Insights from Cyclone Ditwah: Recommendations for Addressing Linguistic Barriers in Sri Lanka's Disaster Early Warning Systems through Language Technology

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***Abstract*—Disaster early warning systems are critical for reducing loss of life and ensuring timely response during emergencies. However, the effectiveness of such systems depends not only on technological capacity but also on the inclusivity of communication. In linguistically diverse contexts, language barriers can significantly limit access to life saving information. This paper presents insights on the role of technology in enabling multilingual disaster early warning and communication systems in Sri Lanka. Drawing on observations from recent disaster events, specifically the catastrophic Cyclone Ditwah in 2025, and a review of existing policy and operational practices, the paper highlights gaps in language consideration within current disaster management frameworks. By analyzing local gaps, such as the incomplete localization of platforms and evaluating global models like Japan's J-Alert and India's SACHET, this study identifies practical, technology driven pathways for inclusion. The paper proposes the integration of AI driven translation, multilingual cell broadcasts, and text-to-speech audio alerts as core infrastructure rather than secondary features. By embedding multilingualism into disaster communication from the planning stage, authorities can ensure that urgency is communicated effectively across all communities, ultimately saving lives through clarity and trust.**

Keywords—Multilingual Early Warning Systems; Disaster Linguicism; Linguistic Equity; Language Technology; Sri Lanka Disaster Management

I. Introduction

Early warning systems (EWS) are widely recognized as a cornerstone of effective disaster risk reduction and crisis management. Advances in digital technologies have significantly improved the speed, reach, and accuracy of disaster alerts. However, technological effectiveness alone does not guarantee that warnings are understood or acted upon by all affected populations. Language remains a critical yet often overlooked dimension of disaster communication.

One of the major aspects of this overlooked dimension is the native languages themselves, as they are a major determinant of the effectiveness of the warnings given. Native language communication is a vital element to a successful disaster response and relief effort. In a disaster situation, individuals are able to comprehend and act on information much faster and accurately if it is communicated to them in their native tongue, especially during a stressful and urgent situation. Communication in native languages is a vital element to breaking down linguistic barriers, making information clear and understandable, and trusting information, and it is vital to ensure that the information communicated to individuals is effective and serves its purpose. Therefore, the use of native languages is not only a necessity but a requirement for saving lives and supporting disaster risk reduction and response.

Sri Lanka is a linguistically diverse country with Sinhala and Tamil recognized as official languages, alongside English as a link language. Despite this constitutional recognition, disaster communication practices frequently fail to ensure consistent multilingual dissemination of information. This paper argues that language should be treated as an essential component of disaster early warning infrastructure rather than a secondary consideration. The recent impact of Cyclone Ditwah in late 2025, which caused an estimated US$4.1 billion in damages and affected nearly 2 million people, serves as a stark reminder of the lethal consequences of information imbalances (World Bank, 2025).

II. Language and Disaster Communication in Sri Lanka

Disaster communication in Sri Lanka faces significant linguistic challenges, despite the country officially recognizing Sinhala, Tamil, and English as official languages. In practice, the functional implementation of language rights during disasters is limited. English continues to be implicitly privileged in formal communication, technical documentation, and institutional processes, reflecting internalized colonial practices. This undermines linguistic equity and restricts access to critical information for many citizens.

The concept of disaster linguicism refers to the exclusion or marginalization of communities during disasters due to language barriers (Mokhele & Mvanyashe, 2025). While Sri Lanka's linguistic landscape does not fit neatly within traditional definitions of disaster linguicism, given that Sinhala and Tamil speakers are not minority populations, significant linguistic challenges and exclusions nevertheless remain.

Recent disaster events in Sri Lanka have highlighted practical challenges in disaster communication. Cyclone Ditwah, which struck Sri Lanka in late November, has caused an estimated US$4.1 billion in direct physical damage to buildings and contents, agriculture and critical infrastructure, according to a World Bank Group Global Rapid Post Disaster Damage Estimation (GRADE) report. The cyclone, which is one of the most intense and destructive in Sri Lanka's recent history, has had a severe impact on nearly 2 million people and 500,000 families in all 25 districts. (World Bank, 2025) Warnings and advisories are often issued in limited languages, inconsistently translated, or delayed, reducing their effectiveness. While disaster related news is often broadcast in Sinhala and Tamil on major television and radio channels,

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these efforts largely remain limited to traditional media. The reliance on TV and radio leaves critical gaps such as, digital and mobile based communication channels, such as SMS alerts, CAP (Common Alerting Protocol) messages, government notices, and official guidelines, are frequently issued in English or lack multilingual versions.

Tamil language disaster communication is even more limited, further marginalizing Tamil speaking communities. For example, during Cyclone Ditwah, assessments of the Disaster Management Centre's (DMC) public output revealed that the majority of critical alerts were issued in English and some in Sinhala, with Tamil content being significantly delayed or entirely omitted (Hattotuwa, 2025). Language technology offers a practical and scalable solution to this challenge. Tools such as automated multilingual alert systems and real time translation technologies can ensure that warnings are simultaneously issued in all official languages. In some instances, communities rely on informal translation by non-credible parties or social media users, which can lead to misinformation or delayed action. As a result, large segments of Sinhala and Tamil speaking communities may be linguistically marginalized, particularly those with limited English proficiency or restricted access to formal information networks.

This limited multilingual coverage is further compounded by the absence of explicit language considerations in national disaster policies and plans. Reviews of the National Disaster Management Policy, the National Disaster Management Plan, and district level emergency response plans indicate that language is rarely treated as a critical factor in disaster risk reduction, preparedness, or post disaster recovery. For example, the Emergency Response Plan for Badulla District outlines communication channels and operational procedures but does not specify the languages in which information should be disseminated, despite the significant Sinhala and Tamil speaking populations in the district.

The current approach highlights a narrow conceptualization of multilingual communication, where language inclusion is largely reactive and confined to broadcast media. Without integrating language as a strategic component across all communication channels, from SMS alerts and official documents to CAP messages and online updates, many citizens are left unable to access timely, actionable disaster information. Strengthening multilingual disaster communication across all channels is therefore essential to ensure linguistic equity, enhance community preparedness, and improve overall disaster resilience.

III. Recommendations: Integrating Language Technology for Linguistic Equity

Recent advances in language technology have transformed how disaster information can be created, translated, and disseminated across diverse linguistic communities. Many countries now use multilingual early warning systems that combine automated translation, text-to-speech tools, mobile alerts, and AI supported communication platforms to ensure warnings reach people in languages they understand. These technologies allow disaster alerts, evacuation instructions, and safety guidelines to be delivered simultaneously in multiple languages, reducing delays and minimizing the risk of misinterpretation. As digital infrastructure and mobile penetration continue to expand globally, the potential for language technology to improve disaster communication is higher than ever, particularly for linguistically diverse societies.

Given these developments, language technology should be treated as an essential component of the disaster management toolkit for Disaster Management Centers (DMCs) in all countries. Rather than being an optional or secondary feature, multilingual communication supported by language technology must be embedded into disaster planning, early warning dissemination, response coordination, and post-disaster recovery processes. This article emphasizes that integrating language technology into disaster risk reduction frameworks is not only a technical upgrade but a governance necessity. Clear, timely, and linguistically accessible communication strengthens trust, improves public compliance, and ultimately saves lives, especially among communities that are otherwise marginalized by language barriers. Technology offers several practical pathways to enhance linguistic inclusion

A. Multilingual Alert Dissemination Platforms

Digital early warning systems can be purposefully designed to disseminate disaster alerts simultaneously and consistently in Sinhala, Tamil, and English across multiple channels, including SMS, cell broadcast, and mobile applications. Allowing users to pre-select their preferred language ensures rapid delivery of information in a familiar linguistic form, reducing confusion during emergencies. From a localization perspective, alerts should be written using plain language, culturally appropriate expressions, and standardized disaster related terminology that is familiar to local communities. Such platforms help move beyond ad hoc translation and establish multilingual communication as a default system feature, rather than an optional add-on. However, existing tools often fall short of these inclusive standards; for instance, Rivernet.lk, a platform real time river level monitoring and flood early warning system for Sri Lanka, claims to offer "inclusive access to timely information" while largely disregarding linguistic inclusivity. Although the interface features buttons for Sinhala and Tamil, these do not result in a fully localized experience, as only a few isolated words are translated while the core technical data remains in English. To be truly effective, such platforms must undergo complete localization, ensuring full script support and language specific interfaces so that linguistic equity is a default system feature rather than an aesthetic add-on.

B. Automated Translation and Localization Tools

AI powered translation and localization tools play a crucial role in enabling real time multilingual dissemination of disaster alerts, particularly when speed is critical. These tools can rapidly generate Sinhala and Tamil versions of alerts issued by authorities, significantly reducing delays associated with manual translation. However, consistent with Industry 5.0 principles, automation should be complemented by human-in-the-loop oversight, where trained language professionals or disaster communication officers validate critical messages. Establishing a centralized terminology management system, with approved translations for disaster related terms such as evacuation, landslide risk, flood warning, and emergency shelter, can further improve accuracy, consistency, and public trust.

C. Text-to-Speech and Audio Based Alert Systems

Text-to-speech and audio based alert systems are particularly valuable in the Sri Lankan context, where literacy

levels, access to smartphones, and visual impairments vary across regions. Voice alerts in Sinhala and Tamil can be integrated with radio, IVR (Interactive Voice Response) systems, public address units, and religious or community centers that already function as trusted information hubs. Linguistically natural pronunciation, appropriate speech rate, and culturally familiar voice styles are essential to ensure clarity and credibility. These systems enhance inclusivity by ensuring that disaster warnings reach individuals who may otherwise be excluded from text-based communication.

Several countries have pioneered the use of audio based and Text-to-Speech (TTS) technologies to bridge the gap between high tech monitoring and local language accessibility (Table 1). These examples provide a blueprint for how Sri Lanka can move beyond its current "English first" default.

TABLE I. GLOBAL MULTI-HAZARD EARLY WARNING SYSTEMS (MHEWS) AND LINGUISTIC INTEGRATION

Country	Tool / System	Linguistic Integration
Japan	J-Alert	Automatically triggers high volume voice alerts on mobile phones and community loudspeakers. It utilizes TTS to convert real-time seismic data into spoken Japanese instructions instantly, even waking up sleeping residents during emergencies.
India	Common Alerting Protocol - SACHET	Through the Sachet app and regional platforms, India uses automated voice calls (IVR) that deliver warnings in over 12 regional languages including Asaame, Bangala, Gujarati, Odia, Kannada and many others. This is crucial for reaching the nearly 25% of the population with lower literacy levels.
Philippines	Project NOAH	The Emergency Cell Broadcast System (ECBS) delivers audio based warnings in Tagalog and regional dialects. In remote island provinces, these are often synced with local community radio to ensure those without smartphones are reached.

D. Location Based Language Targeting

Geospatial and location aware technologies enable disaster alerts to be tailored not only to the hazard but also to the linguistic profile of affected areas. For instance, alerts issued in the Northern and Eastern provinces can prioritize Tamil, while those in the Southern and Central regions can prioritize Sinhala, with English included where relevant. Such location-based language targeting improves message comprehension and response efficiency. Importantly, these systems should remain flexible and inclusive, ensuring multilingual options are always available to avoid reinforcing linguistic boundaries. When combined with human oversight and well managed terminology resources, location-based targeting becomes a powerful tool for equitable and effective disaster communication.

IV. CONCLUSION

To address the persistent "English first" default in Sri Lanka's disaster management, the integration of language technology is essential for establishing a truly inclusive and effective early warning system. By moving beyond reactive, inconsistent translations, which frequently leave Tamil and Sinhala speaking communities marginalized, the state can leverage AI powered platforms, automated translation tools, and text-to-speech audio systems to ensure that lifesaving alerts are disseminated simultaneously and accurately in all national languages. Global models like Japan's J-Alert, India's SACHET, and the Philippines' UP NOAH demonstrate that prioritizing linguistic equity through geospatial targeting and localized digital infrastructure is a governance necessity that directly correlates with higher public compliance and reduced loss of life. Consequently, language must be recognized as a core component of disaster risk reduction infrastructure, ensuring that every citizen has equitable access to the timely, actionable information required to survive a crisis. .

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