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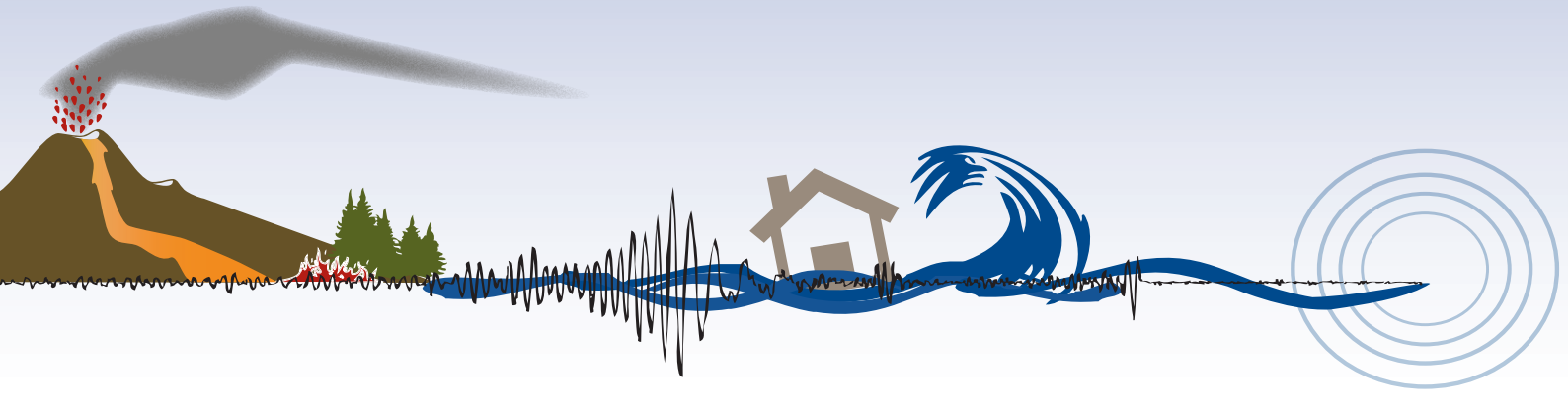

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Designing tsunami risk communication with communities: A site-specific case study from Tūranganui-a-Kiwa, Aotearoa New Zealand

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Abstract

This paper describes a student research project that proposes ways to build earthquake and tsunami awareness through a community-centred approach to tell the story of tsunami as a potential risk. This project is centred on Tūranganui-a-Kiwa (the Poverty Bay region on the East Coast of Aotearoa New Zealand's North Island), an area close to the Hikurangi Subduction Zone which is liable to produce tsunami with little or no time for an official warning. Recent research has revealed that these coastal communities have low levels of tsunami awareness and high expectations of receiving a formal warning before evacuation. In response, this project examined ways to incorporate Mātauranga Māori with Human-Centred Design to produce a meaningful and relevant narrative for encouraging community conversations about tsunami risk. This approach can increase ownership of risk management and recognises that communities, especially tangata whenua - "people of the land", or indigenous communities who have authority in a particular place - hold various bodies of knowledge that can contribute to future risk management. A combination of methods comprised a co-design process, underpinned by Kaupapa Māori research principles, including developing personas and conducting semi-structured interviews and participatory workshops. A narrative developed through this design process manifested in a sculptural pouwhenua - marker posts, usually carved, that are used to mark boundaries of significant places - articulating local earthquake and tsunami hazards. This speculative output was presented in Wellington and Tūranganui-a-Kiwa and is envisaged as an ongoing conversation prompt. This paper describes and reflects on this research process as one that intertwined Human-Centred Design with the author's own situated knowledge as an emerging Māori design researcher. It suggests that a design process that is responsive to community, geography, and culture, undertaken without a predetermined outcome, is valuable in two ways: for the learning that takes place dialogically through the process itself and the potential for an artefact initiated through this process, which embeds narrative storytelling, to catalyse further dialogue in the community and expert groups and between the two.

Keywords: *Tsunami risk, communication, Human-Centred Design, Mātauranga Māori, community*

Pepeha[1]

Ko wai au	Who am I
I te taha o toku papa	My geneology on my father's side
Ko Titirangi te Maunga	Titirangi is my mountain
Ko Ūawanui-a-Ruamatua te Awa	Ūawanui-a-Ruamatua is my river
Ko Horouta te Waka	Horouta is my canoe
Ko Te Aitanga-a-Hauiti te Marae	Te Aitanga-a-Hauiti is my Marae
Ko Ruakapanga te Whare	Ruakapanga is my ancestral house
Ko Ngāti Porou te Iwi	Ngāti Porou is my iwi
Ko Harmony Repia toku ingoa	My name is Harmony Repia

The *pepeha* of the first author establishes their place in terms of their *whakapapa*, which is generally translated as "genealogy" and can be interpreted literally as "the process of layering one thing upon another" (Mahuika, 2019, p. 1), incorporating relationship with place, land, people, and the wider universe. This is important in situating my connection to Tūranganui-a-Kiwa (the Poverty Bay region on the East Coast of Aotearoa New Zealand's North Island) and my position in this research as an emerging Māori design researcher. The Tūranganui-a-Kiwa area gets its name from the ancestor

1 This is the author's *pepeha*, an introductory speech commonly given as part of a *mihimihi* (a Māori formal greeting) that indicates important places and connections and frames a person in terms of their *whakapapa*.

Kiwa, who arrived from Hawaiki on the Tākitimu canoe (Tūpara, 2005). It is the area known as Poverty Bay on the East Coast (Te Tairāwhiti) of Aotearoa New Zealand's North Island and includes the city of Gisborne (formerly called Tūranga). Situated knowledge, a term coined by Donna Harraway in *Simians, Cyborgs, and Women: The Reinvention of Nature* (1991), is the idea that all forms of knowledge reflect the particular conditions in which they are produced, and at some level reflect the social identities and social locations of knowledge producers (Rogers et al., 2013).

Mātauranga Māori refers to the knowledge that Māori have, but also encompasses the Māori way of knowing and the connectedness that knowledge has with the environment out of which it was derived (Goodall, 2016). It has been observed that the science (and science communication) community in Aotearoa is on an ongoing journey towards understanding Mātauranga Māori (Fleming et al., 2020) and appreciating it as a "way of knowing" that, though subjective, is no less legitimate or complete than empirical science. In my experience, the field of design is also on a journey beyond adopting Māori motifs and *tikanga*[2] as a cultural veneer to recognising its holistic importance. However, it would be disingenuous to characterise this research as utilising an overt and specific Kaupapa Māori methodology from the outset (though elements adopted do share commonalities with models such as *negotiated space*, conceptualised by Hudson et al., 2012 , which models the interface between science and Mātauranga Māori). Rather, this research ran in tandem with my own developing appreciation of the synergies and commonalities between Human-Centred Design and the holistic, intertwined relationships between land and living things (fauna, flora, human, spiritual) inherent in Mātauranga. This awareness developed during the research process, informed by the work of Linda Tuhiwai Smith and others (2012; Te Rau Ora, 2017).

This paper focuses more on presenting the process undertaken in this project with important considerations for those wishing to do similar rather than detailed findings from each stage of the research. However, the final outcome of the project is discussed. As such, this paper first introduces the context of the research and then moves through the different stages of the employed design process, concluding with a discussion of the process.

2 *Tikanga* is a series of rules or customs that are passed down from *tūpuna* (ancestors; Kilgour, 2014).

Open Call for Research

In 2015, research identified that coastal communities in Aotearoa New Zealand's North Island did not sufficiently understand tsunami risk (Dhellemmes et al., 2016). As part of the response to these findings, a research project supported by GNS Science and the Joint Centre for Disaster Research (JCDR) hosted at Massey University was proposed to explore novel and creative ways of communicating these natural hazards. An open call was put out for student applicants to undertake this research, based within the Massey University School of Design. My position as a designer, a researcher, and a member of an affected community gave me a unique perspective from which to explore this issue of low understanding of tsunami risk. I was selected to carry out this research as a 1-year Master's of Design (MDes)[3] project by the selection panel from JCDR, GNS Science, and the Massey University School of Design. Though location was not specified in the project brief, I proposed a focus on my own home region, a place I consider my *tūrangawaewae*: translated as "standing place; belonging through kinship and whakapapa" (Te Ipukarea, n.d.e., Definition 1).

Tūranganui-a-Kiwa is situated close to the offshore Hikurangi tectonic plate boundary, potentially the largest source of earthquake and tsunami hazard in Aotearoa (East Coast LAB, n.d.). As well as the possibility of locally generated tsunami, the area is vulnerable to tsunami generated regionally and from more distant sources around the Pacific Rim. In my community, we live with a general background awareness of our vulnerability to tsunami; I have experienced tsunami warnings first-hand. However, Dhellemmes et al.'s (2016) research found that coastal communities have high expectations of receiving a formal warning to evacuate in the event of a tsunami even when no official warning is likely. For instance, for a tsunami expected within an hour, 73% of respondents expect to hear "warning sirens" and 74% expect "radio or TV announcements", compared to just 53% who expected to be warned by "feeling an earthquake". In some circumstances there would not be time for a warning through official channels, and communication from the media would not provide the community with enough notice to protect our *whānau*,

3 An MDes is a Master of Design postgraduate degree considered equivalent to MA or MSc degrees in other disciplines. It is completed by thesis, which incorporates a "design response" (such as a prototype product) and a written exegesis. Master's of Design research titled *Niho Taniwha: Communicating Tsunami Risk. A site-specific case study for Tūranganui-a-Kiwa* and is available online at http://nihotaniwha.makinggood.design/

hapū, and *iwi*[4]. In addition, over 70% of the respondents indicated that they "talked about tsunami" at a frequency of "never" or "once per year or less" and over 86% of respondents "get information about tsunami" at the same frequency. These findings suggest that the current communication centred around the "long or strong, get gone" message (NEMA, n.d.) is not resonating sufficiently with communities for them to fully register the information and provoke dialogue. These findings aligned with my personal experience in Gisborne (a large town in Tūranganui-a-Kiwa).

Research Approach

Indigenous knowledge. My research embraces a shift from western knowledge frameworks towards an indigenous knowledge approach in which Māori values, customs, and indigenous perspectives must inform the basis of research that involves Māori communities. Indigenous peoples share a long-standing connection to their land, community, and natural environment that is maintained through an understanding of practices of belonging, knowledge, and responsibility (Wilson, 2008). Western knowledge is separated into distinct categories such as science, art, and religion, with disciplines disconnected from each other and privileged for this specificity, individualised authorship, and stratification within distinctly western values (Wilson, 2008). Indigenous knowledge on the other hand springs out of the integration of those areas and maintains inter-relationships that reflect a holistic understanding of the world. Pihama et al. (2015) give an example from their own cultural knowledgebase that indicates science and culture are not separated. They describe the navigational expertise of tūpuna Māori who travelled across the Pacific Ocean, highlighting a strong understanding of water-related sciences like ocean swells, tides, and sea movements. Māori have generated different names for these phenomena that tell people about the myriad characteristics, shapes, and nature of an energy that can uphold life but also bring destruction (Royal, 2006). This energy, with all of its forms, moods, and expressions, is known as *Tangaroa*[5].

Through narrativised knowledge, Tangaroa, a *kaitiaki* (guardian) of the ocean is considered an *atua* (ancestor or spirit). Atua have personality, a spiritual self, and a genealogical network where aspects are employed for describing relationships, situations, and events in order to transmit knowledge in memorable ways. These stories assist in passing on information about tasks such as fishing, navigation, and seasonal planning. Within a wider understanding, these narratives bind, link and inter-relate both the land (the underlying sea beds and the continental shelves) and all marine and bird life to the environment and further beyond into the cosmos. In a further example, Hikuroa (2017) shows that Mātauranga Māori can codify risk through *pūrākau*, a traditional form of Māori narrative containing philosophical thought, epistemological constructs, cultural codes, and worldviews (Lee, 2009). They encapsulate and condense into easily understood forms Māori views of the world, ultimate reality, and the relationship between the atua, the universe, and humans. In traditional Māori society, pūrākau were important for teaching, learning, and intergenerational transfer of knowledge (Hikuroa, 2017). Hikuroa gives the example of a *taniwha*[6] in the form of a *ngārara* (lizard) at Waitepuru stream in Eastern Bay of Plenty, which flicks its tail from side to side. Hikuroa (2017) explains how there are simultaneous literal and metaphorical strands to the story: allusions to geomorphology in terms of the placement of the taniwha in relation to the river course and the flicking tail suggesting hazards around the stream. As a result, the pūrākau intertwines and codifies knowledge about both geomorphology and disaster risk reduction. Therefore, an indigenous paradigm comes from the fundamental belief that knowledge is relational (Wilson, 2008). Considering research as relational entails understanding not only these interrelationships, but how research is formed, planned, and carried out.

Community and place-based knowledge. King et al. (2007) suggest that allowing the community to share responsibility for their response to an unfolding crisis opens up new opportunities to raise awareness. My research sought to uncover this potential and to bring to the fore bodies of local knowledge that could inform a response pertinent to the local context and the community's need to raise tsunami awareness. Encouraging community participation is not in itself novel. The disaster risk reduction (DRR) field, especially in a development context (Le De et al., 2015), has looked to community knowledge to bolster DRR planning, utilising tools such as participatory mapping (Cadag & Gaillard, 2012). There are also examples of DRR seeking to

4 *Whānau*, *hapū*, and *iwi* are Te Reo Māori terms that describe tribal groupings. The largest is iwi, which is often translated as people or tribe (Te Ipukarea, n.d.a). Hapū is a smaller social grouping or clan that forms a subsection of an iwi while whānau refers to extended family groups (Taonui, 2005).

5 *Tangaroa* is sometimes described as god of the sea (Royal, 2006).

6 *Taniwha* is translated as "water spirit, monster, dangerous water creature, powerful creature. Regarded as guardians by the people who live in their territory but may also have a malign influence on human beings." (Te Ipukarea, n.d.c., Definition 1).

integrate indigenous knowledge (Mercer et al., 2010). Design also has a long legacy of community participation, with Participatory Design emerging in Scandinavia in the 1970s, starting from "the simple standpoint that those affected by a design should have a say in the design process" (Bjögvinsson et al., 2012, p. 103).

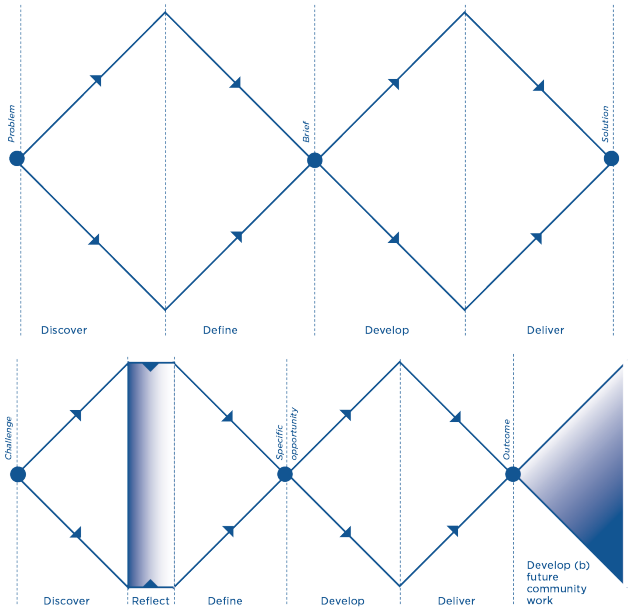
I recognise these schools of practice as knowledge threads that informed me but situate my approach in a different context. I was guided by Mātauranga Māori (through my own indigenous perspective and engagement with scholars and community) alongside Human-Centred Design methodologies (Baker III & Moukhliss, 2020; Giacomin, 2014). My training as a designer incorporates co-design methods (Sanders & Stappers, 2008) to build empathy with my community around shared experiences of tsunami warnings. In different ways, both Mātauranga Māori and Human-Centred Design emphasise intricate, holistic, and interconnected relationships between people and their environments. This blending of approaches helped the underlying problems affecting tsunami awareness and preparedness in Tūranganui-a-Kiwa become visible to me.

Human-Centred Design. Human-Centred Design is an integral part of *design thinking*: a problem-solving approach which reduces a number of broad design methods into a framework for addressing novel challenges in a variety of settings (Baker III & Moukhliss, 2020). Key to Human-Centred Design is "involving and centring the design process around observed and inferred user needs" (Baker III & Moukhliss, 2020, p.309).

Human-Centred Design is grounded in empathising with and understanding the needs and insights of the people for whom the designer is designing, to bring clarity to the underlying problems affecting their communities or the situation that an individual may inhabit. This provides the opportunity for designers exercising a Human-Centred approach to drive creative thinking and offer innovative proposals relative to the situation being considered. The core value of Human-Centred Design recognises that the "people who face those problems every day are the ones who hold the key to the answer" (IDEO, 2015, p. 9). Human-Centred Design is not a one size fits all process, nor is it perfectly linear. Each project brings different perspectives, context, and knowledge that in turn navigates its own contours and character, diverging and converging (IDEO, 2015) as knowledge and ideas are gathered, synthesised, iterated, and refined.

Figure 1

The Double Diamond Model



Note. The top model shows the standard Design Council (n.d.) "Double Diamond" model while the other model is the adjusted version used for the design process in this research project.

I used the Double Diamond model (UK Design Council, n.d.) to structure my design process. The model has four phases: Discover, Define, Develop, and Deliver. In essence, the first diamond is about understanding the issue to identify the problem while the second diamond addresses the ways solutions could manifest. It is necessary to go through the process of the first diamond to offer solutions to the right questions. The Double Diamond framework, presented in Figure 1, was adapted in this research to better understand my audience by taking the time to build stronger relationships and connections with them. The Human-Centred Design process, underpinned by Mātauranga Māori, manifested in this research with the activities presented in Figure 2.

Process

Design Process: Discover

My initial focus was to understand the most recent advice from emergency management experts regarding tsunami hazard and risk at the Hikurangi Plate Boundary and the communication currently carried out by stakeholders such as East Coast LAB and Te Tairāwhiti Civil Defence Emergency Management (CDEM).

Multiple communication methods inform the public of tsunami risk in Aotearoa; there is a need to integrate expert knowledge sources (via mass media

Figure 2

Phases of the Double Diamond

Discover	Define	Develop (a)	Deliver	Develop (b)
Broad phase of secondary research on risk communication, local tsunami risk, extant tsunami awareness and Mātauranga Māori perspectives on tsunami risk. Gathering data and insights that will inform the rest of the design process. Connection with scientists,emergency management and indigenous knowledge experts.	Questionnaire to identify potential participants and broad themes for subsequent phases disseminated through whānau and civil defence networks, leading to kanohi ki te kanohi (face-to-face) semi-structured interviews. Synthesis into 'personas' (composite people to define audience attitudes and needs) to frame the design challenge.	Co-design workshops with the community to generate ideas through participatory asset mapping, sharing stories, and building narratives, and initial design development.	Development of the pouwhenua and initial presentation to Te Tairāwhiti CDEM.	Possible future work with communities to bring the pou back for further conversations.

Hui with indigenous scholars | *Interview data collection* | *Co-design workshop* | *The pouwhenua output* | *Back to Tūranga*

communications) with informal social interactions (e.g., conversations with neighbours). The importance of doing so recognises that local sources of information typically resonate better with the public because they are more personalised (Brenkert-Smith et al., 2012).

The Tūranganui-a-Kiwa region of the East Coast is close to the plate boundary between the Pacific and Australian tectonic plates. Being a subduction-type plate interface, this area has the potential to produce large earthquakes and associated tsunami. Furthermore, the East Coast of Aotearoa is exposed to tsunami generated from around the Pacific Rim (Borrero & Bosserelle, 2019). Current local messaging from Te Tairāwhiti CDEM, informed by tsunami inundation assessments (Borrero & Bosserelle, 2019) and modelling (Power et al., 2016; Power et al., 2018), specifies that the Tairāwhiti region "is vulnerable to tsunami of any size at any time" (Gisborne District Council, n.d., para 1) and highlights that a tsunami may be local, regional (e.g., Kermadec Islands, with around an hour of warning), or distant-source (e.g., originating near Chile or Peru, with around 11 to 15 hours warning). Public advice follows the national "Long or Strong, Get Gone" messaging (NEMA, n.d.), with Te Tairāwhiti CDEM emphasising to "use the natural signs as our warning, self-evacuation is the only option" for a locally generated tsunami. This messaging is available via print materials and online (including social media). In terms of communications that utilise a specifically creative approach, incorporating indigenous knowledge, Hawke's Bay Emergency Management Group developed a children's book called *Rūaumoko's Walk* to communicate the importance of knowing the natural warning signs of tsunami (Andrews & Graham, 2014). *Rūaumoko's Walk* is a bilingual (English and Te Reo Māori) book based on Ngāti Kahungunu legends relating to local hazards. It utilises a Māori understanding of the relationship between earthquakes and tsunami whilst highlighting the actions needed to get to safety through storytelling.

The research that catalysed this project and articulated the problem I was seeking to address was the June 2015 survey undertaken by GNS Science and the JCDR (Dhelemmes et al., 2016). This survey provided some indication of how Tūranganui-a-Kiwa perceived tsunami risk. Coastal communities along the East Coast

of Aotearoa appeared to have low levels of tsunami awareness and high expectations of receiving a formal warning before evacuation. Quantitative and qualitative data highlighted that even though residents understood they lived in a coastal community prone to tsunami, they were not necessarily prepared for a tsunami situation. In particular, the data collected from Wainui, a suburb in Tūranganui-a-Kiwa, identified that although residents expect an earthquake to warn them of a local tsunami (the key message of recent civil defence campaigns) there is still a large proportion of residents who rely on a mixture of communication methods like radio and TV announcements, word of mouth, and warning sirens. A qualitative study with the community of Pauanui on the Coromandel Peninsula of Aotearoa identified similar behaviours to Tūranganui-a-Kiwa (Couling, 2014). Pauanui participants relied heavily on receiving a formal warning (via sirens) in response to the 2009 Samoa tsunami and did not have an accurate perception of tsunami risk or an understanding of the appropriate actions to take.

Risk communication generally has evolved to focus on enhancing conversations between technical experts and publics with the purpose of communicating hazards and managing risk in ways that are easy to understand. This mirrors the general shift in science communication from top-down *deficit model* communication to dialogical approaches that enable informed decision-making by the audience: "the gradual shift in policy discourse from keywords such as 'popularisation' and 'public understanding of science' to 'dialogue', 'engagement' and 'participation'" (Bucchi & Trench, 2008, p.3).

Having developed a sense of the communication landscape and the needs highlighted by Dhellemmes et al. (2016), I shifted to focus on understanding Mātauranga Māori perspectives in relation to tsunami through pūrākau. King and Goff (2010) highlight written records that tell of destructive waves caused by taniwha that endanger the lives of people in coastal communities. Although taniwha in these stories appear to be hostile, McFadgen (2007) considers them to be neutral and only aggressive when described in pūrākau involving events that cause damage or fatalities. King and Goff share that taniwha were usually associated with areas of risk and were used to explain natural hazards like a rapid in a river; pūrākau of these taniwha were told as a warning. I began to look into the history of my own iwi in search of localised tsunami pūrākau, including "Te Tai o Ruatapu", which describes how Ruatapu sent great waves to destroy his half-brother Paikea after being shamed by his father Uenuku (Taumaunu, 2001). However, as much as I appreciated researching this pūrākau in academic texts, I felt the need to talk to local people to acknowledge their specific perspectives relevant to their iwi's understanding of the narrative. I sought to connect with local experts about "Te Tai o Ruatapu" using my own whakapapa connections but found that, because I was still in the discovery stage of my research, I had not laid a strong enough foundation. This highlights that just because I am Māori and whakapapa back to Tūranganui-a-Kiwa did not mean I would be immediately accepted, or have an understanding at an acceptable level, to research iwi pūrākau. As a result, I decided to stay open to the idea of pūrākau but steered towards understanding new narratives that could be developed by a community to understand tsunami risk.

Design Process: Define

The Define phase aimed to synthesise the learnings from the Discover phase with my own qualitative primary research in the Tūranganui-a-Kiwa community. The target audience for this research originally included all of Te Tairāwhiti, but through conversations with Te Tairāwhiti CDEM, I found that smaller communities along the East Coast were already seen as exemplars of self-policing (P. Stuart, personal communication, 2017). Rural communities are exposed to events like road closures, flooding, or being cut off from power due to severe storms which has required them to take extra steps to prepare for such events. This insight led to a closer focus on the urban community.

Initially, I used a questionnaire sent via my whakapapa channels, social media, and Te Tairāwhiti CDEM. The questionnaire was titled "Local Hazards in your Local Area" so that tsunami was not prompted as the initial focus and was used to give me a broad view of my community's perspectives on natural hazards to help inform further interactions. The questionnaire also functioned as a way to locate and screen participants for more in-depth discussion, ensuring a range of awareness and preparedness, demographics, and geographic locations were included in my interview range.

I conducted 12 *kanohi ki te kanohi* (face-to-face) semi-structured interviews to offer a qualitative dimension to complement the existing research and my questionnaire. These were held at a café close to one of Tūranganui-a-Kiwa's well-known beaches, providing a space that was comfortable and familiar for my interviewees but also had relevant meaning to my interview questions. Common themes that came out of the interviews included:

– Low levels of understanding of the different types of tsunami (local, regional, and distant source).
– Confusion around how strong an earthquake needs to be before evacuating for a tsunami.
– Strong emphasis on waiting for a formal warning before evacuating, mostly from Ngati Porou Radio station, Te Tairāwhiti CDEM, or "the siren".
– National messaging did not resonate with respondents because it lacked context to Tūranganui-a-Kiwa.
– When presented with images of CDEM campaigns, participants wanted to know more about the effects tsunami could have on their own region and what they needed to do to prepare[7]. They were more interested in local knowledge as opposed to general messages on the TV.
– There is a lack of urgency to react to tsunami warnings because past warnings have not resulted in a discernible tsunami, so are viewed as "false warnings".
– Local narratives provide an effective way of understanding natural hazards specific to this community, land, and place.

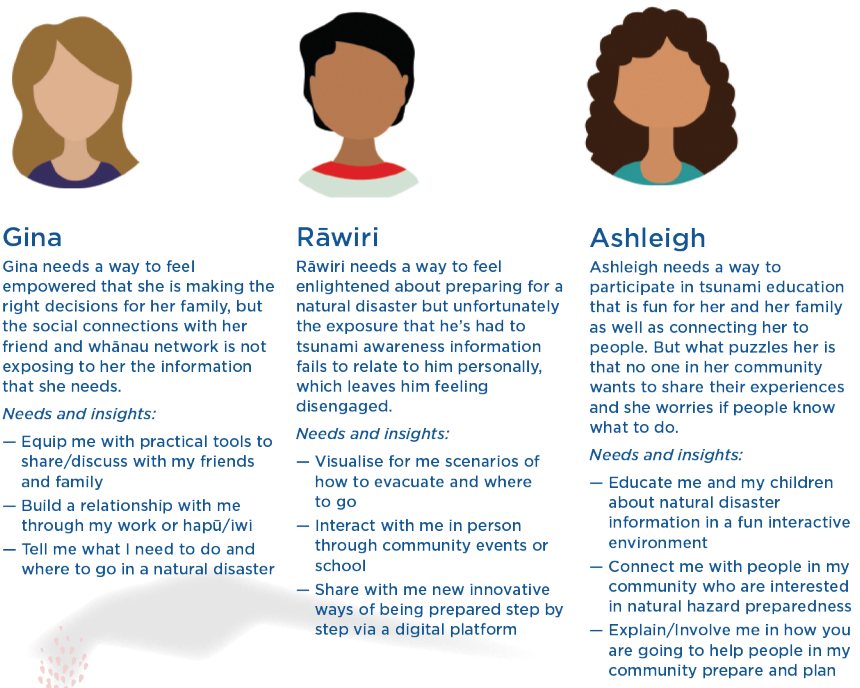
7 Subsequent to my research, granular local inundation and evacuation maps informed by the latest tsunami inundation assessment, (Borrero & Bosserelle, 2019), with safety zones for local and distant tsunami, were produced and disseminated (Gisborne District Council, n.d.). This may go some way to equipping the community with the local situational knowledge they sought.

As well as providing specific local insights, the interview responses were synthesised into three personas (Martin & Hanington 2012, p.132): "Gina", "Rāwiri", and "Ashleigh" (Figure 3). These are composite fictionalised people with associated behaviours, wants, needs, and attitudes representing identifiable groups within the community (Open Design kit, n.d). The process of developing personas and associated problem/insight statements helped me to identify with the community of Tūranganui-a-Kiwa and keep them in mind throughout. Through this process, I also framed a series of *how might we* statements (Open Design kit, n.d). These are designed to suggest that a solution is possible without proscribing a particular answer, so they act as a "frame for innovative thinking" (IDEO, n.d., para 1). These included:

– How might we create relatable content for youth using visuals and technology to increase tsunami awareness?
– How might we encourage the community to share experiences of tsunami preparedness through family orientated activities?
– How might we empower whānau and friends to build relationships with their iwi/hapū/whānau as an entry point to discussing tsunami preparedness and awareness?

Figure 3

Distilled Personas Based on the Interview Process



Note. These personas centre wants, needs, and attitudes rather than demographics.

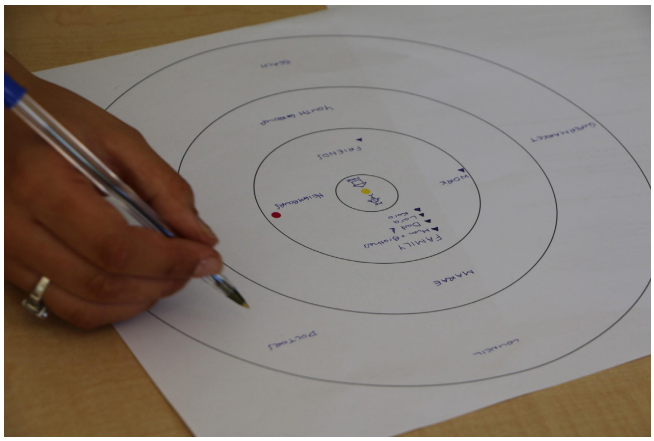
Design Process: Develop

This phase utilised co-design workshops where I encouraged people to share their stories and experiences by mapping them to their local environments. In the workshops there were three activities to generate ideas for design responses: participatory asset mapping, sharing stories, and building narratives.

Participatory asset mapping. Participatory asset mapping combines *participatory mapping*, where community members geographically identify their own people, places, and experiences, with *asset mapping*, identifying community assets like behaviour, knowledge, and skills that support resources for individuals and collective groups in a community (Janice et al., 2012). Participants were asked to illustrate a tsunami warning response by documenting important

Figure 4

Participatory Workshop: Asset Mapping



locations, people, and places that could inform their decision making. For example, the centre circle (see Figure 4) communicates the most important people, places, and/or experiences to consider when responding to a tsunami warning. The outer circles are important to consider but may not be crucial when preparing for a natural hazard event. Participants were encouraged to share their asset maps in a group to discuss how they would respond to a tsunami event and individual maps were combined. This generated considerable discussion between participants and visualised areas of importance as well as whānau structures and how these needed to be incorporated into planning for a tsunami emergency.

Sharing stories. In the second exercise I invited the community to share their experiences with earthquakes and tsunami warnings using story cards, colour-coded by theme for earthquake, tsunami, time, and response (see Figure 5). The colour system was used as a way to break down the information collected during the sharing process and in the analysis phase where I could step back and see the coloured trends. The purpose of this exercise was to share people's responses to earthquakes and tsunami through a directed storytelling process (Martin & Hanington 2012), and to gather insight into whether or not participants were aware that a local tsunami could be triggered by a local earthquake and could require an evacuation response time of less than 15 minutes. Story cards were then added to a map of the Tūranganui-a-Kiwa region, which acted as a canvas for contextualising my participants' stories.

Building narratives. Participants were asked to build tsunami communication structures using printed words that I had gathered through my research process to prompt conversations about design, science, tsunami, and local knowledge (see Figure 6). The idea of discussing narratives and "layering" tsunami/earthquake experiences using physical materials (e.g., cardboard boxes, words, papers, and pens) let the participants

Figure 5

Participatory Workshop: Story Cards

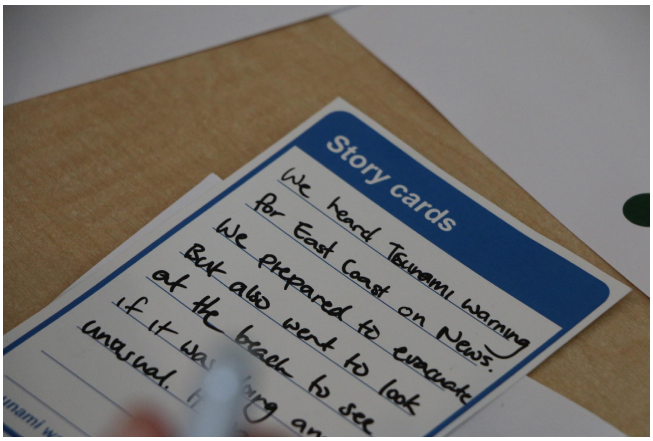


Figure 6

Participatory Workshop: Building Narrative Structures

build speculative tsunami communication prototypes. The layering process builds on my understanding of whakapapa: layers of generations and information. Prompting participants with a selection of pre-selected words helped centre conversations around topics such as tsunami, earthquakes, preparation, geography, and whānau. Participants were also encouraged to write their own words and to use only what felt relevant to them.

Each group contributed, discussed, and negotiated ideas, building their own tsunami communication structure while sharing and extending their own knowledge. As the facilitator, I encouraged each team to utilise the data collected in the previous exercises to drive the rationale behind their designs. At the end of the exercise each team reflected back to the group their own ideas. Concepts that were captured in their tsunami communication structures included:

– Different stages of responding to a tsunami event represented in the different levels of the structure: Confusion (low) > Organised (medium) > Connected (high);
– Navigation by an alert and showing directions;
– Using light as a beacon;
– Community engagement through schools and acknowledging local knowledge;
– Communicating information by using the structures to talk to one another;
– Colour to identify which area of risk you are in (e.g., safe or danger zones);
– Embedding scientific information in the structures; and
– The idea of sound and colour is connected to atua (e.g., the cracking of Rūaumoko, the Māori ancestor/atua of earthquakes and volcanoes).

Collaborating with my community through co-design enabled this research to develop meaningful new narratives. Just as importantly, the workshops themselves enhanced community conversations about tsunami risk in Tūranganui-a-Kiwa, which in itself is a valid and useful tsunami risk communication exercise.

Design Process: Deliver

Pouwhenua. Participants in the workshop sought to utilise local knowledge, beacons of light, and atua in their structures to communicate tsunami risk. They continued to discuss the importance of the whenua and their relationships to it; *kaitiakitanga* (guardianship) as a principle for tsunami communication emerged. This manifested in their ideas to illuminate structures with light (beacons) that navigate you to safety like a *kaitiaki* (guardian, steward) or an atua. My participants' connection to the land and their own whakapapa and understanding of kaitiakitanga are embedded in the structures they created. Local knowledge and the concept of atua and beacons of light became central to my pouwhenua prototype as well, evolving and amalgamating their knowledge and expression with mine as part of the iterative design process. The workshop exercises encouraged me to explore pouwhenua, which in Māori tradition are boundary markers or land

Figure 7

Pouwhenua Light Installation

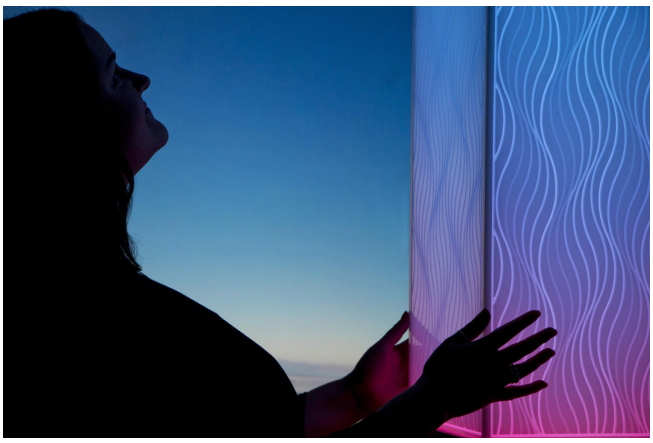
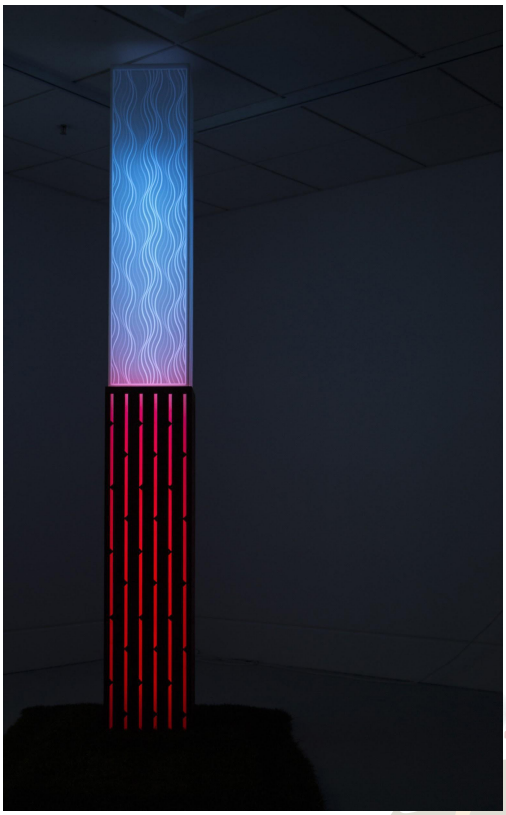


Figure 8

Pouwhenua Light Installation



posts denoting areas or territory. This, I felt, could be extrapolated to denote safe and unsafe zones for tsunami risk. As a result, the design, an interactive sculptural pouwhenua featuring light and pattern, emerged in response to the knowledge from the development process (Figures 7 and 8).

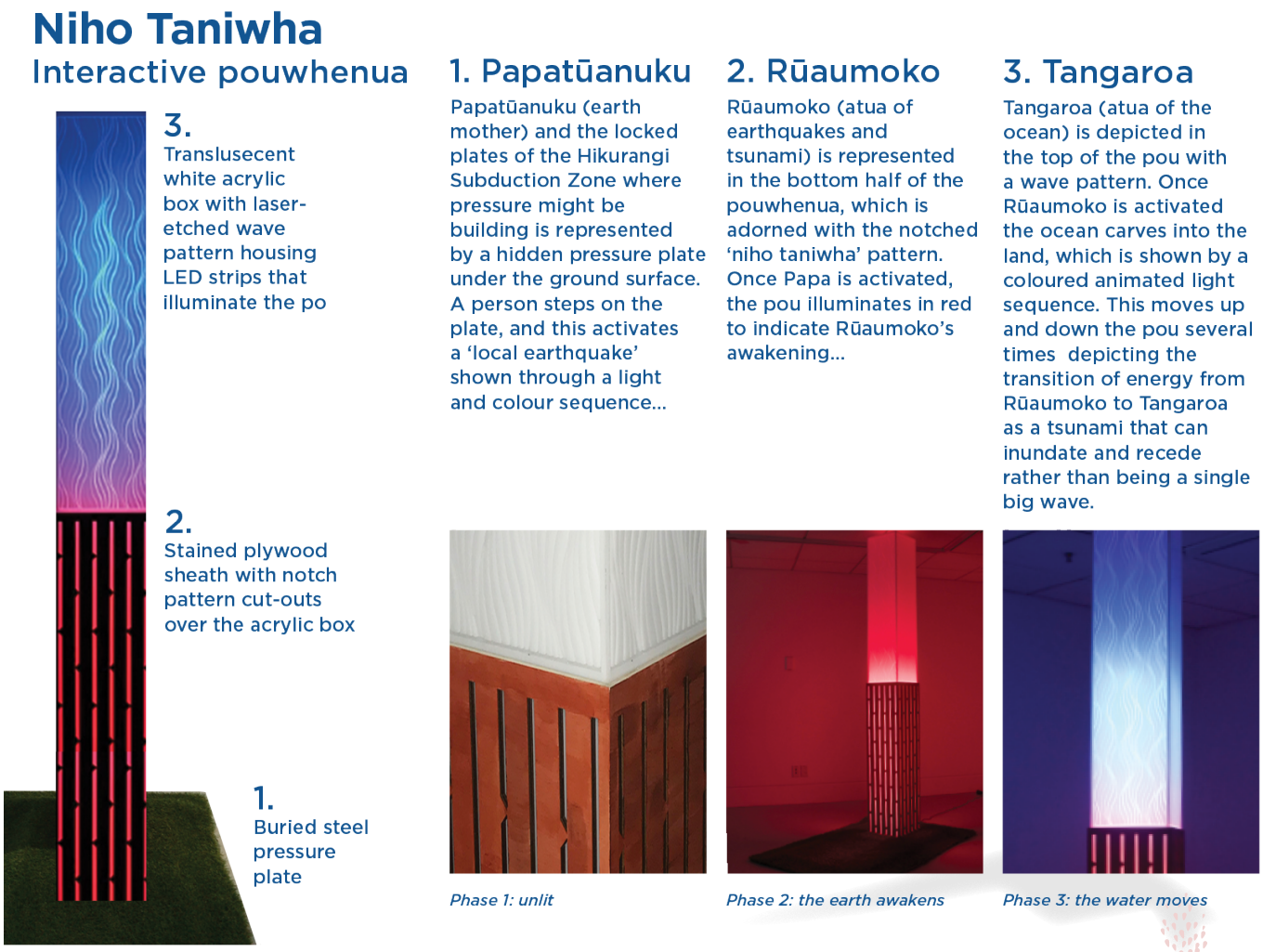
In Māori tradition, Papatūānuku (or "Papa") is the "earth mother". Tangaroa and Rūaumoko, atua of the ocean and atua of earthquakes, are two of her children. These atua are reflected in the narrative of my pouwhenua that recognise Papatūānuku as the continental shelf with Rūaumoko and Tangaroa represented as the earthquakes and tsunami we have experienced in Te Tairāwhiti (see Figure 9).

Papatūanuku's relationship with the earth moving may refer to the Hikurangi Subduction Zone where the two plates are currently locked. When the energy and pressure is built up over time the release of that energy may be seen in large subduction earthquakes that could trigger a local tsunami. In the design of the pouwhenua, Papa is represented by a pressure plate under foot that activates a narrative of light when pressure is applied.

That narrative is the relationship between Papa's movement and the movement of Rūaumoko which causes Tangaroa to react. Rūaumoko is represented in the bottom half of the pouwhenua, which is adorned with the pattern *niho taniwha* ("The Teeth of the Taniwha"). In my initial research, I came across pūrākau that tell of taniwha being a metaphorical understanding of tsunami risk in coastal communities. Therefore the niho taniwha pattern embeds this Mātauranga into the pouwhenua,

Figure 9

Mātauranga Māori Articulated through the Pouwhenua



Note. This figure presents the three elements and states of the pouwhenua and their embedded meanings.

exposing the risks of earthquakes and their relationship to tsunami.

The upper half of the pou is Tangaroa's domain where I have used a wave pattern to signify the water carving into the land as a tsunami might do. The *mauri* (life force) of the pouwhenua is awakened when a person stands on the pressure plate, simulating how seismic forces may trigger tsunami in a real event. The release of energy becomes a metaphor for understanding the relationship between an earthquake and tsunami or the movement between Papatūanuku (shifting plates), Rūaumoko (earthquakes), and Tangaroa (ocean). The energy of Rūaumoko erupts from the bottom half of the pou with a red light (volcanic energy) that transitions into a blue light (ocean energy). The pou then cycles through that transition of energy from Rūaumoko to Tangaroa multiple times indicating that a tsunami wave can inundate and recede numerous times.

Discussion

The aim of the design was to encourage people to interact with the narrative of the pou, to raise awareness and enhance conversation around tsunami risk. This pouwhenua is a passive communication reminder that is specifically connected to the whenua of Tūranganui-a-Kiwa. The pouwhenua embeds the knowledge that an earthquake is the warning for tsunami and utilises the narratives of cultural memory that are embedded in the whenua. This research shifts away from the design of a traditional pouwhenua by adding digital elements of light and interactivity triggered by pressure applied to a base plate in the ground. Tangata whenua can interact and visualise the energy and mauri of our atua, which brings a new meaning to the narratives contained in pouwhenua.

The pou was not a prototype in the sense of a model to rigorously explore technology, materials, or physical attributes, but rather a speculative prototype to discuss the idea of having community identify, generate, and weave narratives into a design response: in this case, a digital "sculpture" that could have a practical application as a signage device, or simply as a catalyst for conversation. From a design industry point of view, the artefact (and the process that "grew" it) were recognised with a gold "Best Award" from the Designers Institute (DINZ, 2018; Peters 2018). As part of the delivery phase the pou was presented back to the community at Te Tairāwhiti CDEM and to wider groups during its presentation and examination for the requirements of the MDes. During that process, conversations between participants, their whānau and friends, and also with the expert stakeholders suggested that the pou could act as a beacon around which talking about the narrative, observed and experienced through the interactive visual elements, could become a gateway to discussing preparedness.

The cultural base of this research was underpinned by three Māori principles:

– whakapapa (kinship),

– kaitiakitanga (guardianship), and

– tino rangatiratanga (self-determination).

These principles provided a framework for ensuring that, both culturally and ethically, the outcomes of this research were community driven.

My whakapapa to Tūranganui-a-Kiwa presented an opportunity to explore the local narratives of tsunami awareness and preparedness within my community. I learned that as a Māori design researcher, time was crucial to building relationships and whakapapa connections including with GNS Science, JCDR, Te Tairāwhiti CDEM, and other agencies that informed this project. Reflecting back on the design process, simply being Māori did not grant me access to be an insider as a researcher. In fact, my kinship and whakapapa to Tūranganui-a-Kiwa requires strengthening by forming healthy ongoing engagement with Māori in my community.

My approach to recognising the local knowledge of Tūranganui-a-Kiwa is not only examined in my Human-Centred Design process as a way of empathising and collaborating with my community but by Mātauranga Māori revealing that the stories shared on behalf of my community are *taonga*[8]. My role as a Māori design researcher transformed into the role of kaitiaki, the new caretaker of the narratives shared by my community, along with which goes a responsibility to uphold the *mana*[9] of the stories by protecting them and sharing them appropriately.

Limitations and Future Research

This project was undertaken as part of a 1-year Master's degree which led to challenges of time in relation to building the relationships of trust, respect, honesty, openness, and integrity that need to emerge through a

8 *Taonga* means treasure, to be of value including socially or culturally valuable objects, resources, phenomenon, ideas, and techniques (Te Ipukarea, n.d.d).

9 *Mana* is a supernatural force in a person, place, or object. Including but not exclusive to: prestige, authority, control, power, influence, status, spiritual power, and charisma (Te Ipukarea, n.d.b).

process of engagement, not via a regimented timetable. This is particularly relevant in Māori and other indigenous communities, and though my whakapapa connections may have opened doors, they did not afford me the right to do this work without first establishing these relationships. This time limitation has meant that follow-up activities with the community have been limited, though the pouwhenua has been gifted to JCDR as a beacon and conversation catalyst for future work.

Having undertaken a process with community participants who were a cross section of Māori and *Pākehā* (a non-Māori New Zealander), it was clear that not everyone had a shared cultural environment. In the workshops, Māori participants shared stories and explained to non-Māori participants the relevance and meaning of, for instance, taniwha, and all participants talked about their relationship with specific places in Tūranganui-a-Kiwa. Through this process, new narratives based on the shared local context grew organically from the group in a way that was meaningful for them across cultural contexts. In terms of the pou as an object, further research might uncover if it remains meaningful when viewed from, or transposed to, a different context, a consideration that Witehira and Trapani (2015) discuss in a design context. Does culturally-specific design bring elements of universal value? Anecdotal feedback gathered from the CDEM stakeholders, and the recognition from the design community (DINZ, 2018), suggests that it does, though this is an area that warrants further research.

Conclusion

This research set out to acknowledge the diversity of perspectives within whānau, iwi, and hapū to produce meaningful and relevant narratives to enhance community conversations that raise awareness of tsunami risk. In risk communication, the need to integrate expert knowledge with informal social interactions to personalise information is well established (Brenkert-Smith et al., 2012). Therefore, the people of a community can be the central source of knowledge when it comes to designing new tsunami communication warning systems. Mechanisms like interviews, workshops, and *hui* (meeting or gathering) throughout this research enabled a space for my community to assert their own autonomy (tino rangatiratanga) and identified the need to integrate local knowledge into risk management for Tūranganui-a-Kiwa. *Manaakitanga* (hospitality) was key to encouraging my community to share their own responses to tsunami awareness and preparedness by using Human-Centred Design methods like asset mapping, story cards, and prototypes to facilitate conversations that support and showcase indigenous perspectives.

As a result, this design-led research proposed the idea of designing a pouwhenua that integrates Mātauranga Māori, local knowledge, and science related to tsunami. A narrative was built through an indigenous understanding of phenomena that tell people about the different forms, shapes, and nature of an energy and expressions that can be seen in a Māori understanding of atua (Royal, 2006). The atua represented in the final pouwhenua describe the relationship between Papatūanuku, Rūaumoko, and Tangaroa, or an earthquake triggering a tsunami, and that the shaking is the warning to evacuate.

Embedding a narrative that responds to traditional knowledge of place may transmit this knowledge in memorable ways. The final pou acts as a catalyst for further discussion and in turn can enhance community conversations that raise awareness of tsunami risk and inform new tsunami communications for Tūranganui-a-Kiwa. The process described here provides a template for how this approach could be employed and/or adapted elsewhere.

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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).

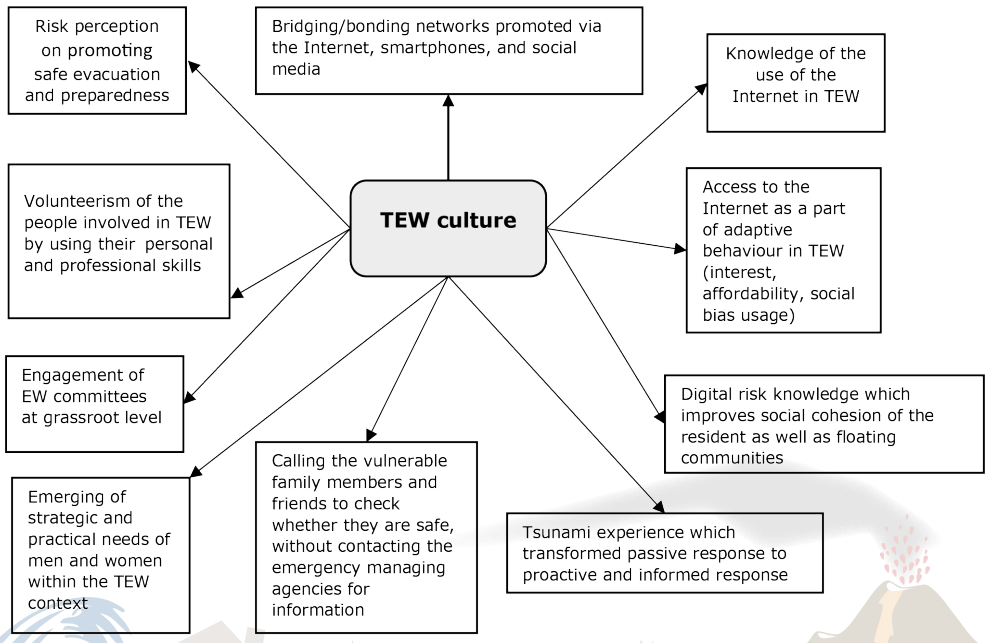
Gender equity linkages with TEW culture. Culture includes "knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by [a person] as a member of society" (Avruch, 1998, p.6). Culture is the learned behaviour of a group of people that generally reflects the tradition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

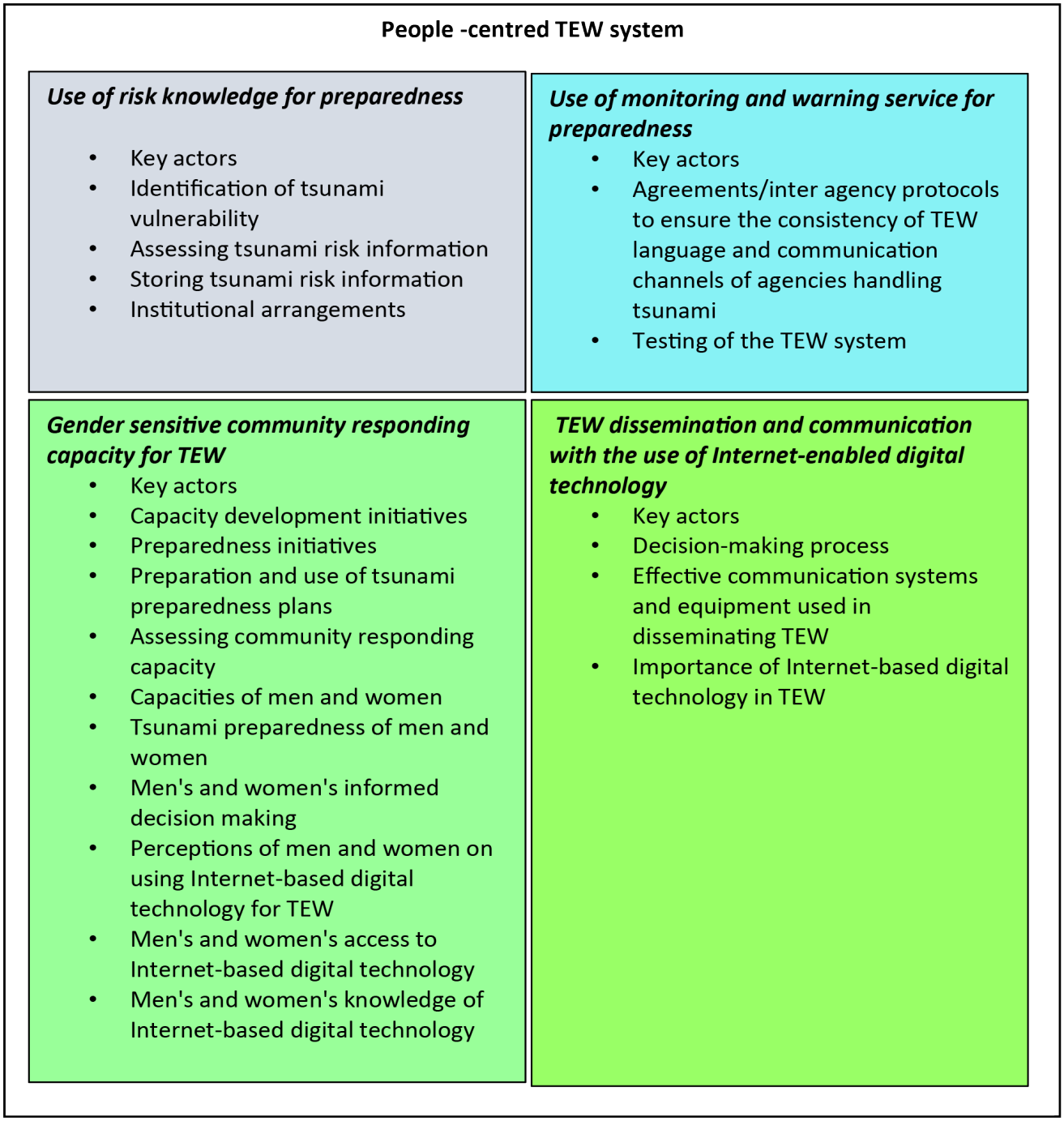
The third component of TEW is dissemination and communication, which typically only examines existing key actors and hierarchical decision-making processes. Therefore, in the present study, there is an examination of the third critical component of TEW systems: dissemination and communication using Internet-enabled 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),

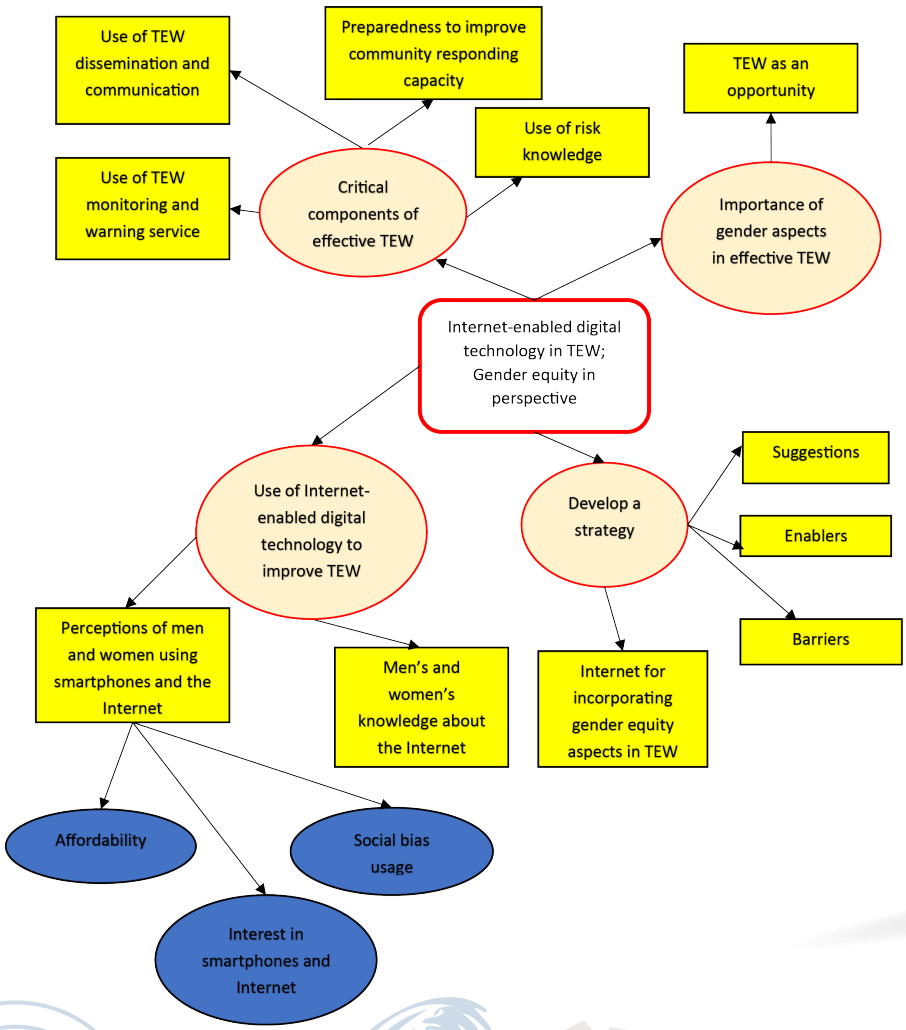
– Use of monitoring and warning service for preparedness (problems and strategies),

– 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;

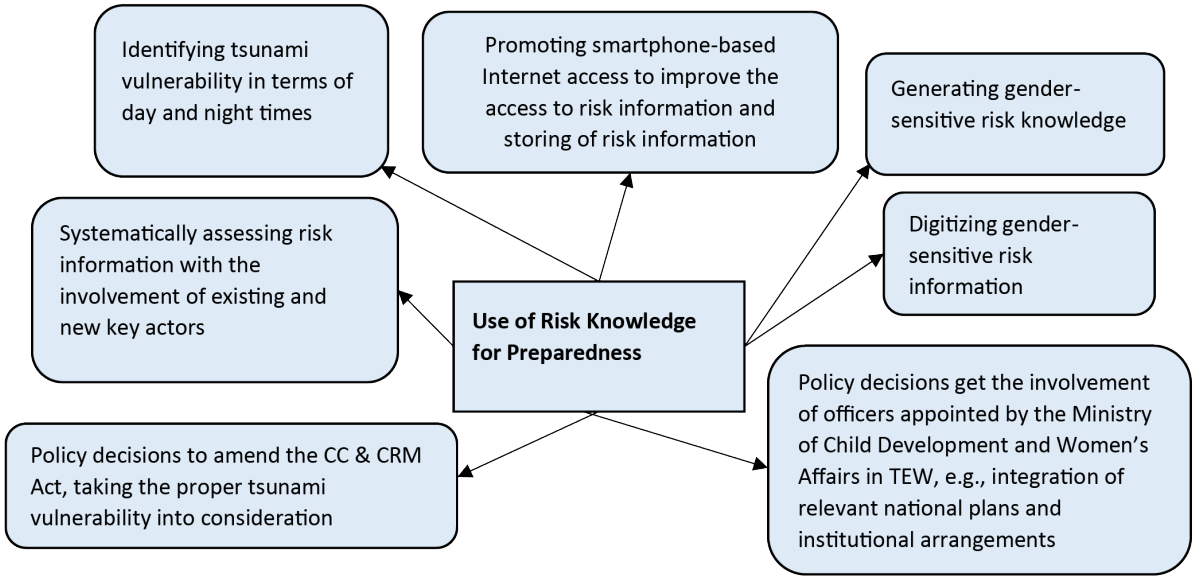
– no systematic monitoring and evaluation system to identify TEW needs, gaps, and measures to fill the gaps;

– 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

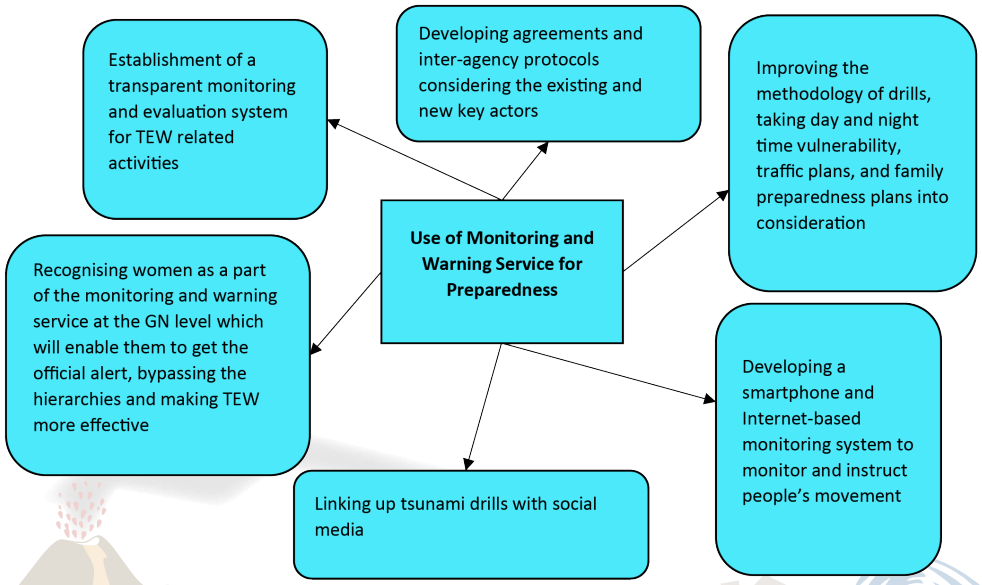


– networking capacity via social media not adequately recognised in TEW monitoring and warning; and
– not recognising women as key actors who are volunteering in TEW for monitoring and warning at the grassroots level.

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.

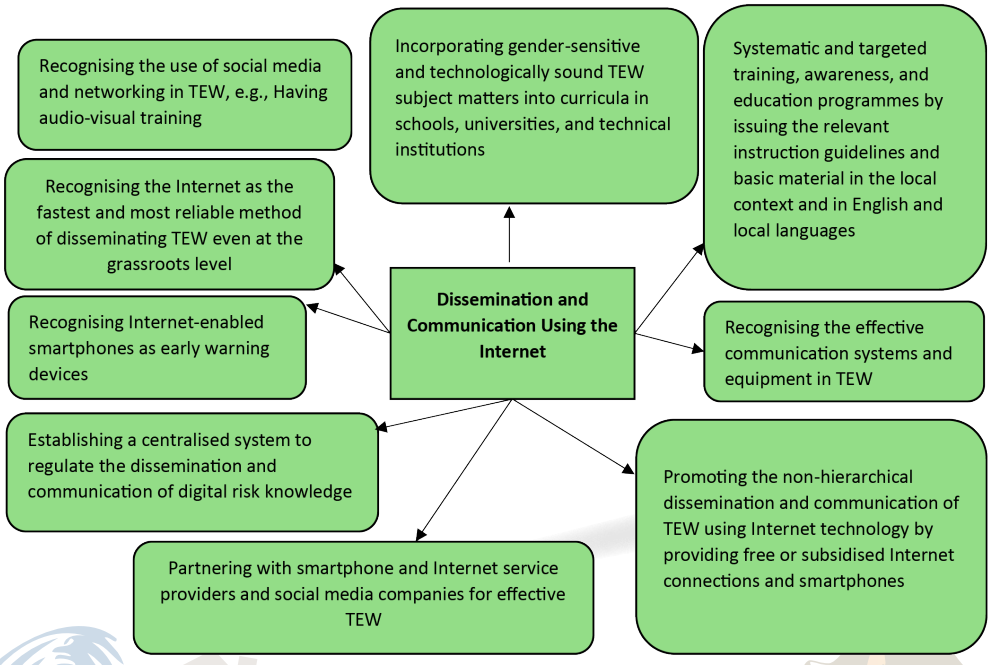
Understanding the importance of Internet-based digital technology in TEW for connectivity.

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:

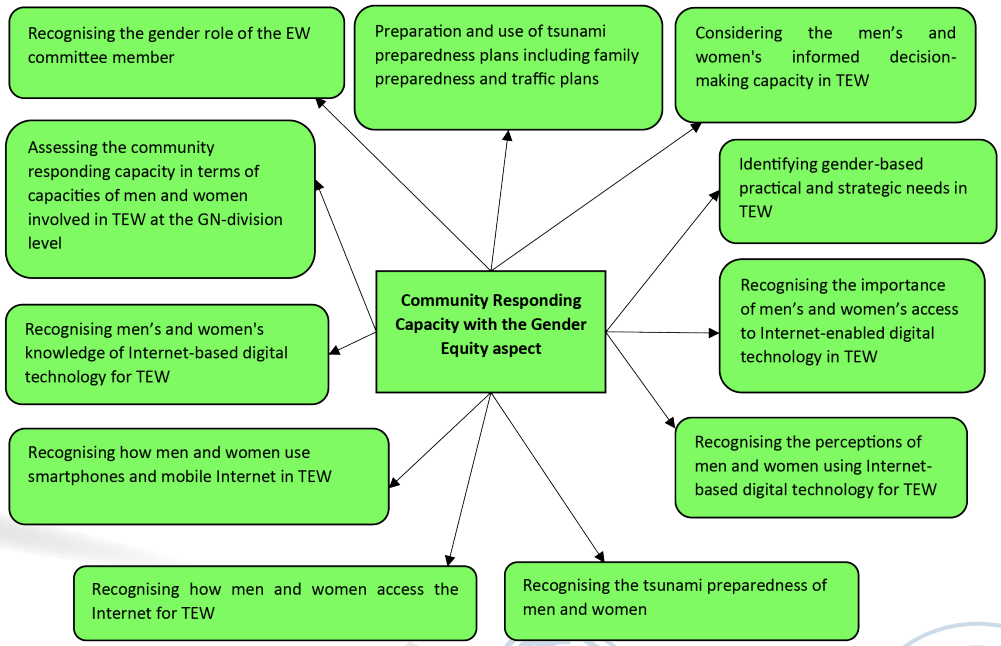
- no mechanism for preparing and updating traffic plans and family preparedness plans as a part of evacuation plans;
- no regular EW committee meetings at the GN level for improving community responding capacity;
- lack of experts in TEW to develop good gender equity-sensitive strategies to improve the 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.

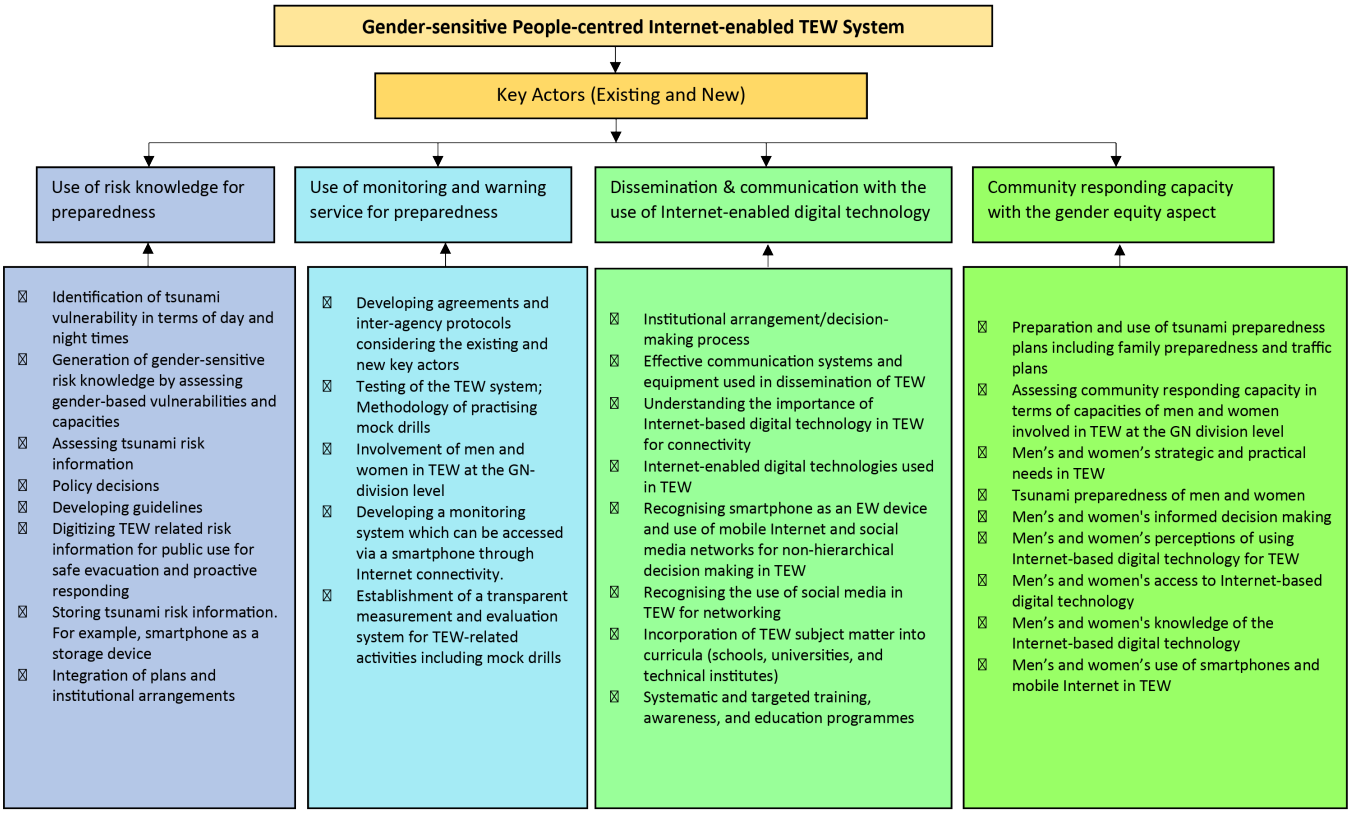
With reference to the use of risk knowledge for preparedness, the generation of gender-sensitive risk knowledge by assessing gender-based vulnerabilities and capacities is important. Furthermore, having digital risk information that can be accessed via the Internet can make TEW more effective. Integration 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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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 asses 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?

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