheless, triangulation across multiple DRR research streams provides a coherent basis for viewing communication as the enabling condition through which technical disaster-risk knowledge is transformed into trusted community action and sustainable resilience.

CONCLUSION AND IMPLICATIONS

The present study concludes that communication is not a supplementary component of disaster risk reduction (DRR) but a fundamental enabling condition through which scientific knowledge, institutional capacity and community resilience are connected. The comparative analysis of the Yokohama Strategy, Hyogo Framework and Sendai Framework demonstrates a progressive movement towards prevention, preparedness and people-centred risk governance; however, the communicative mechanisms required to translate these commitments into effective community action remain comparatively underdeveloped. The persistent last-mile failure of early warning systems demonstrates that accurate forecasts and advanced technologies cannot ensure protective behaviour unless information is understandable, trusted, locally relevant and linked to clear action. Similarly, the findings concerning disaster education and psychological first aid demonstrate that conventional verbal and text-based communication is insufficient for diverse and vulnerable populations. Visual communication, culturally appropriate symbols and non-verbal interpersonal skills can substantially strengthen comprehension, empathy and trust. The study further concludes that communication remains equally important during recovery, when delayed, opaque or exclusionary information can generate rumours, distrust and secondary conflict. The present evidence supports the conceptualization of DRR communication as a continuous process extending from risk assessment and early warning through preparedness, response, psychosocial assistance and recovery. The implications of these findings are both policy-oriented and practical. First, DRR policies and programmes should incorporate communication as a core institutional capacity, with dedicated resources, trained personnel and measurable communication outcomes rather than treating it as an auxiliary dissemination activity. Second, early warning systems should adopt genuinely two-way and participatory approaches that integrate scientific forecasts with local and indigenous knowledge, community networks and culturally appropriate communication practices. Third, disaster preparedness curricula should incorporate visual literacy, pictorial communication, multilingual materials and participatory learning methods to improve accessibility among low-literacy, migrant and socially marginalized populations. Fourth, psychological first-aid training should explicitly address non-verbal communication, cultural sensitivity, empathy and interpersonal interaction. Fifth, recovery authorities should establish transparent, timely and inclusive information mechanisms concerning compensation, reconstruction, housing and resource distribution to prevent communication gaps from becoming sources of distrust and conflict. Finally, the study recommends that implementation of the Sendai Framework should move beyond measuring technological and infrastructural achievements towards assessing whether risk information is actually understood, trusted and acted upon by affected communities. Since the present study is based on policy documents and secondary literature rather than primary empirical data, future research should validate the proposed framework through community-level studies across different hazards, cultures and socio-economic settings. Such evidence would strengthen the practical foundation for making communication a measurable and accountable pillar of disaster resilience.

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