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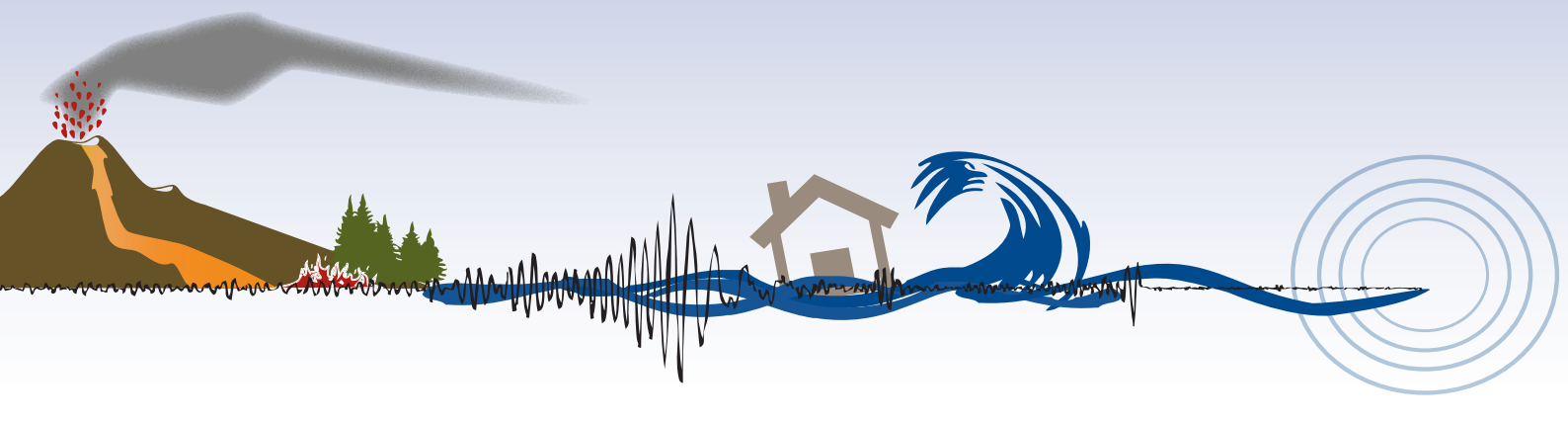

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"We were all heartbroken": Emotional wellbeing and healing after the 2017/2018 Manaro Voui eruptions in Ambae, Vanuatu

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Abstract

Disasters cause psychological harm and distress, yet assessments often overlook these impacts in favour of those more easily quantified and monetised. Few studies have, for example, explored psychological functioning of people during and after disasters in Vanuatu – globally the most at-risk nation to environmental hazards. This paper explores the emotional and psychological impact of the 2017/18 volcanic activity on Ambae Island, Vanuatu, and the subsequent evacuations. Drawing on interviews with eight Ambaeans, we explore experiences of loss and the associated feelings of fear, helplessness, distress, frustration, and anger. We also identify ongoing efforts by participants to cope and heal though return movements, reinstating a sense of normalcy, reviving cultural practices and community, environmental recovery, good leadership, and religion. Disaster preparedness, intervention, and recovery efforts must pay attention to local people's narratives of loss and distress and find ways to support the factors which enable coping and healing of at-risk populations.

Keywords: *Psychological health, disaster, environmental hazard, evacuation, healing*

Disasters driven by natural hazards – such as floods, earthquakes, tsunami, and volcanoes – are often large-scale and sudden events causing significant impacts (Bronfman et al., 2019; Norris et al., 2002). While disasters precipitate both tangible and intangible impacts, the impact of disasters is more commonly assessed by costs that are easily quantified and monetised. Although key intangible impacts such as those on mental health are a growing research area (Goldmann & Galea, 2014; Norris et al., 2002), they are often still given less attention and do not feature centrally in overall disaster impact assessments. In Vanuatu, for example, as the most at-risk nation globally to environmental hazards (Behlert et al., 2020), there have been few studies exploring psychological functioning of residents during and after a disaster (see exceptions: Dawes et al., 2019; Pomer et al., 2019). Studies on the psychosocial health impacts of disaster-induced displacements in low- and middle-income countries are also limited (Uscher-Pines, 2009).

Limited understandings of intangible impacts like these can distort our understanding of disasters, skew decision making (Magee et al., 2016), and hinder the development of adequate disaster preparedness policy and sustainable mental health services (Zahlawi et al., 2019). We draw upon eight semi-structured interviews to explore the psychological and emotional experiences of Ambaeans who were affected by the Manaro Voui volcano which, in 2017/18, entered a phase of activity characterised by eruptions, ashfall, lava flows, and acid rain, among other hazards (Moussallam et al., 2019). These led to the evacuation and displacement of the entire population of Ambae at two different times, in September 2017 and July 2018. The current paper uses interview accounts of the evacuation and displacement to more broadly illustrate the human impacts of these disasters.

Experiencing and Healing from Mental Health Impacts

A growing number of studies have documented locally-grounded experiences and impacts of environmental disasters on mental and emotional health. In their review of the current state of the literature, Goldmann and Galea (2014) identified the key displays of post-disaster mental illness as posttraumatic stress disorder (PTSD), major

depressive disorder, substance use disorder, and other psychological symptoms. Distress induced by volcanic activity and subsequent evacuations around the world has similarly manifested as generalised anxiety, major depression, and PTSD, with distress levels affected by factors including event exposure, gender, marital status, age, number of times evacuated, length of residency in risky areas, and type of psychosocial support received (Chen et al., 2001; Gissurardóttir et al., 2019; Goto et al., 2006; Kokai et al., 2004; Ohta et al., 2003; Shore et al., 1986; Zahlawi et al., 2019). Echoing cautionary tales from the broader disaster literature (e.g., Cernea, 1997; Oliver-Smith, 1991), studies focused on volcanic disasters also document the disempowerment and loss of autonomy that can occur as a result of displacement and relocation (Bowman & Henquinet, 2015; Connell & Lutkehaus, 2017b; Whiteford & Tobin, 2004). The impacts of displacement are a particularly important consideration in Pacific nations like Vanuatu where there are deep-rooted cultural and spiritual attachments to place, and land is often tied to identity and considered an extension of the "self" (Bolton, 1999; Gharbaoui & Blocher, 2018; Havea, 2007). Severing the physical, socio-cultural, spiritual, and ancestral connections to land can, therefore, significantly affect identity, wellbeing, community/social networks, and sense of place in the Pacific Islands (Barnett & O'Neill, 2012; Charan et al., 2018; Perumal, 2018).

In the context of the 2017/2018 evacuations from Ambae, one study indicated that women were disproportionately affected by distress and those without psychosocial support were at greater risk of distress (Zahlawi et al., 2019). We build on this work by bringing Ambaean voices to the fore and exploring their subjective experiences of resource loss and associated distress from disaster exposure and evacuation, while also outlining how healing has transpired for them. Experiences of loss are critical to document as resource loss – whether it is personal belongings, personal characteristics such as self-esteem, conditions such as marriage or employment, or energy such as time or money (Sattler et al., 2018) – is a primary determinant of post-disaster psychological outcomes. This is consistent with Conservation of Resources Theory, as outlined and explored in Hobfoll (1989, 2011), Benight et al. (1999), Freedy et al. (1992, 1994), and Sattler et al. (2014, 2018).

We also build on the growing evidence of people's resilience and strategies to heal after distress. In the context of Ambae and the volcanic eruption specifically, Zahlawi et al. (2019) emphasised that healthcare professionals and traditional community support networks together presented complementary pathways for support and healing. More internationally-focused studies that have examined a range of different disasters (e.g., natural hazards, war, colonisation) have also identified critical factors for healing, including religion (von Vacano & Schwarz, 2014) and communal and collaborative healing (Kuriansky, 2012) as well as collective revival of and participation in culture, cultural practices (Hill, 2014), and normal, everyday activities (Norris et al., 2002). Re-connecting with the natural environment and finding a sense of place can also be critical for healing and recovery (Cox & Holmes, 2000; Cox & Perry, 2011). Amongst studies that focus on volcano-induced displacement and evacuation, albeit not specifically in Ambae, it has been found that returning to, or retaining access to, home environments is critical for healing and recovery. This seems to satisfy a multitude of needs for evacuees: psychological, economic, material (Perry & Godchaux, 2005), spiritual, and/or cultural (Connell & Lutkehaus, 2017a, 2017b; Mercer & Kelman, 2010).

Study Site and Method

The Ambae volcano is a large basaltic shield volcano in Penama Province and, at 2,500 cubic kilometres and 1,496 metres high, is Vanuatu's largest (Bani et al., 2012) and potentially most dangerous (Cronin et al., 2004). After over a hundred years of quiescence, it entered a new phase of activity in 2017 characterised by eruptions, ashfall, lava flows, and acid rain, among other impacts (Moussallam et al., 2019). The entire population, nearly 11,000 people, was evacuated at two different times (in September 2017 and July 2018) as mandated by the Vanuatu government.

Eight semi-structured interviews (which were between half an hour and one and a half hours) were conducted in July and August 2020. There were five men and three women involved, all of whom had three or more children (except one who had none) and were aged between 19 and 61 (with the average age being 48). The livelihoods of participants varied, with many having more than one income stream. These included fishing, weaving mats, poultry, and selling crops or local food as well as being a building inspector, fieldworker, church or community leader, part of the Recognised Seasonal Employer (RSE) scheme in New Zealand, or retired. All participants were connected to Ambae, albeit with different backgrounds; some were born and raised there, while others moved there later in life to live with other family members or for work opportunities.

Epistemologically, we draw from interpretivism given our interest in people's social realities to reveal multiple perspectives and experiences. As such, we used a qualitative approach for its flexible and adaptable nature and ability to derive descriptive data, which is not as easily derived from quantitative approaches with rigid protocols (Holloway & Todres, 2003). The qualitative data allowed us to explore Ambaean perspectives and values, as well as to foreground their voices and nuanced experiences. The semi-structured approach to interviews allowed conversations to be flexible but also focused, to optimise knowledge production (Brinkmann, 2014). Conversations were also informal and relatively casual, to be compatible with the Pacific Islands context (Vaioleti, 2006; Warrick, 2009). It is critical to note here that our findings from these interviews are based on a small sample size and are, therefore, not representative of the experiences, perspectives, and values of all Ambaeans. By focusing on these eight participants, however, we were able to concentrate on deriving and sharing detailed, in-depth, and nuanced storylines and experiences of a few individuals. Future studies should build on and refine our findings through further exploration of Ambaean experiences, perspectives, and values around resource loss and distress from disaster exposure and evacuation, as well as coping and healing.

Researchers and practitioners from a local grassroots organisation, Further Arts, provided the critical roles of conducting interviews and selecting participants based on their existing networks as practitioners (i.e., with Ambaeans that they have worked with before). Given their established connections, it is likely that rapport and trust was high, enabling participants to tell their stories. All interviews were recorded and transcribed verbatim before being analysed through content analysis (Bengtsson, 2016) which enabled us to ascertain patterns and capture the essence of discussions through core themes and storylines. Meaning units (in the form of several sentences of spoken text) were gradually and repeatedly condensed and categorised, eventually becoming core themes and storylines which reflected a cluster of content that shared common underlying meanings (Graneheim & Lundman, 2004). The transcripts were explored multiple times to ensure that relevant text was not overlooked during the analysis process (Burnard, 1991). All participants gave informed consent to participate and the University of Queensland provided the ethical approval for the study (Approval number: 2020000640).

Results

Narratives of Loss and Distress

After the volcanic activity began in 2017, it "change[d] the mentality of the people" and created a sense of fear, helplessness, and stress among Ambaeans (Participant #6). This was often due to Ambaeans losing a sense of control and agency as well as being concerned for their futures:

> *…the volcano ash began to fall on us again. We started to feel bad and lonely and helpless to our children. We didn't know how we were going to save our kids* (Participant #3)

The extent of damage on livelihoods was extensive because "the ash fell on everything" (Participant #3). Ashfall blanketed infrastructure and destroyed basic resources, triggering feelings of stress, worry, and lack of control:

> *When the eruption occurred, our lives were damaged. Because it damaged all our plants, water sources, and food sources and destroyed our houses. It destroyed our living and leaving us very worried and questioning ourselves on how to survive like this* (Participant #4)

Despite already causing extensive loss, the volcanic disaster continued to intensify and threaten further losses. Participants and their families were mostly evacuated to the nearby islands of Santo, Maewo, Efate, and Pentecost. Being displaced for weeks to months at a time led to further losses and emotional distress. The immense distress caused by leaving "home" and losing a sense of place was very clear:

> *We all wept. The children wept and the women too. We were all heart broken. We all had fear in our hearts. We knew that we have lost our island and we weren't happy to go to other islands* (Participant #4)

> *When we left, our dogs cried for us like people were crying and so we didn't know what to expect and worry about. So, when we were evacuated to different islands, we think back to our islands, and we all know we have lost our island* (Participant #3)

Participants experienced a range of difficulties while displaced, especially in terms of acquiring resources: "…my people suffered. We didn't have food, money, or meat" (Participant #4). Some government support and financial aid was provided, although this support eventually ceased, leading to further distress. One community leader expressed that his ability to fulfill

responsibilities as a leader was compromised by the lack of support and recognition from external agencies, which generated feelings of hopelessness, anger, and frustration:

> *I really struggled to look after the people…The people were sad because…the money we were given [by the government] was finished and we haven't been eating meat… I went to the operation centre and settled with the NDMO [National Disaster Management Office] and asked them for help… But they ignored me... I was angry with the VMF [Vanuatu Mobile Force] and swore at them along with the Police* (Participant #4)

Further compounding distress during the evacuation was the way evacuees were treated by host communities on these nearby islands. This affected participants' sense of belonging and contributed to the deep yearning for home:

> *…most of our families were worried and wanted to return to Ambae because we were being ill-treated in these other islands. This makes us reminisce back to the stories of the refugees. And so, when I look at my people I remember in the olden days when the people were refugees and I tear up because it breaks our hearts* (Participant #3)

Distress also arose from the breakdown and fragmentation of social relationships because of the volcanic disaster and evacuation. Some participants expressed, for example, that the compounding effects of stress from losing livelihoods and security infiltrated family life where tensions grew and caused further distress:

> *Disputes and arguments grew in each home because there are risks…My wife and I argued a lot too in my home. Every day we argued. Many families fought for almost every minute an argument stirred up… I was so stressed I felt like I was gonna die* (Participant #4)

The displacement from home also resulted in breakdowns in a sense of community and togetherness. One participant explained the distress he felt from the fragmentation of his church community, which affected his ability to fulfil his role as a church leader:

> *Some of us moved to Santo, others to Maewo and some to Pentecost. When we were there, I felt bad and useless, I didn't know where all my extended families and church members were. Because everyone was scattered everywhere* (Participant #3)

It is, therefore, clear that the volcanic activity on Ambae and the subsequent evacuation resulted in a diverse series of resource losses: sense of control and agency, livelihood security, connection to land and home, ability to fulfil roles as leaders, and family life and sense of community. These losses caused significant emotional and mental distress.

Stories of Recovery and Healing

Participants highlighted numerous enabling factors and strategies for coping with and addressing impacts on emotional wellbeing. In times of crisis where people are fearful, it became clear that turning to religion and God was a key coping strategy that provided a sense of comfort and source of strength and security, especially while Ambaeans were being evacuated or were displaced from home:

> *So then we saw our children and women crying, we thought this was it for us. And during that time, many people who never prayed began to pray. Everyone turned to God and prayed for refuge and safety* (Participant #3)

> *The government told me that my people's lives were in my hands and I was okay with it because I knew God was on our side. Because even though we were in another island, but God brought us back to our home* (Participant #4)

Critical for coping and recovering from the impacts on emotional wellbeing was reinstating a sense of normalcy. This was achieved through several mutually enforcing aspects, although returning to Ambae was critically important. Returning to Ambae provided relief and hope of restoring (materially and symbolically) what had been longed for – home:

> *I had joy in my heart that I was returning home… we thank God for bringing us back… We wanted our old lives back* (Participant #4)

> *Wherever we were, we kept praying for our island back…now that we were back in our island, we felt safer and comfortable* (Participant #3)

Returning home and regaining a sense of place was central to providing hope and motivation. Repatriation was perceived by participants as their best chance of rebuilding livelihoods and futures, as well as renewing lost resources. Therefore, despite returning to destruction and the loss of important tangible assets such as housing, participants were not distressed but motivated to rebuild and recover instead:

> *We lost many things… some houses fell but we didn't worry. We only cared about the houses that could accommodate us until we could rebuild everything…*

After doing so, we saw that our lives were improving (Participant #4)

The importance of returning home and renewing important resources for healing was reflected in the dissolving of family disputes: "people beg[a]n to settle things in their homes" (Participant #4). This is not to say that returning home alleviated distress entirely. Despite longing for repatriation, fear around the dangers of the volcano lingered for some:

… because people have negative thoughts on the volcano and when we return [to Ambae] they do things with fear (Participant #2)

Once Ambaeans were able to return to Ambae, there were several other aspects that interacted to reinstate a sense of normalcy. Alongside regaining home and land, there was a central importance of coming together as a community to revive cultural and normal, everyday, pre-disaster practices. Reviving cultural practices and activities included, for example, "continu[ing] weaving and doing gardening" and "rebuild[ing] damaged houses so that we could teach, teach our language, teach our weaving and the loss we're encountering" (Participant #6). When asked what enabled a fast recovery, one female participant explained:

We talk inside the women's group, inside the church, inside the kava bar… that is why we recover so quickly…We learn the children have to play, dance and everything... We train inside to revive what has been lost, our traditional food, traditional knowledge, how to prepare food of a leader. So, we train inside the Nakamal [traditional meeting place] and to revive the other Nakamals... (Participant #6)

The importance of collective and communal efforts in general was also clear: "We work together to support one else in need for help and we do it like that" (Participant #2). Good leadership was also a related critical enabler of recovery and healing as leaders were perceived as important instigators of re-building a sense of community and unity once Ambaeans returned home:

…we have to revive it and place good leaders because leaders that turn their backs on us are regard as losses…they forget and damage everything in words, attitude which makes people feel bad about it so they don't cooperate together but with the attitude…to get us together and remove the risk that are affecting the community until we establish a foundation, our community will recover (Participant #6)

Participants also indicated how observing recovery in the natural environment of Ambae spurred their own recovery and healing, especially as, finally, "food wasn't much of our worry" (Participant #4):

One of the things I value here [in Ambae], ever since the eruption… has been an increase in the quantity of fish in the sea… Another one is, when you do gardening near your house, it really grows well (Participant #5)

Ambae has returned, it has not altered too much. One good thing that happened is that when you plant crops in this new soil, it grows better and bigger than before (Participant #3)

It is, therefore, clear that Ambaeans are not passive actors in the face of risk and crisis. They have a series of resources and strategies that they used to help them cope and recover from distress and impacts on emotional wellbeing.

Discussion and Conclusion

This study provides examples of resource losses following the Ambae disaster and how they were entangled with significant emotional and mental distress for local people, as identified in previous studies and in alignment with the Conservation of Resources Theory (Hobfoll, 1989; 2011; Freedy et al., 1994; Benight et al., 1999; Sattler et al., 2014, 2018). In this instance, distress occurred from the direct (e.g., destruction of food sources and homes) and indirect impacts (e.g., breakdown in family life because of initial losses) of the volcanic disaster.

It is important that painful emotions such as these are processed so that hope and healing is possible (Head, 2016). Returning to home was important for healing and recovery as it enabled the Ambaeans in this study to access resources, rebuild livelihoods, and envision their futures. Further, it allowed Ambaeans to reconnect with their "place" which, as for many Pacific Island nations, is tied to their identity and sense of self (Bolton, 1999; Gharbaoui & Blocher, 2018; Havea, 2007; Perumal, 2018). Other studies on volcano-induced displacement have similarly found that facilitating return movements or, in permanent relocation, retaining some level of access to home is critical as home and place satisfy vital psychological, economic, material (Perry & Godchaux, 2005), spiritual, and cultural needs (Connell & Lutkehaus, 2017a, 2017b; Mercer & Kelman, 2010). Place is critical for reorientation after disorientation as it can act as the foundation for recreating – both materially

and symbolically – homes and community (Cox & Perry, 2011).

Although return movements mean re-exposure to risk, Ambaeans may perceive volcanic hazards as normative and embedded aspects of culture and experience in contrast to government perceptions of hazards (i.e., as abnormal; Connell & Lutkehaus, 2017b). It is thus not surprising that the Ambaeans in this study wanted to return, preferring their place and the hazards they understand and are connected to rather than the uncertainty of displacement and life on other islands. Once they arrived home, there was also a symbolic importance in the recovering natural environment (e.g., crops growing better) of Ambae as a means of healing psyches (Cox & Holmes, 2000; Cox & Perry, 2011).

Cultural reconnection was also important as often displacement from home generates not just nostalgia for the home from which one is estranged geographically but also for "memories of home" (Hill, 2014). Community-organised practices of collective memory making that revive traditional foods, music, dance, and poetry while sharing history, language, and culture are, therefore, critical (Hill, 2014). These activities can also be important for reconstructing a sense of community (Hill, 2014), which is critical as the tendency to turn to traditional and community networks for support in times of distress has previously been observed in Ambae (Zahlawi et al., 2019). Returning to normal activities and routine encourages everyday social interactions which can ensure there are naturally occurring social resources that can be used as a forum for sharing experiences, feelings, and needs (Kuriansky, 2012; Norris et al., 2002). Future disaster response and recovery interventions should also not underestimate the role of religion, which in this study and others (von Vacano & Schwarz, 2014) has been observed to support community healing through offering meaning for the trauma experienced, providing the strength to move forward and bringing comfort to individuals.

Under the growing spectre of environmental disasters, there is a need for intervention strategies that support the mental health and wellbeing of at-risk populations. Reorientation and healing can be stressful and confusing, but it can also be transformative (Cox & Perry, 2011). We believe that paying attention to local people's narratives of loss and distress are important as these can help guide preparedness, intervention, and recovery efforts in ways that better support vulnerable populations. We suggest that future studies continue to identify ways to support the factors that enable coping and healing, such as a sense of normalcy, cultural practices, environmental recovery, leadership, and religion – aspects that help "replant the local ties" (Participant #6). Further scholarship in this area will be critical for building on, unpacking, and refining the findings of this study.

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References

Bani, P., Oppenheimer, C., Allard, P., Shinohara, H., Tsanec, V., Carn, S., Lardy, M., & Garaebiti, E. (2012). First estimate of volcanic SO2 budget for Vanuatu island arc. *Journal of Volcanology and Geothermal Research, 211-212,* 36-46. https://doi.org/10.1016/j.jvolgeores.2011.10.005

Barnett, J., & O'Neill, S. (2012). Islands, resettlement and adaptation. *Nature Climate Change*, *2*, 8-10. https://doi.org/10.1038/nclimate1334

Behlert, B., Diekjobst, R., Felgentreff, C., Manandhar, T., Mucke, P., Pries, L., Radtke, K., & Weller, D. (2020). *World Risk Report 2020.* Bündnis Entwicklung Hilft and Ruhr University Bochum – Institute for International Law of Peace and Armed Conflict. https://reliefweb.int/sites/reliefweb.int/files/resources/WorldRiskReport-2020.pdf

Bengtsson, M. (2016). How to plan and perform a qualitative study using content analysis. *NursingPlus Open, 2*, 8–14. https://doi.org/10.1016/j.npls.2016.01.001

Benight, C.C., Ironson, G., Klebe, K., Carver, C.S., Wynings, C., Burnett, K., Greenwood, D., Baum, A., & Schneiderman, N. (1999). Conservation of resources and coping self-efficacy predicting distress following a natural disaster: A causal model analysis where the environment meets the mind. *Anxiety, Stress & Coping, 12*(2), 107-126. https://doi.org/10.1080/10615809908248325

Bolton, L. (1999). Women, place, and practice in Vanuatu: A view from Ambae. *Oceania, 70*(1), 43-55.

Bowman, L., & Henquinet, K. (2015). Disaster risk reduction and resettlement efforts at San Vicente (Chichontepec) Volcano, El Salvador: Toward understanding social and geophysical vulnerability. *Society and Volcanoes, 4*(1), 1–18. https://doi.org/10.1186/s13617-015-0031-0

Brinkmann, S. (2014). Unstructured and semi-structured interviewing. In P. Leavy (Ed.), *The Oxford handbook of qualitative research* (1st ed., pp. 278-299). Oxford University Press. https://doi.org/ 10.1093/oxfordhb/9780199811755.013.030

Bronfman, N.C., Cisternas, P.C., Repetto, P.B., & Castaneda, J.V. (2019). Natural disaster preparedness in a multi-hazard environment: Characterizing the sociodemographic profile of those better (worse) prepared. *PLoS One, 14*(4), e0214249. https://doi.org/ 10.1371/journal.pone.0214249

Burnard, P. (1991). A method of analysing interview transcripts in qualitative research. *Nurse Education Today, 11*(6), 461-466.

Cernea, M. (1997). The risks and reconstruction model for resettling displaced populations. *World Development, 25*(10), 1569-1587. https://doi.org/10.1016/S0305-750X(97)00054-5

Charan, D., Kaur, M., & Singh, P. (2018). Customary land and climate change induced relocation: A case study of Vunidogoloa Village, Vanua Levu, Fiji. In W. Leal Filho & J. Nalau (Eds.), *Climate change adaptation in Pacific countries* (pp. 19-33). Springer. https://doi.org/10.1007/978-3-319-50094-2_2

Chen C.C., Yeh, T.L., Yang, Y.K., Chen, S.J., Lee, I.H., Fu, L.S., Yeh, C.Y., Hsu, H.C., Tsai, W.L., Cheng, S.H., Chen, L.Y., & Si, Y.C. (2001). Psychiatric morbidity and post-traumatic symptoms among survivors in the early stage following the 1999 earthquake in Taiwan. *Psychiatry Research, 105*, 13–22. https://doi.org/10.1016/s0165-1781(01)00334-1

Connell, J., & Lutkehaus, N. (2017a). Environmental refugees? A tale of two resettlement projects in coastal Papua New Guinea. *Australian Geographer*, *48*(1), 79–95. https://doi.org/10.1080/00049182.2016.1267603

Connell, J., & Lutkehaus, N. (2017b). Escaping Zaria's fire? The volcano resettlement problem of Manam Island, Papua New Guinea. *Asia Pacific Viewpoint*, *58*(1), 14–26. https://doi.org/10.1111/apv.12148

Cox, H.M. & Holmes, C.A. (2000). Loss, healing, and the power of place. *Human Studies*, *23*, 63–78.

Cox, H.M., & Perry, K-M.E. (2011). Like a fish out of water: Reconsidering disaster recovery and the role of place and social capital in community disaster resilience. *American Journal of Community Psychology, 48,* 395–411. https://doi.org/10.1007/s10464-011-9427-0

Cronin, S. J., Gaylord, D. R., Charley, D., Alloway, B. V., Wallez, S., & Esau, J. W. (2004). Participatory methods of incorporating scientific with traditional knowledge for volcanic hazard management on Ambae Island, Vanuatu. *Bulletin of Volcanology, 66*(7), 652–668. https://doi.org/10.1007/s00445-004-0347-9

Dawes, N., Franklin, R., McIver, L., & Obed, J. (2019). General and post-disaster mental health servicing in Vanuatu: A qualitative analysis. *International Journal of Disaster Risk Reduction, 40,* 101256. https://doi.org/10.1016/j.ijdrr.2019.101256

Freedy, J.R., Saladin, M.E., Kilpatrick, D.G., Resnick, H.S., & Saunders, B.E. (1994). Understanding acute psychological distress following natural disaster. *Journal of Traumatic Stress, 7(*2), 257-273. https://doi.org/10.1002/jts.2490070207

Freedy, J.R., Shaw, D.S., Jarrell, M.P., & Masters, C.R. (1992). Towards an understanding of the psychological impact of natural disasters: An application of the conservation resources stress model. *Journal of Traumatic Stress, 5*(3), 441-454. https://doi.org/10.1002/jts.2490050308

Gharbaoui, D., & Blocher, J. (2018). Limits to adapting to climate change through relocations in Papua-New Guinea and Fiji. In W. Leal Filho & J. Nalau (Eds.), *Limits to climate change adaptation* (pp. 359-379). Springer.

Gissurardóttir, Ó.S., Hlodversdóttir, H., Thordardóttir, E.B., Pétursdóttir, G., & Hauksdóttir, A. (2019). Mental health effects following the eruption in Eyjafjallajökull volcano in Iceland: A population-based study. *Scandinavian Journal of Public Health, 47*(2), 251–259. https://doi.org/10.1177/1403494817751327

Goldmann, E., & Galea, S. (2014). Mental health consequences of disasters. *Annual Review of Public Health*, *35*, 169–183. https://doi.org/10.1146/annurev-publhealth-032013-182435

Goto, T., Wilson, J.P., Kahana, B., & Slane, S. (2006). The Miyake Island volcano disaster in Japan: Loss, uncertainty, and relocation as predictors of PTSD and depression. *Journal of Applied Social Psychology, 36*, 2001–2026. https://doi.org/10.1111/j.0021-9029.2006.00091.x

Graneheim, U.H., & Lundman, B. (2004). Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness, *Nurse Education Today, 24*(2), 105-112.

Havea, J. (2007). The vanua is fo'obake. In J. Webb & K. Nandan (Eds.), *Writing the Pacific: An anthology* (pp. 49-54). Pacific Writing Forum and Association for Commonwealth Literature and Language Studies.

Head, L. (2016). *Hope and grief in the Anthropocene*. Routledge.

Hill, L. (2014). Life after the volcano: The embodiment of small island memories and efforts to keep Montserratian culture alive in Preston, UK. *Area*, *46*(2), 146–153. https://doi.org/10.1111/area.12084

Hobfoll, S.E. (1989). Conservation of resources: A new attempt at conceptualizing stress. *American Psychologist, 44*(3), 513–524.

Hobfoll, S.E. (2011). Conservation of resource caravans and engaged settings. *Journal of Occupational and Organizational Psychology, 84*(1), 116–122.

Holloway, I., & Todres, L. (2003). The status of method: Flexibility, consistency and coherence. *Qualitative Research*, *3*(3), 345-357.

Kokai, M., Fujii, S., Shinfuku, N., & Edwards, G. (2004). Natural disaster and mental health in Asia. *Psychiatry and Clinical Neuroscience*, *58*, 110–116. https://doi.org/10.1111/j.1440-1819.2003.01203.x

Kuriansky, J. (2012). Our communities: Healing after environmental disasters. In D.G. Nemeth, R.B. Hamilton, & J. Kuriansky (Eds.), *Living in an environmentally traumatized world: Healing ourselves and our planet* (pp. 141-166). Praeger.

Magee, L., Handmer, J., Neale, T., & Ladds, M. (2016). Locating the intangible: Integrating a sense of place into cost estimations of natural disasters. *Geoforum, 77*, 61–72. https://doi.org/10.1016/j.geoforum.2016.09.018

Mercer, J., & Kelman, I. (2010). Living alongside a volcano in Baliau, Papua New Guinea. *Disaster Prevention and Management: An International Journal, 19*(4), 412–422. https://doi.org/10.1108/09653561011070349

Moussallam, Y., Rose-Koga, E., Koga, K., Médard, E., Bani, P., Devidal, J.L., & Tari, D. (2019). Fast ascent rate during the 2017-2018 Plinian eruption of Ambae (Aoba) volcano: A petrological investigation. *Contributions to Mineralogy and Petrology, 174*(11), 90. http://doi.org/10.1007/s00410-019-1625-z

Norris, F.H., Friedman, M.J., Watson, P.J., Byrne, C.M., Diaz, E., & Kaniasty, K. (2002). 60,000 disaster victims speak: Part I. An empirical review of the empirical literature, 1981-2001. *Psychiatry, 65*(3), 207–239. https://doi.org/10.1521/psyc.65.3.207.20173

Ohta, Y., Araki, K., Kawasaki, N., Nakane, Y., Honda, S., & Mine, M. (2003). Psychological distress among evacuees of a volcanic eruption in Japan: A follow-up study. *Psychiatry and Clinical Neuroscience, 57*, 105–111. https://doi.org/10.1046/j.1440-1819.2003.01086.x

Oliver-Smith, A. (1991). Successes and failures in post-disaster resettlement. *Disasters, 15*(1), 12-23. https://doi.org/10.1111/j.1467-7717.1991.tb00423.x

Perry, R.W., & Godchaux, J.D. (2005). Volcano hazard management strategies: Fitting policy to patterned human responses. *Disaster Prevention and Management: An International Journal*, *14*(2), 183–195. https://doi.org/10.1108/09653560510595182

Perumal, N. (2018). "The place where I live is where I belong": Community perspectives on climate change and climate-related migration in the Pacific Island nation of Vanuatu. *Island Studies Journal*, *13*. https://doi.org/10.24043/isj.50

Pomer, A., Buffa, G., Ayoub M-B., & Taleo, F. (2019). Psychosocial distress among women following a natural disaster in a low- to middle-income country: "Healthy mothers, healthy communities" study in Vanuatu. *Archives of Women's Mental Health, 22*(6), 825-829. https://doi.org/10.1007/s00737-019-00980-6

Sattler, D.N., Assanangkornchai, S., Moller, A.M., Kesavatana-Dohrs, W., & Graham, J. (2014). Indian Ocean tsunami: Relationships among posttraumatic stress, posttraumatic growth, resource loss, and coping at 3 and 15 Months. *Journal of Trauma and Disassociation, 15*(2), 219-239. https://doi.org/10.1080/15299732.2014.869144

Sattler, D.N., Claramita, M., & Muskavage, B. (2018). Natural disasters in Indonesia: Relationships among posttraumatic stress, resource loss, depression, social support, and posttraumatic growth. *International Perspectives on Stress and Coping, 23*(5), 351-365. https://doi.org/10.1080/15325024.2017.1415740

Shore, J.H., Tatum, E.L., & Vollmer, W. (1986). Psychiatric reactions to disaster: The Mount St. Helens experience. *American Journal of Psychiatry, 143,* 590-595. https://doi.org/10.1176/ajp.143.5.590

Uscher-Pines L. (2009). Health effects of relocation following disaster: A systematic review of the literature. *Disasters, 33*(1), 1–22.

Vaioleti, T. M. (2006). Talanoa research methodology: A developing position on Pacific research. *Waikato Journal of Education, 12,* 21-34.

von Vacano, M., & Schwarz, S. (2014). The religious dimension of coping: The roles of cosmologies and religious practices. In M. Zaumseil, S. Schwarz, M. von Vacano, G. B. Sullivan, & J. E. Prawitasari-Hadiyono (Eds.), *Cultural psychology of coping with disasters: The case of an earthquake in Java, Indonesia* (pp. 245–266). Springer.

Warrick, O. (2009). Ethics and methods in research for community-based adaptation: Reflections from rural Vanuatu. In H. Ashley & A. Milligan (Eds.), *Participatory learning and action 60: Community-based adaptation to climate change* (pp. 76-87). International Institute of Environment and Development.

Whiteford, L. M., & Tobin, G. A. (2004). Saving lives, destroying livelihoods: Emergency evacuation and resettlement policies. In A. Castro & M. Springer (Eds.), *Unhealthy health policies: A critical anthropological examination* (pp. 189–202). AltaMira Press.

Zahlawi, T., Roome, A.B., Chan, C.W., & Campbell, J.J. (2019). Psychosocial support during displacement due to a natural disaster: Relationships with distress in a lower-middle income country. *International Health, 11*(6), 472-489. https://doi.org.10.1093/inthealth/ihy099

Emergency sanitation challenges and opportunities following a large Wellington Fault earthquake scenario: November 2019 workshop

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Abstract

The greater Wellington region of Aotearoa New Zealand is highly vulnerable to large earthquakes because it is crossed by active faults, both on and offshore. A future earthquake on the Wellington Fault is expected to cause extensive damage to water supply and wastewater networks, which is likely to result in prolonged service outages to households. Widespread landslides may also affect road access and isolate households; such impacts mean that residents may have to manage human waste disposal onsite as well as using stored emergency water supplies. Consequences of wastewater network damage for public and environmental health and habitability of homes remain largely unknown for Wellington City. This Practice Update presents findings from a workshop held in November 2019 that brought together researchers, practitioners, wastewater managers, and emergency managers to explore challenges and opportunities for emergency sanitation in the Wellington region following a Wellington Fault scenario earthquake. Key suggestions include using standard and unambiguous terminology, considering diversity inherent in the groups usually termed the community, and the use of the Sanitation Service Chain framework.

Keywords: *Emergency sanitation, Wellington Fault earthquake, public health, emergency preparedness*

The greater Wellington region of Aotearoa New Zealand is highly vulnerable to large earthquakes as it is cut by active faults, both on and offshore. The likelihood of a magnitude 7.5 earthquake occurring on the Wellington Fault within the next century is approximately 10% (Rhoades et al., 2011). Recent work for the Wellington Lifelines Project modelled infrastructure outages following a M7.5 earthquake on the Wellington Fault (Wellington Lifelines Project, 2019). In the absence of major investments to strengthen wastewater assets, outages of 1 to 2 years duration for the wastewater collection network are expected for Wellington City, and greater than 2 years duration for Petone. For wastewater treatment, outages of 1 to 2 years duration are expected for Wellington City, and greater than 2 years duration for much of the Hutt Valley and Wainuiomata. While attention has been paid to the consequences of earthquake damage to road, electricity, and water supply networks, the consequences of wastewater network damage for public health, environmental health, and the habitability of homes remain largely unknown for Wellington City (Brenin et al., 2019).

Following the two major Canterbury earthquakes in 2010 and 2011, the potential for gastroenteritis outbreaks was considered to be very high due to damage to both the water supply and wastewater reticulation systems (Cubrinovski et al., 2011, 2014) that had provided a pathway for pathogenic microorganisms to enter the water supply (Dell & Williams, 2011; Ministry of Health, 2012). Cubrinovski et al. noted that the wastewater system was hit particularly hard by liquefaction and lateral spreading. A month after the earthquake, 31% of the total wastewater pipe length of 1,766 kilometres had limited service and 8% had no service. In comparison, the drinking-water supply system was more resilient with 5.1% of the total length damaged. However, watermains and submains had to be repeatedly pressurised and depressurised to allow for repairs of leaks, which increased the potential for ingress of pathogens.

There were multiple pathways for exposure to pathogens, including contaminated food and water, hygiene challenges for residents with limited access to power and water and restricted road access, and large-scale catering at welfare centres by volunteers who were not

trained in food safety requirements (Johnston, 2012). Key response actions taken to mitigate these risks are presented in Table 1. Overall, the comprehensive and coordinated response was successful in mitigating the substantial public health risks (Dell & Williams, 2011; Ministry of Health, 2012) as only a small increase in gastrointestinal cases in the weeks following the earthquake was recorded. For the period of 22 February to 21 March 2011, there was a total of 141 enteric (gastrointestinal) disease notifications, compared to the average of 124 for the same time window in 2008 to 2010: an increase of only 14% (Dell & Williams, 2012).

Table 1
Key Response Actions Taken to Limit Risk of Gastrointestinal Disease Outbreaks Following the 22 February 2011 Christchurch Earthquake

Action	Reference
Drinking water safety	
City-wide "boil water" notice in place until 8 April 2011	1,2
Chlorination of reticulated drinking water introduced	2
Increased frequency of testing for E.coli and free chlorine residual in drinking water network (from an average of 12 per day pre-earthquake to average of 190 per day over the 6 weeks post-earthquake)	2,4
Provision of tankered water and bottled water to residents	2
Army supplied desalination units	1
Food safety	
Flyers with food and water safety advice distributed via supermarkets	1
Food safety advice provided in several languages	1
Food safety advice for catering for large groups provided to welfare, church, and community groups	1
Food safety advice provided to food businesses	1
General	
Public encouraged to use backyard latrines to keep raw sewage out of reticulation system	3
Provision of emergency sanitation (portable and chemical toilets)	1,3
Consistent, blanket coverage public health messaging on hand washing	2
Advice to public to avoid handling liquefaction silt and waterways, which were likely to have been contaminated with sewage	4
Coordinated approach to disease surveillance	4
Precautionary approach taken for vulnerable populations	2,4
Preventive protocols implemented in welfare centres	4,5

Note. 1: Johnston (2012), 2: Ministry of Health (2012), 3: Wareham and Bourke (2013), 4: Dell and Williams (2011), 5: Chandratilake (2013)

While many lessons have been learned from experiences in Christchurch during the Canterbury Earthquake Sequence (Wareham & Bourke, 2013) and from the 2016 Kaikōura earthquake (Hughes et al., 2017), it is important to note that Christchurch was not isolated. Its interconnected road network remained largely functional and its airport re-opened less than 6 hours after the February 2011 earthquake. Prolonged isolation of parts of the city is likely to be a much greater factor for Wellington households, due to the potential for widespread landslides in hill suburbs affecting road access. This isolation also applies to human waste that may have to be managed onsite because options such as chemical toilets rely completely on road access for delivering chemicals and collecting waste. While some progress has been made on options such as emergency composting toilets (Wellington Region Emergency Management Office [WREMO], 2013), significant knowledge gaps remain concerning how to safely manage waste onsite. In Aotearoa New Zealand, there is also a cultural dimension to the management of waste, including human waste, which is discussed by Ataria et al. (2016) and Pauling and Ataria (2010). Ataria et al. (2016) advocate that the key cultural constructs of tapu and noa, which were central to traditional Māori society but continue to inform thinking and practice in modern Māori society, be integrated into biowaste management, and provide suggestions for facilitating this.

Emergency Sanitation

The World Health Organization (2018) defines sanitation as "access to and use of facilities and services for the safe disposal of human urine and faeces" (p. 1). Emergency sanitation in this context refers to the sanitation technologies, hardware, human behaviours, systems, messaging, and other information for emergency response utilised in the time after a disaster has occurred and prior to the re-establishment of networked wastewater removal systems. The behaviours and practices of people are also important to recognise given the way that human waste evokes disgust and avoidance (Rosenquist, 2005). Emergency sanitation therefore also includes preparation such as community and stakeholder engagement.

WREMO carried out a trial in 2012 to investigate the acceptability and practicality of composting toilet use by households and businesses in Wellington (WREMO, 2013). Eleven households and workplaces participated in the 4-week trial. WREMO concluded that households and workplaces could safely and hygienically use a compost

toilet exclusively for up to a month, and that compost toilets therefore should be promoted as a viable toilet option in an emergency where sewerage systems are disrupted. Further work is currently underway at Massey University optimising conditions in composting toilets for pathogen die-off.

QuakeCoRE[1]-funded research on post-earthquake emergency sanitation options is underway on two fronts: 1) investigating options for safe onsite management of human waste using composting toilets; and 2) initiating conversations on emergency sanitation among researchers, emergency managers, wastewater managers, and other practitioners. The current paper is focused on the second of these objectives and presents and discusses findings from a workshop held in Wellington on 15 November 2019.

Method

On 15 November 2019, a QuakeCoRE-funded workshop was held at Massey University, Wellington, to progress the conversation on emergency sanitation and review current thinking and practice. This half-day workshop brought together 26 people with an interest in emergency sanitation. Participants included emergency management practitioners, local iwi representation, wastewater infrastructure managers, academics, engineers, and representatives from several community advocacy groups. Consistent with the requirements of Massey University, this research was assessed as low risk under Ethics Notification Number: 4000021974.

The workshop had the following objectives: 1) for key representatives to update the group on their current activities and future plans; 2) to identify challenges, opportunities, and gaps in regard to improving the current preparedness and response strategies; and 3) to identify points of collaboration between sector partners. The workshop focused on preparedness at the household level. Topics beyond the scope of the workshop included emergency sanitation needs of public and large facilities, recovery of the wastewater network, and timeframes beyond the hazard event and recovery of the network. Participants were given a summary of the workshop for feedback, which did not result in any significant changes.

Workshop Design

The workshop was designed to bring together a diverse range of people representing organisations directly involved in emergency management, decision makers in the field, community and interest groups, and researchers. The workshop objectives were drafted and emailed out to the participant list for comment and feedback prior to the workshop to maximise relevance and benefit. Workshop convenors requested short presentations from key participants to allow as much time

1 QuakeCoRE is a Centre of Research Excellence aiming to transform the earthquake resilience of Aotearoa New Zealand. The work described here is funded by Flagship 5: Pathways to Increased Resilience.

Table 2
Summary of Short Presentations for Emergency Sanitation Workshop

Presenter	Title	Description
Joint Centre for Disaster Research, Massey University	"The sanitation service chain: a framework for understanding the sanitation challenge"	This presentation introduced a framework for the assessment and management of different sanitation options with the objective of conveying the complexity of the challenge. This framework seeks to break down the management of waste into stages and within each stage bring an understanding of different cultural, social, environmental, economic, health, and logistical aspects. The framework has been adapted from Zakaria et al. (2015).
Wellington Water	"Seismic resilience of the Wellington wastewater network"	This presentation described expected timeframes for the re-establishment of the wastewater network in different locations and under different scenarios, along with a preliminary "Quake to Flush" strategy (under development at the time of the workshop) with a long-term goal of building resilience in the network for a 30-day reconnection plan.
Wellington Regional Public Health	"Public health, diseases and hygiene"	A public health perspective on emergency sanitation was provided detailing the role of Regional Public Health pre- and post-disaster. The importance of safe and hygienic sanitation was underlined using statistics on the number of cases of enteric diseases in the Wellington region in "normal" and post-disaster times.
WREMO	"Learning what to do when there's nowhere to go"	This presentation described one staff member's personal experiences living in Christchurch in the aftermath of the 22 February 2011 earthquake with no public sanitation or other utilities.
WREMO	"Wastewater solutions for people who don't give a … but need to"	This presentation detailed the current state of general disaster awareness and preparation across the Wellington region, including emergency sanitation. The use of quotes from community members served to highlight differing social and cultural perspectives on emergency sanitation and also to highlight that emergency sanitation preparations are typically regarded as being low priority in the community at large.

as possible for discussion. The workshop was structured in three sections as follows:

Part 1: Five short (10 minute) presentations by key organisations to set the context for post-earthquake emergency sanitation. Presentations are summarised in Table 2.

Part 2: Group Discussion - Engaging communities and marginalised groups in the conversation.

Part 3: Group Discussion - The sanitation options: What are the options and are they suitable and practical? Applicable to whom?

Summary of Discussions on Engaging Communities and Marginalised Groups in the Conversation

The second part of the workshop tackled the issue of how to bring communities and marginalised groups into the conversation on emergency sanitation. The discussion also canvassed participants' views on the adequacy of information currently available, and participants identified key information needs.

Several of the presentations from the first part of the workshop highlighted the limited degree to which people have planned or even considered toileting needs as part of their emergency kit. This was the basis for a discussion

Table 3
Summary of Discussion on Engaging Communities and Marginalised Groups

Prompt question	Responses
What key information needs to be part of a pre-disaster conversation?	- Projected wastewater service outage durations when toilets cannot be flushed. - Consequences of flushing toilets when the wastewater network is damaged; waste will be discharged into some residences, onto residential land, and overland in streets or to waterways. - Serious nature of diseases transmitted by the faecal-oral pathway. - Options for emergency sanitation (may be location dependent). - Probability that some homes may be uninhabitable following the scenario earthquake or disasters with similar wastewater consequences.
What are the main challenges for the pre-disaster conversation?	- Agencies engaging with community groups need better information on options and context to help with conversations and planning. - How do we even define communities? Who are they and what challenges might they face in their particular situation? For example: students or those in apartments, people living with a disability, migrants and refugees, and those for whom English is a second language. There is a diversity of community groups with differing needs and abilities to access and maintain sanitation facilities. - To reach different communities, start with approaching key people/influencers. - Consider pre-planning messaging and assistance for those who will most need help.
What socially and culturally awkward norms do we need to consider when coming up with solutions?	- Environmental, social, and cultural standards may be temporarily compromised following an event. - There is social awkwardness and squeamishness around bodily functions, with reference to Rosenquist (2005). However, for emergency preparedness communications, use of euphemisms such as "human waste" may not be helpful. Participants agreed on the need for consistent terminology and suggested that the terms "wee" and "poo" be adopted as they are direct and unambiguous, if informal.
What will those who have lesser capacity do?	- Groups representing the disabled find it difficult to prioritise emergency preparedness in general, as their finite resources are occupied with day-to-day issues such as transport and access. - The disabled are more likely to favour emergency sanitation solutions based on their regular toilet arrangements (e.g., bag inside toilet) due to ease of use. - It is incumbent on all community members to support those with reduced capacity.
What are some of the tikanga Māori perspectives and plans for sanitation in disasters?	- Marae around the Wellington region are well set up to cope in a disaster, although many urban marae may lack the appropriate space for the separation of sanitation facilities from other areas (due to overall space limitations). - Marae are likely to source portable toilets where appropriate and able to do so, with long drops also identified as an option. The larger marae have pre-identified places where long drop toilets may be located. Pre-digging of long drops has been put forward as an appropriate action. - All plans should align with the Treaty of Waitangi principles and articles.
Who is best to lead work on engaging communities and marginalised groups in the conversation about emergency sanitation?	- WREMO are the appropriate lead as they have the regulatory authority under the Local Government Act. - Other stakeholders must be engaged, and collaboration is essential. - WREMO should be a public voice but in partnership and with input from other key partners such as Regional Public Health and Wellington Water. - All advice should be evidence based.

where several questions were posed to the group as prompts. The questions posed are summarised in Table 3 along with a summary of points raised in the discussion.

Summary of Discussion on Emergency Sanitation Options

The third part of the workshop was based on a discussion of the Sanitation Service Chain (SSC) framework as a basis for understanding and evaluating different sanitation options and how they might apply in different contexts (Zakaria et al., 2015). The SSC framework is based on the concept that emergency sanitation should be perceived beyond the provision of latrines/toilets to include storage/containment of the waste, emptying and transport, treatment, and final disposal or re-use (Figure 1). The main discussion points for each option are presented in Table 4.

While there was insufficient time during the workshop to work systematically through the entire matrix for each emergency sanitation option (shown in Figure 1), there was general agreement from participants that the SSC framework was an appropriate basis on which to proceed and that the options identified were appropriate for more detailed consideration. The SSC framework highlights the complexity of the challenges and knowledge gaps in the management of human waste and also provides a mechanism to support decisions on the provision of emergency sanitation. Participants also noted that there is merit in providing end users with options for their emergency sanitation.

Next steps include the following: 1) planning for a follow-up workshop for detailed consideration of the viability of the proposed emergency sanitation options using the SSC framework, 2) clarifying roles and responsibilities for all parties during a response and identifying resource requirements, and 3) developing key messages and opportunities to increase household preparedness.

Conclusion

As explained in the introduction, although many useful reports were produced following the Canterbury

Figure 1
The Sanitation Service Chain Framework as Presented for Discussion

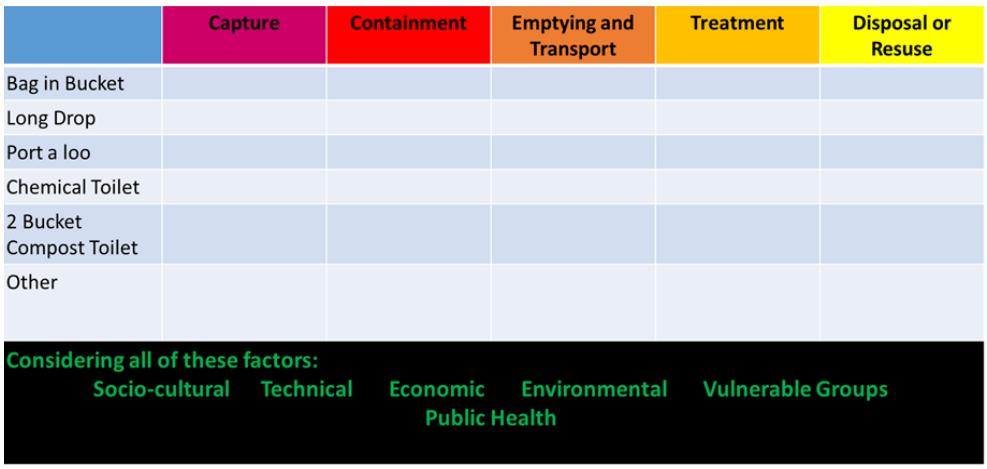

Table 4
Summary of Discussion on Emergency Sanitation Options

Emergency sanitation option	Points raised
Bag in Bucket	For the Bag in Bucket option, there are likely to be substantial public health risks at the "emptying and transport" stage if domestic waste collection trucks are used to collect bags, because trucks are not sealed and waste will probably leak from bags and trucks and contaminate roadways.
Long Drops	Long drops are a simple and effective option for many households, but location and soil type should be considered. In sites such as the Hutt Valley, proximity of groundwater bores to long drop toilets may be an issue. Many other locations in the hill suburbs may be on bedrock with insufficient soil depth to excavate a long drop. A further problem may be waste seeping downslope in these hill suburbs into lower elevation properties.
Portable Toilets	Portable toilets were not discussed further in this workshop because it was considered that their use would be impractical in post-earthquake Wellington where road access is likely to be very limited, particularly in hill suburbs.
Chemical Toilets	Chemicals used in chemical toilets can present problems for waste treatment plants if there is not sufficient dilution. Road access is required to deliver chemicals and collect waste.
Two-Bucket Composting Toilet	Preliminary research suggests that composting, with the use of carbon additives, can reduce pathogen levels in human waste in approximately 10 weeks, so that it can be handled using similar precautions as for potting mix. The emptying and transportation of waste from the two-bucket composting system requires more assessment from a public health and logistics perspective. A further problem may be that water supplies are likely to be very limited following a large earthquake on the Wellington Fault, so it will be difficult to clean the bucket following emptying.

earthquake sequence, specifics of the Wellington context mean that these lessons are not entirely applicable. For example, recently revised timeframes of 1-2 years for the re-establishment of networked wastewater collection and treatment in Wellington following a major Wellington Fault earthquake provide additional urgency to consideration of emergency sanitation options and arrangements for the region. This workshop, held in November 2019, was an attempt to initiate a conversation between emergency management practitioners, local iwi representatives, wastewater managers, academics, engineers, and representatives from several community advocacy groups. Participants commented on the value of assembling a diverse range of people to discuss this important and often-overlooked topic in emergency preparedness. Key findings from the workshop were: a recognition that standard and unambiguous terminology is required when communicating about this sensitive subject, an acknowledgement that the community is made up of diverse groups with diverse needs and that different strategies may be required to engage with these groups, and that the Sanitation Service Chain framework is an appropriate basis on which to progress emergency sanitation arrangements. Finally, we note that the provision of emergency sanitation is just one component of an effective, comprehensive, and co-ordinated public health response to manage the risk of gastrointestinal disease outbreaks following a major earthquake. Planning therefore needs to proceed on multiple fronts.

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References

Ataria, J., Baker, V., Goven, J., Langer, E.R., Leckie, A., Ross, M., & Horswell, J. (2016). *From tapu to noa – Maori cultural views on biowastes management: A focus on biosolids*. Centre for Integrated Biowaste Research. www.cibr.org.nz/assets/Uploads/Newsletter-Thumb/CIBR-From-Tapu-to-Noa.pdf

Brenin, M., Stewart, C., Horswell, J., Johnston, D., McLaughlin, V., Kaiser, L., & Wotherspoon, L. (2019). *Minimising public health risk from human waste after a large Wellington Fault earthquake* [Poster]. QuakeCoRE 2019 Annual Conference, Nelson, New Zealand. http://hdl.handle.net/10092/17149

Chandratilake, S.E. (2013). *Spatial modelling of gastroenteritis prevalence following the February 22, 2011 earthquake and identification of successful factors preventing outbreaks at emergency centres* [Master's thesis, University of Canterbury]. UC Research Repository. https://ir.canterbury.ac.nz/handle/10092/9185

Cubrinovski, M., Hughes, M., Bradley, B., McCahon, I., McDonald, Y., Simpson, H., Cameron, R., Christison, M., Henderson, M., Orense, R., & O'Rourke, T. (2011). *Liquefaction impacts on pipe networks.* Civil and Natural Resources Engineering, University of Canterbury. www.naturalhazards.org.nz/static/download/NHRP/unicanti/NHRP-STRP6-Report-v1_0-22DEC11.pdf

Cubrinovski, M., Hughes, M., & O'Rourke, T.D. (2014). Impacts of liquefaction on the potable water system of Christchurch in the 2010-2011 Canterbury (NZ) earthquakes. *Journal of Water Supply: Research and Technology – Aqua, 63*(2), 95-105. https://doi.org/10.2166/aqua.2013.004

Dell, R., & Williams, D. (2011). *Public health response to the February 22 Christchurch earthquake progress report*. Canterbury District Health Board. www.cph.co.nz/Files/Feb11EQ-CPH

Hughes, M.W., Nayyerloo, M., Bellagamba, X., Morris, J., Brabhaharan, P., Rooney, S., Hobbs, E., Wooley, K., & Hutchison, S. (2017). Impacts of the 14th November 2016 Kaikōura Earthquake on three waters systems in Wellington, Marlborough and Kaikōura, New Zealand: Preliminary observations. *Bulletin of the New Zealand Society for Earthquake Engineering, 50*(2), 306-317. https://doi.org/10.5459/bnzsee.50.2.306-317

Johnston, S. (2012) Shake, rattle and roll: Risk assessment and management for food safety during two Christchurch earthquakes. *Western Pacific Surveillance and Response Journal, 3*(2), 24-29. https://doi.org/10.5365%2FWPSAR.2012.3.2.011

Ministry of Health. (2012). *Annual report on drinking-water quality 2010-2011.* www.health.govt.nz/system/files/documents/publications/annual-report-on-drinking-water-quality-2010-2011.pdf

Pauling, C., & Ataria, J. (2010). *Tiaki Para: A study of Ngāi Tahu values and issues regarding waste*. Manaaki Whenua Press. www.landcareresearch.co.nz/publications/researchpubs/LRSS39_Tiaki_Para.pdf

Rhoades, D.A., van Dissen, R.J., Langridge, R.M., Little, T.A., Ninis, D., Smith, E.G.C., & Robinson, R. (2011). Re-evaluation of conditional probability of rupture of the Wellington-Hutt Valley segment of the Wellington Fault. *Bulletin of the New Zealand Society for Earthquake Engineering, 44*(2), 77–86. https://doi.org/10.5459/bnzsee.44.2.77-86

Rosenquist, L. (2005) A psychosocial analysis of the human-sanitation nexus. *Journal of Environmental Psychology, 25*(3), 335-346. https://doi.org/10.1016/j.jenvp.2005.07.003

Wareham, D., & Bourke, M. (2013). The 2010-2011 Canterbury Earthquakes: Impact on the liquid waste management system of Christchurch, New Zealand. *Civil Engineering and Environmental Systems, 30*(1), 1-14. https://doi.org/10.1080/10286608.2012.709507

Wellington Lifelines Project. (2019). *Protecting Wellington's economy through accelerated infrastructure investment programme business case.* https://wremo.nz/assets/Uploads/Wellington-Lifelines-PBC-MAIN-Combined-20191009.pdf

Wellington Region Emergency Management Office. (2013). *Report on the trial of emergency compost toilets*. https://

wremo.nz/assets/Publications/Compost-Toilet-Trial-Report.pdf

World Health Organization. (2018*) Guidelines on sanitation and health*. www.who.int/water_sanitation_health/publications/guidelines-on-sanitation-and-health/en/

Zakaria F., Garcia, H. A., Hooijmans, C. M., & Brdjanovic, D. (2015). Decision support system for the provision of emergency sanitation. *Science of the Total Environment 512-513*, 645-658. https://doi.org/10.1016/j.scitotenv.2015.01.051

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