

WHAT'S THAT SOUND?

Public & Official Perceptions of the
January 2018 Tsunami Warning and
Evacuation in the Alberni Valley

Final Findings – March 2019

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Updates from Preliminary Report

The goal of our preliminary report was to communicate the most relevant information from our study quickly to emergency managers and planners in the Alberni region following our fieldwork. In the time since the preliminary report, we have been able to explore the data in greater depth and review the many written comments we received from our online survey participants. This additional time has allowed us to clarify ambiguous addresses and to fine-tune how we coded responses, especially where participants made use of the many 'other' categories while taking the survey. For this reason, a few numbers may have changed slightly from what was published in the initial report. The numbers in the final report better reflect the full responses provided to us by our survey participants. We believe this version of the report will be more useful for understanding this event, and the findings should be of greater use to communities outside the Alberni Valley.

Research Ethics Approval

This study received ethics approval from the Behavioural Research Ethics Board (BREB) at the University of British Columbia on March 29th, 2018, UBC BREB Number H18-00397. Any questions or concerns about how the research was conducted can be directed to the study's lead investigator, Dr. Ryan Reynolds, by email at ryan.reynolds@ubc.ca.

Research Funding

This research study was funded through a grant provided by the [Institute for Catastrophic Loss Reduction](#) (ICLR) through their [Quick Response Program](#). This program is designed to provide small funding grants that "allow social, behavioural and economic scientists to quickly deploy to a disaster-affected area in the aftermath of a flood, extreme weather event or earthquake to collect perishable data ... to [expand] academic knowledge."¹ The researchers conducted this study independently of the ICLR; the only requirement from the funding agency was to provide a brief report at the conclusion of the research that will allow the ICLR to share the work with a wider audience.

Special Thanks

We would like to extend our sincere thanks to the officials and staff at the City of Port Alberni, the Alberni-Clayoquot Regional District, the Port Alberni Fire Department, and the Port Alberni Detachment of the RCMP who participated in, and assisted us with, our research. We'd like to thank Ian Foss at EMBC for helping us understand EMBC's response protocols and how they get the message out about tsunami warnings to potentially affected communities. We'd like to thank Tugce Congar, Mark Keilthy, and Cindy Marven for providing feedback and edits on the final report. Finally, and most importantly, we'd like to thank the many people of Port Alberni and the Alberni Valley who took the time to complete our survey. We greatly appreciate your assistance and your time!

¹ ICLR (2018). ICLR Quick Response Program. Institute for Catastrophic Loss Reduction website. Retrieved February 11th, 2019 from <https://www.iclr.org/wp-content/uploads/2018/04/ICLR-Quick-Response-Program.pdf>

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Summary

At 3:00 AM on the morning of January 23rd, 2018 many residents of the Alberni Valley were woken by the sounds of the local tsunami warning system. A magnitude 7.9 earthquake had been detected in the Gulf of Alaska with the potential to trigger a tsunami affecting communities along the western coast of British Columbia (BC). An official tsunami warning was issued for several B.C. communities, including those in the Alberni Valley in central Vancouver Island.

Our team conducted a survey exploring the events of that morning seeking to learn more about the event and what lessons could be learned to aid other coastal communities to respond to future tsunami and similar hazard warnings in the future. We were especially interested in learning how the evacuation was perceived both by emergency officials and affected community residents. As part of this research, we interviewed 11 current and past emergency managers, planners, and first responders, and conducted surveys with affected community members.

A public consultation was performed through a week-long door-to-door survey campaign which was supplemented through a month-long online survey. Over 450 public surveys were completed, with a concentration from those living within the official tsunami inundation zone. Survey participation was key in understanding how the evacuation was undertaken at the individual household level and helped us to understand public perceptions of a large-scale early-morning evacuation better.

Perceptions of the event were generally positive for both the officials and members of the public. Several specific barriers to effective evacuation were identified, both in our interviews and through public consultation. Our report identifies each of these issues, along with potential solutions which could be used to address several of these issues in the future.

Of those living within the official tsunami inundation zone, 93% of participants indicated that they had evacuated, or begun evacuating, their homes by the time the evacuation was ended. Most of these households sought shelter in the homes of friends or family members living elsewhere in the community or nearby communities, while others gathered in the parking lots of large businesses and at other locations at higher elevations. Few reported travelling to the official reception centre that was set up at the Echo Recreation Centre on the east side of town, but this site was not ready to register guests until almost an hour following the first sounding of the warning sirens.

Most participants indicated that they opted to evacuate by vehicle, with only 4% indicating that they began their evacuation on foot. This heavy reliance on vehicles likely contributed to reported traffic congestion, slowing the evacuation process for some residents located within the inundation zone. A small number of those we surveyed indicated that they were unable to evacuate due to a lack of assistance, illness or disability in the home, or for fear of looting. A few survey respondents indicated that they did not believe that a tsunami presented a risk to them or their households and opted to remain at home.

One important factor we identified affecting the decision by the public to evacuate was a lack of certainty or misunderstanding about whether their homes were located inside or outside the evacuation zone. This confusion contributed to several residents mistakenly believing they were safe at home when they were, in fact, located in the inundation zone. Some living safely outside the inundation zone also opted to evacuate either because they did not know they were located outside the zone, or out of an abundance of caution.

A small majority of our study participants reported no issues during their evacuation. However, a sizeable minority reported issues related to traffic congestion along their preferred evacuation route. Other barriers identified in our

study included a lack of clear information from officials about what residents should do, where they should go, and what routes they should take to get there. Many participants indicated to us that their searches for this information online went unfulfilled as official websites and social media accounts were not updated during the event.

A common theme in our discussions with residents during our doorstep surveys, and was repeated in our online surveys, is that a sizable percentage of households in Port Alberni do not have an up-to-date emergency response plan prepared, or that their existing plans were not effective. This is likely true of Canadian households across the country. Several of our participants indicated that this event had incited them to create a new household emergency response plan or to update their existing plan.

When we explored the impacts that this event had on resident perceptions of tsunami risk, we see different impacts depending on where residents live. Those living within the inundation zone appear to have already understood the risks they face, and their perceptions of those risks did not change significantly. Those living outside the inundation zone were more likely to perceive tsunami risk to be greater following the evacuation than they had prior to the event.

Since the evacuation, several aspects of official response protocols have been identified for improvement. The City of Port Alberni and the Alberni-Clayoquot Regional District (ACRD) have already updated their communication plans to ensure that key communication staff are present during an emergency and that critical information is better communicated to residents in future emergencies. This includes official websites and related social media accounts.

Finally, we conclude the report by exploring lessons identified from the evacuation that might be of interest to other coastal communities facing tsunami risk, or any community considering how to better prepare themselves to deal with a potential early morning mass evacuation.

– Ryan Reynolds, Ph.D.

Alaska Earthquake Triggers Tsunami Warning

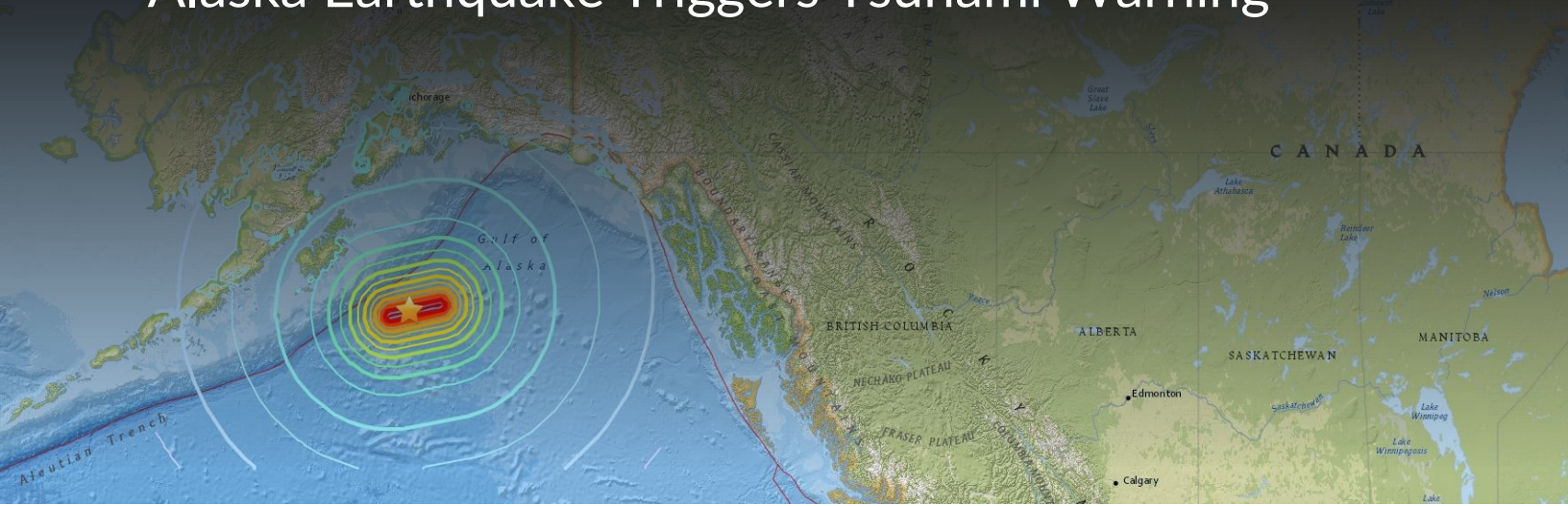


Figure 1: Location of the January 23rd, 2018 Earthquake (USGS, 2018)

At 1:31 AM (PST) on January 23rd, 2018 a 7.9 magnitude (M_w) earthquake centred in the Gulf of Alaska began triggering seismic sensors around the world. The epicentre of the earthquake was located approximately 280 km southeast of Kodiak, Alaska (Figure 1) at a depth of 14.1 km.² This earthquake was associated with the Alaska-Aleutian subduction zone off southern Alaska, a fault line with the potential for large and destructive seismic events capable of triggering tsunamis affecting coastal communities around much of the Pacific Ocean, including those in British Columbia.

In the community of Port Alberni, centrally located on Vancouver Island (Figure 2) in British Columbia (B.C.), most residents were either preparing for bed or already asleep at the time of the Alaskan earthquake. Ninety minutes following the earthquake the tsunami warning towers in this community would begin to rouse residents and warn them to get to higher ground.

An approximate timeline of the events of that morning is summarized in Figure 3 and described in more detail below.

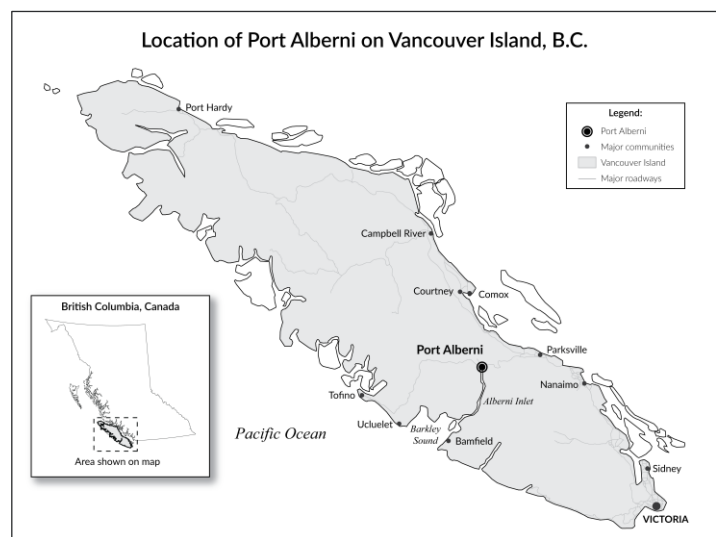


Figure 2: Location of Port Alberni, British Columbia on Vancouver Island

² USGS. (2018). *M 7.9 - 280km SE of Kodiak, Alaska*. USGS Earthquake Hazards Program Website. Retrieved April 24th, 2018 from <https://earthquake.usgs.gov/earthquakes/eventpage/us2000cmv3#executive>

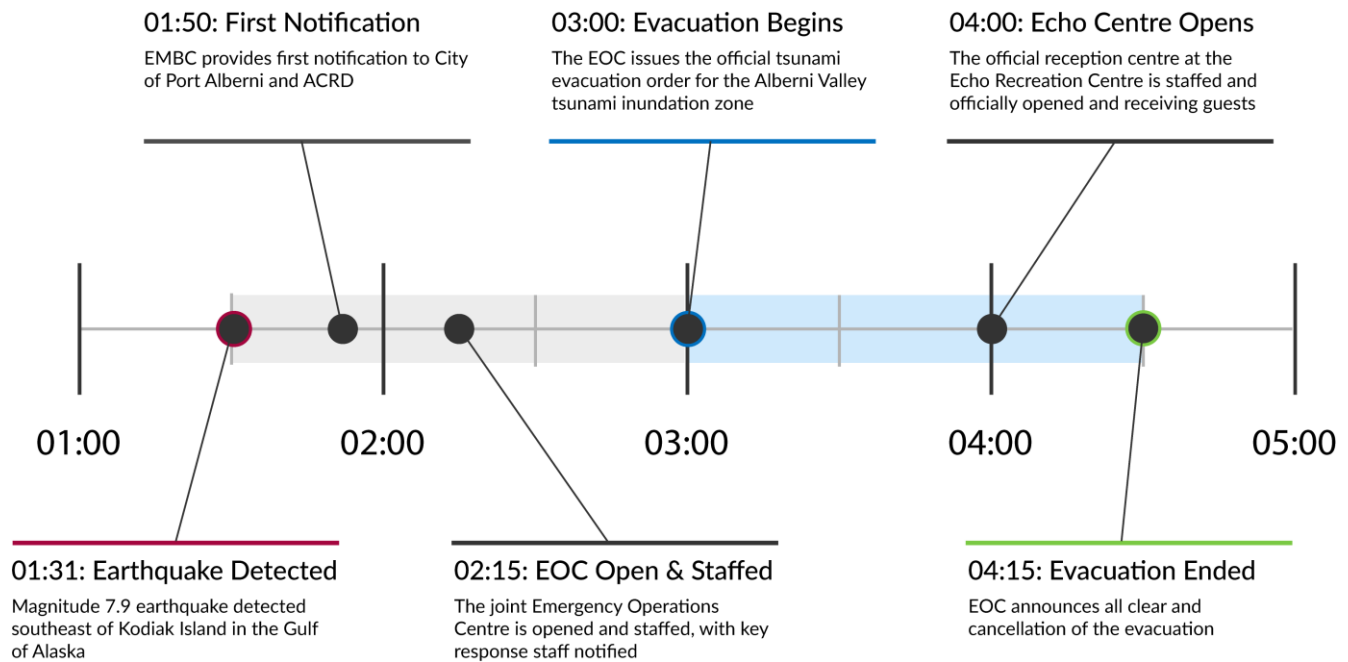


Figure 3: Timeline of Major Events for the January 2018 Tsunami Warning & Evacuation

1:36 AM—FIRST OFFICIAL TSUNAMI WARNING ISSUED

Five minutes after the first seismic waves were detected, the [National Tsunami Warning Centre](#) (NTWC) in Palmer, Alaska issued tsunami watches and warnings for coastal regions of Alaska, B.C., Washington, Oregon, and California.³ These warnings were based on the preliminary location, depth, and magnitude of the early morning earthquake and would be updated as sensors detected potential tsunami waves as they spread out from the origin point.

In addition to their roles in emergency planning, response, and preparedness, [Emergency Management BC](#) (EMBC) is the provincial agency responsible for assessing tsunami risks in B.C. Per protocol; it was EMBC that began receiving notifications of the event from the NTWC. EMBC staff monitored the situation while also initiating the process of notifying community officials in at-risk regions.⁴ Given the early morning timing of the event, EMBC operations officers began contacting their designated community colleagues using email and other media. Officers followed-up with phone calls to these contacts to ensure information was received in a timely manner, providing what information was available at the time of each call. Given the location of the earthquake, a North-to-South prioritization was made for Vancouver Island communities.⁵

³ NOAA. (2018). *Tsunami Warning, AK/BC/US West Coast Warn/Adv./Watch #1*. National Tsunami Warning Center Website. Retrieved April 24th, 2018 from <http://ntwc.arh.noaa.gov/?p=PAAQ/2018/01/23/p3054t/1/WEAK51>

⁴ PreparedBC. (n.d.) *Earthquake and Tsunami Guide*. Retrieved February 3rd, 2019 from <https://www2.gov.bc.ca/gov/content/safety/emergency-preparedness-response-recovery/preparedbc/know-the-risks/tsunamis>

⁵ Foss, I., personal communication, February 11th, 2019.

1:50 AM—ALBERNI OFFICIALS FIRST NOTIFIED OF WARNING

At approximately 1:50 AM an EMBC operations officer contacted Tim Pley, Chief Administrative Officer (CAO) for the [City of Port Alberni](#). A similar call was made to the CAO of the [Alberni-Clayoquot Regional District](#) (ACRD), Doug Holmes, at his home outside of Port Alberni. These initial calls informed the CAOs of the activate tsunami warning for their respective communities and provided what limited information was available at the time.

2:15 AM—ACTIVATION OF THE EOC

The City of Port Alberni and the ACRD operate a joint [Emergency Operations Centre](#) (EOC) which is designated to assess and respond to emergencies facing communities in the Alberni Valley and the Alberni-Clayoquot region more broadly. At the time of this event, the CAOs of the City of Port Alberni and the ACRD were both empowered to act as Director of the EOC in times of need. The Acting Director of the EOC has authority to enact pre-established response protocols and to place resources where they are needed in an emergency. In extended emergencies, the role of Acting Director would change hands between the two CAOs to ensure 24-hour support and coordinated decision-making is maintained throughout the emergency.

January 23rd the CAO for Port Alberni activated the EOC and had it staffed and operational by 2:15 AM per the regional tsunami response plan. That response plan, developed in cooperation between the City, ACRD, surrounding communities, nearby First Nations, and provincial and federal partners, ensures a rapid local response is possible in the event of a tsunami threat. The Acting Director of the EOC is tasked with all critical decision-making during such events and is authorized to initiate a mass evacuation of the designated tsunami inundation zone autonomously if the time to evacuate becomes critical and current information has not ruled out the possibility of a tsunami.

2:15 AM TO 3:00 AM—ASSESSING ALBERNI VALLEY TSUNAMI RISK

Given the location of the Alaskan earthquake, the first tsunami wave would be expected to arrive approximately 4:30 AM. The primary goal for EOC staff was to take the time available to assess the risk to the Alberni region and begin putting resources and people in place to respond should an evacuation be necessary. The purpose of such an evacuation would be to get as many at-risk residents as possible to higher ground before a potential tsunami reached the community.

While the purpose of an evacuation would be to reduce casualties associated with a tsunami, the very act of evacuating a community can present its own hazards to those evacuating. Evacuees in a large-scale evacuation face potential danger from trips and falls, vehicle accidents, increased anxiety, as well as other risks from fellow evacuees trying to get to safety. It is therefore important, *when the time is available*, for emergency managers to take the time to properly assess a potential tsunami threat before initiating a full-scale evacuation to ensure lives are not placed at additional threat from the evacuation unnecessarily.

Protocol in this situation called for EMBC to provide the EOC with regular updates as information was passed to them from the National Tsunami Warning Centre and interpreted by local experts. If a tsunami threat was confirmed through EMBC, the Alberni Valley EOC would issue an evacuation order immediately to ensure as much time as possible would be available for residents to get to safer locations on higher ground. In cases where information is ambiguous, or the lines of communication between the EOC and EMBC is disrupted, the decision on whether and when to initiate an evacuation would rest with the Acting Director of the EOC. In that event, the decision of whether to evacuate would be made based on estimates of how long it would take to evacuate the inundation zone. The desire would be to ensure enough time to effectively communicate evacuation instructions and have residents implement their household emergency response plans (if they have one). Given the potential risks discussed above, this is not a decision that is made lightly.

Public Tsunami Warning Activated & Evacuation Initiated

3:00 AM—ALBERNI TSUNAMI WARNING SYSTEM ACTIVATED

At 3:00 AM the Acting Director of the EOC initiated the Alberni Valley tsunami warning system. The information available at that time did not yet indicate that the community was safe from tsunami threat, and the window in which to safely execute a full evacuation of the inundation zone was rapidly closing. At 3:00 AM the public address systems on the community's six tsunami warning 'towers'⁶ began broadcasting a loud siren which was followed by an announcement about the tsunami warning, and instructions to evacuate low-lying areas (Figure 4, below). The verbal instructions were provided using both male and female voices in an effort to improve understandability of the message, however many of our study participants indicated that the verbal announcements were often too quiet, garbled, or echoey to understand at their homes.⁷ The siren and announcements were repeated throughout the evacuation.

3:00 AM TO 4:30 AM—FIRST RESPONDERS GO STREET-BY-STREET

Knowing that the tsunami warning system broadcasts could be difficult to understand in some areas and that many heavy sleepers might sleep through the warnings, Alberni-area firefighters and members of the RCMP detachment enacted their tsunami response plans. These plans saw RCMP and fire vehicles travelling through vulnerable areas with their lights, sirens, and loudspeakers active to help reinforce the messages broadcast by the tsunami warning system. Their goal was to wake as many potentially impacted residents as possible and make them aware of the tsunami warning and the need to evacuate to higher ground. All first responders had instructions to be clear of the inundation zone no later than 4:30 AM (the estimated arrival time for the first wave) to ensure their safety should a tsunami arrive.

⁶ These "towers" are utility poles with omnidirectional speakers located at the top.

⁷ At the time of writing this document, a YouTube video with the sound of the tsunami warning system can be found at <https://youtu.be/6zbZw9wXOdw>.

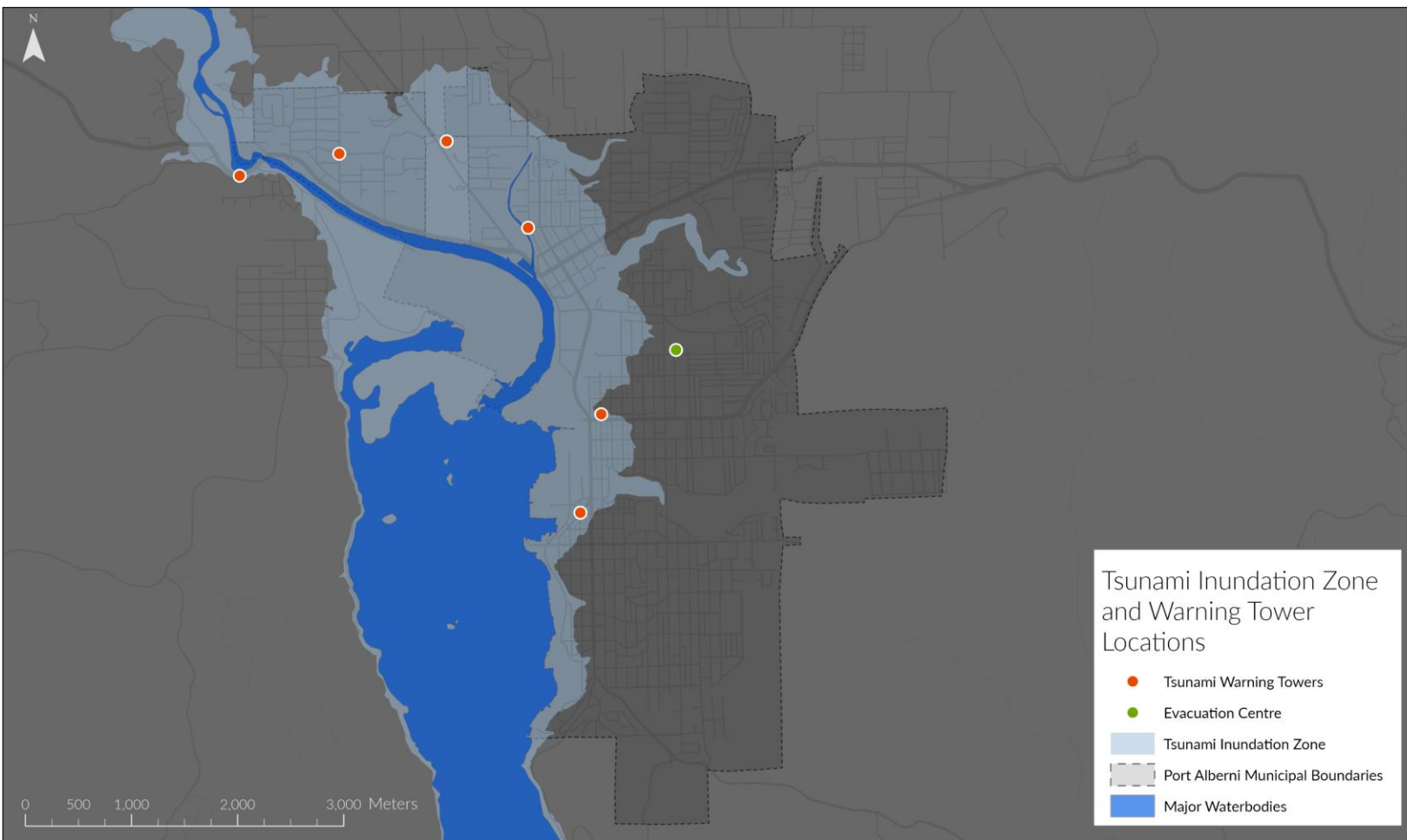


Figure 4: Location of Official Tsunami Inundation Zone, Evacuation Centre, and Tsunami Warning Towers

3:00 AM TO 4:30 AM—POLITICAL REPRESENTATIVES BRIEFED

Local political representatives from the City of Port Alberni (Mayor and Councillors) and the ACRD (Directors) came together near the EOC so that they could be updated as conditions changed. While authority rests with the EOC during an emergency of this nature, it is important to have elected representatives kept informed about what is occurring and ready to respond should they be needed.

3:00 AM TO 4:30 AM—RADIO BROADCASTS EVACUATION DETAILS

The Alberni Valley radio station—93.3 The Peak FM—began broadcasting shortly after the evacuation was initiated and would continue to broadcast updates to the community as information became available from the EOC. Many of our study participants indicated that the radio was their best source for information during the emergency and praised The Peak’s news director.

4:00 AM—EVACUATION CENTRE OPENS

The Echo Aquatic and Fitness Centre has been designated as a local evacuation centre (or “reception centre” in local planning language) for those residents who are unable to take shelter with friends or

family in the community, or who may have additional needs. Staff at the centre are trained first to take care of their own families first and then to report to the centre when and if they are able. As an aquatic centre, many staff at the facility have first aid training and can provide minor medical assistance should it be needed, in addition to providing limited refreshments, registration services, and physical shelter. Staff began arriving at the centre at 3:30 AM and the centre was opened to residents at 4:00 AM.

The All Clear—Tsunami Warning Ended

Emergency Management BC contacted the EOC at approximately 4:30 AM to inform them that tsunami warnings for the region had been lifted and they could stand-down. Moments later the all clear was issued to residents via the tsunami warning system and a similar message was reported on local radio. All residents were cleared to re-enter the tsunami inundation zone at that time.

Shortly afterwards, participating units within the City and ACRD began to evaluate their response reactions during the event. As is normal when protocols are tested, these groups would go on to identify areas of their response that could be improved and aspects of the regional response plan that could be updated to better prepare for future emergencies. As of the time of this research, some of these suggestions have already been implemented, while others are still being considered.

Evacuation Aftermath

Criticism of Official Response in the Media

Criticism of the official response in the media was quick to follow the end of the evacuation. Within 24 hours, headlines like “*Tsunami scare exposes communication breakdown in vulnerable B.C. city*”⁸ and “*City of Port Alberni ‘dropped the ball’ in communicating tsunami warning on social media*”⁹ began to circulate.

A lack of communications from the City on the municipality’s website and social media accounts became a focal point of media attention about the official response, though this was certainly not a complaint limited to just Port Alberni.¹⁰ Many in the community looked to the Port Alberni and ACRD websites and social media accounts for ‘official word’ about the event. These online sources would remain silent throughout the event causing some residents to become uncertain whether the evacuation was real and unclear if they needed to evacuate. “People have an expectation to get real-time information on social

⁸ Larsen, K. (2018, 23 January). Tsunami scare exposes communication breakdown in vulnerable B.C. city. *CBC News*. Retrieved May 17th, 2018 from <http://www.cbc.ca/news/canada/british-columbia/tsunami-scare-exposes-communication-breakdown-in-vulnerable-b-c-city-1.4499890>

⁹ Blats, K. (2018, 24 January). City of Port Alberni “dropped the ball” in communicating tsunami warning on social media. *Alberni Valley News*. Retrieved May 17th, 2018 from <https://www.alberniavalleynews.com/news/city-of-port-alberni-dropped-the-ball-in-communicating-tsunami-warning-on-social-media/>

¹⁰ DeRosa, K. (2018, 23 January). Tsunami warning: How well did we respond, communities ask. *Times Colonist*. Retrieved March 7th, 2019 from <https://www.timescolonist.com/news/local/tsunami-warning-how-well-did-we-respond-communities-ask-1.23153170>

media platforms, and clearly we dropped the ball on that,” CAO Tim Pley told the Alberni Valley News.⁹ Mayor Mike Ruttan noted, “There are some communications that could have happened a little bit better, particularly getting some information on the City’s Facebook page and the City’s Twitter account.”¹¹ Plans have since been updated to ensure better communications from the City directly to the public in future emergency situations.

Criticism of Official Response from Residents

Overall, residents we spoke with in our doorstep surveys were happy with the official response, though many mirrored the concerns from the media about the online communication breakdown with the public. Some study participants indicated they were unsure where to evacuate to, particularly as the Echo Centre was not open to receive evacuees during the first hour of the evacuation.

There were reports of individuals living in the inundation zone who did not hear the tsunami warning system or the sirens and loudspeakers of first responders. Some residents were deep sleepers or reported hearing disabilities that prevented them from being woken by the warning system. Others noted that the evacuation messages broadcast over the tsunami warning towers were garbled, echoed, or were otherwise difficult (and in some cases, impossible) to understand.

Another criticism raised by some residents was concern about the time differential between when the tsunami warning was first issued by the National Tsunami Warning Center and when the evacuation was initiated in the Valley. They compared the timing of evacuation orders with those in nearby communities, such as Tofino and Ucluelet, whose warnings were initiated much earlier. Many of these residents felt the evacuation notice should have happened as soon as officials were informed by EMBC about the tsunami warning rather than waiting an hour.

Mitigating Community Tsunami Risk

There is, unfortunately, nothing a community can do to prevent an earthquake-generated tsunami, but it can be possible to take actions to help mitigate the injuries, loss of life, and damage that tsunamis can cause. We discuss a few of the most common approaches below.

Mitigation Efforts

Damage from tsunamis is usually the combined result of inundation (i.e., flooding) and damage from debris. Vulnerable communities are often quite limited in the actions that they can take to reduce these physical damages.

¹¹ Larsen, K. (2018, 23 January). Tsunami scare exposes communication breakdown in vulnerable B.C. city. *CBC News*. Retrieved May 17th, 2018 from <http://www.cbc.ca/news/canada/british-columbia/tsunami-scare-exposes-communication-breakdown-in-vulnerable-b-c-city-1.4499890>

While tsunamis themselves may be unavoidable, there are actions that can be taken to limit who and what is at risk within a tsunami inundation zone and to reduce the potential impacts of a tsunami-related disaster to a community. The most commonly employed mitigation efforts include zoning initiatives, structural protections, and resilience-building efforts, including vertical evacuation towers and household preparedness planning.

LAND USE/ZONING INITIATIVES

Most efforts to mitigate potential tsunami damage in North America focus on land-use controls and zoning efforts. These initiatives often take the form of zoning restrictions that limit or prevent future building in vulnerable areas of the community with the goal of limiting the populations, property, and critical infrastructure at risk in these zones. Alternatively, initiatives may allow for new construction in potential inundation zones provided they undertake efforts to make structures resilient to tsunami impacts, using strong building materials, heavily anchoring structures, and/or limiting residential uses. Communities may opt to replace older at-risk residential, commercial, or industrial uses with parks and other recreational spaces during redevelopment efforts. The goal of such rezoning would be to limit the number of structures at risk and reduce potential pollution from industrial sites if damaged. Finally, communities may be faced with the purchase or expropriation of the most vulnerable properties. These extraordinary efforts are usually taken as a last resort and are used to reduce the population living within the risk zone, remove potentially hazardous commercial or industrial uses in the inundation zone, and/or to reduce the amount of material that may become debris during a tsunami.

IMPROVEMENTS TO EVACUATION ROUTING

Most communities facing tsunami risk on Vancouver Island have some type of evacuation planning in place. A significant body of literature, both academic and practitioner-based, exists exploring evacuation optimization, for vehicles and pedestrians. These efforts seek to improve evacuation conditions, identify and improve chokepoints, and generally optimize evacuating routing to safer locations. Such initiatives often include lane reversals, streamlined traffic controls to increase the flow of traffic out of at-risk areas, road/sidewalk widening efforts, emergency 'shortcut' routes out of vulnerable communities (used only during emergencies), and improvements to evacuation routing signage. The goals here are to help reduce barriers to a free flow of evacuees from potentially threatened areas to safer locations. These efforts help to protect pedestrians (and often cyclists) and to ensure a clear route to safety is available and identifiable from any point in a tsunami inundation zone. Such improvements can be especially helpful to communities with high numbers of tourists, who are unlikely to know how to respond in the event tsunami warning broadcasts start wailing. Some in the region have expressed fears that prominent signage about tsunami risk could impact property values in the inundation zone. Unfortunately, there has not been an extensive study of this potential effect in the North American context. Limited studies from the U.S. appear to indicate that there is no statistically significant impact on housing values related

to proximity to tsunami inundation zones when all other factors are accounted for, and this is likely to be true for tsunami warning signage as well, although further study is required.¹²

STRUCTURAL PROTECTIONS

Structural protections—such as dyking, barrier construction, flood proofing, seismic improvements, and tsunami-resilient construction—may also be helpful in some situations. These structures can be expensive to build and maintain and are very dependent on local geography. While the use of dykes is common throughout the world, other large-scale structural protections—such as those seen in Japan—are not particularly common in North America. Further, there are concerns from some that such efforts may result in a false sense of security and may lead vulnerable residents to feel safe when they might not be. There are also concerns from nearby residents that such structures may obscure the views of the water they have come to enjoy. Broader seismic improvements that also incorporate tsunami-resilient aspects may help reduce damage in some circumstances, but such efforts are currently quite limited in Canada.

Vertical Evacuation Structures

[Vertical evacuation](#) is a concept that has seen some development in Japan and other Asian communities and is starting to be explored in the North American context. In cases where long distances must be travelled from at-risk areas to the nearest safe destinations on higher ground, or where local populations (e.g., young children, the disabled, or the elderly) would be unable to make such an evacuation in a timely manner, tall reinforced structure can be created that provide above-water refuge within the potential inundation zone (Figure 5 and Figure 6, below). The first published guidelines for vertical evacuation structures in North America were created by the U.S. Federal Emergency Management Agency (FEMA) in 2008,¹³ and the first vertical evacuation site on the continent was an elementary school in Westport, Washington that was constructed in 2015–2016.¹⁴ Vertical evacuation options for B.C. have been discussed in several media articles over the past several years.¹⁵

¹² The most detailed exploration of this effect we could find in a North American context showed other factors far outweighed tsunami-risk-related impacts on housing value: Harris, S. W. S. (2015). *A Hedonic Regression Analysis of Humboldt Country Property Data Integrating the Effect of the Tsunami Evacuation Boundary on Real Estate Price* (master's thesis). Humboldt State University, Arcata, California.

¹³ FEMA. (2015). Guidelines for Design of Structure for Vertical Evacuation from Tsunamis. *FEMA website*. Retrieved February 4th, 2019 from <https://www.fema.gov/media-library/assets/documents/14708>.

¹⁴ Washington Emergency Management Division. (2015, 16 January). Breaking New Ground on Nation's First Tsunami Vertical Evacuation Site. *Washington Military Department website*. Retrieved February 4th, 2019 from <https://www.mil.wa.gov/blog/news/post/nations-first-tsunami-vertical-evacuation-center-breaks-ground>.

¹⁵ Two examples include "[Coastal Communities at Risk of Tsunamis Consider the Merits of Evacuating Up](#)," published June 30th, 2018 by the Vancouver Star, and "[Tofino Considers Tsunami Evacuation Towers](#)," published July 6th, 2018 by City News 1130.

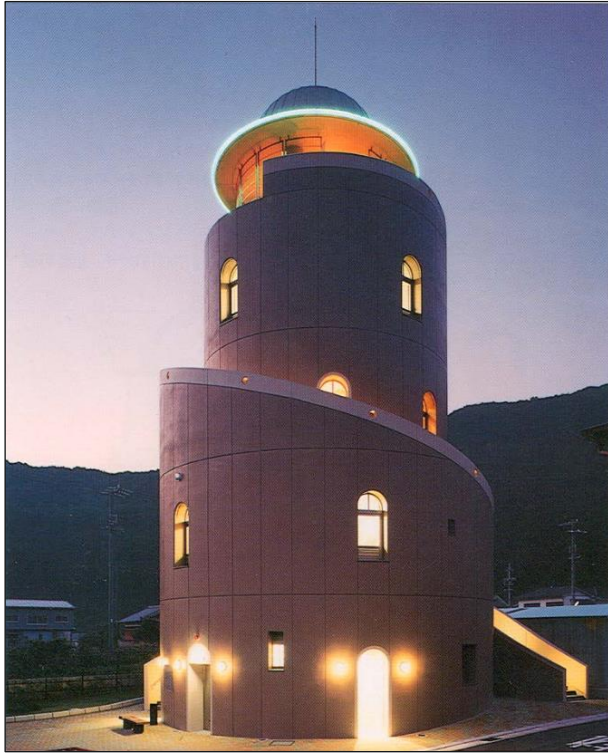


Figure 5: Nishiki Tower Vertical Evacuation Site in Kise, Japan
(Source: FEMA P-646, 2012)



Figure 6: Tasukaru Tower Life-Saving Tower in Japan
(Source: FEMA P-646, 2012)

Public Education Programs

It is important that residents in at-risk communities attain at least a basic understanding of the risks they face from earthquakes and tsunamis, including how to prepare their households and families to be ready to respond, should the need arise. Vulnerable residents should know what warning systems are in place, where they should go, and how they should get there. This includes not only planning for when a family is at home, but also how they will respond if they are at school or work, or out in the community. It should also extend to a [communications plan](#) to ensure separated family members are able to re-connect with one another safely once everyone is out of the inundation zone.

It is important that efforts to inform vulnerable publics about tsunamis extend beyond the Earth Science lectures of how tsunamis form to include information about potential impacts and how households should respond in the event of a tsunami watch or warning. Public communications around tsunami risk should provide at-risk residents with information about where the tsunami inundation zone is located, what evacuation routes they should follow when leaving the zone, and where they can go for shelter. Additionally, information relating to household and workplace preparedness planning has been shown to go a long way towards improving community resilience to tsunami hazards.

Public education approaches usually take several forms in order to reach the widest possible audience. Not all members of the community read the newspaper, listen to the radio, use social media, or would

be interested in attending preparedness workshops. However, a significant portion of the population is likely to participate in at least one of these activities. Educational messaging can be as simple as regular reminders about tsunami risk on government websites and social media accounts, notes attached to property tax bills, or increased public signage. These sources can provide links to more detailed information for those who are interested, and signage can also inform visitors to the community about how to respond in the event a tsunami alert is issued.

Information that helps residents undertake household preparedness actions or develop personalized household response plans can be conveyed via newspaper articles, media interviews, pamphlets, or on government websites. Existing community evacuation plans, information about local inundation zones, and the locations of designated evacuation centres can be presented to residents via pamphlets for pick up or mailed regularly to residents.

To provide more in-depth information, public information sessions and/or hands-on workshops can help residents to learn about tsunami/seismic risk, help them to develop response plans that fit the needs of their individual households, and teach them how to build emergency response kits (i.e., “Go Bags”). Guided ‘High Ground Hikes’¹⁶ are a relatively new activity for B.C. that actively engages vulnerable residents and encourages them to learn the routes they would need to follow to safety. These hikes also act as mini tsunami drills while educating residents about tsunami risk and response planning.

Municipalities and regional districts can also work with local educators to bring programs into schools, addressing potential tsunami risk using age-appropriate materials available from provincial and federal governments.¹⁷ School drills of their tsunami response plan can reinforce these educational efforts, while also reminding teachers, support staff, parents, and local officials about what actions the school will take if a tsunami watch or warning is issued for the area. Tsunami drills were shown in a recent study from Japan¹⁸ to be crucial in facilitating positive evacuation behaviour in participants compared to those who had not participated, following the Great East Japan Earthquake, though it’s difficult to tell if that is generalizable to a North American context.

Emergency Communication

How communities communicate information about tsunami warnings and related evacuations can vary significantly based on the size and makeup of the community, the level of tsunami risk it faces, and the financial and human resources available. Public warning systems, whether structural public announcement systems or simple sirens, can be very effective at quickly notifying residents about a

¹⁶ PreparedBC has collected information on High Ground Hikes on their website and has facilitated a number of such hikes in vulnerable areas: <https://www2.gov.bc.ca/gov/content/safety/emergency-preparedness-response-recovery/preparedbc/know-the-risks/tsunamis/high-ground-hike>

¹⁷ The ‘Master of Disaster’ program from PreparedBC is a great spot for educators to get started: <https://www2.gov.bc.ca/gov/content/safety/emergency-preparedness-response-recovery/preparedbc/master-of-disaster>

¹⁸ Nakaya, N. et al. (2018). Effect of tsunami drill experience on evacuation behavior after the onset of the Great East Japan Earthquake. *International Journal of Disaster Risk Reduction*, 28, 206–213.

possible tsunami risk. Emergency broadcasting systems have been a central component of emergency communication for decades. Supplementing these with systems that connect to mobile devices can help reach even larger populations with actionable instructions during an active tsunami watch, advisory, or warning. Television and radio broadcasts may provide details to those affected, though it is important to acknowledge that TV and radio are no longer as likely to be where residents first learn about emergencies as in decades past. Today, broadcast messages sent via social media can also be a quick and effective way to reach those with internet access at home, work, or via their mobile devices.

Public warning systems, such as the ones in the Alberni Valley, need to be audible to a reasonable majority of homes and businesses located in the inundation zone to be effective. These may be supplemented through actions from first responders, reverse 911 systems, or text alerts. It needs to be clear to residents when a system is being tested and when it is an actual emergency. If different messages or tones are used in testing versus an actual emergency, this needs to be made very clear to residents so that they know what to expect in the case of an actual warning. Changes from expectations can cause additional stress and confusion to residents at a time when they may already not be thinking clearly, so reasons for differing emergency and test sounds and procedures should be carefully considered before implementation.

Regardless of the form they take, emergency broadcasts must address five specific elements: what the source of the hazard or risk is, which locations are at risk, what guidance or instructions residents should follow, and a reasonable indicator of the amount of time available to react.^{19, 20} If evacuations are called for, instructions should also indicate safe places people can or should go where basic services such as washrooms, drinking water, and first-aid will be available. Clear communications also benefit visitors and tourists in the community. These individuals may not be aware of the risks associated with tsunamis or have any idea how they should respond during an evacuation.

It should be clear to most people in a danger zone when they need to act and what form those actions should take. It is important for communicators to understand that during an emergency the public generally follows a sequence of steps: i) hearing the warning; ii) understanding the contents of the warning message; iii) determining the credibility of the message; iv) personalizing the warning to oneself or one's household; v) confirming that the warning is true and that others are also taking action; and vi) responding by taking protective action (or, alternatively, actively choosing not to take action).²¹

Clear, consistent, and regular communications from authorities are critical during emergencies, and affected municipalities should take all reasonable efforts to connect with residents using the sources residents are using to look for information. Television, radio, government websites, and social media are

¹⁹ That said, it is human nature to take as long as we have available and leave at the last possible moment, so emergency messaging should take this behavior into account.

²⁰ Sorensen, J. H. (2000). Hazard warning systems: Review of 20 years of progress. *Natural Hazards Review*, 1(2), 119–125

²¹ Mileti, D. S., Sorensen, J. H., & O'Brien, P. W. (1992). Towards an explanation of mass shelter use in evacuations. *International Journal of Mass Emergencies and Disasters* 10(1), 25–42.

an excellent start, but variable messaging road signs can also be helpful and can adapt to changing conditions. Whiteboards or other updateable messaging boards can be posted at evacuation centres, registration sites, and other prominent locations and updated with official information as it becomes available. Where possible it should be clear when the next update can be expected, and that updates may come sooner if warranted. Even an update that indicates that no update is currently available can help to reassure the public that their safety is being considered and that officials are being transparent and communicating all relevant information to the public.

Having access to current information from effective communicators can significantly help to reduce stress and anxiety associated with evacuation situations and can help build goodwill and trust with residents. Likewise, a poor communication strategy can destroy years of trust for some in a matter of minutes.

Household Preparedness Planning

While household preparedness is not a silver bullet, prepared households have generally been shown to be better able to weather the events during and following a disaster.²² Household preparedness should be viewed as a spectrum, rather than as *prepared* or *not prepared*. Small actions taken by households in advance can help to save time during an evacuation, can improve the evacuation experience, and in some cases can reduce the impacts households experience following disasters. That said, prepared households are still likely to be affected following a tsunami.

Household preparedness information is often conveyed to residents via pamphlets; on local, regional, provincial, or federal government websites; or some combination of these sources. An increasing body of evidence suggests that these passive methods of providing risk information do not result in the adoption of significant household preparedness by affected residents. At most, a Red Cross survey suggests that 20% of those who access the information will go on to take *any* steps towards preparedness planning. Most residents simply will not access the information from these *passive* sources.²³

A better approach—and one we saw mentioned in comments from our survey participants—is to engage with interested residents to actively assist them in household preparedness. Active participation events can include information seminars and hands-on workshops, with the latter being shown to result in greater uptake by residents. These events, if held regularly (for example, quarterly) and well advertised, can engage interested community members to determine what actions they can take to prepare based

²² Cramer, L. A, Cox, D., & Wang, H. (2018). Enhancing a Culture of Preparedness for the Next Cascadia Subduction Zone Tsunami. In *Coastal Heritage and Cultural Resilience* (pp. 243–264). Springer, Cham.

²³ American Red Cross. (2009). American Red Cross Emergency Preparedness Survey. In Uscher-Pines et al. (2012). Citizen Preparedness for Disasters: Are Current Assumptions Valid? *Disaster Medicine and Public Health Preparedness*, 6(2), 170–173.

on their own personal needs. Such efforts may also help build social networks and encourage a sense of community, which may help to reinforce the goal of a prepared and resilient community.

A great example of an active participation event is High Ground Hikes, which have recently begun in B.C. In these free events, community members 'hike' from a location within a tsunami inundation zone to a place of safety on higher ground. Such events not only bring residents together with local experts to learn about tsunamis and generally raise awareness of emergency preparedness planning, but they also help build a sense of community. Recent events in Tofino have seen strong participation.²⁴

Regardless of how preparedness information is presented, it is important to note that many low-income residents lack the funds, time, and often even the storage space required to maintain an adequately stocked disaster response kit. Those who rent also face additional challenges, as they may not be able to implement changes to improve household safety. However, there are still small actions individuals and households can take to reduce the barriers and anxiety they may face during a future evacuation. A simple household communication plan that helps separated family members safely reconnect during an evacuation can be very helpful, takes only 30 minutes or so to create, and costs virtually nothing. Likewise, learning in advance where shelter will be made available can ensure affected residents know where to go should warning sirens sound again.

²⁴ Bailey, A. (2018, 29 March). High Ground Hike sees big turnout in Tofino: Locals brush up on emergency preparedness. *Tofino-Ucluelet Westerly News*. Retrieved March 7th 2019 from <https://www.westerlynews.ca/community/high-ground-hike-sees-big-turnout-in-tofino/>

Our Research



Figure 7 : The Port Alberni Maritime Discovery Centre (Source: the author)

The primary goal of our research was to explore public and official perceptions surrounding tsunami risk and how the January 2018 evacuation event may have altered those perceptions. We identified four key research questions that we wanted to address as part of this study:

1

How was the tsunami warning and evacuation perceived from the different perspectives of emergency officials and community residents?

2

How did residents living in the tsunami inundation zone respond to the tsunami warning and evacuation?

3

What difficulties did residents experience while evacuating, and what lessons can emergency planners learn from these experiences?

4

What impact has this event had on community perceptions of tsunami risk, their trust in emergency officials, and their participation in future evacuations?

How the Research was Conducted

To assess public and official perceptions of this event we needed access to a reasonable sample of the affected population and those officials responsible for developing and implementing local emergency plans. We undertook three different approaches to ensure appropriate information was collected for both groups:

PUBLIC'S PERCEPTIONS:

- A targeted door-to-door survey was undertaken to connect with households located within the tsunami inundation zone and along its fringe; and
- A broader online survey was open to all residents of the Alberni Valley, regardless of their proximity to the inundation zone.

OFFICIALS' PERCEPTIONS:

- In-person and telephone interviews were conducted with past and present emergency planners, emergency managers, first responders, and elected political representatives (collectively referred to as 'officials' herein).

The Door-to-door Survey

The door-to-door survey consisted of approximately 40 questions, plus some basic household demographic information. The survey was dynamic and adapted to responses from participants to present only questions that were relevant to each participant's experiences. On average, surveys were completed in ten to fifteen minutes at the doorstep.

This survey was conducted in the Alberni Valley between Tuesday, April 4th and Monday, April 9th by the authors. **During this time, we visited more than 400 households and spoke with residents in approximately 275 homes. Of these, 111 residents agreed to complete the doorstep survey.** This response was considerably larger than expected.

In addition, leaflets describing the study and a link to the online survey were left with many residents who indicated that it was not convenient for them to complete the survey at the doorstep. We were able to track these addresses and determined that many of these residents did go on to complete the survey online.

	Door to Door Surveys
Total households visited	> 400
Residents spoken to	275
Completed surveys	111

The Online Survey

The online survey was conducted through the UBC Qualtrics survey system and consisted of approximately 45 questions, plus some basic household demographic information. The survey was dynamic and adapted to responses from participants to present only questions that were relevant to participant experiences. On average, online surveys were completed in 15 to 30 minutes, depending on the depth of responses provided by the participants.

Online Surveys

Surveys initiated	366
Surveys completed	358
Verified addresses	353

Information about the online survey, including a link to take the survey, was included on posters placed in prominent locations around Port Alberni, on posts to academic and regional social media accounts, and included in media coverage of the study.

The online survey ran from Sunday, April 1st through Monday, April 30th. This survey was open to all residents of the Alberni Valley. **In total 366 surveys were initiated, and 358 of these surveys were completed. Of these, we were able to confirm that 353 responses were from adult (19+) residents living in the community who were present at the time of the tsunami warning and evacuation.** Again, this response was considerably larger than we had anticipated and will allow us to perform a more in-depth analysis than originally planned.

Interviews with Officials

A total of 11 interviews were conducted with past and present emergency planners, emergency managers, first responders, and elected political representatives. Most interviews were conducted in person between April 4th and April 9th during our visit to the community. A few additional interviews were conducted later by telephone for individuals who were not available during our visit.

Interviews were semi-structured, with a set of pre-established questions forming the core of a wide-ranging discussion that was tailored to the responsibilities and responses of each participant. Participants were emailed a copy of the initial question set prior to the interviews but were encouraged to speak about topics that they felt were important from their own experiences during the evacuation.

These interviews allowed us to explore preparedness planning that had gone into the development of the community's tsunami response plan, to discover how each participant experienced the early morning evacuation, to identify any difficulties they experienced in their roles, to explore areas that worked better than expected, and to highlight what aspects of the evacuation have been identified for additional attention in the future. The interviews also allowed us to explore the thinking behind various aspects of the official plans and procedures, to determine what information was available to key decision-makers, and to discuss briefly some 'What if?' scenarios with planners and managers.

Interview participants tended to be positive and were quite open and frank about their experiences during the period of the tsunami warning and evacuation. They shared their perceptions around community preparedness, response planning, and tsunami risk. Most importantly, they helped us to establish a solid timeline of events for the morning, placing issues and difficulties into a broader context that was not available to us from media reports and conversations with members of the public.

Why Conduct this Research?

Mass evacuations due to natural hazards are, thankfully, quite rare in Canada. Those that do occur are most often related to large-scale flooding or wildfire. These events tend to impact large areas, usually resulting in the destruction of housing, businesses, and infrastructure.

This tsunami evacuation event in the Alberni Valley represents an opportunity for us to explore the impacts of evacuations without the associated destruction of personal, commercial, and industrial property and infrastructure that can occur. By studying an event without the stress and anxiety related to social and physical impacts to our participants, we believe we were better able to explore the impacts the evacuation process itself had on the community.

Port Alberni and the Alberni Valley are, in many ways, representative of small and medium-sized coastal communities across the country. As such, we believe that much of the knowledge gained from this study can help to inform public safety and natural hazards response planning in communities from Vancouver Island to Newfoundland. While tsunamis are the hazard being explored in this study, similar processes exist for other hazards affecting Canadian communities and some lessons identified should be applicable in other contexts.

Finally, this was an excellent opportunity to gather real-world evacuation data that will help improve academic understanding of the human behaviours expressed during an emergency evacuation. Researchers can use this information to improve evacuation modelling, develop agent 'behaviours' to mimic those of actual evacuees, and validate our understanding of evacuation modelling.

Research Findings

As part of our research we spoke with residents at more than 275 homes in Port Alberni. Around 40% of these residents agreed to complete our doorstep survey. Due to our sampling methods, most of these homes were located within the official tsunami inundation zone.

Our online survey resulted in 353 surveys that we were able to verify were from homes located in the Alberni Valley and where residents were home at the time of the tsunami evacuation. Addresses for both surveys were manually assessed by our research team to determine whether participating households were located within, or outside, the inundation zone. We split the results from the two studies based on their location relative to the inundation zone and whether members of the household evacuated during the January event. There were also six survey responses from residents who were not present in the community at the time of the evacuation. The breakdown of the survey participants is shown below:

Table 1: Survey Results Broken Down by Survey Type, Household Location, and Evacuation Status.

	Living Within Inundation Zone		Living Outside Inundation Zone		Away from the Community		All Combined	
	Door to Door	Online Survey	Door to Door	Online Survey	Door to Door	Online Survey	Total	%
Household evacuated (full)	90	129	1	65	-	-	285	61%
Household evacuated (partial)	-	4	-	7	-	-	11	2%
Household did not evacuate	7	11	7	137	-	-	162	35%
Not present	-	-	-	-	6	-	6	1%
Sub-Total	97	144	8	209	6	-	464	100%

Socially Vulnerable Populations

A significant body of literature has shown that not all households are equally impacted when disasters strike. Studies from all over the world have shown that some segments of our communities face additional challenges and barriers when responding to a potential disaster. Identified groups include (but are not limited to), those with low income, those with infants and young children, single-parent households, those who are older, those with disabilities, those without vehicles, those living alone, and renters. These socially vulnerable groups are generally (though certainly not always) less resilient to the impacts of hazards-related disasters and may take significantly longer to recover from a tsunami disaster than those in more resilient social groups.

We chose to minimize the personal information that was collected about our study participants due to the mildly invasive nature of our door-to-door survey methodology. As a result, we are limited in our ability to identify whether a given participating household falls into any possible socially vulnerable group. There were, however, four groups we feel face some of the greatest difficulties when evacuating during a tsunami warning that we were able to identify in our data: single-occupant households, households with very young children, households with older residents, and households with disabled residents. To help distinguish households that do not fall into any of these groups, we will use the term “Socially Resilient Population Group,” though we fully acknowledge these households may also face other barriers that were not recorded in our data (e.g., single-parent households).

Table 2: Socially Vulnerable Populations Present During Evacuation

		Living Within Inundation Zone	Living Outside Inundation Zone	Total	%
Socially Vulnerable Populations Groups*	Households with a single occupant	57	28	85	19%
	Households with children 10 and under	43	50	93	20%
	Households with adults 65 and older	92	48	140	31%
	Households with disabilities	39	14	53	12%
	Households in one or more vulnerability groups	165	114	279	61%
Socially Resilient Population Group	Households not in the above groups	76	103	179	39%
				N=458	

* Participant households may fall into more than one vulnerable population group

Approximately **61%** of our study participant households indicated that they fall into one—or more—of these four vulnerable population groups. We've broken out the numbers for these groups above (Table 2).

Evacuation Status of Residents by Location

We combined the responses from our two surveys to learn more about the evacuation status of households. For our purposes, a household was deemed to have fully evacuated if all members of the household evacuated, and to have partially evacuated if one or more individual household members evacuated while one or more members remained in the home.

A spatial analysis of survey responses indicates that most participants living close to the Alberni Inlet and Somass River opted to evacuate (Figure 8). You'll note in the map below two small but significant gaps indicating areas of lower likelihood to evacuate. These gaps are associated with i) Hupacasath First Nations lands that were not surveyed in the door-to-door survey, and ii) the commercial area along Roger Street and Roger Street Park where we received no responses to either of our surveys.

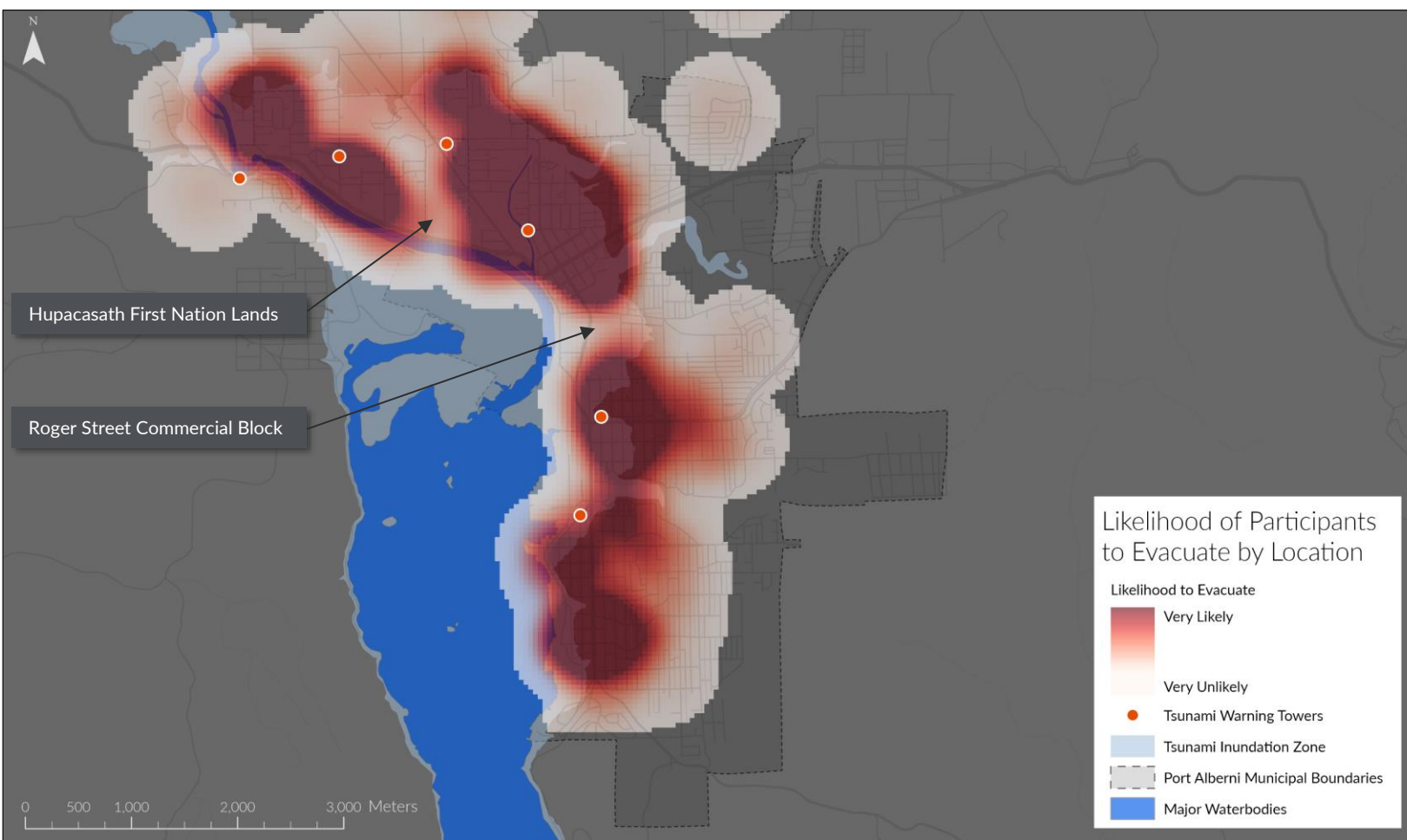


Figure 8: Likelihood of Household Evacuation by Study Participants

Residents Living Within the Tsunami Inundation Zone

We would expect that most of the study participants who live within the inundation zone would have opted to evacuate during the January evacuation. Based on early discussions and media reports we knew this number would not be 100% and expected values somewhere above 90%.

Our study results show that most of the study participants living within the inundation zone did indeed evacuate to safety outside of the zone (Table 3).

Approximately **7%** of participating households located within the inundation zone indicated they did not evacuate during this warning. We address some reasons participants provided for why their households may not have evacuated [later in this document](#).

Table 3 : Evacuation Status for Residents Living Within the Inundation Zone

	Living Within Inundation Zone		Both Studies Combined	
	Door to Door	Online Survey	Total	%
Fully Evacuated	90	129	219	91%
Partially Evacuated	-	4	4	2%
Did not evacuate	7	11	18	7%
Total	97	144	241	100%

Residents Living Outside the Tsunami Evacuation Zone

We would expect that most of the study participants who live outside of the inundation zone would have opted not to evacuate during the January evacuation. Given the opt-in nature of our online survey and early discussions with members of the community, we expected this number to be somewhere in the order of 75%-80%.

Our study results (Table 4) show that roughly two-thirds of study participants who lived outside the inundation zone did not evacuate, as expected.

Approximately **34%** of participating households located outside the inundation zone opted to partially or fully evacuate during this warning. This was higher than our initial expectations. Based on participant feedback from the online survey and discussions with residents during the doorstep survey, we believe some of these individuals chose to

Table 4 : Evacuation Status for Residents Living Outside the Inundation Zone

	Living Outside Inundation Zone		Both Studies Combined	
	Door to Door	Online Survey	Total	%
Fully Evacuated	1	65	66	30%
Partially Evacuated	-	7	7	3%
Did not evacuate	7	137	144	66%
Total	8	209	217	100%

evacuate due to the confusion around the exact location of the inundation zone boundaries while others referenced an abundance of caution or a lack of clarity around what the “air raid” style warning siren meant. As noted above, the opt-in nature of the online survey likely results in a [self-selection bias](#), which is likely to be stronger for those living outside the inundation zone.

Evacuation Status of Vulnerable Households

If we compare the evacuation status of socially vulnerable households to more resilient households located within the tsunami inundation zone, an interesting trend appears. Households that did not fall into any vulnerability groups tended to have an evacuation rate of approximately 89%. This is slightly lower than the overall average of 91%.

Households with members in one or more vulnerable population groups were around 5% more likely to evacuate than households with no vulnerable population groups. This was true for all social vulnerability groups except single-occupant households, which had the same likelihood to evacuate as less vulnerable households. The group most likely to evacuate appears to have been households with one or more children aged 10 and under, with 98% of participating households in this group opting to evacuate.

Table 5: Evacuation Status for Vulnerable Populations Compared to Less Vulnerable Population Living in the Inundation Zone

		Full Evacuation	Partial Evacuation	Total Evacuations	Total Households	%
Socially Vulnerable Populations Groups*	Households with a single occupant	51	-	51	57	89%
	Households with children 10 and under	40	2	42	43	98%
	Households with adults 65 and older	84	17	85	92	92%
	Households with disabilities	36	-	36	39	92%
	Households in one or more vulnerability groups	152	3	155	165	94%
Socially Resilient Population Group	Households not in any vulnerability groups	67	1	68	76	89%
* Participant households may fall into more than one vulnerable population group					N=458	

Socially vulnerable populations are often less able to respond to an emergency quickly, and some groups—particularly those with mobility issues—may be slower to initiate an evacuation. It may, therefore, be valuable to communities with larger vulnerable populations to assist and encourage these groups to implement household preparedness plans to help them evacuate more quickly. The fact that we see these groups are more willing to respond is encouraging. However, data from our study does not help us to understand *why* they were more likely to evacuate during this event.

Analysis of Participant Evacuation Experiences

It was important for us to gather information about how residents responded to the tsunami warning and evacuation to answer some of our research questions. These experiences reflect how these events were perceived by individual households, and what actions they took during the evacuation. We can use this data to tailor how information is conveyed to residents during an emergency, adjust local emergency plans, and help guide evacuation modelling efforts.

How had Participants First Learned of the Warning & Evacuation?

A critical question for emergency planners and managers alike is how to get information about imminent emergencies to as broad a population as possible as quickly as possible. We asked study participants how they first learned about the tsunami warning and evacuation to help us determine methods of communication were most effective at reaching a large audience. We summarize these responses in Table 6, below.

55% of our study participants indicated they first learned about the tsunami warning and evacuation from hearing the official community tsunami warning system.

We know from conversations during our doorstep survey and comments from online surveys that other participants learned of the warning from friends or family living in Eastern Canada or overseas. These distant contacts were already beginning their day at the time the sirens sounded in the Alberni Valley. Participants noted that they received text messages, phone calls, or instant messages from their friends and family warning them of the tsunami alert or checking in to see if they were safe.

Some night owls indicated to us that they first heard about the warning and evacuation via social media posts, news articles appearing on TV, or web-based news sources. A few reported first hearing about it on the local radio once the evacuation had started and The Peak FM radio station started reporting on the evacuation.

Several community-minded individuals reported knocking on the doors of their neighbours to make sure they were aware of the evacuation, and some offered assistance and transport, particularly to neighbours without vehicles or unable to drive.

Table 6: First Warning of the Tsunami Warning & Evacuation for Residents Present During Evacuation

	Living Within Inundation Zone		Living Outside Inundation Zone		All Combined	
	Door to Door	Online Survey	Door to Door	Online Survey	Total	%
Community's warning system / siren	50	78	7	115	250	55%
A neighbour, friend, or family member by Phone	21	29	1	34	85	19%
A posting on social media	2	9	-	14	25	5%
An emergency responder via loud speaker	-	6	1	13	20	4%
A neighbour, friend, or family member by text message	5	2	-	8	15	3%
A neighbour, friend, or family member knocking on door	6	4	-	4	14	3%
Other	11	16	-	20	47	10%
Not sure or not reported	1	-	-	1	2	<1%
Total					458	100%

That said, a small number of the participants we heard from in our study indicated that they had not heard about the tsunami warning or the evacuation until well after it had started, and in some cases not until after it had already ended.

We heard that the siren was incredibly loud and very difficult to ignore in some places, while others reported sleeping right through the sound and learning about the event from other sources. It is quite likely these results would be different if the tsunami warning had been issued when residents are normally awake, such as during a weekend day or an early evening.

Was the Tsunami Warning System Audible?

We were aware from past research in the area that the monthly tests of the tsunami warning system were not always audible to all residents in all homes located in the inundation zone. This is a known issue with both warning siren and public announcement-style warning systems. The sounds generated by these systems travel through the environment, getting quieter with distance. Any interaction with the environment, including buildings, trees, or hills, can cause the sounds to reflect, causing distortions, amplifying or quieting the sound to some degree. Such effects often combine with one another to make

the sounds difficult to make out. This can mean that houses a short distance away from each one another can experience the sounds of the warning towers very differently.

The City of Port Alberni and the ACRD were aware that the hilly nature of the local geography, coupled with areas of heavy vegetation and straight-sided buildings, could result in areas of the inundation zone where it was difficult to hear or understand the warning system. As part of our study, we wanted to see if our participants were able to

hear the warning system at their homes on the morning of the evacuation, even if the warning sound wasn't what first alerted them to the tsunami warning. The results from this question are broken down by region and survey type in Table 7.

Approximately **13%** of our study participants indicated that they could not hear the tsunami warning system from their homes the morning of the evacuation. This number drops to around **9%** when we look exclusively at participants living within the inundation zone.

We were hopeful that our combined surveys, with over 450 results, would provide us with the geographic coverage necessary to perform a spatial analysis to help identify areas where the siren and public address announcements could not be heard within the inundation zone.

The results of our analysis (Figure 9, below) proved to be inconclusive and open to interpretation. For example, gaps in our survey coverage imply areas that it might be difficult to hear the warning system when in reality there is simply no data one way or the other. Further, it was not uncommon to have neighbouring households provide very different responses to this question, making it difficult to determine from our data if these effects related to the geography of the region, or individual abilities to hear (either especially well or especially poorly) the specific tones related to the warning system. **We, therefore, recommend using caution when drawing conclusions about how well the system can be heard at any given location in the community from the map in Figure 9.**

Table 7 : Was Warning System Audible Morning of Evacuation?

	Living Within Inundation Zone		Living Outside Inundation Zone		Both Studies Combined	
	Door to Door	Online Survey	Door to Door	Online Survey	Total	%
Yes, it was audible	84	125	8	162	379	83%
No, not audible	10	14	-	37	61	13%
Uncertain	1	4	-	9	14	3%
Not reported	2	1	-	1	4	NA
Total	97	144	8	209	458	100%

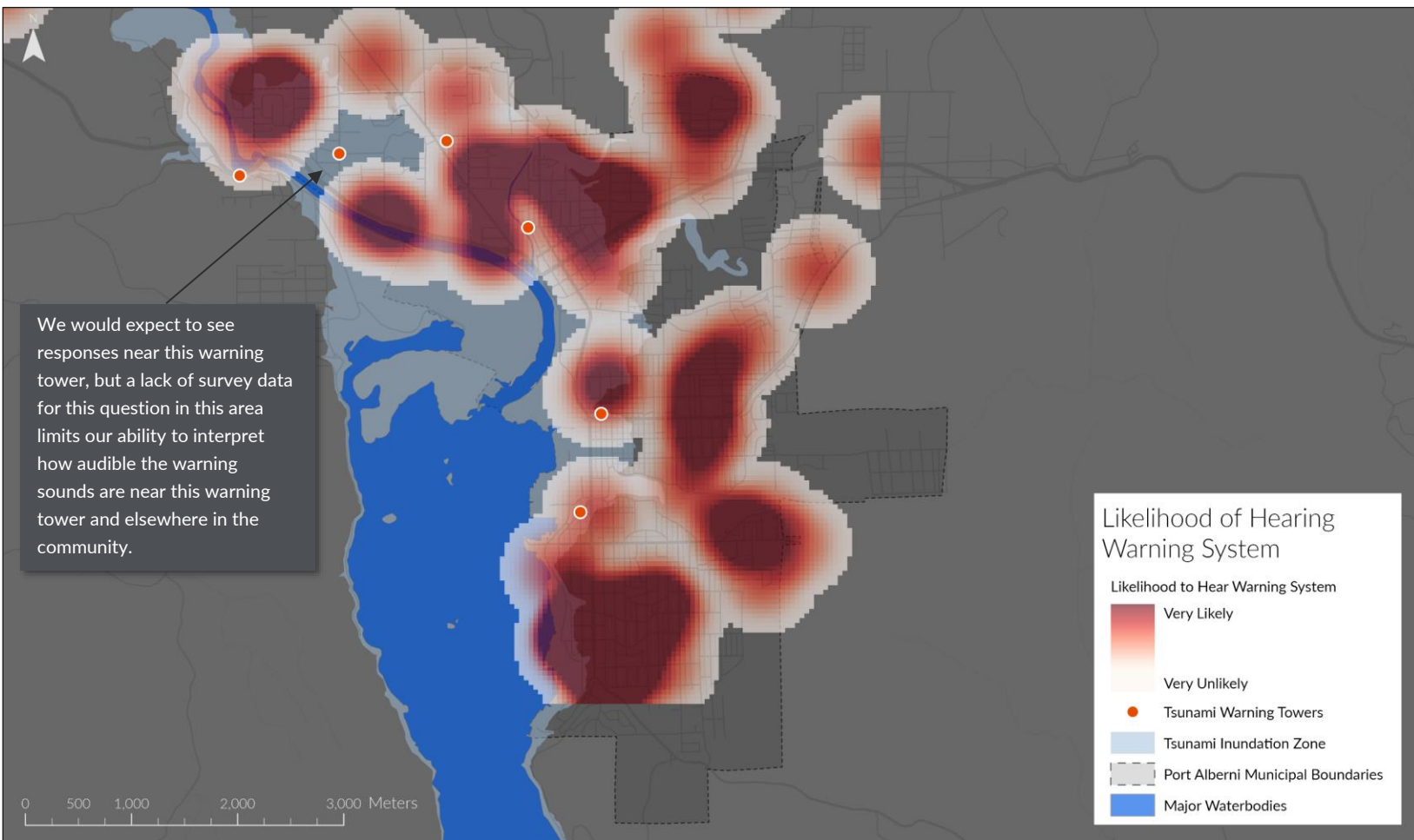


Figure 9: Likelihood of Hearing Official Tsunami Warning System Siren & Announcements

How did Residents Evacuate?

When it comes to evacuation planning, it is important to know how your community's residents will be moving to safer locations. In Canada, the passenger vehicle is generally the dominant mode of transport. Pedestrian evacuations are also common throughout the country, particularly in warmer regions. Bicycles, snowmobiles, all-terrain vehicles (ATVs), boats, and airplanes have all seen use in evacuations in different areas of the country.

In Port Alberni, we expected most of our study participants—and the population in general—would opt to evacuate using passenger vehicles (cars, light trucks, vans and recreation vehicles). We expected a small number of participants to report evacuating on foot. We also expected some of these pedestrians would convert from an on-foot evacuation to a vehicle evacuation part-way through, either by travelling on foot to the home of a friend or family to evacuate with them by vehicle or as a result of being picked up mid-way through their evacuation. The breakdown of results reported by our study participants is shown in Table 8, below.

Table 8 : Mode of Transport and Number of Vehicles Used to Evacuate Household

	Living Within Inundation Zone		Living Outside Inundation Zone		Vehicle-Only Evacuations		All Evacuations	
	Door to Door	Online Survey	Door to Door	Online Survey	Total	%	Total	%
On Foot	2	3	1	6	-	-	12	4%
1 Vehicle	75	101	-	59	235	84%	235	80%
2 Vehicles	10	26	-	7	43	15%	43	15%
3 or More Vehicles	1	2	-	-	3	1%	3	1%
Total	88	132	1	72	281	100%	293	100%

Around **96%** of evacuating participants indicated that their household initially evacuated by vehicle. Only 4% of study participants indicated they initially evacuated on foot, which was lower than expected. None of our participants reported evacuating by means other than vehicles or on foot.

How Many Vehicles Did Households Use to Evacuate?

A key data point we will need to develop evacuation models for the Alberni Valley in the future is the average number of vehicles used by evacuating households. This information helps us to estimate the number of vehicles that different household types are likely to use when evacuating. Knowing this information helps us to properly estimate the number of vehicles on the road during an evacuation, allowing us to identify areas of potential traffic congestion and to assess how vehicle-pedestrian interactions may affect regional evacuation efforts.

We expected that most households that participated in the evacuation using vehicles would use a single vehicle given the average number of household residents in the community from the latest census data. For the purposes of this study, a 'vehicle' included passenger cars and trucks, vans, and recreation vehicles (RVs). Vehicles with attached trailers or camper units were counted as a single unit. Our results are shown in Table 8, above.

Of those evacuating by vehicle, **84%** of study participants indicated that their household used only a single vehicle. Another 15% reported using two vehicles, while only 1% reported using three or more vehicles.

To Where did Residents Evacuate?

A critical question in evacuation planning is where evacuating residents will go for shelter during an evacuation. Knowing the evacuation destinations of community residents help us to assess the needs of evacuees in terms of the number and size of evacuation centres required, and to estimate the impacts on evacuation route congestion.

Based on prior discussions with emergency managers and general knowledge of the community, we anticipated the largest percentage of evacuees would travel to the homes of friends or family, with commercial parking lots and the official evacuation centre at the Echo Recreation Centre as other popular destinations. We were also aware anecdotally that many chose to travel to 'The Hump.'²⁵ For our purposes, we limited responses to the first location outside the inundation zone that residents reported stopping. The results from the surveys are shown in Table 9.

We found that **40%** of study participants reported evacuating to the home of friends or family,

with only **3%** indicating that the Echo Recreation Centre or nearby Alberni Valley Multiplex was their first destination.

The second-most popular destination reported by study participants, at 35%, was the parking lots of large businesses such as Walmart, Canadian Tire, and grocery stores. This also included restaurants that are open late, such as Tim Hortons. For the most part, these parking lots tend to be large, open spaces that can accommodate many vehicles, and are relatively easy to access. When associated stores are

Table 9: Evacuation Destinations Reported by Evacuating Residents

	Evacuating Participants		Both Studies Combined	
	Door to Door	Online Survey	Total	%
Home of friend or family	33	82	115	40%
Commercial parking lot / restaurant	33	68	101	35%
The Hump	3	16	19	7%
Above the tracks or to higher ground	8	11	19	7%
Port Alberni Hospital	2	7	9	3%
Echo Centre/Alberni Valley Multiplex	-	8	8	3%
Other	7	13	20	7%
Total	86	205	291	100%

²⁵ For those not familiar with the region, "The Hump" is the name given to the stretch of Highway 4 along the summit of the mountains that divide the east and west sides of Vancouver Island. It is the highest elevation point in the area.

open, they may also provide public washroom facilities and the ability to purchase food, water, and supplies, if utilities like power, water, and sewage have not been affected.

Some of the residents we spoke to indicated that they had travelled to The Hump, Cathedral Grove, Parksville, and even Nanaimo out of an abundance of caution or a lack of clarity around where to go. While there is nothing inherently “wrong” in going well above the 20m elevation of the inundation zone, this is probably unnecessary travel in most situations. Also, because there are no services available at The Hump and only limited washroom facilities at Cathedral Grove, these locations may not be ideal destinations.

Official evacuation centres are generally a good choice for shelter during an evacuation as most services, including washrooms, are usually available (assuming utilities are operating), and there is staff available to provide assistance. The Echo Centre in Port Alberni also has staff trained in First Aid, which may be important for those with minor medical conditions or anxiety associated with the evacuation. However, those with more acute care needs would need to seek such care at the Hospital.

However, only 3% of our participants indicated that they travelled to the official evacuation centre at the Echo Centre. That such a small number of our participants stated that the Echo Centre was their evacuation destination might be related to a couple of key factors. First, residents have been encouraged to take shelter in the homes of friends or family living outside the inundation zone if possible. Doing so may help reduce the strains on the evacuation centre and ensure those who need it most can make use of the services available there. The second major factor was the fact the Echo Centre was not open and receiving evacuees until 4:00 AM, nearly an hour after the evacuation began, which we found concerning.

The Echo Centre was opened in October 1967, the same weekend the towns of Alberni and Port Alberni officially joined to become the city of Port Alberni.²⁶ While the centre is in good shape for a building of its age, building codes and construction methods have changed over the past half-century. Combine this with the potential fragility of roads and bridges in the event of a major earthquake in the area, and it may be time to re-evaluate the location evacuation centres in the region. In the event of a worst-case Cascadia-related earthquake and tsunami event, large portions of the city could be cut off from road access to the Echo Centre, possibly including some of the staff required to operate the site in the initial hours of an evacuation.

Evacuation Signage

Knowing how to get to safety during an emergency can be very important, especially if you are unfamiliar with the threat posed by a hazard, new to an area, or simply visiting for a brief time. In areas prone to predictable hazards, like tsunamis, this information is generally conveyed through customized road signs

²⁶ Rardon, E. (2017, 25 October). Port Alberni celebrates 50th anniversary of amalgamation. *Alberni Valley News*. Accessed 7 March 2019 from <https://www.alberniavalleynews.com/news/port-alberni-celebrates-50th-anniversary-of-amalgamation/>

notifying residents and visitors about the location of hazardous zones and which routes to follow to get to safety in the event of an emergency.

When it comes to tsunamis, many affected communities make use of standardized informational street signs. In North America, these signs usually use a white-on-blue colour scheme with a wave motif and a person climbing to higher ground. Signs may be used to mark primary evacuation routes (Figure 11), the beginning or end of the evacuation zone (Figure 10), the location of safe evacuation sites, or some combination of all three.

Some communities, particularly in New Zealand, also make use of painted street markings—usually, large white-on-blue painted sections across roads, similar to crosswalks—to clearly indicate the extent of the tsunami inundation zone for drivers (Figure 12, below). These street markings unambiguously indicate the extent of the evacuation zone and the beginning of the safe zone. Smaller versions of these markings that are similar in size to stop lines can also be used for lesser-used or very wide roads (Figure 13, below) where it would be too expensive for wider markings.



Figure 10: Example of standardized Tsunami Hazard Zone Sign in North America (Source: [Digital Journal](#))



Figure 11: Example of Tsunami Evacuation Route Sign near Tofino (Source: [Times Colonist](#))



Figure 12: Example of Tsunami Safe Zone Road Marking from New Zealand
 (Source: [Waikawa Beach Ratepayers Association](#))



Figure 13: Example of Smaller Tsunami Safe Zone Road Marking from New Zealand
 (Source: [Newswire.co.nz](#))

As part of our study, we wanted to know if Port Alberni residents felt local tsunami warning signage met the needs of residents. **The response to our question was mixed, with almost an equal number of participants feeling signage was clear (39%) versus unclear (37%).** Approximately 21% of the respondents were uncertain, and approximately 3% did not provide a response to the question. The results are broken out in Table 10.

We discuss our impressions of tsunami warning signage in the community later in the [Discussion](#) section of this document.

Table 10 : Evacuation Signage is Clear

	All Participants		Both Studies Combined	
	Door to Door	Online Survey	Total	%
Signage is clear	55	126	181	39%
Signage not clear	35	135	170	37%
Uncertain	7	91	98	21%
Not reported	14	1	15	3%
Total	111	353	464	100%

Tsunami Warning System Siren Confusion

The Alberni Valley tsunami warning system uses the sound of a [didgeridoo](#), a wind instrument played by Indigenous Australians, during their monthly test of the system speakers.²⁷ This sound was selected to vigorously test the speakers and batteries of the warning system during the regular tests, without using the high-pitched 'air raid' style siren normally used in an emergency that might cause panic. The didgeridoo sound was implemented by the region in 2015 after being selected from several options by a group of high school students. Prior to the implementation of the didgeridoo sound, the monthly tests used only a female voice indicating the system was being tested.

In the years since the new sound was implemented, residents have come to expect the gentle, but ghostly sound each month. There was confusion by some when woken at 3 AM to the loud, high-pitched warning siren of an actual tsunami warning. Despite extensive media coverage that the didgeridoo sound would only be used for tests, some residents had come to expect the didgeridoo sound if a tsunami warning were issued, and were unclear what the siren sound meant, with one study participant telling us they thought a nuclear missile had been launched.

We had not anticipated the confusion around the siren in our survey design. However, enough people brought it up in the open-ended comment fields of the online survey, or in our discussions at their doors, that we were able to collect some basic data on how many people experienced confusion. These results are summarized in Table 11, below.

²⁷ An example of the didgeridoo sound can be found about one minute into the video on this Global News story from June 25th, 2015: <https://globalnews.ca/video/2075530/port-alberni-chooses-didgeridoo-for-tsunami-warning-system>.

5% of our study participants indicated either confusion or displeasure related to the use of a different sound for testing of the tsunami warning system and an actual emergency. This may indicate that messaging around the two different sounds used in the system (the didgeridoo vs. the siren) needs to be more clearly and regularly communicated to residents. It may also suggest that while the didgeridoo

sound meets the objectives set out for testing the system (to test the speakers and batteries without causing panic), residents have also come to expect to hear that sound during an emergency and that the confusion experienced in January 2018 may continue in the future.

The New Zealand Ministry of Civil Defence and Emergency Management (CDEM) have created an excellent standards guide²⁸ for tsunami warning sirens based on research from the [University of Canterbury Acoustics Research Group](#) that may provide useful guidance for Canadian communities around the use of such systems.

Barriers to Effective Evacuation Experienced by Residents

It's one thing to know that you need to evacuate and another entirely to quickly and safely reach a safe destination. Evacuating residents may face barriers that make it more difficult, and in some cases impossible, to evacuate to higher ground in a safe and timely manner during a tsunami evacuation. Some of these barriers are structural, some may be personal, and others may be related to how critical information is communicated to residents prior to and during an evacuation.

The January 2018 event was the first major test of the Alberni Valley tsunami warning system since an accidental false alarm in 2006. As such, this event really represents our first ability to explore the impacts of a large-scale evacuation in the region in nearly 12 years. A lot will have changed in that time, as new residents have moved to the community, smartphones have become nearly ubiquitous, and advanced warning technology has changed. Understanding the difficulties evacuees experienced during this event can provide emergency planners with critical information they need to reduce (or even eliminate) some of these barriers in future evacuations.

Table 11 : Confusion Around Didgeridoo or Alarm Sound

	All Participants		Both Studies Combined	
	Door to Door	Online Survey	Total	%
Made comments related to confusion about didgeridoo sound	4	19	23	5%

²⁸ New Zealand Ministry of Civil Defence & Emergency Management (CDEM). (2014, July). Technical Standard [TS03/14]: Tsunami Warning Sirens. Wellington: CDEM. Retrieved March 7th, 2019 from <https://www.civildefence.govt.nz/assets/Uploads/publications/Tsunami-Warning-Sirens-TS-03-14.pdf>

When asked about their evacuation experiences, 52% of evacuating study participants did not report any difficulties in getting to their evacuation destination. For roughly half of our respondents, this was a smooth and effective evacuation experience.

Unfortunately, **48%** of participating evacuees indicated they experienced one or more barriers that they believe negatively impacted their evacuation, which is quite high. We summarize the top barriers identified by our participants in Table 12.

Traffic Congestion

The single largest barrier experienced by evacuating study participants was traffic congestion or slow-moving traffic during their journey. To some degree, traffic congestion is a reality of mass evacuations, as many vehicles are entering the road system at about the same time and generally travelling in the same direction. There are some systemic changes that could be implemented if congestion becomes a serious issue, such as lane reversals, modified traffic signals, and traffic direction by police at key chokepoints.

These efforts can help to reduce strain on the road network under some evacuation conditions.

We understand that people, even those living right on the edge of the inundation zone, are often reluctant to leave a vehicle behind. Vehicles are a significant expenditure, and many are simply unwilling to leave them behind. In a worst-case scenario, those vehicles may take on significant importance, providing residents with short-term shelter, the ability to access shelter in another community, or a place to store their belongings until other arrangements can be made. At the same time, increasing the number

Table 12: Barriers to Effective Evacuation Reported by Evacuating Residents

	Evacuating Participants		Both Studies Combined	
	Door to Door	Online Survey	Total	%
No difficulties experienced	58	96	154	52%
Traffic congestion / slow traffic	25	28	53	18%
Not clear where to evacuate to	1	47	48	16%
Did not know where to get information	4	38	42	14%
Critical information was poorly communicated	-	37	37	13%
Did not hear the tsunami warning system	3	18	21	7%
Did not have access to a vehicle	2	11	13	4%
Did not know about the evacuation	1	6	7	2%
Did not have a driver with a valid driver's license	-	6	6	2%
Long distance to get to safety	-	5	5	2%
Did not feel safe going to the reception centre	1	2	3	1%
Other	3	9	12	4%

* Participants could select more than one barrier

N = 296

of vehicles on the road contributes to the traffic congestion experienced during the 2018 evacuation, slowing down evacuations for everyone, especially those furthest from safety.

Risk Communication

Three of the top five barriers identified by study participants relate to how risk information and evacuation instructions were communicated to residents in advance of—and during—the evacuation. Sixteen percent of participating evacuees indicated they did not know where they needed to evacuate to at the time of the evacuation. Another 14% were unsure where to find the information they needed to make informed decisions about whether they needed to evacuate. Around 13% felt that critical information necessary to decision-making was poorly communicated, particularly via online sources, as noted above.

During emergencies like a tsunami evacuation, evacuating residents need to be able to answer some basic questions: i) “Do we need to evacuate our home?”; ii) “Where do we evacuate to?”; and iii) “How should we get there?” Much of this information can be provided to residents in advance of an evacuation, but all this information should be available to them via official sources at the time an evacuation is initiated. We provide some risk communication guidance in the [Lessons Identified & Best Practices](#) section at the end of this report.

Reasons Given for Not Evacuating

Understanding the reasons why people choose to remain at home during an evacuation can be very useful for officials when developing emergency response and evacuation protocols. The decision by affected residents whether to stay or evacuate is complex and can vary considerably on a case-by-case basis. There may be physical, structural, medical, and even psychological barriers that affect an individual or family’s decision to stay in their homes during an emergency evacuation.

While it can be difficult to specifically address the thought process at work during an evacuation, particularly one initiated at three o’clock in the morning when we might not be at our best, we still felt it was important to see if we could understand why some opted to remain behind.

There were only 22 households in our study that were located within the inundation zone and either opted to remain or were unaware of the evacuation and thus did not evacuate. This is a very small sample size, and while their responses are helpful, we would caution against using these results as a proxy for community response in general. Responses are summarized in Table 13, below.

Approximately 32% of respondents who live in the inundation zone indicated they opted not to evacuate because it was their belief that their homes were located outside the inundation zone. This speaks to a sense of confusion about exactly where the official tsunami inundation zone is located. Unsure of exactly where the boundaries of the zone are located, it can be difficult for residents near the edge of the zone to determine if their home located inside or outside that zone. We received feedback about this fact in our discussions with participants while collecting our door-to-door surveys and noted in the open

comments from the online forms. Currently, the only method for residents of determining if a household is located within the inundation is via the Alberni Valley Tsunami map available on the [ACRD website](#).

Other reasons for not evacuating include not being aware of the evacuation (including sleeping through the alarm), not seeing any point in evacuating, and not believing the tsunami represented a credible threat to their household or the community as a whole. A small number of respondents indicated a fear of looting or theft, that they felt safer at home than at an official evacuation centre, or medical issues that prevented them from leaving.

Table 13: Reasons for not Evacuating Reported by Non-Evacuating Residents

	Living Within Inundation Zone		Both Studies Combined	
	Door to Door	Online Survey	Total	%
Did not believe household located in the inundation zone	2	5	7	32%
Did not know about the evacuation	2	3	5	23%
Did not see the point in evacuating	2	3	5	23%
Did not believe a tsunami represented a threat to household	3	2	5	23%
Did not want to leave for fear of looting / theft	-	2	2	9%
Felt safer at home than reception centre	-	1	1	5%
Other	1	3	4	18%

* Participants could select more than one reason

N = 22

Awareness of Location Relative to Official Inundation Zone

We were aware from past research we had conducted in the area that there was some confusion of residents living near the edges of the official tsunami inundation zone about whether their homes were located inside or outside of the official tsunami inundation zone. We wanted to see how prevalent this confusion was, particularly for those located within the inundation zone. We asked participants, "To the best of your knowledge, is your home located within the official tsunami inundation zone?" and residents could select "Yes," "No," or "Uncertain." We then independently determined if their homes were located inside or outside of the zone and checked to see if they were correct in their beliefs. Residents who mistakenly believe they live outside of the zone may make choices based on these beliefs which may place them and their families at increased risk. Our results for this question are shown in Table 14, below.

Table 14 : Awareness of Household Location Relative to Official Inundation Zone

Reported Location of Participant Home	Verified Location of Participant Home		Both Studies Combined
	Within the inundation zone	Outside the inundation zone	Total
Indicated they lived within the inundation zone	49%	5%	54%
Indicated they lived outside the inundation zone	3%	33%	36%
Uncertain of location relative to inundation zone	2%	8%	10%
Total	53%	47%	<i>N</i> = 464

Approximately **8%** of participating households were mistaken in their understanding of whether their homes were located inside or outside the official inundation zone, while another **10%** admitted to being uncertain about their home's location relative to the inundation zone boundaries.

There are three groups that are of particular interest to this study:

- 1) Those who believe they live *outside* the zone when they actually live within the zone;
- 2) Those who believe they live *within* the zone when they actually live outside the zone; and
- 3) Those who were uncertain of their household's location relative to the inundation zone.

Mistaken Inundation Zone Awareness by Those Living Within the Zone

The first of these groups is the most concerning: those households that are actually located within the boundaries of the inundation zone *but believe that they live outside this zone*. This group makes up approximately 3% of our total sample, and 5% of participating households located within or touching upon the official inundation zone boundaries.

This group is of concern as they may opt to remain in their homes during an evacuation because they mistakenly believe that they are located outside of the danger zone. This risk could be compounded if they also take in friends or family from elsewhere in the inundation zone because of these beliefs.

Mistaken Inundation Zone Awareness by Those Living Outside the Zone

Of less concern are those households that are actually located outside the boundaries of the inundation zone *but believe that they live within the zone*. This group makes up approximately 5% of our total sample,

and 12% of participating households located outside the inundation zone. While on the surface this might not sound that concerning, the issue with this group appears when viewed from the standpoint of road network capacity. As many of these households opted to evacuate, an additional number of vehicles are being added to the road system at a point that may block vehicles farther back into the inundation zone. This increase in vehicles may contribute to traffic congestion, potentially slowing the evacuation of those most at risk within the hazard zone. In the case of an urgent evacuation, as would be needed in the event of a Cascadia-related earthquake, additional congestion could make it difficult—or even impossible—for those needing to travel the greatest distance to reach safety in a timely manner.

Those Who Were Uncertain of Household Location Relative to Inundation Zone

The final group of interest are those participants who were uncertain if their home was located within the boundaries of the official inundation zone. This group makes up approximately 10% of the total number of study participants. When we checked on the evacuation status of these households, 61% opted to exercise caution and evacuated during the January 2018 event. The remaining 39% either opted to remain in their homes or were unable to evacuate.

A quick visual inspection showed that some of these households were located within the fringe of the tsunami inundation zone, and it was even difficult for members of our research team to assess the status of some of these homes visually using the [official inundation zone map](#). However, by moving to a GIS-based solution,²⁹ we were able to objectively establish if a given home was located inside or outside the official inundation zone boundary lines. There were still some participants who lived a significant distance from the inundation zone boundaries, and their confusion is less easily explained.

Given the potential risks involved, we would recommend any households who are unsure of their household location relative to the inundation zone first evacuate and then perform an assessment once they are out of any potential danger.

A systemic solution that reduces confusion and helps residents to become more familiar with their status relative to the tsunami inundation zone is a better long-term solution to this issue. Risk communication efforts by local governments that empower residents to learn about risks and actively engage in risk mitigation planning efforts not only inform residents about risks but may also help to strengthen trust in official planning and emergency response efforts.

Perceptions of Official Response

With any large-scale precautionary evacuation, local governments and individual emergency managers can be placed under additional scrutiny in the days, weeks, and months following the evacuation. The events that lead up to any potential evacuation can vary significantly. This can make mass evacuations

²⁹ Geographic Information Systems (GIS) allow us to precisely map the boundaries of the inundation zone and household properties to remove any doubt when determining if homes are located inside or outside the official zone.

difficult to pre-plan, and almost impossible to test without complete community involvement. As such, there will often be unanticipated complications once an evacuation is initiated.

Given the largely negative framing of media reporting following the evacuation, we were interested to see how residents perceived the official response and the decision-making process behind the evacuation. The results from our combined surveys are provided for review in Figure 14, with positive responses in blue on the left and negative responses in pink on the right.

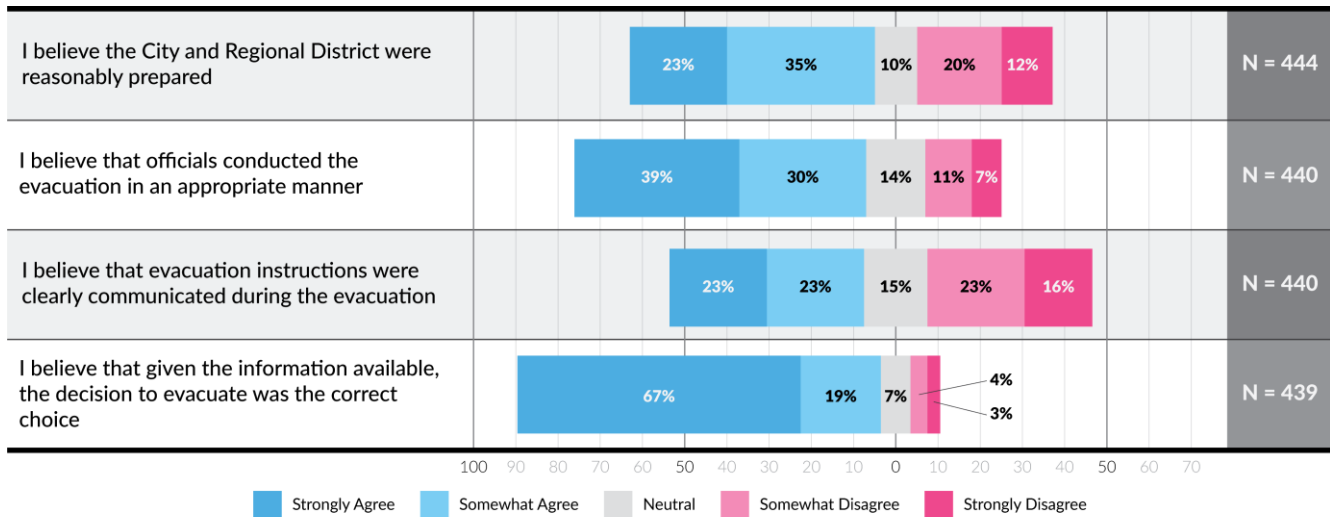


Figure 14: Public Perceptions of Official Response to Tsunami Warning

Approximately **58%** of study participants indicated they somewhat or strongly agreed with the statement “I believe the City and Regional District were reasonably prepared” for a mass evacuation. When asked how they felt the evacuation was conducted, 69% indicated they somewhat or strongly agreed that “officials conducted the evacuation in an appropriate manner.” On the question of the clarity of communications during the event, responses were more mixed, possibly reflecting previous comments about how information was communicated online during the event.

For us, the most critical question related to official response centred on the decision-making around initiating the evacuation of the tsunami inundation zone. To this, **86%** responded that they somewhat or strongly agreed that the decision to evacuate was the correct choice, given the information available at the time. We believe it is fair to say that this response shows public support for the evacuation. Open-ended comments from our online survey and discussions with residents during our door-to-door survey largely support this. Most who elaborated on their answers felt that officials should evacuate the zone if there is a reasonable probability of a tsunami event in the community, even if this means there will be occasional ‘false alarms’ or ‘near-miss’ events.

Our final question in this section asked participant what impact, if any, this event would have on their intentions to evacuate if a future tsunami warning to occur (Figure 15).

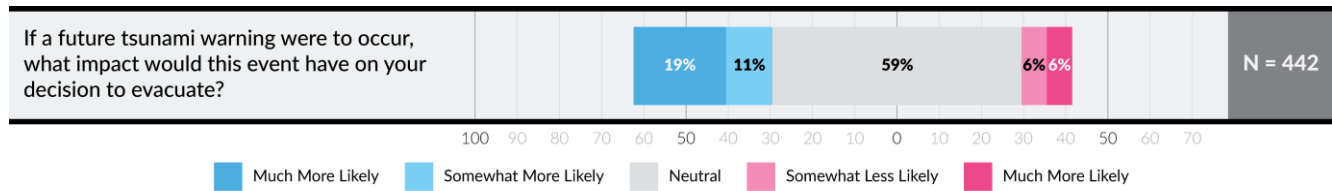


Figure 15: Impact this Event Had on Stated Intentions to Evacuate

59% of our survey respondents indicated that this event was not likely to influence their decision to evacuate in the future. Approximately 30% indicated they would be somewhat or much more likely to evacuate in the future, while 12% indicated they would be somewhat or much less likely to evacuate in a future event as a result of their recent experience.

It is important to place that last 12% into context: some participants indicated they have discovered since the morning of the evacuation that they do not live in the inundation zone, and thus will be less likely to evacuate in the future. This may help to explain some of the reasoning behind this statistic.

Overall, public perceptions of the official response were largely positive, though a small proportion of study participants held strongly negative views. The vast majority of the residents we heard from in person and in the comments of the online survey felt that this event was a success, despite the previously identified online communication issues. There were some specific comments relating to the official response that we address in the discussion section of the paper; however, this event does not appear to have had any overall negative impact on public trust towards emergency officials.

Household and Community Preparedness

We believe that household and community emergency preparedness is a key element to a successful tsunami warning and evacuation response. While not a silver bullet, evidence shows that households and communities that have taken the time to become informed about local tsunami hazards, prepared materials that allow rapid response to a tsunami warning, and have a pre-formulated response plan, are able to respond more quickly than households and communities that have not taken such preparations.

As part of our study, we wanted to explore how informed and prepared the residents of Port Alberni felt prior to and following the January 2018 evacuation. Specifically, we asked our study participants how strongly they agreed or disagreed with five statements about household and community preparedness relating to tsunami risk. The results of these statements are summarized in Figure 16.

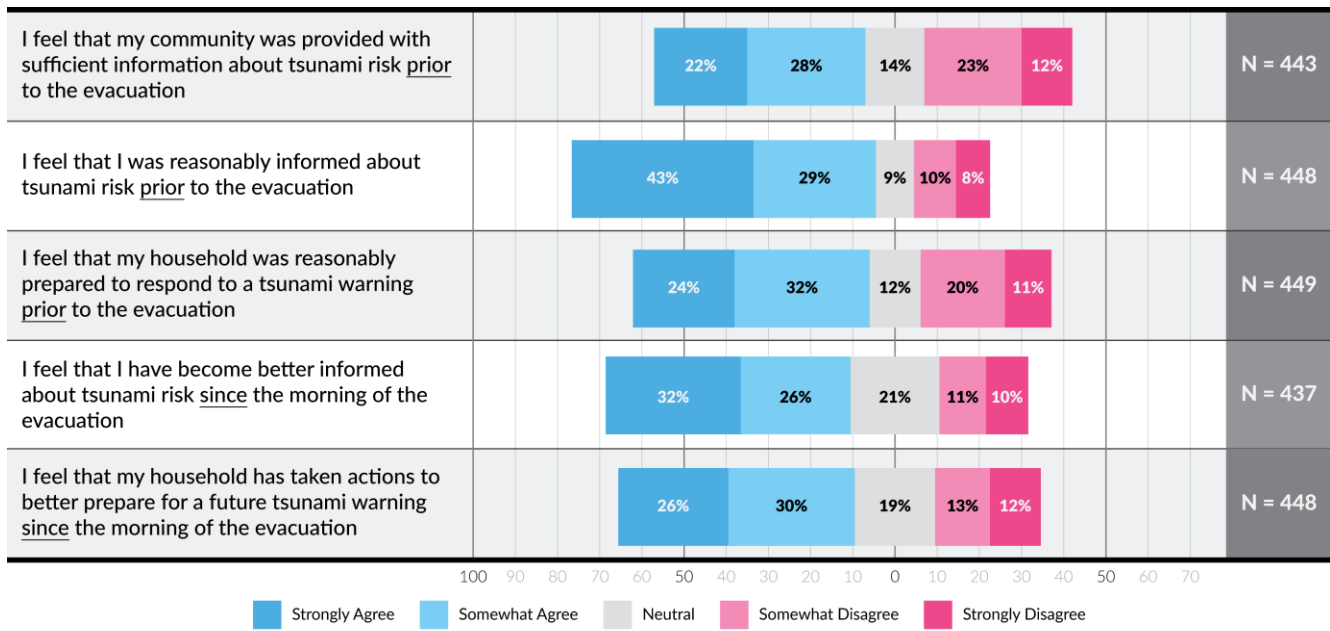


Figure 16: Questions Related to Community and Household Preparedness

50% of study participants indicated that they felt the community had been provided with sufficient information about tsunami risk prior to the morning of the evacuation. Approximately 72% of participants believed they personally were reasonably well informed about tsunami risk (as they personally defined that), and 58% have become better informed about tsunami risk since the morning of the evacuation. Over half (56%) of the study participants indicated their households were reasonably prepared to respond to a tsunami warning prior to the evacuation, and approximately the same number have taken action(s) since the morning of the evacuation to become better prepared to face future tsunami alerts.

We also explored household preparedness planning to see if participating households had emergency response plans in place prior to the evacuation, to gauge how effective those plans were, and to see if plans had been created or updated as a result of this event. The results of these questions are summarized in Table 15 and Table 16, below.

Approximately 40% of participating households reported having any kind of emergency plan and/or emergency kit in place at the time of the January 2018 tsunami evacuation. Of those with plans, only 3% of participants reported that their household plans were not effective at all during the evacuation.

Of those who had plans in place at the time of the evacuation, approximately 62% indicated that they would or had already updated their plans in light of this event. Of those who did not have a plan in place, or were unsure about their household plan, 55% indicated they have already created or intend to create a household emergency plan as a result of the January evacuation.

Table 15 : Household Emergency Evacuation Planning

	All Participants			Total
	Yes	No	Uncertain	N
Did your household have an emergency response plan <u>prior</u> to this evacuation event?	40%	56%	3%	460
If yes: Will you, or have you already, <u>updated</u> your household emergency plan following this event?	62%	36%	2%	181
If no or uncertain: Will you, or have you already, <u>created</u> a household emergency plan following this event?	55%	33%	12%	275

Table 16: Reported Household Emergency Plan Effectiveness

	Very Effective	Moderately Effective	Slightly Effective	Not Effective	N
I feel that our household emergency plan was ...	19%	43%	36%	3%	174

While not perfect, these numbers are encouraging, as it appears a significant portion of the community—at least at the time of our surveys—has reassessed their household tsunami risk and intend to take emergency preparedness actions. Whether they actually undertake those actions would require further study.

Public Perceptions of Tsunami Risk

We asked participants several questions relating to their perceptions of tsunami risk in order to understand how vulnerable communities integrate this type of hazard risk into their daily lives. We also wanted to see if this event changed residents' risk perceptions to any significant degree. The most interesting information from this part of the research appears when comparing households where participants believe their homes are located within the inundation zone compared to those who believe they live outside the zone.³⁰

We asked our study participants to indicate their perceived risk from tsunamis on a scale from zero (very low risk) to ten (very high risk), both for before the evacuation and post-evacuation. We've plotted the results in Figure 17, below. The grey lines in these graphs represent what the trend would be if there

³⁰ We asked participants if, to the best of their knowledge, their home was located inside the inundation zone. While we later worked to confirm the reality of the situation, it is the participant *beliefs* about living inside or outside the zone that were most relevant to, and had the largest impact on, this question.

was no change in risk perception between the two points in time (pre- and post-evacuation). The red lines indicate the average change in risk perception.

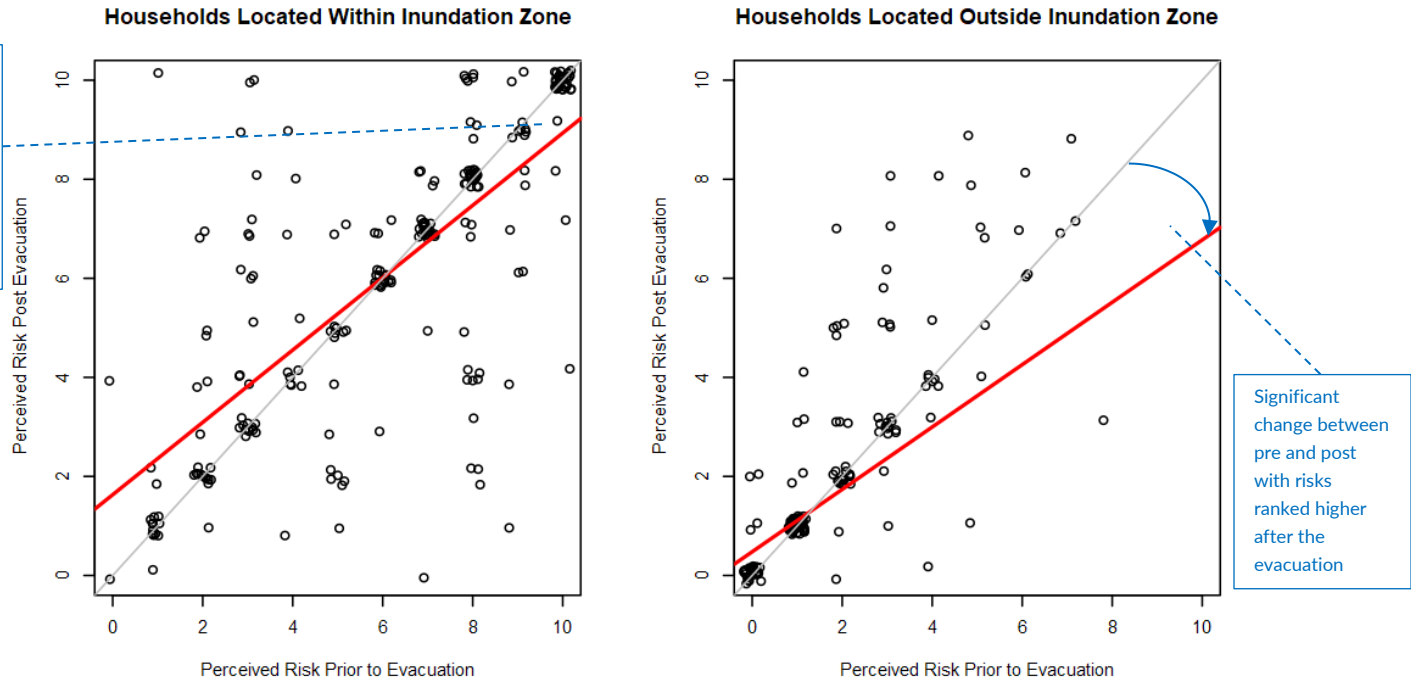


Figure 17: Scatterplots Showing Perceived Risks Prior to and After the January 2018 Evacuation

For those participants who live within the inundation zone, there was no significant change in their perceived tsunami risk following the evacuation (Figure 17, left). Mean perceived risk for this group before the evacuation was 6.07 and post-evacuation was 6.04.³¹

For those participants who live outside the inundation zone, there was a significant shift towards a perception of higher risk following the evacuation than before (Figure 17, right). Mean perceived risk for this group before the evacuation was 1.98 and post-evacuation was 2.32.³²

We expected that perceived tsunami risk would be greater for those who believe they live in the inundation zone than those who believe they live outside the zone. This bears out, with most inside the zone generally believing that tsunami-related risk to their households was moderate, while those living outside the zone generally felt it was very low.

What we did not expect was the significantly differing changes in risk perceptions following the evacuation for these two groups. We found no meaningful change in perceived risk by those who believe that they live in the inundation zone, but a significant change in perceived risk by those who believe that they live outside the inundation zone. Those living inside the zone generally continued to believe their

³¹ Not statistically significant using a paired sample T-test.

³² Statistically significant at $p=0.001$ level using a paired sample T-test.

homes were at moderate risk from tsunamis, while those living outside the zone generally indicated that tsunamis presented a higher risk to their homes following the evacuation.

One possible explanation for these results is that those who believe they live within the inundation zone have already incorporated or normalized tsunami-related risk into their lives, and this event largely confirmed their existing beliefs—they feel they remain at risk, but not significantly more so than they did before the evacuation. Meanwhile, it is possible those living outside the inundation zone have not internalized or normalized this risk in the same manner. This event may have caused these individuals to re-evaluate their perceptions around tsunami risk and, at least in the short period between the evacuation and our study, to increase their assessment of household risk from tsunamis.

It is also quite possible that some of our study participants who live outside the inundation zone opted to participate in the study *because* they now perceive a risk when before they did not; again, a type of self-selection bias that may exist within our sample.

Finally, the difference between the mean perceived risks (both before and after) is also quite revealing, with those in the inundation zone rating their tsunami risk an average of four points higher on the (unitless) scale than those outside the zone.

Discussion



Figure 18 : The Port Alberni Maritime Discovery Centre

The primary goal of our research was to explore public and official perceptions surrounding tsunami risk and how the January 2018 evacuation event may have altered those perceptions. We posed four key research questions at the outset of this study that we wanted to address through our discussions with affected residents and the emergency planners, managers, and other officials responsible for ensuring the safety of the residents of Port Alberni. We specifically speak to those four questions, plus some elements that arose throughout our research, in the following section.

Public and Official Perceptions of the Evacuation

“How was the tsunami warning and evacuation perceived from the different perspectives of emergency officials and community residents?”

Broadly speaking, the public has responded positively to the events of the morning of January 23rd, with most of our participants in the tsunami inundation zone indicating they travelled to points of safety outside the zone in a timely manner. There was some confusion and anxiety related to the sudden sounding of the emergency system, likely amplified by the early morning hour of the alarm. For some, this was something they had been prepared to respond to for decades; for others, this was the first they had heard about tsunami risk since moving into the community in the past weeks or months.

While most of the residents we spoke with were polite and happy to speak with us, there was also underlying unhappiness from some who felt the social contract between officials and the people had been bruised or broken by their experiences that morning. This largely centred around the perceived lack of information available to residents from City Hall and the ACRD that morning, particularly from online sources, including official websites and social media accounts. There were also concerns expressed that officials waited an hour before initiating the evacuation, which they felt was time taken away from their evacuations.

Officials we spoke to admitted that their execution that morning was not without flaw, and every single official we spoke with acknowledged the communication issue gave a black eye to what was otherwise an effective response. However, given all the moving pieces necessary to protect the community in light of the information that was available to them at the time, officials generally felt that the event as a whole was a success. Several specific issues have been identified that should be reviewed, or addressed in updates to regional tsunami response plans, and some of these changes have already been implemented by the City, the ACRD, or both. Feedback from residents, some provided directly to officials, and some coming from this study, will be used to review and revise plans and protocols going forward.

For many residents, this was a reminder of a risk that they have known and lived with for years or decades. For others, this was a wake-up call, a spur to create or update their household's emergency response plans, or a nudge to learn more about the potential risks of living in the inundation zone. And like the officials we spoke with, most residents felt that—overall—this event was a success.

Resident Responses to the Tsunami Warning & Evacuation

“How did residents living in the tsunami inundation zone respond to the tsunami warning and evacuation?”

Over half of our study's respondents indicated that the community's tsunami warning system broadcasts were their first warning about the potential tsunami and that an evacuation had been initiated. Others reported being woken by the sirens or loudspeakers on RCMP and Fire Department vehicles as they travelled through at-risk areas; learned of the warning by phone call, text message, or instant messages from friends and family outside the community notifying them of the event; or found out about the alert from late-night television or radio broadcasts.

Regardless of how they found out, nearly all residents living in the tsunami inundation zone opted to evacuate to safety on higher ground. The largest number of these residents found shelter in the homes of friends or family in the community or in nearby communities. Many came together in the parking lots of major businesses and restaurants. A small number travelled to much higher ground at The Hump, while others continued their journeys on to Cathedral Grove, Parksville, or even Nanaimo. Only a small fraction of our study participants reported travelling to the evacuation centre at the Echo Centre, though some of those who did indicated they found it closed when they first arrived.

Very few participants who know they live in the inundation zone opted to remain behind. However, potentially more concerning was the small number of individuals who live in the zone but mistakenly believe their homes are safely placed outside the danger area and not at risk. Likewise, there were a small number of residents who live outside the zone who chose to evacuate because they were either unsure or mistakenly believed their homes were inside the inundation zone.

Most households reported evacuating by vehicle, with only a small fraction reporting evacuating on foot. Some of those who started on foot reported getting rides at the homes of friends or neighbours or getting picked up part way into their trips. Once in motion, most travelled directly to a safe point outside

the evacuation zone, though a smaller number reported stopping to pick up friends, family, pets, or supplies before exiting the zone.

Evacuation Barriers Experienced by Residents

“What difficulties did residents experience while evacuating, and what lessons can emergency planners learn from these experiences?”

Traffic Congestion

Over half of our study participants indicated that they did not experience any difficulties during their evacuations. Those who did encounter barriers most commonly identified traffic congestion, which affected approximately 18% of survey respondents. As discussed above, there are some systemic solutions that could be brought into place to lessen the impacts of traffic (e.g., lane reversals, modified traffic lights), however, given the size of the community and the amount of time the community would likely have to implement these approaches just prior to an evacuation, it is unlikely that most of these solutions would have much impact given the associated costs. The only solution we see as having any possible impact at a reasonable cost is lane reversals along Roger Street, Johnston Road and possibly Lathom Road. However, a full analysis would be required before we could make any such recommendation. For the time being, we do not have any recommendations that would help Port Alberni reduce potential traffic congestion from a tsunami.

Communication of Tsunami Risk and Evacuation Instructions

Issues related to how risk information and evacuation instructions were communicated to the public were mentioned as three of the top five most commonly cited barriers, affecting between 13% and 16% of respondents. At the time of the evacuation, the City of Port Alberni’s Manager of Communications had only been on the job for a few weeks and was not a part of the team at the EOC on the morning of the evacuation. Online communication responsibilities were not picked up by other members of the team that morning.

Getting risk communications perfect, or even mostly right, is a tall task for any communications team, and this can be especially true in small and medium-sized communities with fewer resources. The City has since improved its internal protocols to help ensure appropriate communications staffing in the event of an emergency. Assuming it is safe to do so, the communications manager would travel to the EOC and lead communications efforts. In the event it is not safe to do so, an alternate staff member would assume the communication responsibilities and work with the EOC to disseminate information across all available City platforms. For communities looking at how to improve their risk communications with their residents, please see the [Lessons Identified and Best Practices](#) section at the end of this report.

Reaching Beyond the Tsunami Warning System

Approximately 7% of participants indicated that they did not hear the tsunami warning system, and 2% reported being completely unaware of the evacuation until afterwards. We believe that the City of Port Alberni and the ACRD response protocols—including the tsunami warning system and having first responders travel through the inundation zone with loudspeakers announcing the evacuation—are appropriate to the needs of the community. It is unlikely any given solution can ever reach 100% of residents, however, and the early morning timing of the January 2018 event was likely a worst-case scenario. The recent public deployment of the [AlertReady](#) system nationwide may help to address some of this issue by contacting affected residents by text message in the event their area is impacted by a tsunami warning, particularly during daytime hours. We would also recommend that neighbours quickly check on especially vulnerable neighbours as part of their evacuation plan. This may include briefly ringing doorbells or knocking on the doors of households with elderly, hearing impaired, or live-alone residents before continuing with their own evacuations, but only if it is safe to do so.

Lack of Vehicle Access and Pedestrian Evacuations

Around 4% of participants reported not owning a vehicle, and approximately 2% noted they did not have a valid driver's license. It is not reasonable to expect emergency officials to be able to provide transport for all residents without vehicles in the inundation zone during an evacuation. We would, therefore, recommend that these households make plans in advance with friends, family, or nearby neighbours to seek assistance evacuating. Neighbourhood efforts have been effective in assisting vulnerable households in other evacuation situations, and the strong community-minded effort of Alberni Valley residents likely makes it so that such a program could be implemented to connect vulnerable households with help in advance of a threat.

Confusion Around the Evacuation Zone Boundaries

There was considerable confusion expressed to us about whether specific homes were located within the inundation zone, and how far people would need to travel to get out of the zone. We found that approximately 10% of study participants were uncertain if their homes were located in the inundation zone, and another 8% were mistaken in their beliefs when systematically inspected by our research team.

We believe two efforts by officials could help to mitigate this barrier: i) clarifying the tsunami risk maps to use more easily identified boundaries, and ii) improvements to evacuation signage and road markings.

MAP OF INUNDATION ZONE BOUNDARIES

The [inundation map](#) provided by the ACRD and City of Port Alberni is a precise representation of the tsunami risk zone. However, the inundation zone boundaries shown on the map are often difficult to relate to real-world locations, and it can be very difficult for people located along the fringe of the zone to establish whether their homes would be affected by a tsunami. We would recommend updating the

map to use road centerlines, railway lines, and other more easily identified landmarks when communicating risk zone information to residents. This approach makes it easier to determine if a given property is inside or outside the tsunami inundation zone but may slightly inflate the number of homes needing to evacuate during an emergency. This seems to be a reasonable compromise.

STREET SIGNS AND ROAD MARKINGS

While there are some road signs to indicate the extent of the tsunami inundation zone in Port Alberni, there are very few of these signs, and they are limited to only the major routes. A brief assessment of the major evacuation routes in at-risk zones shows that there is likely insufficient evacuation routing signage and that anyone without prior knowledge of the area would have difficulty assessing if they are at risk at most points while driving through the community. We would suggest taking lessons from New Zealand, Japan, Washington, Oregon, and California, to increase the size and number of warning signs, and to add road markings to indicate the extent of the tsunami inundation zone. While these efforts have some expense associated with them, they will more clearly inform residents and visitors alike that a risk exists and inform them unambiguously where the risk zone is located and how to get out of it from most at-risk locations.

Confusion Around the Didgeridoo Sound

As we noted above, we were not specifically seeking information from study participants related to the use of the didgeridoo sound during the monthly testing of the tsunami system. However, we received unprompted comments related to the confusion around the use of the sound in such numbers that we felt we needed to take a closer look. What we found was that approximately 5% of all study participants made a comment or raised concerns about this confusion on their own.

This confusion is not unique to the Alberni Valley tsunami warning system. Such confusion is one of the reasons the authors suggest that drills, exercises, and system tests mirror as closely as possible the conditions that are likely to be experienced in an actual emergency. The goal of using the didgeridoo sound is to provide the necessary testing of the system infrastructure without causing undue panic at the beginning of each month as it is tested. This goal is both understandable and laudable. However, the other side of the argument is that by associating the testing sound with tsunamis there is inevitably going to be some confusion by some residents when exposed to a different—more ‘brutal’ and arguably ‘scarier’—sound during an actual emergency. This confusion was likely compounded in January 2018 as people were groggy after waking up in the middle of the night.

Our recommendation is to test with what the public will experience in an actual emergency so that their expectations and reality line up when urgent action is required. Delays caused by trying to figure out what the ‘new’ sound represents may slow critical response times as residents seek out information to learn what the warning means or establish if the event is real. We acknowledge this approach may not be popular with residents located near tsunami warning towers but believe reducing confusion in an emergency serves a greater goal.

Impact on Risk Perceptions & Trust in Emergency Officials

“What impact has this event had on community perceptions of tsunami risk, their trust in emergency officials, and their participation in future evacuations?”

Maybe one of the most important research questions we had during our study was to explore the impact that this event has had on the community’s perceptions surrounding tsunami risk, their trust in emergency officials, and their potential participation in future evacuations.

Changes to Community Tsunami Risk Perceptions

The impact that this event has had on tsunami risk perceptions seems to depend largely on where individuals live in the community. Those who believe their homes are located within the tsunami inundation zone have not generally changed their perceptions about tsunami risk, which remain in the middle range. However, those who believe their homes are located outside the tsunami inundation zone have, broadly, come to see that their homes are at a greater risk from tsunamis than they felt was the case before the January evacuation. The magnitude of this change is by no means large but remains significant. We believe the difference between the two groups is most likely related to how the residents living in these different areas have incorporated tsunami risk information into their overall understanding of the risks faced by their households. When presented with new information arising from the evacuation residents living inside the inundation zone largely received confirmation of their beliefs, while those living outside the zone were being confronted with larger perceived risks than they had expected before the evacuation.

Changes to Public Trust in Emergency Officials

With any event where the public is placed on alert against a threat and that threat fails to materialize there is always the risk that the trust the public places in emergency officials could be negatively impacted. This is usually discussed using the fable of [The Boy Who Cried Wolf](#) or described as ‘warning fatigue.’ The theory is that communities facing repeated warning messages about events which end up not occurring will ‘turn off’ or become desensitized to the threat and the warning messages.³³

Feedback from our study participants suggests that there has not been a significant impact on the trust placed in the region’s emergency planners, managers, or first responders as a result of this evacuation. Residents have pointed out areas they feel require additional attention, particularly as it relates to communication with the public during emergencies. Most residents we spoke with seem to believe that this event was a success and are happy to give the City and the ACRD the benefit of the doubt that

³³ Mackie, B. (2013). *Warning Fatigue: Insights from the Australian Bushfire Context (Doctoral dissertation)*. The University of Canterbury, Christchurch, New Zealand. Retrieved May 27th, 2018 from https://ir.canterbury.ac.nz/bitstream/handle/10092/9029/Thesis_fulltext.pdf?sequence

issues raised during this event will be addressed and improvements made to the region's emergency response efforts in a timely manner.

Willingness to Participate in Future Evacuations

As noted, there is a general fear that an evacuation arising from a 'near miss' event could strain trust in emergency officials, resulting in some residents deciding not to evacuate again when some future warning occurs. The academic literature exploring the concept, becoming more popular with Breznitz in 1984,³⁴ have largely relegated this idea to myth status, with no 'smoking gun' evidence presented to directly show that repeated warnings resulted in warning fatigue as long as these events are infrequent and officials are able to show they believed there was a credible threat given the information available to them at the time the alert was issued.

If we look at the results from our two surveys, this event does not appear to have had a significant negative impact on residents' likelihood to evacuate for a future tsunami warning. If anything, the opposite may be true, with around 30% of participants indicating that this event has made them *more* likely to evacuate during future warnings, and only around 12% indicating they are less likely to evacuate.

Stated intentions, however, do not always line up with future actions, and the real answer to this question may not be available until the region experiences another tsunami-related evacuation.

Addressing Comments from Residents

There were a small number of questions and comments that appeared several times in the comment fields of our online questionnaires, or in discussions during the doorstep survey. We'd like to finish our discussion by providing some limited responses to these comments.

Best Place to Go?

Approximately 16% of our study respondents reported not being clear about to where they needed to evacuate. We know that many reported travelling to commercial parking lots, to the hospital, to The Hump, to a local church, and even as far away as Parksville and Nanaimo.

We strongly recommend encouraging shelter with friends or family in the community whose homes are located outside of the tsunami inundation zone. For those where this is not possible, we recommend encouraging residents to seek shelter at an official evacuation centre, once those have been set up and opened. The Echo Centre is currently the primary evacuation centre for the area, but local policy is that officials will announce which locations will act as 'reception' centres once they are ready to receive evacuees. These centres are not likely to be open immediately following an evacuation.

³⁴ Breznitz, S. (2013). *Cry wolf: The psychology of false alarms*. Psychology Press.

We do not recommend travel to The Hump, Cathedral Grove, or to communities on the other side of the Island, especially in the event of a major earthquake in the area. The Hump and Cathedral Grove do not have the facilities to act as an appropriate staging area and may not be easily accessible by emergency services in an emergency. Travel to and from these locations pass through heavily forested hilly areas that may become dangerous during aftershocks in the event of an earthquake. These locations could be cut off from assistance and provide no greater benefit than seeking shelter at locations on higher ground within the community.

The City asks residents not to evacuate to the hospital, and we would agree. That facility has limited space which may be needed to treat those in great need, and the hospital is not set up to receive evacuees. Only those in need of acute medical care should travel to the hospital.

Evacuation/Reception Centres

We heard feedback from some study participants that they would like to see more evacuation centres, particularly for those living in the city's northwest. We know this is a topic that continues to be discussed, and the data from our study, unfortunately, doesn't help to contribute to that discussion. Given the age and location of the Echo Centre, it would be prudent to have an alternate location available to act as a 'reception' centre, should the need arise. There is also some risk that the northwest portion of the community could be cut off from the Echo Centre if earthquake shaking affected the bridges along River Road. We believe this is an area deserving of some additional attention in the future.

An alternative idea we heard suggested was the set up of 'outposts' at popular evacuation destinations, such as the Walmart parking lot. Presumably, these would be staffed by City, ACRD, or Search and Rescue staff with radio or cell phone connections allowing them to receive and pass along regular updates from the EOC. While we like the idea in general, we do not believe that there are currently sufficient resources available to train and staff these positions appropriately. Still, it is an idea worth considering.

Finally, we heard that some residents believe the official evacuation centres should be opened more quickly to ensure residents, particularly older or disabled residents, have a safe place to go if they do not have family living in the area. While we would support having evacuation centres open earlier, we understand that Echo Centre staff must first safely evacuate their own families, travel to the Echo Centre, and set the facility up before beginning to receive evacuees. It may be possible to open evacuation centres earlier if staff are provided with a sufficiently advanced warning of an evacuation, such as in the case of a distant tsunami; however, such warning time cannot be guaranteed, and will not be possible in a worst-case Cascadia-related event.

Siren Too Loud

We heard from a small number of people that the warning system siren was too loud, or that the continuous sounding of the alarm caused them stress or anxiety, both during and following the event.

They indicated they felt the system did not need to sound repeatedly or could be made quieter. We truly feel for these residents, especially those located very near to a warning system tower. However, the purpose of this system is to inform as many residents as possible about an emergency tsunami warning and evacuation. The system must be loud and must issue continuous warnings to ensure as wide a population is reached as possible.

Household Preparedness

We heard from many of our participants that they would be interested in information related to household preparedness, including regular workshops sponsored by the City, the ACRD, or a community service organization. It might also be possible to integrate such information into existing community events. We believe household preparedness is a very important element in creating a hazards-resilient city and would support such efforts to help build community hazards knowledge.

For those interested in learning more about household preparedness on their own, we would highly recommend the [preparedness materials](#) developed by PreparedBC, including their [Building an Emergency Kit Guide](#) and [Earthquake and Tsunami Guide](#) documents, which can be found for free online. We recommend relying only on reliable government sources or the [Canadian Red Cross](#) when looking for preparedness information online.

Information for specific groups:

- [Preparedness for pets and animals](#)
- [Preparedness for people with disabilities](#)
- [Preparedness for seniors](#)

Earlier Warning/Evacuation

We heard from many in the community that they were concerned that other communities had been evacuated earlier than the Alberni Valley, and felt rushed to get to safety once the Alberni tsunami warning system was activated. While this is a complicated topic, in short, we believe that emergency officials acted correctly in taking the available time to assess the tsunami risk before initiating a tsunami evacuation. As noted above, there are risks in evacuating a large area in addition to those evacuees might face from a potential tsunami, and it is important to balance those risks when deciding to initiate an evacuation.

That said, there were three approaches mentioned that we'd like to address:

- 1) **Earlier information:** The EOC could passively begin informing residents earlier via online channels (website and/or social media) that they are aware of a tsunami warning and are currently working with their provincial partners to assess the risks, without initiating an evacuation. Being open about the situation can inform residents of the potential risk, show those who are aware of the situation that actions are being taken on the information that is available,

and may help to alleviate stresses that can arise from a perceived lack of action. Obviously, only those seeking this type of information would be likely to find it. This approach would be the easiest to implement and may help demonstrate transparency around emergency response.

- 2) **Optional evacuation stage:** Building on the previous idea, the EOC could initiate an official 'optional' evacuation for any residents living in the inundation zone who felt they needed extra time or were at heightened risk and could use the time to prepare and/or evacuate early, with the understanding that new information may eliminate the need for them to seek shelter and that evacuation centres are unlikely to be open during an optional evacuation. Again, this is a passive approach, and only those seeking this type of information would be likely to find it unless supplemented with media (i.e., radio & TV) announcements. This approach would require a significant assessment by local emergency officials prior to being implemented to ensure it is a good fit for the community but may be workable in the context of the Alberni Valley, particularly in the case of a distant tsunami.
- 3) **Earlier evacuations:** The EOC could initiate evacuations earlier, based on the preliminary information available at the time. This approach could mean an increase in the number of evacuations from 'near miss' events and may place an undue strain on community residents, contributing to warning fatigue. We would not recommend this approach, particularly for an evening event, as evacuations themselves present certain risks that may be more serious than what they are attempting to address.

We would like to acknowledge that local officials are generally recognized to be in the best position to make decisions around the need to evacuate a community. A local EOC is generally in constant contact with EMBC and is constantly assessing the balance of risks they face when considering an evacuation. Local officials also have a better understanding of how different hazards may impact their communities, what resources are available, how quickly resources can be put in place, and how much time their community will need to evacuate identified risk zones. We believe that taking the time to assess the risk from a tsunami event properly is the correct choice in situations where such time is available. Where time and/or information are scarce, decision-makers should err on the side of caution.

Lessons Identified & Best Practices



Figure 19 : The Port Alberni Harbour Quay

One of the key reasons we opted to conduct this study, and part of our third research question, was to see what lessons could be identified from the event and to discover any best practices related to how hazards risk—and tsunami risk in particular—can best be communicated to potentially vulnerable residents in small and medium-sized Canadian communities.

Based on the information we received from our two surveys, interviews with emergency officials, and reviews of the academic literature, we have identified a number of best practices, separated into six themes, that could be implemented to help improve hazards-related evacuations in Alberni Valley and elsewhere in Canada. Not all of our suggestions will be appropriate in all contexts, but the goal is to put information into the hands of emergency planners and managers to select those ideas they feel might work best in their own communities.

Make Risk Communications Part of the “Front Line”

One of the clear messages arising from the January 2018 tsunami evacuations across Vancouver Island, and in Port Alberni in particular, is the need for communicators to be made part of the ‘front line’ of responders. Information we received from the public and officials in the Alberni Valley consistently highlighted the lack of clear communications as a key failure for this event. Partly this was because there was no one in the EOC who was focusing on communicating important information with the public during the evacuation, and partly this was because this information was not easily accessible to residents online prior to the evacuation event.

Communications teams are a critical component of the function of an EOC: to get the appropriate messages out to the public, either directly or through local media. They not only compose messages during an emergency but also develop the necessary materials that might be needed in advance of such

an emergency. Communicators need to know exactly how they will integrate into the EOC and need to become active participants in all test scenarios and exercises.

Before an Evacuation:

- Communications teams should know exactly how they will integrate into the EOC and should be active participants in scenario planning and exercises
- The communications team should be aware of planned evacuation scenarios and have messages planned for likely scenarios
- Key scripts, website and social media login information, and media contact lists should be prepared, constantly updated, and ready at hand if needed

During an Evacuation:

- Ensure communications representative is part of the 'first notifications' team
- Ensure communicators are given as much notice about a potential evacuation as possible to allow them to begin preparing the necessary materials for distribution
- Have at least one 'backup' communicator in the 'first notifications' team who is aware of communication plans to cover when primary staff are not available, or if primary communicators are directly impacted by the evacuation

Meet the People Where They Are

Anyone seeking out information before or during an evacuation should be able to gain access to that information relatively easily. Risk communicators need to learn where people are looking for this information and provide the information in the places where the public is. Even if this is simply providing a link from a social media account to where the information on a local government website, it should be very easy for risk-related information to be located by vulnerable residents.

Before an Evacuation:

- Identify where community members will be seeking out risk-related information; this may be: official websites, social media accounts, TV, radio, or event whiteboards located at evacuation centres, City Hall, or anywhere else residents may believe the information will be posted
- Ask the community what information they are likely to need in an emergency; build engagement with the community whenever communicators are interacting with residents
- Know in advance the answers to the most pertinent questions: *Who is at risk? Where should they go? How should they get there? What should they bring with them?*
- Ensure information is not buried deep on official websites or on website menus — it should be easy for residents to get to hazards-related risk information, preferably from one click on a website home page

During an Evacuation:

- Cast as wide a net as possible to ensure you can reach as many affected residents as possible
- Use the materials you have previously prepared, but be ready to adapt to the situation quickly as needs and the direction of a response changes
- Ensure all official media (websites, social media accounts, etc.) have up-to-date links to information residents need to know or are seeking out
- Provide regular updates, even if the update is to say that there is nothing new to report at this time — stale information dissolves the trust in the system
- Where possible, remove out of date or inaccurate information: this should not be done to hide mistakes, but to ensure only correct information is available
- If links to hazard risk information are not already quickly accessible and obvious from website home pages, add a temporary notice with links to the information that will remain for the duration of the evacuation

Integrate Communications into Drills & Exercises

While it may not be appropriate to include communications of tests of specific aspects of a system or protocol, in general, it is important to test the same way things will (hopefully) happen in reality, including how information will be provided to affected residents.

For Internal Tests/Exercises:

- Test as it will happen ‘for real’ – if communication messages would normally be sent, similar messages should be made internally as part of the test
- The communications team should be included at the table when tests or exercises are planned, executed, and during after-action assessments
- Tests of the communication protocols should be made and assessed along with all other systems—where can improvements be made?
- Ensure prepared materials are ready and appropriate for likely scenarios—proactively identify gaps or areas that need updating

For Public Tests/Exercises:

- Ensure that all communications during a public test or exercise are marked to indicate they are tests
- Where possible and appropriate, remove test communications after the tests/exercises to avoid confusion
- Seeing such messages will help train the public where they can find this type of information in the future should they need it
- Including communications of public tests/exercises helps build good habits, both for the emergency response team and the for the public

Risk Zone Mapping: Understandable is Better than Perfect

Hazard risk maps are intended to quickly and easily communicate information about hazard risks to the public. The goal is to make it as easy as possible to establish where the boundaries of the hazard zone are located relative to where people or their homes are located.

While accurate, precise boundaries (Figure 20, below) may be ‘truer’ to reality, they are often very difficult for the public to understand and use. Such precise maps can cause confusion about where exactly the boundaries of a risk zone are located and may lead residents to be mistaken in their beliefs about their risk as a result. This was a lesson we identified in our study, as a small but significant portion of the at-risk public was uncertain or incorrect about their home’s location relative to the tsunami inundation zone.

We instead recommend the development risk maps that sacrifice accuracy and precision for ease of understandability. When creating such maps, risk zones should have clear and easy to understand boundaries that align with identifiable landmarks, such as roads, rivers, rail lines, or other easily described locations (Figure 21, below). When coupled with street signs and/or road markings, it should be possible for most residents to assess their home’s risk status with only a little effort.

Depending on the hazard faced, or the accuracy of the hazard zone, it may be reasonable to add a ‘caution’ zone adjacent to a risk zone. These areas are unlikely to be affected but may still need to take lesser actions to prepare than those in the risk zone. Flood zone mapping is often a good example of this approach.

The goal with risk maps is to be clear about who needs to evacuate, which will, in turn, reduce confusion, help ensure vulnerable households become aware of their risk, and potentially reduce unnecessary evacuations from those living outside the identified risk zones.

Be Clear and Open About Evacuations

Open and clear communication before and during emergencies help to build public trust in how emergency officials plan for and respond to an emergency. At the same time, vague, infrequent, or difficult to understand messaging can quickly erode trust. The goal of communicators during an evacuation should be to be clear and open about what is happening.

Before an Evacuation:

- If there are areas of the community that are at extreme risk or would be slow to evacuate to safety, consider developing staged evacuation plans:
 - *Optional pre-evacuation stage*: intended for those most at risk, or those who may need extra time to evacuate
 - *Mandatory evacuation stage*: all residents within the evacuation zone must leave
- Help residents identify in advance what actions they may need to take, and what materials they should prepare, in case they need to evacuate
- Give specific guidance to especially vulnerable groups: *older residents, those with very young children, those with mobility issues, and those at extreme risk*
- Publish information on risk zones, primary evacuation routes, areas to avoid, etc. well in advance of an evacuation to aid in household planning

During an Evacuation:

- Begin communications as quickly as reasonably possible, prioritize where messages are released based on expected audience size
- Avoid publishing information that has not been confirmed by appropriate staff in the EOC, and correct mistaken information as quickly as possible
- Ensure links to critical information are working, and flag or replace broken links as quickly as possible
- If time permits, try to answer the most commonly asked questions on websites or social media, or direct online users to where the most current information is available (e.g., “Our Twitter account will be where we will be providing updates as they become available”)
- Provide regular updates, even if the update is to say that there is nothing new to report at this time



Figure 20: While accurate, precise risk zone maps can be difficult to understand



Figure 21: Less accurate but clearer boundaries can be easier to understand

A message relating to an optional evacuation stage may look something like this:

“An earthquake has been detected that has the potential to trigger a tsunami affecting our community. Emergency officials are evaluating the need for an evacuation of the tsunami inundation zone. No official evacuation has currently been ordered; however, those who may need extra time to evacuate due to health or mobility issues may choose to optionally evacuate to higher ground now. The tsunami warning system will be activated if a need for a full evacuation of the inundation zone is identified. We will provide an update here at 5:10 PM, or as new information becomes available.”

Make it Easy for Residents to Prepare

It should be easy for residents to learn about and begin to prepare for local hazards. Information about what specific risks the community faces, and where those risks are located is an important first step to raising awareness. Hazards risk information should be quick and easy for residents to access. Links should either be available directly on municipality or regional district website home pages or be easily located in the website’s main menu.

Many government agencies have developed preparedness information packages that you can link to from your own website instead of having to create the information internally. [PreparedBC](#) and the [Canadian Red Cross](#) maintain excellent household preparedness information that is relevant for most communities in Canada and have been vetted by experts.

Integrate information about local hazards and household preparedness as part of regular postings on social media. Adjust messaging to occasionally focus on specific groups to help them develop customized preparedness plans. For example, highlight special planning information for the elderly, those with very young children, those with disabilities, those without access to vehicles, those with pets, and those living at areas of elevated risk.

Promote community preparedness initiatives such as information sessions or workshops that focus on local hazards risks or household preparedness. Work with local schools to integrate hazards awareness and preparedness into the classrooms.

Conclusions



Figure 22 : The Port Alberni Maritime Discovery Centre

Our study explored the events of the tsunami warning and evacuation in the Alberni Valley early in the morning on January 23rd, 2018. We wanted to understand how the event occurred, what decisions were made that morning, and how the overall event was perceived by community residents and emergency officials. Over 450 public surveys and 11 interviews with officials were conducted approximately two-and-a-half months after the evacuations to answer four research questions.

Our analysis shows that approximately 93% of households located within the official tsunami inundation zone chose to evacuate, most to the homes of friends or family in the community. 96% opted to evacuate by vehicle, contributing to traffic congestion along certain routes out of the inundation zone. Of those who did not evacuate the inundation zone, many indicated it was because they did not believe their homes were located within the zone; a confusion that we believe is partly related to how tsunami risk information has been communicated has been residents.

A message we heard repeatedly was that key information residents felt they needed was not available to them online via the City's website or social media accounts. This lack of communications may have contributed to a sense of confusion that was made worse by the early morning timing of the evacuation. New plans have been put in place by the City of Port Alberni to ensure critical information will be made available to residents in the event of a future tsunami warning.

We saw that how tsunami risk is understood by Alberni Valley residents depended in part on where they live. Those living in the inundation zone, while having a higher sense of risk from tsunamis overall, did not change their perceptions around tsunami risk following this event. Those living outside of the zone, generally with a low sense of risk from tsunamis, were more likely to believe their risk from tsunamis had increased following the event.

We also looked at whether public trust in officials had been impacted by the evacuation. We learned that 86% of study participants believed that the decision to evacuate the inundation zone was the correct choice, given the information that was available at the time. While the issues relating to online communications were raised, most participants believed that the City of Port Alberni and the ACRD were prepared to handle an evacuation and that the event had been conducted appropriately. The fact that no tsunami occurred does not appear to have significantly impacted public trust in officials, with 89% reporting they were equally or more likely to evacuate in the event of a future tsunami warning.

We explored a number of topics raised by community residents to attempt to mitigate tsunami risks and to better communicate tsunami-related risk information to residents and visitors. This included potential improvements to tsunami-related signage, improvements to tsunami risk maps, and the potential need to explore how evacuation centres are located and set up in the community. We addressed the question about whether the evacuation should have been initiated earlier in the morning, noting that the procedures in place in January 2018 were appropriate, given the time available and the information at hand.

Finally, we identified a number of lessons that can be learned from this event. Much of these focus on risk communications efforts and how such communications are integrated into the EOC, but we also identify a need to assist community residents in developing household emergency response plans. While household preparedness alone is not sufficient to ensure all residents will be aware of and able to evacuate in the event of a future tsunami threat, these efforts can go a long ways towards ensuring residents are capable of responding quickly should the need arise again. This is especially true for socially vulnerable groups, including older residents, households with young children, and lone-resident households.

This event should be seen as a soft 'nudge,' reminding coastal communities throughout Canada that tsunami risk is a quiet but ever-present threat. Many residents of the Alberni Valley have responded by seeking out information about tsunami risk, reviewing their household's risk to tsunami impacts, and—hopefully—updating their emergency response plans. We know emergency officials in the area have taken the time to identify issues the community encountered during this event, and are in the process of making the changes needed to address these issues for future events.

While it would be ideal if tsunami waves never again threatened the Alberni Valley, this is unlikely. It is important that residents and officials continue to share tsunami knowledge and help one another to face future tsunami threats through preparedness. A prepared community will be more resilient and better able to recover should the worst ever happen.