

Strategies for Internet-enabled and gender-sensitive tsunami early warning

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Abstract

Despite the scientific and technological progress made in coping with disasters, many lives are still lost due to gaps in warning communication. Women are overrepresented in the disaster death toll, particularly for tsunami, due in part to lower capacity for response and lack of access to tsunami early warning, a clear case of gender inequity. This is despite the Sendai Framework for Action (SFDRR) emphasising the importance of early warning systems meeting the needs of the end-user, including considering gender. However, Internet interaction provides opportunities for increasing gender-based potentials. As such, the present research explores Internet use to improve gender equity of the Sri Lankan tsunami early warning system. The present research adopted multiple case studies selecting the Municipal Councils areas in Sri Lanka most affected by tsunami (Galle, Batticaloa, and Hambantota). Thirty-eight semi-structured interviews demonstrated that the existing people-centred early warning system can be transformed into a gender-sensitive, Internet-enabled, and people-centred tsunami early warning system with new strategies including: use of risk knowledge for preparedness, use of monitoring and warning services for preparedness, dissemination and communication with the use of Internet-enabled digital technology, and community responding capacity with the gender equity aspect. In contrast to the literature, common key actors were found for the above components. Strategies such as identification of women as key actors in tsunami early warning, tailoring to men's and women's strategic and practical needs, recognising social media networks and smartphones, and digital risk information are important

for effective, gender-sensitive, Internet-enabled tsunami early warning.

Keywords: *Internet, tsunami early warning system, gender equity*

Despite the progress made in new scientific and technological developments to cope with disasters due to natural hazards, disasters have continued to impact the well-being and safety of communities and countries; according to the United Nations Office for Disaster Risk Reduction (UNDRR; 2015), over 700,000 lives were lost and more than 1.5 billion people affected in the decade to 2015. This highlights the importance of aspects such as knowledge of the occurrence of disaster events, potential losses, likelihood, frequencies of occurrence, measures to mitigate the impact, and early warning (EW) for saving lives (UNDRR, 2015, 2019). For example, any possible forecasting of such disasters is not always effectively communicated to the people at risk (Davis et al., 2012).

As women are overrepresented in disaster death tolls (Alderman et al., 2012; Doocy et al., 2013), it can be argued that women are more disadvantaged by this lack of response capacity for EW. However, women's engagement in EW can reduce their rescue needs as well as others (Enarson, 2006; Fordham, 2001; Fothergill, 1996). For example, there were no deaths reported as a result of Hurricane Mitch in La Masica, Honduras, where women had been educated about and made in charge of the EW system (Buvinic, 1999). Therefore, it can be argued that recognising women's proactive decision-making capacity in tsunami early warning (TEW) can make EW more effective at preventing loss of life. However, EW decision-making aspects such as recognising the ways people interpret risks and choose actions based on their interpretations are not always properly considered in strategies for disaster risk reduction (Eiser et al., 2012).

The present research examined the process of TEW regarding improving gender equity in community responding capacity with the use of the Internet. As a result, the strategies were developed to assist the conversion of the existing people-centred TEW system into a gender-sensitive and Internet-enabled TEW system.

Aims and Objectives

The research problem of the present study is the need to improve gender equity within the Sri Lankan TEW system with the use of Internet interaction, with the overall research aim to critically examine the effect of Internet-enabled digital technology on gender equity within TEW systems. Within this overall aim, this paper focuses on two specific objectives:

- Exploring the critical components of effective TEW to enhance community preparedness; and
- Developing strategies for incorporating Internet-enabled digital technology in TEW to improve gender equity.

Literature Review

This section reviews literature relating to women’s overrepresentation in disaster death tolls, the gender equity linkages with TEW culture, and the associations between TEW, gender equity, and the Internet.

Women’s overrepresentation in disaster death tolls. Women appear to have a higher risk of mortality in disasters such as cyclones, floods, and tsunami, as well as other disasters with a natural hazard origin (Alderman et al., 2012; Doocy et al., 2013; United Nations [UN], 2009). In the 2004 Indian Ocean tsunami, approximately two-thirds of the fatalities in Indonesia, India, and Sri Lanka were confirmed as women (UNDRR et al., 2009). The 2018 tsunami in Central Sulawesi Indonesia killed 2,077 people with an overrepresentation of women in the death toll (International Tsunami Information Centre, 2018). Of the 16,146 who died in the 2011 Great East Japan earthquake, 52% were female (Koyama et al., 2012).

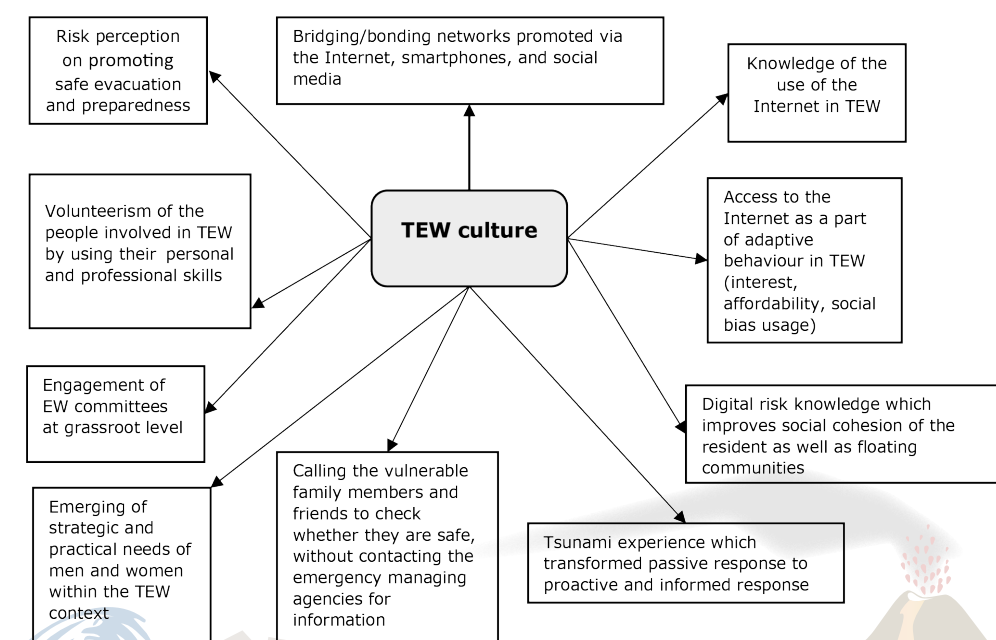
Gender equity linkages with TEW culture. Culture includes “knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by [a person] as a member of society” (Avruch, 1998, p.6). Culture is the learned behaviour of a group of people that generally reflects the tradition of that group. Culture is socially

transmitted from generation to generation through social learning but changes according to circumstances and goals (Dirette, 2014; Hofstede, 1997; Nasir et al., 2006). Therefore, culture is not static since it needs to be explained within the given context. Thus, cultural factors need to be identified within a specific context. The culture associated with the present study is presented in Figure 1. For example, cultural factors such as risk perception, bridging/bonding networks, risk knowledge, volunteering to help other community members by using personal and professional skills, social cohesion, and use of digital information can be highlighted. These TEW cultural elements are critical parts of the people-centred TEW system explored in this research.

The association among TEW, gender equity, and the Internet. As women are overrepresented in disaster death tolls, it can be argued that women are more disadvantaged in terms of response capacity. Women were also overrepresented in the death toll of the 1991 Cyclone event in Bangladesh (UN, 2009). EW information about the cyclone and associated floods rarely reached women directly, contributing to a death rate five times higher than that of men (Ikeda, 1995; Skutsch et al., 2004). This impact of women’s reduced access to EW and subsequent lower ability to respond on disaster fatalities highlights the importance of the present research examining socially constructed gender roles.

Another aspect of the response capacity for EW is the knowledge and use of, and access to, digital

Figure 1
Tsunami Early Warning Culture



technology that enables informed decision making. In this regard, recognising women as active participants in EW at a strategic level is important. As mentioned before, recognising women's proactive decision-making capacity in TEW can make EW more effective at reducing loss of life, as was the case with Hurricane Mitch in La Masica, Honduras (Buvinic, 1999). However, previous researchers tend to overlook the importance of developing strategies for making TEW gender sensitive, considering women as key actors at the grassroots level. This is a focus of the present research.

Approaches in disaster management can be improved by considering factors such as the failure to reduce death tolls despite implementing mitigation efforts and the absence of the dissemination technology transfer (Alexander, 1997; Paul, 2011). In terms of large-scale technology transfer, women remain in a disadvantaged position. Even if gender equity had been a central focus of research on power and positionality, gender equity associated with technology has historically been largely ignored in social science research (Crocco et al., 2008). Therefore, gender equity sensitive TEW systems using Internet technologies can help fill the gender equity gaps in technology. Consequently, the present research explores the critical components of TEW systems for improving community preparedness as well as making TEW gender sensitive and technologically sound.

Women's reduced access to and use of Internet-enabled digital technology for TEW is a key barrier associated with gender equity that was examined in the present research. The Internet provides a space for realising gender-based potentials (Hans et al., 2011) and reconceptualising gendered scripts (Bruckman, 1993; Loureiro & Ribeiro, 2014). For example, social media facilitates online interaction (Lind, 2012), with this interaction expanding the boundaries of permitted gendered behaviour (Riegert & Ramsey, 2013) as well as maintaining relationships (Ledbetter & Mazer, 2014).

According to Liu (2015), technological changes in human society will lead to scientific revolution. The Internet and mobile phones are networking technologies and represent pathways to changing gender inequity (Jacobsen, 2011). Internet use can influence labour markets (Autor, 2001); high-speed Internet increased married women's participation in the labour force (Dettling, 2015). Consequently, the present research considers Internet technology in TEW as an opportunity for improving gender equity. The present research argues that Internet use and access to risk information can allow the bypass of hierarchies in decision making. In

this regard, factors such as knowledge and use of, and access to, the technology are important.

Some researchers have investigated how people-centred EW systems can be gender sensitive within the context of floods (Mustafa et al., 2015; Shrestha et al., 2014). However, these studies did not discuss gender equity and Internet interaction in decision making during TEW. Therefore, the present research explored the critical components of people-centred TEW systems with preparedness, gender sensitive, and Internet interaction aspects.

Components of an EWS. The existing literature on people-centred EW systems comprises four critical components:

- risk knowledge (to ensure the systematic generation of knowledge for people at-risk to use),
- monitoring and warning services (to identify the risk level of the particular event),
- dissemination and communication (to ensure that the relevant people receive warning information without delay),
- and community response capacity (to ensure that people at risk respond in an appropriate manner to reduce fatalities; Badan Meteorologi, Klimatologi, dan Geofisika [BMKG], 2012; UN, 2015; UNDRR, 2006; World Meteorological Organisation [WMO], 2018).

However, these components have not been thoroughly explored regarding improving gender equity and considering Internet interaction to increase TEW effectiveness.


As shown in Figure 2, there are sub elements under each main component of a TEW system. Some sub elements are common across components while others are unique (De Leon et al., 2013; International Labour Organization [ILO], 2005; UNDRR Platform for Promoting Early Warning [UNDRR-PPEW], 2005; WMO, 2018).

Conceptual Framework

The conceptual framework for this research was developed based on an extensive literature review demonstrating the importance of using prior knowledge of the risks confronted by the communities, using technical monitoring and warning services associated with these risks, disseminating understandable warnings to those at risk, and being prepared to act (De Leon et al., 2013; ILO 2005; UNDRR-PPEW, 2005; WMO, 2018). Furthermore, the United Nations Education, Scientific and Cultural Organization (UNESCO; 2011) identified effective governance, institutional arrangements, a multi-

Figure 2

Components of an Early Warning Framework



Risk knowledge	Monitoring and warning service	Dissemination and communication	Response capacity
Establishing the aim	Establishing the aim	Establishing the aim	Establishing the aim
Identification of key actors	Identification of key actors	Identification of key actors	Identification of key actors
Establishing organisational arrangements	Establishing institutional mechanism	Institutionalisation of the decision-making process	Respecting the warning
Identification of natural hazards	Developing a monitoring system	Effective communication systems and equipment	Developing disaster preparedness and response plans
Analysing the community vulnerability	Establishing the forecasting and warning systems	Recognising and understanding warning messages	Assessing the community response capacity and strengthening
Assessing the risk		Enhancing public awareness and education	Enhancing public awareness and education
Storing information and making it accessible			

Note. Adapted from UNDRR (2006).

hazard approach, the involvement of local communities, and the consideration of gender perspectives as factors influencing the effectiveness of a people-centred EW system. Furthermore, as is shown in the existing literature, risk knowledge is identified, considering existing key actors and institutional arrangements as well as for tsunami vulnerability by explaining the existing mechanism for assessing tsunami risk information (UNDRR, 2006).

It is important that the language for generating and transferring risk knowledge is understood by local at-risk communities (Basher, 2006; Parker & Handmer, 1998; Schwere, 1982). However, there is a lack of research specifically focused on improving TEW by using gender-sensitive risk knowledge to improve preparedness. For example, little work has explored the strategy of identifying existing and new key actors involved in generating gender-sensitive risk knowledge (Cvetkovic et al., 2018; UNDRR, 2019). The aspects of risk knowledge for preparedness considered in this research are presented in Figure 3.

As is highlighted in the literature, the second critical component in EW is a monitoring and warning service. In many countries, Departments of Meteorology (DoM; also Meteorological Services/Offices) are designated as the national focal point for monitoring and warning services. In the case of tsunami, the Internet is used

to send information from Regional Tsunami Service Providers (RTSPs) to the above national focal points. In Sri Lanka, where the present research was conducted, DoM is the national focal point/authority for receiving TEW from RTSPs and deciding on country-level TEW alerts. The Disaster Management Centre (DMC) has become the authority for disseminating TEW to the relevant stakeholders, including the public (Ministry of Disaster Management, 2014). The aspects of monitoring and warning services for preparedness considered in this study are presented in Figure 3.

The third component of TEW is dissemination and communication, which typically only examines existing

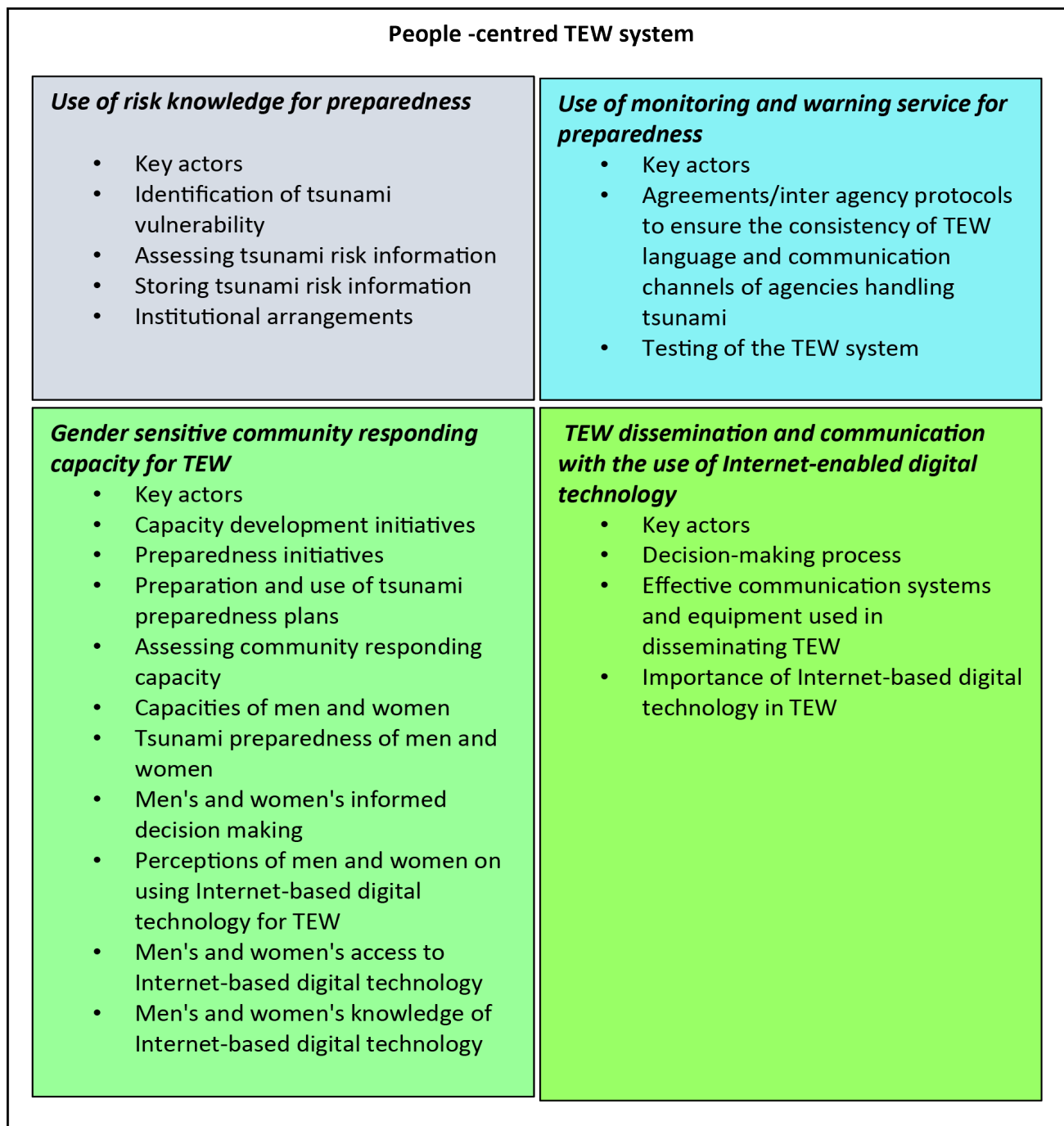
key actors and hierarchical decision-making processes. Therefore, in the present study, there is an examination of the third critical component of TEW systems: dissemination and communication using Internet-enabled digital technology (see Figure 3).

With reference to the fourth critical component of TEWS, the community response capacity, the Internet provides space for realising gender-based potentials (Hans et al., 2011) and helps re-conceptualise gendered scripts (Bruckman, 1993; Kelly et al., 2006; Loureiro & Ribeiro, 2014). For example, social media facilitates online interaction (Lind, 2012). Therefore, the fourth critical component of TEW systems, community response capacity, was examined in the context of gender equity aspects associated with Internet interaction including gender differences in access to and perceptions and knowledge of the Internet, capacity for informed decision making, and tsunami preparedness (see Figure 3 for the full list of aspects).

This study used a case study approach, conducting interviews with key stakeholders in three tsunami-affected areas of Sri Lanka to explore governmental and community perspectives of the components of the conceptual framework.

Figure 3

Conceptual Framework of the Present Study



Method

In terms of research philosophies, objectivism represents the position where social entities exist externally to social actors concerned with their existence (Crotty, 1998). Subjectivism embraces social phenomena from the perceptions and consequent actions of social actors concerned with their existence (Saunders et al., 2012). As this study interprets participants' subjective experiences and understanding of reality to gain insight

into their situations and perspectives within a specific context, interpretivism was applied (Carson et al., 2001).

Multiple case studies were conducted in Sri Lanka, where there was no overall TEW framework with gender equity and Internet interaction aspects. The case studies were conducted in three of the Municipal Council (MC) areas most affected by tsunami: namely Galle (Case 1), Batticaloa (Case 2), and Hambantota (Case 3). A mixed-method approach was adopted in conducting

case studies involving semi-structured interviews and questionnaire surveys. This paper focuses on the results from the interviews, rather than the surveys, concentrating on the grassroots-level community perspectives associated with the key themes in the conceptual framework. The questions in the interview guideline were developed based on the conceptual framework, research questions, and objectives (see Appendix 1). The researcher conducted the interviews between mid-2017 and mid-2018 with the approval of the School Research Ethics and Integrity Committee (SREIC) of the University of Huddersfield, received on the 4th of May 2017.

The participants for the semi-structured interviews were involved in TEW at the case-study level including the head of the EW committee members at the Grama Niladhari (GN) level and Divisional Secretariat/MC level, the Disaster Management Authority at the MC level, the

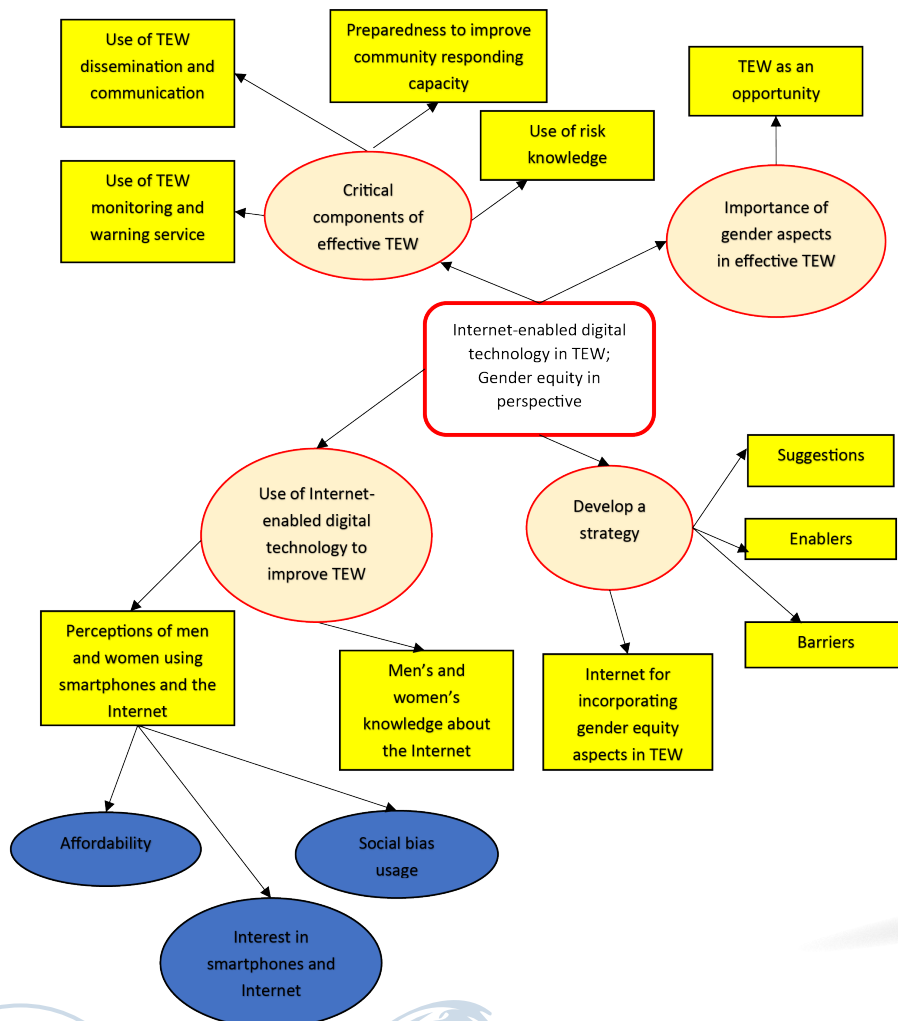
MC authority, and focal points from military and other agencies. A further 11 interviews were with experts at the national level including policy makers, representatives of the Indian Ocean Tsunami Warning Monitoring System (IOTWMS), academics, and decision makers from disaster management authorities, technical agencies, and independent commissions.

All 38 interviews were conducted using the same interview guideline mainly focused on the following themes:

- Existing and new key actors,
- Use of risk knowledge for preparedness (problems and strategies),
- Use of monitoring and warning service for preparedness (problems and strategies),
- Dissemination and communication with the use of the Internet (problems and strategies), and
- Community responding capacity with gender-equity aspects (problems and strategies).

Figure 4

Cognitive/concept Map of Nodes



Data Analysis

Transcriptions of the interviews were analysed using NVivo 11, with codes identified based on the responses. These codes were categorised under nodes (themes) as shown in Figure 4. The nodes of the thematic analysis were created based on the themes that had been already identified in the conceptual framework as well as emerging themes based on the transcripts. The same semi-structured interview guideline was used for case study and national-level expert interviews. Therefore, the same approach was used to analyse the four sets of data (Cases 1, 2, and 3 and experts' interviews).

A cross-case analysis compared the case findings of each critical component in the conceptual framework. For instance, cross-case analysis of the strategies related to the monitoring and warning services for preparedness showed that all strategies were

identified in all cases. Improving the methodology of practicing the tsunami mock drills, developing inter agency protocols and establishing a proper monitoring and evaluation system, and recognising men and women at grassroot level as key actors in monitoring and warning were common to all three cases. Furthermore, cross case findings were compared with the findings of the expert interviews. For instance, in contrast to the case study findings, the experts explained the problems and strategies to overcome the problems in more detail.

Results and Discussion

This section presents the findings under the key themes highlighted in the conceptual framework. It is worth noting that at the time of the 2004 Indian Ocean tsunami, which devastated parts of Sri Lanka, the country did not have a TEW system or a legal Act to manage disasters; as a result, the Disaster Management Act was passed in 2005. The DMC and the District Disaster Management Units (DDMUs) were established as a requirement of the Act with a mandate to establish an early warning system. However, there was no specific focus on integration of gender equity into the disaster management plans and initiatives in the country. Participants in this study represented the relevant disaster management institutions which had been involved in developing the disaster management sector in the country and specifically the existing TEW system.

Key Actors (*Existing and New*)

It was found that *existing* and *new* key actors were involved in receiving TEW alerts and information from TEW issuing agencies and disseminating it to the relevant people. Existing key actors refers to actors who are contributing in TEW and formally recognised as actors in the TEW system. New actors are those who are voluntarily contributing in TEW and yet to be formally recognised as actors in the TEW system. As a whole, they were not involved in a systematic risk information generation or dissemination process nor a monitoring and evaluation process. Furthermore, they were not a part of a community-based capacity assessment process.

It was also found that the common functions of existing and new key actors had not been recognised in the existing TEW process. Such common functions were the use of risk knowledge for preparedness, the use of monitoring and warning services for preparedness, dissemination and communication using the Internet, and improving gender-equitable community responding capacity. It is important to recognise that, apart from the

existing key actors, there are new key actors who are not a part of the hierarchical TEW governing/decision-making structure. Recognising these actors will also help to convert the decision-making process from hierarchical to non-hierarchical.

Existing key actors at the international/regional level: Indian Ocean Tsunami Warning System (IOTWS), Regional Tsunami Service Providers (RTSPs), Indonesia Tsunami Early Warning System (InaRTSP), Indian National Centre for Ocean Information Services (ITEWC), Joint Australian Tsunami Warning Centre (JATWC), United States Geological Survey (USGS), and the international media.

New key actors at the international/regional level: Relevant research communities.

Existing key actors at the national level: Ministry of Disaster Management, DoM, DMC, Geological Survey and Mines Bureau (GSMB), National Aquatic Resources Research and Development Agency (NARA), District Disaster Management Coordination Units, the media, army, navy, air force, police, fire service departments, Ceylon Electricity Board, Lanka Electricity Company, Road Development Authority, Provincial Road Development Authority, National Water Supply and Drainage Board, Central Environment Authority, airport and aviation services, Department of Customs, Department of Immigration & Emigration, Ministry of Health, Ministry of Foreign Affairs, and the Ports Authority.

New key actors at the national level: Telecommunication Regulatory Commission, mobile service and Internet service providers.

Existing key actors at the district, divisional, MC level: District and Divisional Secretariats (DS), GNs, EW committee members at district/divisional/GN levels, Department of Fisheries and Aquatic Resources, SLCG, the media, the naval, aviation, and marine sector communities, transport sector stakeholders, and fisheries and harbour communities.

New key actors at the district, divisional, MC level: Field officers attached to the DS such as relief service officers, officers of Vidatha Centres, the Department of Coast Conservation and Coastal Resources Management (CC & CRM), the Marine Environment Protection Authority, technical colleagues, commerce and industry, Sri Lanka Red Cross volunteers, officers of the Ministry of Women and Child Affairs (MWCA) attached to the DS such as women development officers,

counselling officers/assistants, child right promotion officers, child protection officers, psychosocial officers, early childhood care and development assistants and relief sisters, officers of the Ministry of Social Services attached to the DS and also District and Divisional Women Federations, and social media platforms, namely Twitter, Viber, WhatsApp, Facebook, and IMO.

Existing key actors at the GN level/Village level: GNs and EW committee members.

New key actors at the GN level/village level: Women engaged in TEW, friends and relations of vulnerable communities in countries such as Australia, Indonesia, India, and the United Arab Emirates as well as friends and relations in safe areas within the country, community-based organisations such as women's societies at the village level and women parliamentarians/local authority members, and social media, namely Twitter, Viber, WhatsApp, Facebook, and IMO.

Use of Risk Knowledge for Preparedness

This section highlights the problems found across the three case studies and the expert interviews; none of the problems could be highlighted only in a specific area. Common problems associated with the use of risk knowledge for preparedness within the contexts of identification of vulnerability, generation of risk information, assessing the risk information, storing the risk information, and institutional arrangements are outlined as follows:

- not recognising the CC and CRM established coastal buffer zone policy taking tsunami vulnerability into consideration,
- not having a proper and updated tsunami vulnerability assessment for the country,
- not having the tsunami risk profile for the country,
- no strategy for assessing risk information at periodic intervals,
- not generating gender-sensitive risk knowledge,
- not recognising the smartphone as a risk information storage device available for the community, and
- no integration of institutional arrangements as a measure of synchronising preparedness capacities.

Participants identified several strategies to overcome the above problems including assessing the vulnerabilities of men and women during the day and at night, involving experts to identify cross-cutting areas such as men's and women's needs in TEW and the generation of gender-sensitive risk knowledge by assessing gender-based

vulnerabilities and capacities. Generating TEW risk information in the local context, in English and in local languages (Sinhala and Tamil), was also important. The synchronisation of preparedness capacities for assessing gender-sensitive risk by involving officers appointed by the MWCA and the use of gender-segregated data was another strategy. In this regard, it is necessary to officially involve the officers appointed by the MWCA in TEW.

Furthermore, it is important to make policy decisions based on risk knowledge, such as digitising TEW-related risk information for public use and having a primary system that includes mobile networks, legislation, and a mandate for handling digital information. It is also important to have adequate funds to bear the cost and maintain international standards in the local context. In terms of storing tsunami risk information, recognising the smartphone as a risk information storage device accessible to the communities at risk is pivotal.

It is also important to develop guidelines on how to strengthen the GN-level EW committees in a gender-equitable and technologically sound manner by sharing the research findings with the relevant stakeholders, including the institutes that set standards. The final strategy identified involved integrating plans and institutional arrangements, such as incorporating gender-sensitive aspects in the National Action Plan for empowering women into the National Disaster Management Plan (NDMP). A summary of the above strategies is illustrated in Figure 5.

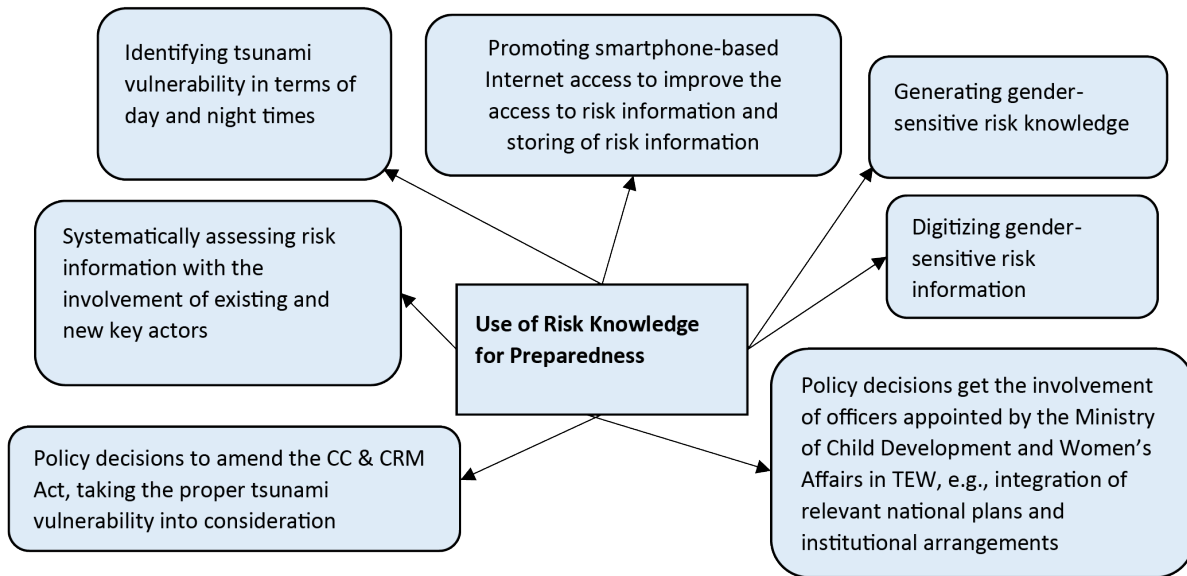
Use of Monitoring and Warning Services for Preparedness

Similar to risk knowledge, participants across case studies identified common problems associated with the use of monitoring and warning services for preparedness within the context of inter-agency protocols/agreements, the method for practising mock drills, and monitoring and evaluation, as listed below:

- no agreement of inter-agency protocols to ensure the consistency of warning language and communication channels of the agencies handling tsunami hazards in Sri Lanka;
- no systematic monitoring and evaluation system to identify TEW needs, gaps, and measures to fill the gaps;
- not conducting tsunami drills taking day and night vulnerabilities into consideration;
- no traffic plan-based tsunami drills;

Figure 5

Strategies for Using Risk Knowledge for Preparedness

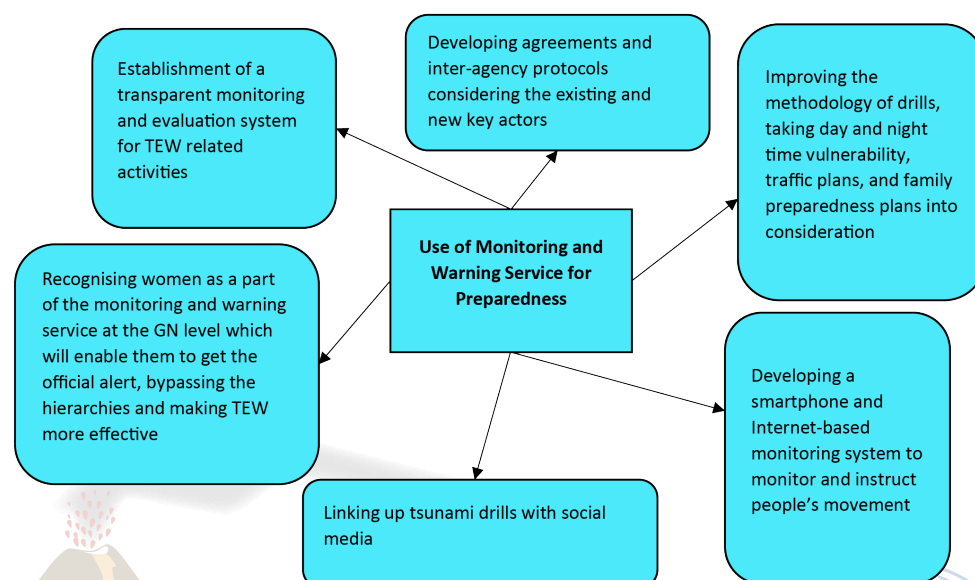


- networking capacity via social media not adequately recognised in TEW monitoring and warning; and
- not recognising women as key actors who are volunteering in TEW for monitoring and warning at the grassroots level.

The above problems were also highlighted in expert interviews as common to many areas beyond those of the case studies. Proposed strategies to overcome these problems are presented in Figure 6.

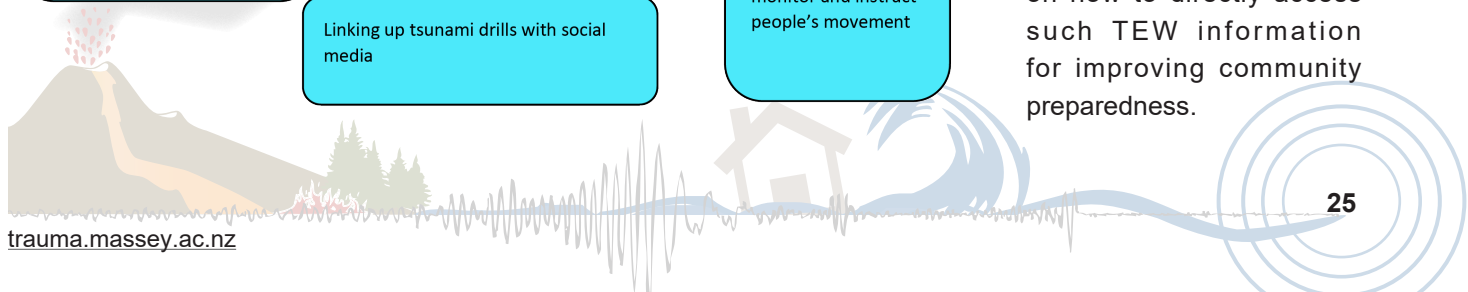
Figure 6

Strategies for Using Monitoring and Warning Service for Preparedness



For example, it is necessary to utilise women involved in TEW at the GN level in terms of their volunteer commitment and knowledge for monitoring TEW and safer evacuation. It is also important to update EW committee members' lists which provide evidence of the overrepresentation of women in TEW activities. Recognising women as a part of the monitoring and warning service at the GN level will enable them to get official alerts, bypassing the hierarchies. Furthermore, it is essential to recognise social media and mobile Internet providers

as actors in monitoring and warning services. Tsunami drills linked with social media with a transparent monitoring and evaluation system are also required so that EW committee members and communities at the GN level receive TEW alerts via social media networks. As these alerts can be received well in advance to the official warning alert, it is important to systematically educate, train, and raise the awareness of those vulnerable to tsunami on how to directly access such TEW information for improving community preparedness.



Dissemination and Communication with the Use of Internet-Enabled Digital Technology

This section presents the problems and strategies associated with the institutional arrangements/decision-making process for hierarchical and non-hierarchical decision making and discusses Internet-enabled effective communication systems and equipment in the dissemination of TEW. The main problems are as follows:

- inadequacy of digital risk information and a system to regulate the dissemination and communication of digital risk information;
- not having systematic and targeted training, awareness, and education programmes with the necessary materials in English and local languages;
- not recognising the importance of non-hierarchical dissemination and communication of TEW which happens via the Internet;
- not recognising the use of social media and networking in TEW;
- not having gender-sensitive and technologically-sound TEW subject matters in education systems;
- not recognising the Internet as the fastest and most reliable method of disseminating TEW;
- gaps in recognising effective communication systems and equipment in TEW; and
- not recognising smartphones with Internet access as early warning devices which are accessible to men and women involved in TEW.

To overcome the above problems, the following strategies were proposed.

Institutional Arrangement/ Decision-Making Process in TEW

It is critical to recognise that TEW dissemination and communication occur via hierarchical as well as non-hierarchical methods. The hierarchical method includes RTSPs sending the alerts to national tsunami focal points. In the case of Sri Lanka, it is DoM. Other national agencies, such as DMC, GSMB, and NARA who are part of TEW also access or receive TEW alerts, mainly

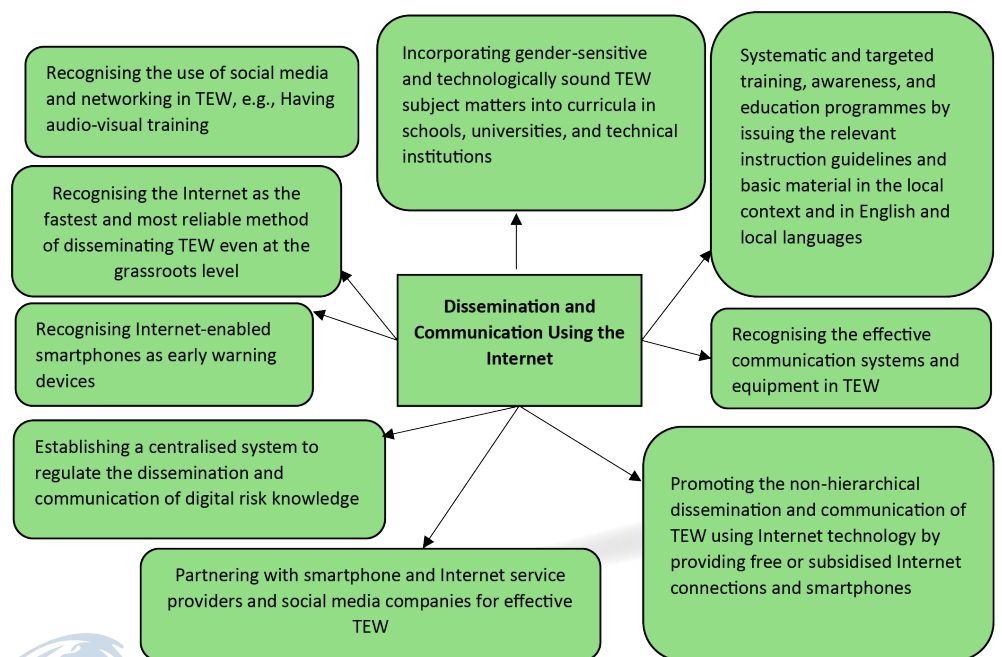
via the Internet. DMC disseminates TEW to the relevant stakeholders at the national and local levels. However, at the DS level, another non-hierarchical method of TEW decision making is the use of Twitter. This account is operated by a relief services officer or field officer of the Vidatha Centre under the guidance of the DS using a personal smartphone and Internet connection. Furthermore, at the GN level, people access TEW via social media networks and visiting relevant websites; this non-hierarchical model means the information can reach vulnerable men and women, as well as family and friends, more directly and quickly.

Understanding the importance of Internet-based digital technology in TEW for connectivity.

To overcome the problems associated with dissemination and communication using the Internet, it is important to strategically recognise the role of Internet-based digital technologies in TEW (see Figure 7). Men and women at risk receive TEW alerts via social media networks from friends and relations who live in India, Indonesia, Australia, and the United Arab Emirates, as well as communities in safe areas within the country. Such friends and relations access TEW on relevant web sites such as IOTWS, InaRTSP, ITEWC, JATWC, and USGS.

Recognising the smartphone as an EW device and the use of mobile Internet and social media networks for non-hierarchical decision making in TEW is important. The non-hierarchical dissemination and communication

Figure 7
Strategies for Communication and Dissemination using the Internet



of TEW using Internet technology needs to be promoted with intensive programmes which also provide free or subsidised Internet connections and smartphones. This will benefit more women as they were outnumbered in non-hierarchical decision making in TEW at the GN-division level. However, they need to be made responsible for and systematically trained to respond to TEW using digital information. It is also critical to partner with smartphone and Internet service providers and social media companies for effective TEW.

Incorporating gender-sensitive and technologically sound TEW subject matters into curricula in schools, universities, and technical institutions for the long-term dissemination and communication of risk information will be of benefit. Such subject matters can be made available in digital form as well. Systematic and targeted training, awareness, and education programmes should issue the relevant instruction guidelines and basic material in the local context and in English and local languages. This will assist women with limited mobility to access the above information via the Internet with ease. Finally, audio-visual training programmes on TEW and disseminating via social media networks such as Viber, WhatsApp, Facebook, and IMO would likely be effective.

Community Responding Capacity with the Gender Equity Aspect

The following problems are associated with the community responding capacity with the gender equity aspect:

- no mechanism for preparing and updating traffic plans and family preparedness plans as a part of evacuation plans;
- no regular EW committee meetings at the GN level for improving community responding capacity;
- lack of experts in TEW to develop good gender equity-sensitive strategies to improve the TEW process;
- men's and women's preparedness and capacity aspects were not considered in the existing TEW process, which is

also governed by the hierarchical decision-making structure;

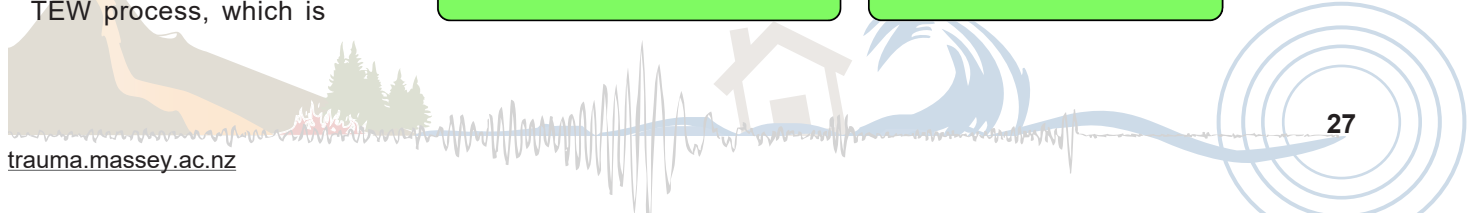
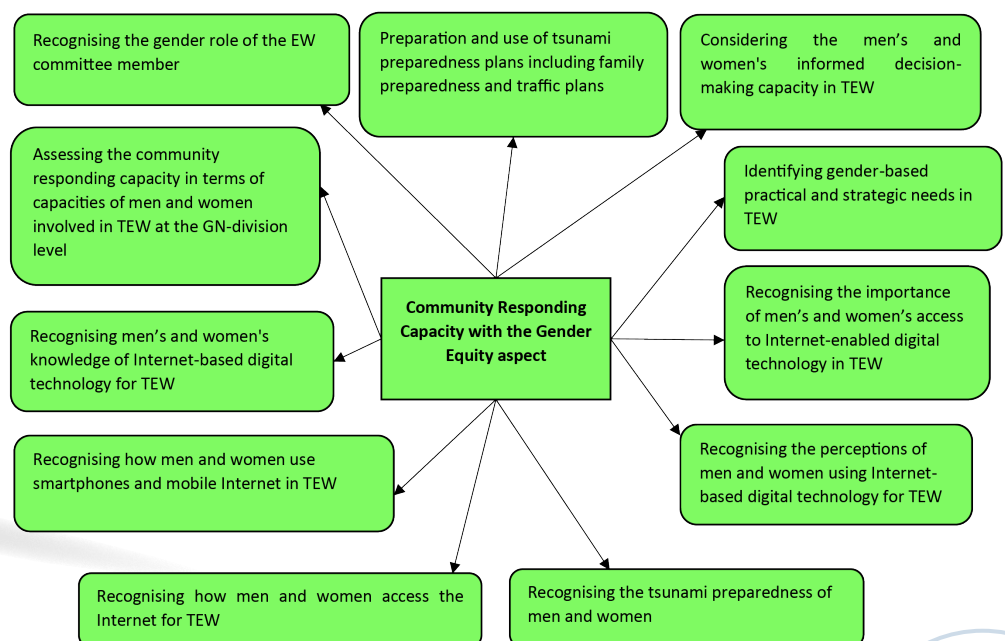
- lack of identification of strategic and practical needs of men and women within the context of TEW;
- lack of recognition of women's role as EW communicators/actors;
- lack of recognition of gender equity as important in the existing TEW decision-making structure;
- lack of recognition of men's and women's Internet-based knowledge in the existing TEW decision-making process;
- lack of recognition of men's and women's access to the Internet in the existing TEW decision-making process;
- lack of recognition of men's and women's perceptions of using the Internet for TEW in the existing TEW decision-making process;
- socially biased usage of smartphones to access the Internet; and
- not recognising community networking capacity as a strategic need to improve the existing TEW decision-making process.

Figure 8 presents strategies to address these problems.

Preparation and use of tsunami preparedness plans including family preparedness and traffic plans. It is important to develop a family preparedness plan for TEW defining the social roles of men and women in the family.

Figure 8

Strategies for Improving the Community Responding Capacity Using the Internet



In the plan, the elements such as ways of acquiring risk knowledge, ways of evacuating, and ways of helping others to evacuate should be included in a gender-segregated manner. Developing a traffic plan with the involvement of a traffic committee in the MC and having it online is another strategy to improve gender-equitable community responding capacity.

Assessing the community responding capacity in terms of the capacities of men and women involved in TEW at the GN-division level. In the case study areas, women tend to spend more time in the village due to their social roles. Therefore, recognising women's caregiving role for children and adults can protect lives. Although more men are involved in TEW decision making at the national level, more women are involved at the GN-division level, including participation in awareness programmes. Following the 2004 Indian Ocean tsunami, women shifted from being passive recipients of TEW into more proactive and informed decision makers. Given that the participants believed that properly trained men and women have equal capacity for responding to TEW for saving lives and that women clearly have an interest in and commit to volunteering in TEW, a strategy is required to utilise women's interest in TEW and build their capacity for proactive responding with the necessary preparation. To understand the responding capacity of men and women, it is important to identify how men and women differ in terms of receiving, understanding, and responding to TEW. Systematic training and awareness programmes with digital information on safe places for vertical and horizontal evacuation which can also be accessed via smartphones can improve the gender-equitable community responding capacity.

Identifying gender-based practical and strategic needs. Identifying gender needs within the context of TEW can minimise vulnerabilities and improve response capacity. Such gender needs include:

- Men's strategic needs: participating in training and awareness programmes;
- Men's practical needs: receiving information on safe evacuation when they engage in economic activities including the traffic plan, alternative roads, and routes that their family members can use to evacuate at the onset of tsunami hazard;
- Women's practical needs: caretaking of children, elders, and disabled people at the onset of tsunami hazard; and
- Women's strategic needs: participating in training, awareness programmes, and mock drills and having facilities (devices and services with the relevant

training) for fast and cost-effective dissemination and communication of TEW.

Recognising the tsunami preparedness of men and women. It is of immense importance to recognise that women's and men's socially assigned roles and responsibilities within the institution of the family contribute to gender differences in tsunami preparedness. Gender bias in society contributes to a women's community management and reproductive roles, lack of opportunities for proper training and awareness, lack of policies that support household balance, and lack of access to digital information and technology.

Recognising the perceptions of men and women of using Internet-based digital technology for TEW. It is important to recognise that people use smartphones intensively for networking, to access knowledge and services, and for saving emergency information. However, information on TEW and risk could be pushed to mobile Internet service providers' customers. EW committee members at the GN-division level could target this aspect and be educated and trained on how to handle TEW digital risk information using smartphones. In the Sri Lankan context, if the family can afford one smartphone, it will be owned by the male head of the household, but the women can use it when the male counterparts are at home; women, usually the mother, are typically given a smartphone when the family can afford more than one. Further, men can freely visit places such as Internet cafés, friends' homes, or offices to access the Internet; women typically do not have as many options which creates a difference in men's and women's access to the Internet.

Across all case studies, both men and women preferred to access the Internet via a smartphone. By using a smartphone with Internet access, the information can be shared in a convenient, affordable, and reliable manner. According to the members of the coastal communities interviewed in this study, Internet coverage, signal strength, and the consistency of signal were good. For the low-income groups, a smartphone and mobile Internet is the most affordable way to access the Internet as smartphones tend to be available at local markets for an affordable price. Therefore, women tend to purchase smartphones as an essential commodity for networking; this use of the Internet for networking and communication has contributed to increased involvement in EW by women.

As fishing communities cannot move away from tsunami risk areas, receiving a reliable tsunami alert in the fastest

manner is important for saving lives. During the 2004 Indian Ocean tsunami, many people received TEW alerts via social media networks from family or friends. These were then followed by official alerts from the head of the local EW committee to corroborate the reliability of the unofficial social media alerts.

Men's and women's knowledge of Internet-based digital technology. Men and women demonstrated relatively equal knowledge of Internet use for TEW in terms of the knowledge criteria given below. This indicates the potential of TEW information equally benefitting men and women if they have access to the Internet. The knowledge criteria are as follows:

- dissemination and communication of TEW;
- acquiring knowledge of the tsunami hazard (occurrence, magnitude, inundation, wave height, time of arrival, frequency, place of origin, travel time, etc.);
- acquiring knowledge of tsunami vulnerability and deficiencies in preparedness (vulnerable locations, routes, infrastructure, etc.);
- acquiring knowledge of capacity for responding to tsunami disasters (safe places, safe routes, tsunami evacuation signboards, safe buildings, preparedness plans, evacuation plans, etc.);
- acquiring knowledge about relevant stakeholders and their roles and responsibility to get assistance;
- acquiring knowledge about TEW systems to proactively engage with TEW decision making;
- being aware of tsunami preparedness measures; and
- ways of practising mock drills and related training on TEW for better responding.

Men's and women's use of smartphones and mobile Internet in TEW.

The majority of TEW communities received alerts via smartphone and the Internet. Consequently, smartphones help people make the decision to evacuate, even before the official country alert, as people obtain social media alerts from friends and relations abroad. Compared to men, women were more likely to have online friends and be in contact with relations in countries such as Australia, Indonesia, and India, from whom they can receive tsunami-related alerts via social media. However, participants reported that the mobile phone usage of young females was more closely monitored in the family compared to male members' phone usage. Women's smartphone and Internet connection ownership needs to be promoted, in terms of convenient, unshared access, and there should be multiple other communication

channels such as TV, SMS text messaging, tsunami towers, voice calls, police loudspeakers, family members, and EW committee members to ensure TEW dissemination.

Financial constraints present a barrier to women (and men) using the Internet for networking or acquiring knowledge for informed decision making. This barrier contributed to the creation of Twitter accounts in case study areas Batticaloa (Case 2) and Galle (Case 1) for sending TEW alerts.

Conclusions

As per the empirical findings, the framework of strategies developed for making Internet-enabled TEW gender sensitive is presented in Figure 9.

In contrast to much of the previous literature, the existing and key actors are common to all components. In recognising the new key actors who are not a part of the existing hierarchical TEW, the decision-making structure becomes important to convert the hierarchical decision-making process into a more effective and gender-equitable non-hierarchical decision-making process.

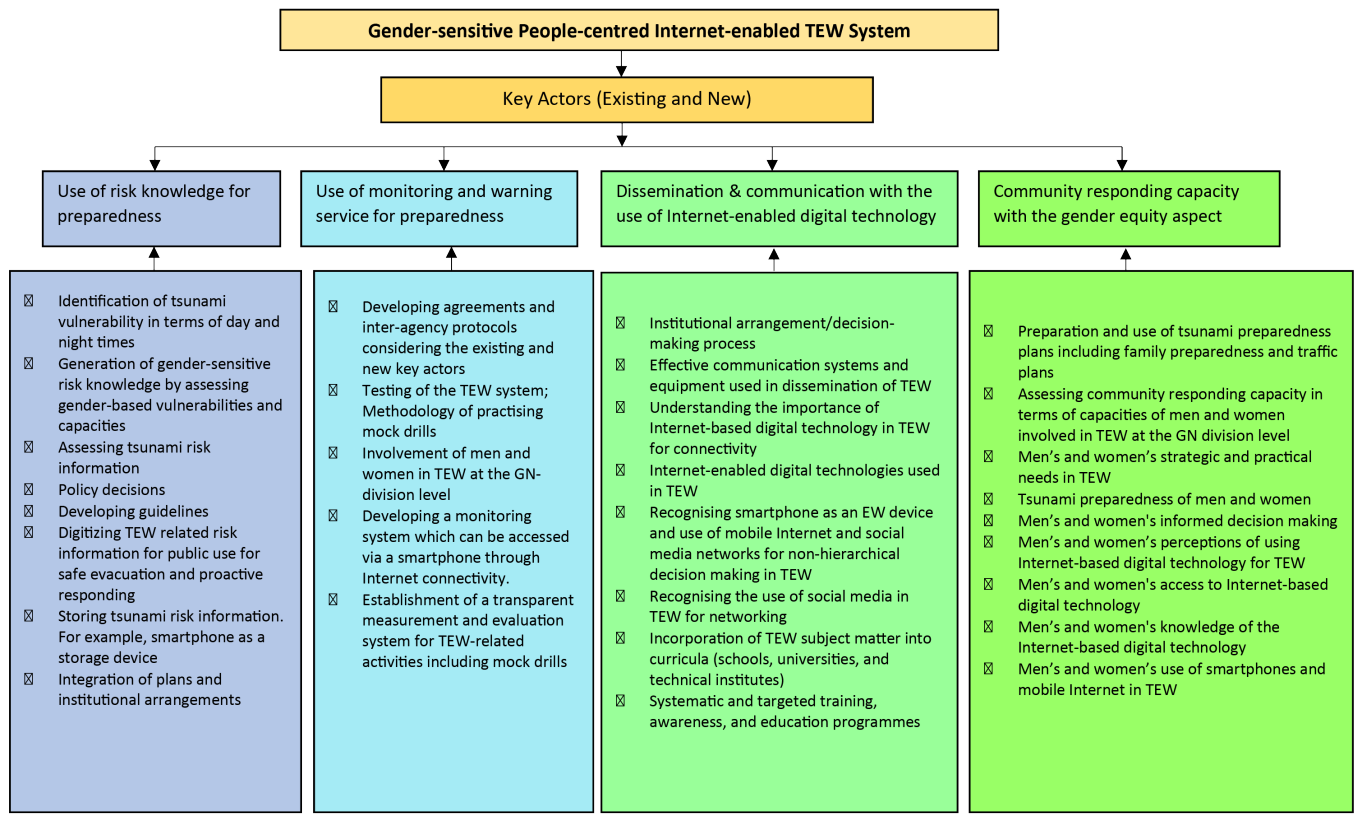
With reference to the use of risk knowledge for preparedness, the generation of gender-sensitive risk knowledge by assessing gender-based vulnerabilities and capacities is important. Furthermore, having digital risk information that can be accessed via the Internet can make TEW more effective. Integration of plans, having institutional arrangements, and recognising the smartphone as a risk information storage device are other strategies that can be implemented.

In terms of the use of monitoring and warning services for preparedness, it is important to develop inter-agency agreements/protocols among existing and new key actors as well as to recognise women and men in the community as key actors in TEW monitoring and warning services due to social networking. Recognition of such women as a part of monitoring and warning services at the GN-division level will increase access to official TEW alerts. In addition, receiving systematic awareness and training programmes on TEW will improve risk knowledge and preparedness. Establishing a transparent monitoring and evaluation mechanism and improving the methodology of practising the mock drills are also pivotal.

TEW dissemination and communication happens via hierarchical and non-hierarchical methods; the Internet is the fastest and most reliable non-hierarchical method of disseminating TEW, even at the grassroots level. The

Figure 9

Framework of Strategies for Incorporating Internet Enabled Digital Technology in TEW to Improve Gender Equity



non-hierarchical dissemination and communication of TEW using Internet technology needs to be promoted with intensive programmes providing free or subsidised Internet connections and smartphones. Furthermore, women involved in TEW can be formally recognised and made responsible by providing them with appropriate training on how to use and respond to TEW with digital information. It is important to issue the relevant instruction guides and basic materials in English as well as in local languages (Sinhala and Tamil) and integrate gender-sensitive TEW subject matters into school, university, and technical college curricula. Further, a centralised system could regulate the dissemination and communication of digital risk information. In this regard, partnering with mobile and Internet service providers and social media companies for effective TEW is important to reduce the cost of such initiatives.

Women's and men's socially assigned roles and responsibilities are different, which contributes to differences in strategic and practical needs in TEW. These differences in needs are exacerbated by societal gender biases contributing to women having fewer opportunities for proper training and awareness, a lack of policies that support balancing household and

community management roles, and less access to digital information and technology.

The identification of gender role-based practical and strategic needs in the context of TEW helps to minimise gender-based vulnerabilities and improve the equity of response capacity; the strategies developed in the present research cater for these strategic and practical gender needs, thereby suggesting ways in which to make TEW more gender equitable and ultimately more effective at saving lives.

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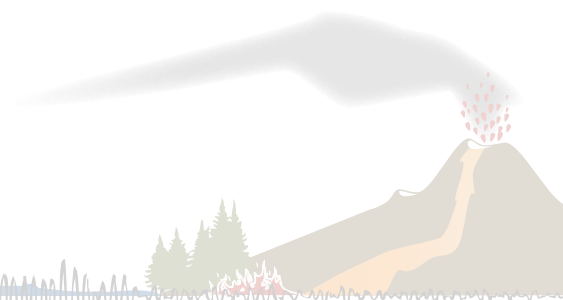
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Appendix 1: Interview guideline for governmental officials, policymakers, academics, experts and practitioners

Research Title: Internet-enabled Digital Technology in Tsunami Early Warning (TEW); Gender Equity in Perspective

A. Personal information

- 1) Name
- 2) Organisation
- 3) Designation
- 4) Gender
- 5) How are you related to the TEW?
 - ◇ Attached to the local government
 - ◇ Attached to the central government
 - ◇ Policy maker
 - ◇ Academic
 - ◇ Researcher
 - ◇ Any other (Please specify)

B. Risk knowledge related to TEW

- 6) Who are the key actors involved with TEW?
- 7) What is the institutional arrangement for TEW?
- 8) What are the other natural hazards that the TEW system can be used customised for?
- 9) What do you consider when identifying tsunami vulnerability?
- 10) What is the mechanism for assessing the risk information?
- 11) What is the mechanism for storing tsunami risk information?
- 12) What do you understand by disaster preparedness for TEW?
- 13) What do you understand by capacity for TEW?
- 14) What are the policies related to TEW?
- 15) What are the capacity development initiatives related to TEW?
- 16) What are the preparedness initiatives related to TEW?

C. Monitoring and Warning of TEW

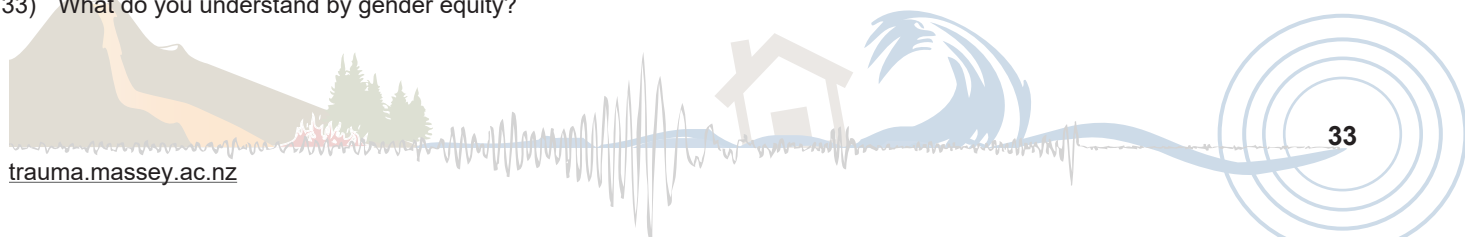
- 17) Who are key actors in monitoring and warning of TEW?
- 18) Whether there are agreements and inter-agency protocols to ensure consistency of warning language and communication channels of agencies handling tsunami hazard?
- 19) Whether warning system are tested and exercises/mock drills are practised? If so how frequently and details about the methodology?

D. TEW dissemination and communication

- 20) Who are key actors in TEW dissemination and communication?
- 21) What is the TEW decision-making process?
- 22) What are the effective communication systems and equipment used for TEW?
- 23) How do you recognise & understand tsunami warning messages?
- 24) What are the mechanisms for enhancing public awareness & education on TEW?
- 25) How is TEW disseminated to you?
- 26) Do you think it is important to use Internet-based digital technology for improving TEW?. If so, why? If not, why?
- 27) What are the Internet-enabled digital technologies that you use for TEW dissemination and communication?

E. Gender-sensitive responding capacity for TEW

- 28) Who are key actors involved with TEW response?
- 29) How do you consider the TEW?
- 30) How do you prepare and use Tsunami preparedness and response plans?
- 31) How do you assess the community response capacity?
- 32) How do you strengthen enhancing public awareness & education on TEW?
- 33) What do you understand by gender equity?



- 34) Do you think it is important to consider capacities of men and women for improving response capacity for TEW? If so, why? If not, why?
- 35) Do you think tsunami preparedness of men and women is important for saving lives due to tsunami disaster? If so, how? If not, why?
- 36) Is there a difference between men and women with regard to informed decision-making in TEW? If so, why? If not, why?
- 37) What are the perceptions of men and women using Internet-based digital technology for TEW?
- 38) Is there a difference between men and women with regard to access to Internet-based digital technology? If so, why? If not, why?
- 39) Is there a difference between men and women with regard to knowledge of Internet-based digital technology? If so, why? If not, why?
- 40) What are the ways of Internet-enabled digital technology that can be evolved in improving gender-sensitive tsunami early warning?
- 41) What are the suggestions for improving tsunami early warning system for proactively responding?
- 42) What are the enablers, barriers associated with the TEW and suggestions to make TEW gender-sensitive with the use of Internet-enabled digital technology?

