# WHAT'S THAT SOUND?

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

*Preliminary Findings – June 2018*


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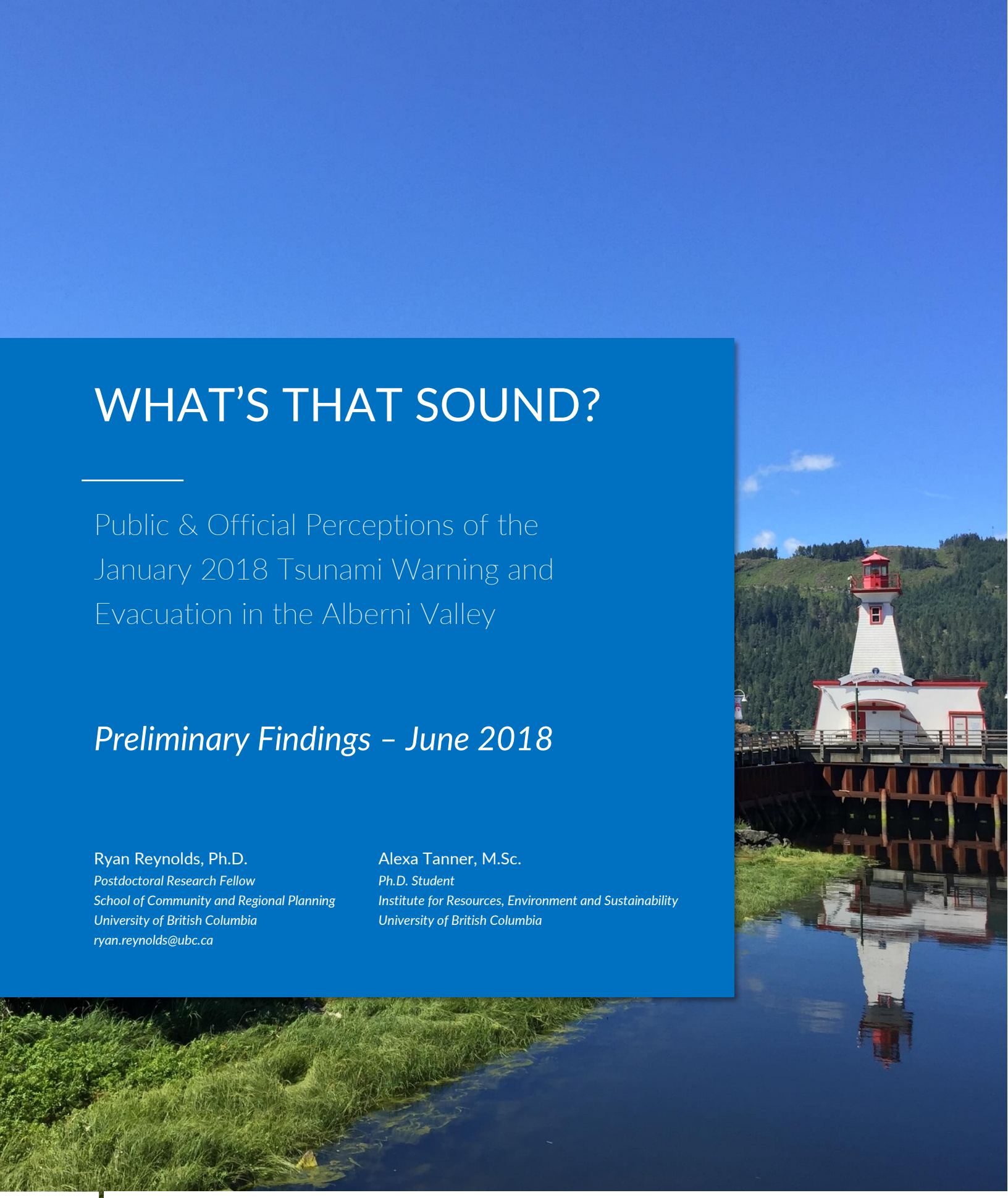


THE UNIVERSITY OF BRITISH COLUMBIA

## Research Ethics Approval

This study received ethics approval from the Behavioural Research Ethics Board (BREB) at the University of British Columbia on 29 March 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 or by telephone at (604) 396-2979.

## Research Funding

This research study was funded through a grant from 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.

## Media Information

Members of the media interested in learning more about this study are encouraged to contact Lou Bosshart with UBC Media Relations. She can be contacted by email at lou.bosshart@ubc.ca or by telephone at (604) 822-2048.

## 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 greatly appreciate your assistance!

[1] ICLR (2018). ICLR Quick Response Program. Institute for Catastrophic Loss Reduction website. Retrieved 15 May 2018 from https://www.iclr.org/wp-content/uploads/2018/04/ICLR-Quick-Response-Program.pdf

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# Summary

Our team conducted a study exploring how residents and officials perceived the tsunami warning and evacuation that occurred in the Alberni Valley on 23 January 2018. Officials with the City of Port Alberni, Alberni-Clayoquot Regional District (ACRD), Port Alberni Fire Department, and Port Alberni RCMP were interviewed in person or by telephone. We heard from past and present emergency planners, emergency managers, communication professionals, first responders, and key front-line staff. In total **11 official representatives** were interviewed.

Area residents were surveyed for their information about their evacuation experiences and feedback for emergency planners through a week-long door to door survey campaign which was supplemented through a month-long online survey. The response we received from the community was beyond all expectations, with **over 450 public surveys completed**. Feedback was received from most areas of the community, with a concentration from those living in or near the official tsunami inundation zone. This feedback from at-risk residents was key to understanding how the evacuation was undertaken at the individual and family level, and to help us understand how the public perceived the event.

**Of those living within the inundation zone, 94% of participants indicated that they had evacuated,** or begun evacuating, their homes by the time the evacuation was ended. The response from these individuals was that their evacuation experiences were generally positive. Most evacuating households got to a safe point on higher ground in a timely manner, though evacuation times for many were longer than is considered ideal. Most evacuating participants indicated they sought refuge in the homes of friends or family members living in the community or nearby communities (37%), while others gathered in the parking lots of large businesses (34%) and at other locations at higher elevations. A few travelled to the designated reception centre at the Echo Recreation Centre, but early participants noted that the centre was not open upon their arrival and they travelled to other locations. Only 4% of participants indicated they began their evacuations on foot, and several indicated they were picked up by others part-way through their journey. A small number of participants noted being unable to evacuate due to a lack of assistance, illness or disability in the home, or for fear of looting.

68% of participants felt that emergency managers had conducted the evacuation effectively under the conditions. 87% of study participants indicated they believed the decision by the Director of the Emergency Operations Centre (EOC) to evacuate the community was the correct choice given the information available, with many telling us they would always prefer officials err on the side of caution if there is any doubt in the future.

As part of this study, we wanted to explore where the tsunami warning system broadcasts could be heard. About 85% of those living within the boundaries of the inundation zone indicated that they could hear the warning system at their homes. The community's tsunami warning system was the first warning that 54% of the community received about the pending evacuation. Some in the study noted that there was confusion about the siren sound broadcast as part of the warning, as they were expecting the didgeridoo sound that was used for testing and they were not sure what the siren sound indicated. This confusion may have delayed some residents as they sought to determine what the sounds indicated, especially if they were in areas of the community where the voice component of the broadcasts was unclear. We plan to explore how geography plays into how well the tsunami warning system was heard and understood in more detail over the summer and will include our results in our final findings.

While most participants (53%) reported no issues during their evacuation, roughly 18% reported that traffic congestion was a barrier to their evacuation. Other difficulties identified included a lack of information from officials about what residents should do, where they should go, and what routes they should use to get there. Many

participants reported that their searches for this information online went unfulfilled. This was also something identified by local and national media in the hours and days to follow the evacuation. We discuss some potential reasons for this communication gap later in the document along with expected changes to the community's official response plan.

One thing that was common in our discussion with residents during the doorstep survey, and was repeated in the online surveys, is that a sizeable percentage of Alberni Valley households do not have an emergency response plan, and some of those that did noted their plans were not effective. Several households indicated that this event spurred them to create a new household emergency response plan or to update their existing plans. PreparedBC offers several resources that households can use to develop customized emergency response plans on their website.

Since the evacuation, emergency officials have identified several areas for improvement. The City and ACRD have already revamped their emergency communication plans to ensure that key communication staff are present in the EOC during an emergency and that critical information is better communicated to residents. This includes via the City's website and their social media accounts. There have also been suggestions that there may be a need for more than a single reception centre in the community that residents can go to in an emergency. There is a recognition that the current reception centre, the Echo Recreation Centre, is getting older, and may not be accessible by all residents in the event earthquakes affect local roads and/or bridges. Officials have also noted the importance of ensuring that the reception centre (or centres) should be open and staffed as quickly as possible, and preferably by the time a mass evacuation is called.

In summary, emergency officials and affected residents have both indicated that the January tsunami evacuation event was mostly successful, with room for improvements in the future. All sides identified an important communications gap between the EOC and the public during this event. This gap has already been addressed and will continue to be improved upon in the future. Most households that participated indicated a need to create or update their own emergency response plans in light of their experiences. Some barriers to evacuations have been identified, but most participants experienced few difficulties in getting to safety. It was noted that the official reception centre at the Echo Recreation Centre needs to be opened earlier, if possible, so that it is ready to receive and register guests as they arrive. Community members are encouraged to assist one another during emergency events as first responders do not have the time or resources to assist everyone during an evacuation. As a whole, this event does not appear to have had a major impact on the community's trust in emergency planners and managers, nor does it appear to have significantly altered the public's perceptions surrounding tsunami risk in the Alberni Valley or their plans to evacuate should future warnings be issued.

## Next steps:

In the next several months our research team will be looking into the data from our surveys and interviews in greater depth. This will help us to better understand how tsunami risk is perceived, and how residents and officials responded during this event. We will be testing a series of possible evacuation scenarios that have been suggested by officials, residents, and our own team as possible ways to improve evacuations in the Alberni Valley. **We currently anticipate that the comprehensive version of this report, including detailed evacuation modelling, will be completed in October 2018.** We hope this additional work will allow us to thoroughly examine different evacuation scenarios and make concrete recommendations for emergency planners in the community.

- Ryan Reynolds, Ph.D.

# M 7.9 Earthquake in the Gulf of Alaska

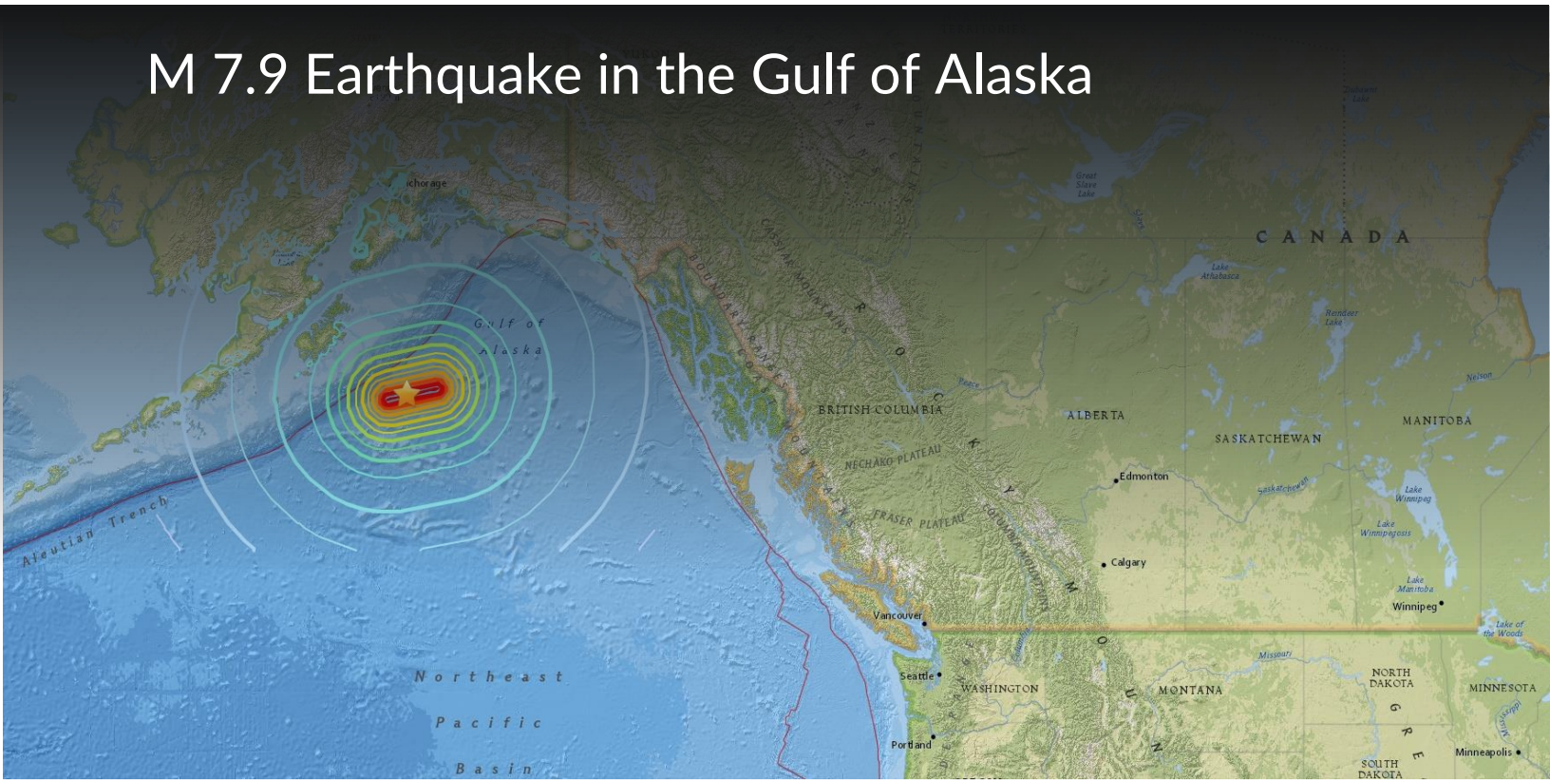


*Figure 1: Location of the 23 January 2018 Earthquake (USGS, 2018)*

On 23 January 2018 at 1:31 AM (PST) there was a 7.9 magnitude (Mww) earthquake centred in the Gulf of Alaska, approximately 280km southeast of Kodiak, Alaska.[2] Minutes later the National Tsunami Warning Centre (NTWC) in Palmer, Alaska issued tsunami watches and warnings for coastal regions of Alaska, British Columbia, Washington, Oregon, and California.[3]

Emergency Management BC (EMBC) monitored the tsunami risk to the coastal communities of British Columbia, and just before 2:00 AM contacted Tim Pley, the Chief Administrative Officer for the City of Port Alberni to inform him of the active tsunami warning for the Alberni Valley. By 2:15 AM the regional Emergency Operations Centre (EOC) was activated and staffed, per the regional tsunami response plan developed jointly by the City of Port Alberni and the Alberni-Clayoquot Regional District (ACRD).

## Emergency Operations Centre Activated

With the EOC active, the primary goal for emergency response staff was to assess the risk to the Alberni region and begin putting resources and people in place to act should an evacuation be necessary. Protocol in this situation called for EMBC to provide the EOC with regular updates based on the

[2] USGS. (2018). M 7.9 – 280km SE of Kodiak, Alaska. USGS Earthquake Hazards Program Website. Retrieved 24 April 2018 from https://earthquake.usgs.gov/earthquakes/eventpage/us2000cmy3#executive

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

observed tsunami activity at gauges located closer to the earthquake epicentre. The decision to evacuate the region would be based on a number of factors, including distance from the source of the tsunami, measured wave heights closer to the source, and the amount of time estimated to evacuate the inundation zone.

In the event the lines of communication between the EOC and EMBC were to be disrupted at any time, or relevant information not be available in a timely manner, the emergency response protocol called for the Director of the EOC to make the call to evacuate the inundation zone based on all information that was available to them at the time, ensuring enough time to effectively communicate evacuation instructions and have affected residents enact their household emergency response plans.

Given that large-scale evacuations present a certain degree of risk and are a disruption to life in the community, this is not a decision that is made lightly. The best option is to avoid an evacuation if at all possible, especially one in the early hours of the morning. While the goal of an evacuation is to get everyone to safety, the very act of evacuating a community can present its own hazards to those evacuating, not limited to vehicle accidents, trips and falls, and heightened levels of anxiety. However, if the call is not made in time and a tsunami is imminent, lives could be placed in danger unnecessarily.

## Evacuation Initiated by Emergency Operations Centre

Lacking solid information from upstream sources, the Port Alberni Chief Administrative Officer, Tim Pley — acting as Director of the EOC — initiated an evacuation of the official tsunami inundation zone for the Alberni Valley at 3:00 AM. At that time a tsunami warning and evacuation message were broadcast from the region's six tsunami warning towers, located in low-lying areas of Port Alberni and nearby First Nations communities (Figure 2). This broadcast began with a very loud siren and followed with evacuation instructions in both male and female voices. Residents throughout the Alberni Valley reported hearing the warning broadcast, though whether it was audible, and instructions were clearly understandable, varied considerably by location.

City of Port Alberni firefighters and members of the Port Alberni RCMP detachment also enacted their tsunami response plans at this time. This included driving through the low-lying areas of the community with sirens and loudspeakers active to help reinforce the tsunami warning broadcasts, particularly in areas where the sirens were known to be difficult to hear. The goal was to wake as many potentially impacted residents as possible and make them aware of the tsunami warning and resulting evacuation. All first responders had instructions to be clear of the inundation zone no later than 4:30 AM to ensure their safety should tsunami waves begin to arrive.

Local political representatives from the City of Port Alberni and the ACRD came together near the EOC so that they could be briefed 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.

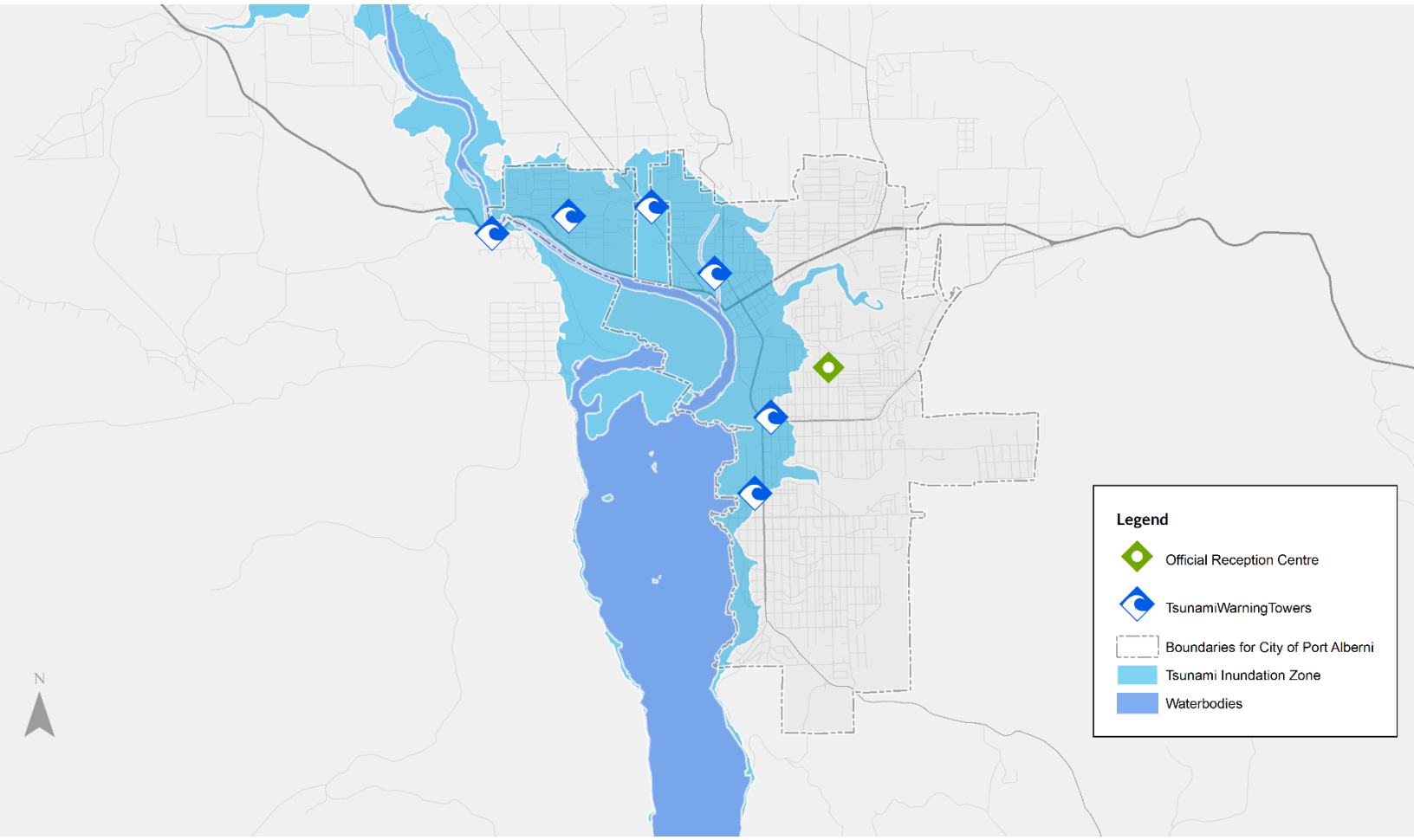


*Figure 2: Locations of the Official Tsunami Inundation Zone, Reception Centre, and Tsunami Warning Towers*

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

During a daytime evacuation, several additional elements of the community tsunami response plan may be enacted, at the discretion of the Director of the EOC. This includes sending active buses and/or taxis to the waterfront area to pick up pedestrians and facilitate their rapid evacuation to higher ground. During the early morning hours, however, all buses and most taxis are out of service. Enacting this plan would have required sending drivers into the inundation zone to get their vehicles, have them travel to the waterfront (which was mostly vacant) to pick up evacuees, and then travel out of the inundation zone to safety. This component of the response protocol is appropriate during standard business hours when vehicles and drivers are already near the inundation zone. In the early morning hours component of the plan could place civilian drivers at unnecessary risk, and it was not initiated during the January evacuation.

## Resident Response

Many residents located within the inundation zone were woken by the tsunami warning broadcasts and the joint efforts of the Fire Department and RCMP. Others awoke to phone calls, text messages, or knocks on their door from concerned family, friends, or neighbours. Rising from the depths of sleep, it took many residents a little while to process what was happening and to understand exactly what they needed to do. Some already had household emergency plans that they put into place and began their evacuation immediately. Others struggled to figure out what they needed to do and where they needed to go.

Many residents reported turning on the television or radio for news, while others turned to news websites and social media to determine if this was a real event, and how they should react. The most common questions that residents had during the event were "What is happening?", "What should I do?", and "Where do I go?" Some residents looked to the City to provide them with answers to these questions on their website, or via the City's social media accounts on Facebook and Twitter. Others relied on major news broadcasts from Canadian and U.S. sources to learn about the tsunami warning and look for information about evacuations.

Most of those living in the inundation zone opted to evacuate to higher ground, getting their family up and into waiting vehicles, or for the walk up the hill to refuge in the homes of friends or family, at the designated reception centre at the Echo Centre, or in various commercial parking lots and the few open restaurants. Some, deciding to exercise as much caution as possible, opted to travel to 'The Hump'[4] or to the homes of friends and family living in communities outside of the potential danger zone. A few are reported to have travelled as far as Parksville and Nanaimo.

## 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 via the tsunami warning towers and a similar message was reported on local radio. All residents were cleared to return home at this time.

Shortly afterwards, participating units within the City and ACRD began to evaluate their response reactions during the event. These groups identified areas of their response that could be improved upon and aspects of the regional response plan that could be updated in the event of future emergencies. As of the time of this research, some of these suggestions have already been implemented, while others are still being considered.

[4] "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.

# Evacuation Aftermath

With the timing of the end of the evacuation so close to starting times for work and school, many residents returned home and then continued to work. Some parents reported keeping their children home from school to help recover from the stress and lack of sleep resulting from the evacuation.

## *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*"[5] and "*City of Port Alberni 'dropped the ball' in communicating tsunami warning on social media*"[6] started to appear.

The lack of communications from the City on the municipality's website and social media accounts justifiably became the focal point about the response in the media. These online locations were places many in the community looked to for information, but the City's website and social media sites remained silent during the event. "People have an expectation to get real-time information on social media platforms and clearly we dropped the ball on that." CAO Tim Pley told the Alberni Valley News.[6] 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 were happy with the official response, though many mirrored the concerns from the media about the communication breakdown with the public. Others were unsure where to evacuate to, particularly as the Echo Centre was not immediately open to receive evacuees.

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. Many noted that the evacuation messages broadcast over the tsunami warning towers were garbled or otherwise difficult (or even impossible) to understand. Some residents were deep sleepers or reported hearing disabilities that prevented them from being woken by the warning system.

Another criticism raised by some residents was concern about how long it took officials to issue the evacuation compared to similar communities such as Tofino and Ucluelet. Many of these residents felt the evacuation notice should have happened as soon as officials were informed by EMBC about the

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

[6] Blats, K. (2018, 24 January). City of Port Alberni "dropped the ball" in communicating tsunami warning on social media. *Alberni Valley News*. Retrieved 17 May 2018 from https://www.albernivalleynews.com/news/city-of-port-alberni-dropped-the-ball-in-communicating-tsunami-warning-on-social-media/

tsunami warning rather than waiting an hour. As we discuss later in this document, there are many factors that go into the decision to enact a region-wide evacuation.

## Responding to a Tsunami

There is nothing a community can do to prevent a tsunami, but it can be possible to limit the loss of life and damage that these disasters can cause. This generally takes three forms: damage mitigation efforts, public education programs, and emergency communication plans.

### *Damage Mitigation*

Vulnerable communities are limited in the actions that they can take to limit tsunami-related damages. Most tsunami mitigation efforts undertaken by vulnerable communities in North America focus on land-use controls. This includes zoning restrictions, relocation of vulnerable infrastructure, improvements to evacuation routing, and in some cases expropriation of vulnerable property. These efforts attempt to limit the populations, property, and infrastructure at risk in tsunami inundation zones. Zoning efforts help to limit the density and height of residential and commercial properties in at-risk areas. Parks and recreational spaces may replace residential, commercial, or industrial uses during redevelopment efforts. The goal of these approaches is to reduce the number of people potentially affected by a tsunami and limit the damages the community experiences.

Structural protections — such as dyking, barrier construction, flood proofing, seismic improvements, and tsunami-resilient construction — may also be helpful in some situations but can be expensive and are very dependent on local geography. While structural protections have seen considerable use in Japan, such works are uncommon in the North American context. There are concerns that such efforts may result in a false sense of security and may result in increased damages if the protections are breached or prove insufficient to handle the size or strength of a tsunami. Seismic improvements that incorporate tsunami-resilient design may help reduce damage in some circumstances, but such efforts have been limited in Canada.

### *Public Education*

It is important that residents in at-risk communities gain at least a basic understanding of the risks they face from tsunamis and how they should prepare for, and respond, should the need arise. Efforts taken to inform vulnerable populations about how tsunamis act, how they may impact the community, what households can do to become more resilient, and how they should respond in the event of a tsunami warning act as a solid foundation towards building tsunami-resilient communities.

Public education usually takes 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 attend preparedness lectures, but a significant portion of the population would participate in at least one of these activities. Educational messaging can be simple reminders about tsunami risk and short information

messages on government websites and social media accounts. These can link out to more detailed information for those who are interested, if appropriate.

Information about how to undertake household preparedness actions and to develop personalized response plans can be conveyed via newspaper articles or radio interviews. Specific community plans can be presented to residents via pamphlets and/or maps, as appropriate. Seminars and hands-on workshops can be held to help residents become more prepared. 'High Ground Hikes'[7] are a relatively new activity for B.C. that engages vulnerable residents and encourages them to learn the routes they would need to follow to safety. These hikes act as mini tsunami drills while educating residents on tsunami risk and response.

Municipalities and regional districts can also work with local educators to bring programs into schools, addressing potential tsunami risk using age-appropriate materials widely available from provincial and federal governments.[8] 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.

## *Emergency Communication*

The first line of communication in affected communities will vary based on the size and shape of the community, the level of tsunami risk it faces, and the resources available. Public warning systems, whether structural public announcement systems or simple sirens, can be very effective at quickly notifying residents about a 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 can provide details to those affected, though it is important to acknowledge that tv and radio are no longer as central to people's lives the way they once were. Messages via social media can be quick and effective ways to reach those with internet access at home, or via their mobile devices.

Public warning systems, such as the ones in the Alberni Valley, need to be audible to the majority of homes and businesses located in the inundation zone to be effective. These may be supplemented through actions from first responders. 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

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[7] 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

[8] The 'Master of Disaster' program from PreparedBC is a great spot for educations to get started: https://www2.gov.bc.ca/gov/content/safety/emergency-preparedness-response-recovery/preparedbc/master-of-disaster

at a time when they may already not be thinking clearly, so reasons for differing emergency and test sounds 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 the amount of time available to react.[9, 10] If evacuations are called for, instructions should also indicate safe places people can or should go to 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 understand the risks associated with tsunamis or how to respond.

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) personalising the warning to oneself or one's household; v) confirming that the warning is true, and others are also taking action; and vi) responding by taking protective action (or possibly choosing not to take action).[11] Clear, consistent, and regular communications from authorities are critical during emergencies, and affected municipalities should take all reasonable efforts to connect with residents where residents are looking for information. Television, radio, government websites, and social media are 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 reception centres, registration sites, and other prominent locations and updated with current information. 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 there is no update will help to reassure the public that their safety is being considered and that officials are 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, poor communication can destroy years of trust in a matter of minutes.

## Alberni's Tsunami History: The Good Friday Tsunami

This is by no means the first time that the Alberni Valley has had to deal with the threat of a tsunami. On Good Friday, 27 March 1964, a magnitude 9.2 (Mw) earthquake occurred in Prince William Sound,

[9] It is in our nature to take as long as we have available, so emergency messaging should take this behavior into account.

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

[11] 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.

Alaska which triggered a tsunami that travelled south along the west coast of North America. This was, and remains, the most powerful earthquake ever recorded within the United States.[12]

The tsunami resulting from the Good Friday earthquake spread out from Prince William Sound and was detected in over 20 countries, including along British Columbia's Pacific Coast. The largest wave associated with the tsunami was recorded in Shoup Bay, Alaska, with a height of approximately 76m (220ft). A total of 123 deaths were attributed to the tsunami in Alaska, Oregon, and California.[13]

The tsunami devastated parts of the Alberni Valley, with maximum wave heights measured retroactively at approximately 3.6m.[14] The waves did not reach Port Alberni until just after midnight on 28 March, after many in the community had gone to sleep. While the tsunami caused significant damage, the worst occurring along the Somass River, there was thankfully no loss of life resulting from the event, due in part to the actions of the RCMP and Alberni Valley Rescue Squad. The official damage tally after the event was estimated at over $10 million, and the Army was called in by the Provincial Civil Defense Co-ordinator to help with recovery.[15] The Good Friday Tsunami remains the costliest tsunami disaster in Canadian history according to the Canadian Disaster Database.[14]

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[12] U.S. Geological Survey. (15 June 2015). *The Great Alaska Earthquake and Tsunami of March 27, 1964.* Earthquake Hazards Program, U.S. Geological Survey website. Retrieved 21 May 2018 from https://earthquake.usgs.gov/earthquakes/events/alaska1964/

[13] Sokolowski, T. J. (n.d.). *The Great Alaska Earthquake & Tsunami of 1964*. In Reynolds, R. P. (2017). *Personalizing Tsunami Risk on Vancouver Island with GIS: A Mixed-Methods Case Study Exploring the Use of GIS in Public Tsunami Risk Assessment and Personal Preparedness in Port Alberni, B.C.* Doctoral dissertation, University of Calgary).

[14] Public Safety Canada. (2013). The Canadian Disaster Database. *Public Safety Canada.* Ottawa. Retrieved 21 May 2018 from https://www.publicsafety.gc.ca/cnt/rsrcs/cndn-dsstr-dtbs/index-en.aspx

[15] Civil Defense Coordinator's Office. (1964). *Civil Defense Circular: Special Report on Alberni Tidal Wave Disaster*. Victoria, BC.

# Our Research

*Figure 3 : The Port Alberni Maritime Discovery Centre (the author)*

The primary goal of our research was to explore public and official perceptions surrounding tsunami risk and how the January 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 of 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.

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

This survey was conducted in the Alberni Valley between Tuesday 4 April and Monday 9 April by the authors. **During this time, we visited more than 400 households and spoke with residents in approximately 275 households. Of these, residents in 111 households agreed to complete the doorstep survey.** This response was considerably larger than expected. Having a larger sample size allows us to perform a more detailed analysis than we had originally planned for several aspects of the study.

In addition, pamphlets 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 many of these addresses and determined that many of these residents did go on to complete the survey online.

## *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 submitted | 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 region social media accounts, and included in media coverage of the study.

The online survey ran from Sunday 1 April through Monday 30 April. This survey was open to all residents of the Alberni Valley. **In total 366 surveys were initiated and 358 surveys were submitted. 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 4 April and 9 April 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 briefly discuss 'What if?' scenarios with planners and managers.

Interview participants tended to be 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 impact large areas, usually resulting in the destruction of housing, businesses, and infrastructure. The tsunami evacuation in the Alberni Valley represents an opportunity for us to explore the impacts of evacuations without the associated destruction of personal, business, and industrial property and infrastructure that can occur. By examining the evacuation event itself, without the additional impact of an underlying hazard, we believe we were able to get a better idea of how such evacuations are conducted and what impacts they may have on the affected populations.

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 coastal communities, and the lessons learned should be applicable to these other hazards in other communities.

Finally, this is an excellent opportunity to gather real-world evacuation data that will help improve our understanding of the human behaviours expressed during a hazards-related evacuation. We can use this information to better inform academic evacuation modelling, develop agent 'behaviours' to mimic those of actual evacuees, and validate our understanding of evacuation modelling. Much of this work will be undertaken over the summer of 2018 and should be ready to present in the early autumn.

## Preliminary Results

Our goal with this report is to get the initial results from our survey into the hands of emergency planners and managers as quickly as possible. As such, there are aspects of the research, and entire research questions, which will not be addressed until the complete report is available in October 2018.

# Preliminary Research Findings


As part of our research we spoke with residents at more than 275 homes in Port Alberni. Around 40% 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 375 surveys that we were able to verify were from homes located in the Alberni Valley. 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 or not 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 survey results is shown in Table 1.

*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) | 89 | 130 | 2 | 67 | - | - | **288** | 62% |
| Household evacuated (partial) | - | 3 | - | 7 | - | - | **10** | 2% |
| Household did not evacuate | 7 | 7 | 7 | 139 | - | - | **160** | 34% |
| Not present | - | - | - | - | 6 | - | **6** | 1% |
| **Sub-Total** | **96** | **140** | **9** | **213** | **6** | **-** | **464** | 100% |

A heat map showing the approximate locations of participants' homes for the combined studies is shown in Figure 4. Together, the two surveys provide excellent coverage of the inundation zone within, and adjacent to, Port Alberni.

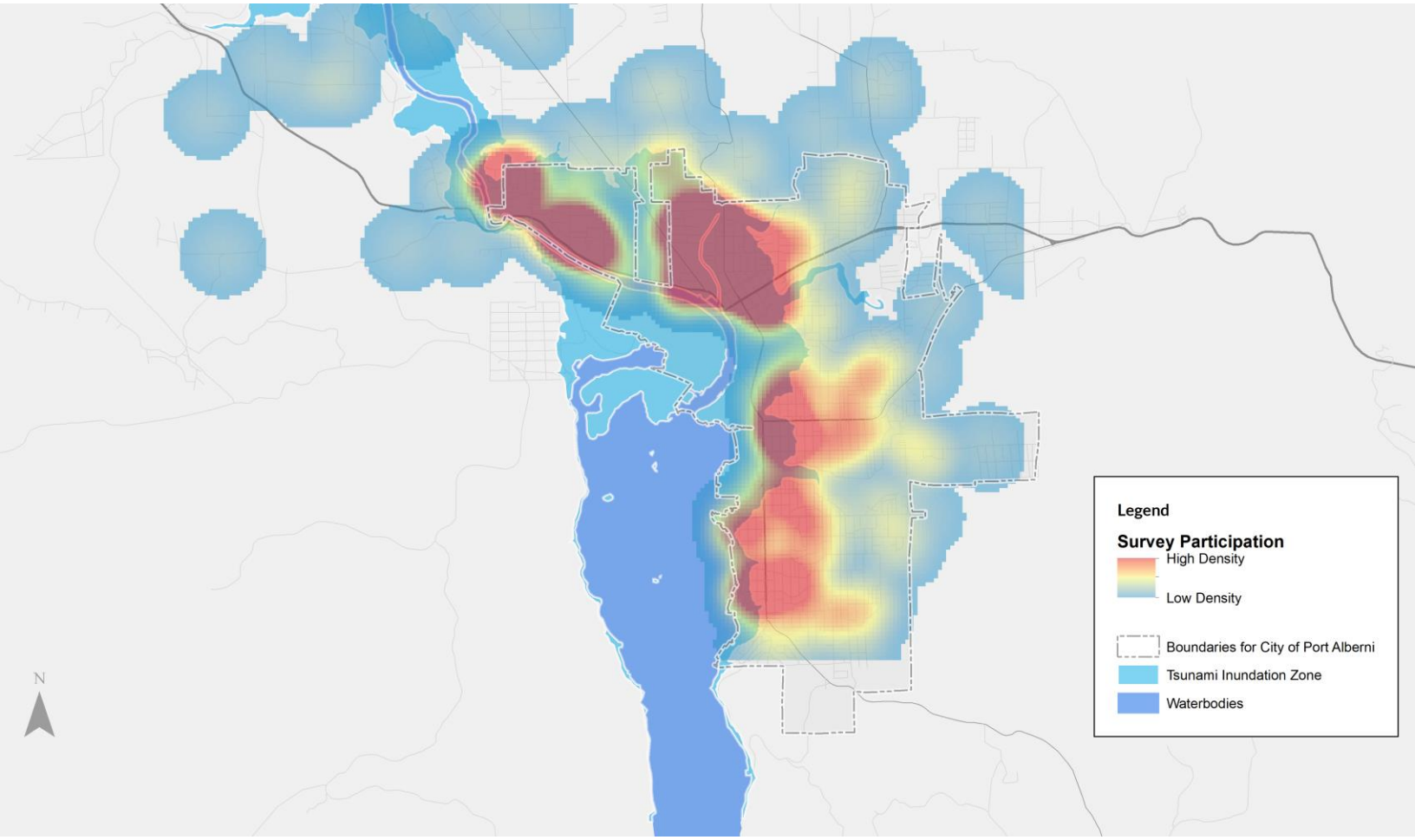


*Figure 4: Heat Map Showing the Combined Survey Participation*

## Evacuation Status of Residents by Location

We combined the responses from the two surveys to learn more about the evacuation status of households. We then removed responses from those residents who indicated that they were not present in the community at the time of the evacuation. For our purposes, a household was deemed to have evacuated if one or more members of the household evacuated.

A spatial analysis of survey responses indicates that most participants living close to major water bodies did indeed evacuate (Figure 5). A couple of small gaps indicating a lower likelihood of evacuations can be seen on the map that are likely artifacts of how the surveys were conducted. A small gap over the Hupacasath First Nation is likely because the door to door survey was limited to households in the City of Port Alberni and did not target homes on Hupacasath lands. The gap near Roger Street is likely

because this is a predominantly commercial area and we did not receive any survey responses from this area.

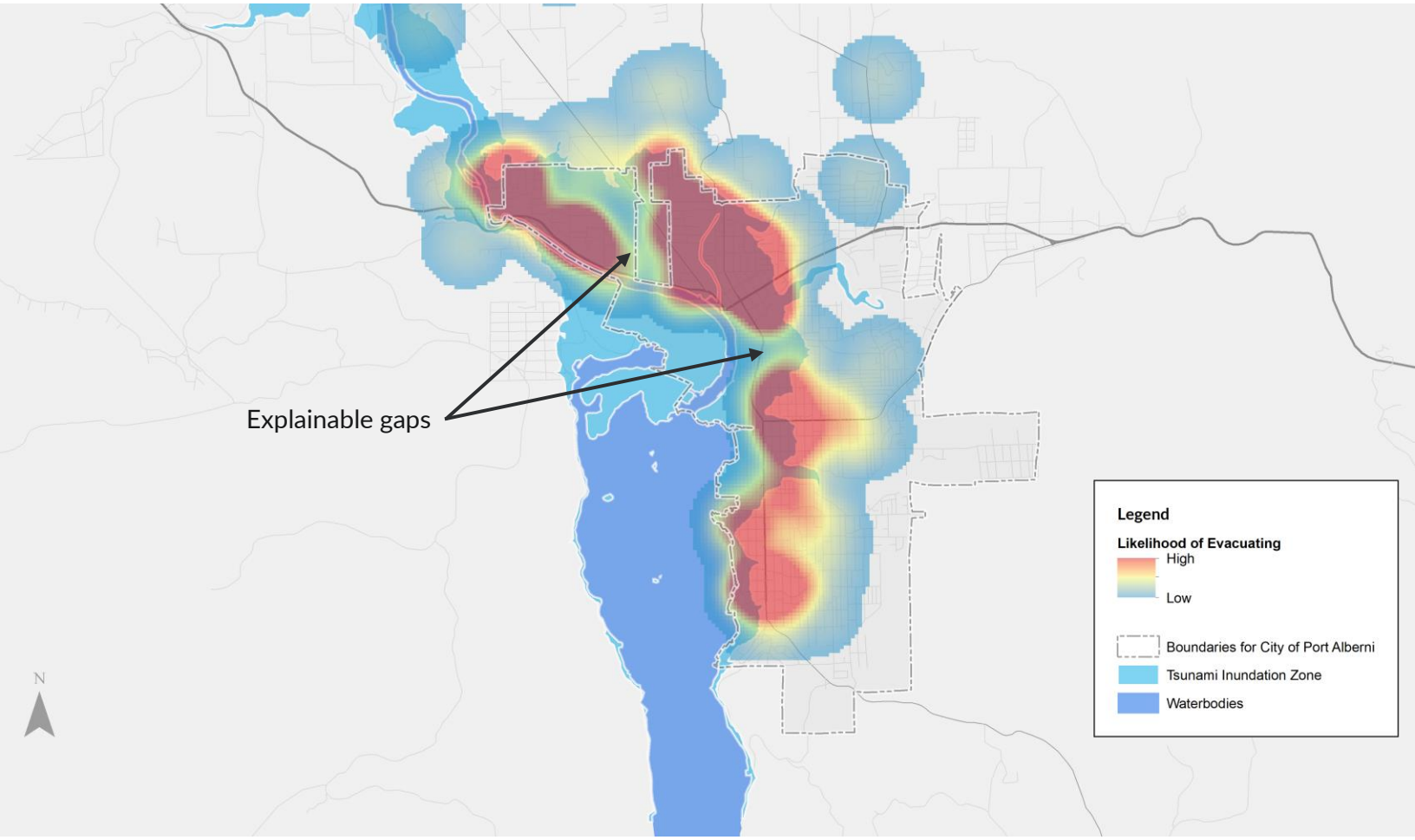


*Figure 5: Likelihood of Household Evacuation by Study Participants*

## *Residents Living Within the Tsunami Inundation Zone*

We would expect that most residents who participated in our two studies and live within the official inundation zone would have opted to evacuate during the January evacuation. Our results show that approximately 94% of these residents did indeed evacuate to safety outside the zone (Table 2).

**Only 6% of participating households located within the inundation zone indicated they either chose not to evacuate or were unable to evacuate.** We discuss reasons households may not have evacuated later in this document.

## *Residents Living Outside the Tsunami Evacuation Zone*

We would expect that most residents who participated in our surveys and live outside the inundation zone would have opted not to evacuate. The results of our study show that 66% of participants did stay home, but this was considerably lower than expectations (Table 3).

**Around 34% of households located outside the inundation zone opted to evacuate.**

We believe some of this can be explained by the confusion around the exact location of the inundation zone boundaries, which we had anticipated. However, closer inspection shows homes located well outside the inundation zone still opted to evacuate to higher ground. This has the potential to place added stress on the system during an evacuation, which we discuss in greater detail later in the document.

*Table 2 : Evacuation Status for Residents Living Within the Inundation Zone*

| | Living Within Inundation Zone | | Both Studies Combined | |
|---|---|---|---|---|
| | *Door to Door* | *Online Survey* | *Total* | *%* |
| Evacuated | 89 | 132 | **222** | 94% |
| Did not evacuate | 7 | 7 | **14** | 6% |
| **Total** | **96** | **140** | **236** | 100% |

*Table 3 : Evacuation Status for Residents Living Outside the Inundation Zone*

| | Living Outside Inundation Zone | | Both Studies Combined | |
|---|---|---|---|---|
| | *Door to Door* | *Online Survey* | *Total* | *%* |
| Evacuated | 2 | 74 | **76** | 34% |
| Did not evacuate | 7 | 139 | **146** | 66% |
| **Total** | **9** | **213** | **222** | 100% |

# Analysis of Participant Evacuation Experiences

It was important to 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 information to tailor how information is conveyed to residents during an emergency, adjust local emergency plans, and help guide our evacuation modelling efforts.

## *First Warning of the Tsunami Warning & Evacuation*

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

Table 4 lists how residents reported they first learned about the event. We heard from residents during our door to door survey 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 at a different time of day, such as during the regular workday.

*Table 4: First Warning of the Tsunami Warning & 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 | 75 | 7 | 117 | **249** | 55% |
| A neighbour, friend, or family member by Phone | 21 | 29 | 1 | 32 | **83** | 18% |
| A posting on social media | 2 | 9 | - | 14 | **25** | 5% |
| An emergency responder via load speaker | 1 | 5 | - | 12 | **18** | 4% |
| A neighbour, friend, or family member knocking on door | 6 | 4 | - | 4 | **14** | 3% |
| An alert on radio or television | 1 | 7 | - | 6 | **14** | 3% |
| A neighbour, friend, or family member by text message | 4 | 1 | 1 | 7 | **13** | 3% |
| An alert issued to a mobile device (alert or app notification) | 3 | 4 | - | 6 | **13** | 3% |
| A news story on TV, radio, newspaper, or a website | 6 | 1 | - | 4 | **11** | 2% |
| Other | 1 | 5 | - | 10 | **16** | 4% |
| Not sure or not reported | 1 | - | - | 1 | **2** | - |
| **Total** | **96** | **140** | **9** | **213** | **458** | 100% |

**55% of our study participants indicated the official community tsunami warning system was their first notice about the tsunami warning and evacuation.**

Many participants learned of the warning from friends or relatives living in Eastern Canada, who were already beginning their day at the time the sirens sounded in the Alberni Valley. These relatives called, texted, or sent instant messages to those living in the area to check in and make sure they were safe or were being evacuated.

Some night owls noted that they first heard about it via social media posts or news articles appearing on TV or web-based news sources. A few reported first hearing about it on the local radio once the evacuation was 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 elderly and disabled neighbours.

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

## *Tsunami Warning Audible*

### Warning System Audible at Home?

It is known that the tsunami warning towers are not necessarily audible throughout the entire Alberni Valley tsunami inundation zone. Partly this is due to the geography of the area, and partly due to some areas of dense vegetation cover. To this end, we asked study participants if the warning system was audible at their homes the morning of the evacuation. The results, broken down by location and survey type are shown in Table 5.

**About 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. This means that over 90% of study participants living within the inundation zone reported being able to hear the warning broadcasts from their

*Table 5 : 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 | 121 | 9 | 166 | **380** | 84% |
| No, not audible | 9 | 13 | - | 37 | **59** | 13% |
| Uncertain | 2 | 4 | - | 9 | **15** | 3% |
| Not reported | 1 | 2 | - | 1 | **4** | - |
| **Total** | **96** | **140** | **9** | **213** | **458** | 100% |

homes the morning of the evacuation, even if that was not how they first learned about the event.

We were aware that the City of Port Alberni had conducted some brief surveys exploring this question in the past. However, two new warning system towers have been added to the area since that time. Further, our large sample size should allow us to conduct a broader spatial analysis than the City was able to perform in the past, and to specifically look for clusters where it may be difficult to hear the warning system. **This additional work will be included in the final version of the report.**

*Table 6 : Is Warning System Usually Audible at Place of Work?*

| | All Study Participants | | Both Studies Combined | |
|---|---|---|---|---|
| | *Door to Door* | *Online Survey* | *Total* | *%* |
| Yes, it is audible | 49 | 184 | **233** | 63% |
| No, it is not audible | 15 | 103 | **118** | 32% |
| Uncertain | 3 | 14 | **17** | 5% |
| Not reported or not applicable* | 44 | 52 | **96** | - |
| **Total** | **111** | **353** | **464** | 100% |

* Includes those not currently working, working out of town, or retired

### Warning System Audible at Work?

A second question on our surveys asked whether the monthly testing warning system could usually be heard at the participants' places of work. Many in our study indicated that they do not have a regular place of work, either because they are currently not working, are retired, work in multiple locations, or work out of town. We also did not ask the locations where people work, so it is not possible to perform a more detailed analysis of responses to this question. Still, the results, shown in Table 6, show that 63% residents who work in town are able to hear the monthly testing of the tsunami warning system while at work.

## *Mode of Transport*

When it comes to evacuation planning, it is important to know how your community's

*Table 7 : Mode of Transport Used to Evacuate Household*

| | Living Within Inundation Zone | | Living Outside Inundation Zone | | All Combined | |
|---|---|---|---|---|---|---|
| | *Door to Door* | *Online Survey* | *Door to Door* | *Online Survey* | *Total* | *%* |
| By vehicle | 87 | 129 | 1 | 69 | **286** | 96% |
| On foot | 2 | 3 | 1 | 5 | **11** | 4% |
| Not reported | - | 1 | - | 0 | **1** | - |
| **Total** | **89** | **133** | **2** | **74** | **298** | 100% |

residents will move to safer locations. In Canada, the passenger vehicle is generally the dominant mode of transport. Pedestrian evacuations are also common throughout the country, and other modes, including bicycle, snowmobile, ATV, boat, and plane can be found in different areas of the country.

We expected most of our study participants would indicate that they had opted to evacuate by vehicle, with a smaller number reporting on-foot evacuations. We also expected that some who started out on foot would convert to vehicle evacuations, either being picked up by others on the way, or specifically travelling to the home of a friend, family member, or neighbour for a ride. The breakdown of results reported by our study participant is shown in Table 7, above.

**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 other means.

## *Number of Vehicles Used for Evacuation*

Another key data point that will be necessary to develop customized evacuation models for the region is the average number of vehicles used by evacuating households. This information will help us to predict traffic flows and identify areas of traffic congestion in our evacuation models.

*Table 8 : Number of Vehicles Used to Evacuate Household*

| | Living Within Inundation Zone | | Living Outside Inundation Zone | | All Combined | |
|---|---|---|---|---|---|---|
| | *Door to Door* | *Online Survey* | *Door to Door* | *Online Survey* | *Total* | *%* |
| 1 vehicle | 76 | 102 | - | 61 | **239** | 84% |
| 2 vehicles | 10 | 25 | - | 7 | **42** | 15% |
| 3 or more vehicles | 1 | 2 | - | 0 | **3** | 1% |
| Not reported | - | - | 1 | 1 | 2 | - |
| **Total** | **87** | **129** | **1** | **69** | **286** | 100% |

We anticipated that most households evacuating by vehicle would use a single vehicle but did not have any expectations around how many would use more than one vehicle. For our purposes, a 'vehicle' includes passenger cars and trucks, vans, and recreation vehicles (RVs). Vehicles with trailers or camper units counted as a single unit. The breakdown of our results is shown in Table 8.

**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.**

These numbers will allow us to set up our evacuation models to mirror how households in the region evacuated during the January event. We can use these to stress test several different evacuation scenarios and compare them to the realities experienced during the actual event.

## *Evacuation Destination*

An important question we wanted to explore as part of the study was where evacuating residents went during the evacuation. For our purposes, we limited responses to the first location outside the inundation zone that residents reported stopping at.

Based on prior discussions with emergency managers and knowledge of the community, we anticipated the largest percentage would go to the homes of friends and families, with commercial parking lots and the official reception centre at the Echo Recreation Centre as other popular destinations. We were also aware that many chose to travel to the Hump. The results from the surveys are shown in Table 9.

**We found that 38% of study participants reported evacuating to the home of friends or family, while only 2% indicated that the Echo Recreation Centre was their first destination.**

*Table 9: Evacuation Destinations Reported by Evacuating Residents*

| | Evacuating Participants | | Both Studies Combined | |
|---|---|---|---|---|
| | *Door to Door* | *Online Survey* | *Total* | *%* |
| Home of friend or family | 31 | 79 | **110** | 38% |
| Commercial parking lot / restaurant | 37 | 63 | **100** | 34% |
| Above the tracks or "higher ground" | 9 | 13 | **22** | 8% |
| The Hump | 3 | 15 | **18** | 6% |
| Out of town | 0 | 11 | **11** | 4% |
| Port Alberni Hospital | 2 | 7 | **9** | 3% |
| Local church | 3 | 5 | **8** | 3% |
| Echo Recreation Centre | 0 | 5 | **5** | 2% |
| Alberni Valley Multiplex | 0 | 1 | **1** | 0% |
| Other | 1 | 7 | **8** | 3% |
| Not reported | 5 | 1 | **6** | - |
| **Total** | **91** | **207** | **298** | 100% |

Those with friends or family in the community who live outside the inundation zone should continue to use these locations as their primary evacuation destination. Doing so provides them with shelter, the potential for food and water, and important emotional support during an emergency. Further, this

reduces the number of individuals seeking shelter at official reception centres, freeing up limited space for those with nowhere else to go.

The second-most popular destination reported by study participants, at 34%, ended up being 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. These parking lots tend to be large, open spaces that can accommodate many vehicles, and are relatively easy to access. When open, they may also provide public washroom facilities and purchases of food, water, and supplies may also be possible.

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. 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. Further, in the event of an earthquake-generated tsunami, there is always a chance of aftershocks that could impact access to these areas and cut evacuees off from emergency services from Port Alberni or other communities. In most cases these individuals would be equally well served at other locations in the community with easier access to services such as the hospital, should they be needed.

Only 2% of our participants indicated that they travelled to the official reception centre at the Echo Centre. This may be partly because the location was not open and receiving evacuees until around 4:00 AM, nearly an hour after the evacuation was officially begun. Official reception centres are generally a good choice as an evacuation destination as most services, including washrooms, are usually available, and there are staff available to assist. The Echo Centre also has staff trained in First Aid, which may be important for those with minor medical conditions resulting from the evacuation or anxiety associated with the evacuation (however, those with more acute care needs should seek such care at the Hospital). Changes are being discussed that may allow the Echo Centre to open more quickly in the event of an after-hours evacuation in the future.

Residents should avoid using the Hospital as an evacuation destination if they do not require medical care. Doing so frees up space for those who may need medical assistance.

## *Evacuation Times*

It can be very difficult to estimate the amount of time a community will have available to completely evacuate a tsunami inundation zone. Largely this is dependent on the distance tsunami waves need to travel to arrive at the community, and part of it is related to the complexity of coastal and near-shore waters. In the case of Port Alberni, there is only a single historic data point to use: the 1964 tsunami. In that case, we know it took the waves about ten minutes to travel between Bamfield and Port Alberni.

Thankfully we have been able to do tsunami wave travel modelling for some time now. These models allow us to estimate how long it will take tsunami waves to travel outward from the source location to

potentially affected communities. By running such models for multiple source locations, it becomes possible to estimate 'average' and 'worst-case' scenarios for a given community.

For the Alberni Valley, we know that a worst-case scenario would be an earthquake-caused tsunami occurring along the nearby Cascadia Subduction Zone (CSZ). Such an event would give residents living in the inundation zone **as little as twenty minutes** from the time the ground stopped shaking from a large-magnitude quake to the time the first tsunami wave arrived. This is not much time for everyone located in the inundation zone to get to safety on higher ground.

With a greater travel distance — say an earthquake centred near Japan, Russia, Alaska, or Chile — residents could expect a longer warning period in which to get to safety. This can range from an hour to the better part of a day. When it comes to evacuation planning, we should, therefore, take two separate times into account: a short evacuation time to cover the worst-case scenario, and a longer evacuation time to account for the additional warning time associated with a longer travel time.

We asked our study participants to estimate two times for their evacuation:

1. How long it took from the time they *first* learned about the tsunami evacuation (whenever that was) to the time they left their home; and
2. How long it took from the time they left their home to the time they arrived at their initial destination outside the inundation zone.

We determined 'total' evacuation time by combining the values for both of these categories for each household. Table 10 shows the evacuation times estimated by our study participants broken down by question and survey type. The dashed dark pink line indicates the cut-off point for an ideal twenty-minute evacuation. The dashed blue line indicates the cut-off point for a sixty-minute evacuation time.

**We found that 96% of those participants who evacuated their households managed to get to a safe destination on higher ground in under sixty minutes. However, only around 33% managed to reach their destinations in twenty minutes or less.**

These are self-reported times, however, and may be subject to over- or under-reporting due to how our perception of time can be unreliable during times of stress[16] or, in the case of the door to door survey, a desire not to be judged harshly by the person taking the survey. Some travel times may also be exaggerated for those who opted to travel to safe destinations out of town, who would likely have been safe long before arriving.

Improved household preparedness has been shown to help reduce overall evacuation times, specifically making it easier and faster for residents to collect important items before leaving their home. The advance preparation of a 'go bag' containing critical items such as important documents, a change of

[16] Bar-Haim, Y., Kerem, A., Lamy, D., & Zakay, D. (2010). When time slows down: The influence of threat on time perception in anxiety. *Cognition and Emotion*, *24*(2), 255–263. DOI: 10.1080/02699930903387603

*Table 10: Participant-Estimated Evacuation Times*

| | Time from Receiving Warning to Leaving House | | Time from Leaving House to Arriving at Destination | | Total Evacuation Time | | All Combined | |
|---|---|---|---|---|---|---|---|---|
| | *Door to Door* | *Online Survey* | *Door to Door* | *Online Survey* | *Door to Door* | *Online Survey* | *Total* | *%* |
| Under 5 minutes | 12 | 37 | 16 | 36 | 0 | 0 | **0** | 0% |
| 5 – 10 minutes | 23 | 65 | 32 | 64 | 1 | 10 | **11** | 4% |
| 10 – 14 minutes | 25 | 34 | 23 | 44 | 9 | 25 | **34** | 12% |
| 15 – 19 minutes | 7 | 27 | 12 | 23 | 17 | 33 | **50** | 17% |
| 20 – 24 minutes | 9 | 17 | 3 | 18 | 16 | 28 | **44** | 15% |
| 25 – 29 minutes | 1 | 3 | 1 | 8 | 19 | 28 | **47** | 16% |
| 30 – 34 minutes | 7 | 8 | 2 | 5 | 6 | 31 | **37** | 13% |
| 35 – 39 minutes | 0 | 2 | 0 | 3 | 7 | 9 | **16** | 5% |
| 40 – 44 minutes | 2 | 4 | 0 | 0 | 3 | 10 | **13** | 4% |
| 45 – 49 minutes | 0 | 2 | 0 | 0 | 5 | 7 | **12** | 4% |
| 50 – 54 minutes | 0 | 0 | 0 | 0 | 1 | 6 | **7** | 2% |
| 55 – 59 minutes | 0 | 0 | 0 | 0 | 0 | 3 | **3** | 1% |
| 60 minutes or greater | 0 | 5 | 0 | 0 | 2 | 9 | **11** | 4% |
| Not sure | 3 | 1 | 0 | 2 | 3 | 3 | **6** | 2% |
| Not reported | 2 | 2 | 2 | 4 | - | - | - | - |
| **Total** | **91** | **207** | **91** | **207** | **89** | **202** | **291** | 100% |

clothes, medications, etc. can help shave minutes off evacuation times. Knowing evacuation routes in advance, and having a backup route, can also help reduce evacuation travel times and route around

barriers or congestion on primary routes.

Some structural changes by municipalities can also help to make evacuation travel faster and less prone to issues. In some situations, this can include lane reversals, limiting turns, adjusting traffic signal timing, blocking off problematic routes, and preventing traffic from returning to the evacuation zone. Some structural changes may be required to protect the safety of evacuating residents but may result in slower evacuations. Vulnerable infrastructure may necessitate changes, for example, such as blocking off bridges or roads that are not seismically sound or prone to landslides, flooding, or tsunami inundation.

## *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 this is generally accomplished through road signs notifying residents and visitors about the location of dangerous areas and what routes to follow to get to a safe place.

In Port Alberni, there are signs along major roadways that indicate to drivers when they are entering or leaving the tsunami hazard zone. Such signs are limited, so it may not be clear from any given location whether one is located within the inundation zone, or safely outside it.

*Table 11 : Evacuation Signage is Clear*

| | All Participants | | Both Studies Combined | |
|---|---|---|---|---|
| | *Door to Door* | *Online Survey* | *Total* | *%* |
| Signage is clear | 53 | 128 | **181** | 40% |
| Signage not clear | 38 | 134 | **172** | 38% |
| Uncertain | 11 | 89 | **100** | 22% |
| Not reported | 9 | 2 | **11** | - |
| **Total** | **111** | **353** | **464** | 100% |

**We asked study participants if they felt that that the signs marking emergency evacuation routes were clear enough. The results of this question were mixed, with 40% indicating they felt the signage was clear, and 38% replying that it was not clear.** The remaining 22% of respondents were uncertain. The results are shown in Table 11.

A couple of issues may be at play here:

1. Residents may have become 'blind' to these signs due to familiarity with their environment, and simply do not remember they are there;
2. Residents may not frequently travel routes where the signs are posted; or
3. There may be too few signs, existing signs may be too small, or existing signs are not readily visible to residents.

# Barriers to Effective Evacuation Experienced by Residents

It's one thing to know that you need to evacuate and another entirely to get to safety. At-risk residents can face barriers and other difficulties that can make it difficult or even impossible to get to a safe point. Some of these can be mitigated through actions at the individual, household, or community level, however, some require special actions to overcome.

**When asked about their evacuation experiences, 53% of evacuating participants did not report any difficulties in getting to their evacuation destination.**

The top obstacles study participants reported encountering are listed in Table 12. Residents were most likely to encounter traffic congestion, which is not surprising when a large number of vehicles are attempting to leave an area at the same time. It was also not clear to some residents where they should be evacuating to, and/or where they could get official information about the tsunami warning and evacuation. Approximately 8% reported not hearing the tsunami warning system.

*Table 12: Barriers to Effective Evacuation Reported by Evacuating Residents*

| | Evacuating Participants | | Both Studies Combined | |
|---|---|---|---|---|
| | *Door to Door* | *Online Survey* | *Total* | *%* |
| No difficulties experienced | 50 | 104 | **154** | 53% |
| Traffic congestion / slow traffic | 26 | 28 | **54** | 18% |
| Not clear where to evacuate to | 2 | 49 | **51** | 17% |
| Did not know where to get information | 8 | 38 | **46** | 16% |
| Critical information was poorly communicated | 6 | 34 | **40** | 14% |
| Did not hear the tsunami warning system | 5 | 19 | **24** | 8% |
| Did not have access to a vehicle | 4 | 10 | **14** | 5% |
| Did not know about the evacuation | 0 | 7 | **7** | 2% |
| Did not have a driver with a valid driver's license | 1 | 6 | **7** | 2% |
| Long distance to get to safety | 0 | 6 | **6** | 2% |
| Did not feel safe going to the reception centre | 1 | 2 | **3** | 1% |
| Other | 2 | 1 | 3 | 1% |

$N = 292$

* Participants could select more than one barrier

As the first large-scale evacuation experienced in the Alberni Valley since a false tsunami warning in 2006, this event represents an excellent opportunity to learn what barriers and other difficulties were experienced by Alberni area residents.

Even in the best thought-through evacuation plan, there are aspects that may be unexpected, unavoidable, or inherent to individual households that can make an evacuation more difficult or even impossible for some residents.

The goal for emergency planners and managers should be to identify as many of these in advance and address those they can given the time and resources available. Not every single barrier can, or even should, be addressed by officials. Instead, those that have the largest impact and can be mitigated through systematic changes should be considered.

Many of these barriers occur at the individual resident or household level, such as medical conditions, household preparedness and information seeking, anxiety related to theft, etc. Others are simply unavoidable and must be planned around, such as emergency road work or unexpected road closures. Still, others may be addressed through proactive educational efforts.

## Reasons for Not Evacuating

We were interested to learn some of the reasons why some households did not evacuate. For those not living in the inundation zone, the primary reason they opted not to evacuate was *because* they didn't live in the inundation zone.

There were only 14 participants living within the inundation zone who did not evacuate. All 14 participants provided one (or more) reasons for not evacuating, and these are listed in Table 13.

*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 | 5 | 3 | **8** | 57% |
| Did not know about the evacuation | 2 | 2 | **4** | 29% |
| Did not see the point in evacuating | 3 | 1 | **4** | 29% |
| Did not believe a tsunami represented a threat to household | 2 | - | **2** | 14% |
| Did not want to leave for fear of looting / theft | - | 2 | **2** | 14% |
| Not home at the time | - | 1 | **1** | 7% |
| Unable to evacuate due to disability or illness | 1 | - | **1** | 7% |
| Not enough information was publicly available to make an informed decision | - | 1 | **1** | 7% |
| Felt safer at home than reception centre | 1 | - | **1** | 7% |

$N = 14$

## Awareness of Proximity to Official Inundation Zone

For us, understanding whether residents were aware if their homes were located within the official tsunami inundation zone was a critical question. Residents who are unaware if they live in the tsunami danger zone, or who are mistaken in their beliefs, are potentially at increased risk. We asked study participants if they believed their home was located within the official inundation zone and then our research team manually verified each home's status. The results are shown in Table 14.

*Table 14 : Awareness of Household Proximity to Official Inundation Zone*

| | **Verified Location of Participant Home** | | **Both Studies Combined** |
|---|---|---|---|
| **Reported Location of Participant Home** | *Within the inundation zone* | *Outside the inundation zone* | *Total* |
| Indicated they lived within the inundation zone | 48.1% | 5.9% | **54.0%** |
| Indicated they lived outside the inundation zone | 2.8% | 32.9% | **35.7%** |
| Uncertain of proximity to inundation zone | 1.5% | 8.7% | **10.2%** |
| **Total** | **52.5%** | **47.5%** | 100% |

Upon examining the numbers, 64% of those participants who were uncertain about their proximity to the zone exercised caution and opted to evacuate during the January event. The remaining 36% opted to remain home or were unable to evacuate. It is possible that making the inundation zone boundaries easier to understand or more clearly denoting where the boundaries are, might assist residents who are unsure about their home's status in the event of a tsunami warning.

Of similar concern is the approximately 3% of study participants who mistakenly believe they live outside the evacuation zone when, in fact, their homes are located inside it. Some of these homes are located along the fringes, and their misunderstandings are easily understood, however, some of these responses came from individuals a reasonable distance from the official zone boundaries. The concern is that this group of residents may feel a false sense of security about their position and may opt not to evacuate in a future tsunami warning even though their homes may be at risk. This is something that was partially confirmed in the reasons given by those in the inundation zone who did not evacuate (Table 13, above). Again, making inundation zone boundaries easier to understand or more clearly denoting the locations of the boundaries may help inform residents about their risk.

Our final observation is that almost 6% of participants believe they are living in the inundation zone when they are not. On the surface, this is not a large concern and may be viewed as exercising caution in the face of uncertainty or confusion. However, this does present an issue when viewed from the

standpoint of the capacity of the road network and other support facilities to support the additional number of households who are evacuating. The more 'unnecessary' evacuees moving away from the inundation zone in their vehicles, the more congested the road network is, and that congestion slows traffic all the way back to the point of longest evacuation times. This means that in an urgent evacuation, for example in the event of a Cascadia-related earthquake, the roads out of the inundation zone could become clogged with unnecessarily evacuating vehicles, making it difficult for the most at-risk residents to get to safety in the limited time available.

Helping residents to become more familiar with their status relative to the tsunami inundation zone may empower them to make better decisions that help reduce unnecessary evacuations and help improve the ability of those at-risk to evacuate in a timely and efficient manner.

## Personal and Community Preparedness

Emergency preparedness is a key element to a successful response to a tsunami, or other hazard-related, warning. Households that have taken the time to become informed about local hazards, prepared materials to quickly respond, and formulated a response plan, are going to react more quickly than those that do not prepare.

We asked our participants a few questions related to how strongly they agree or disagree with provided statements about tsunami risk and preparedness. These are shown in Table 15.

*Table 15: Questions Related to Community and Household Preparedness*

| | Strongly Agree | Somewhat Agree | Neutral | Somewhat Disagree | Somewhat Disagree | *N* |
|---|---|---|---|---|---|---|
| I feel that my community was provided with sufficient information about tsunami risk *prior to the evacuation* | 22% | 28% | 15% | 23% | 12% | **445** |
| I feel that *I* was reasonably informed about tsunami risk *prior to the evacuation* | 43% | 28% | 10% | 10% | 8% | **450** |
| I feel that *I* have become better informed about tsunami risk *since the morning of the evacuation* | 32% | 25% | 21% | 11% | 10% | **442** |
| I feel *my household* was reasonably prepared to respond to a tsunami warning *prior to the evacuation* | 24% | 32% | 13% | 20% | 12% | **450** |
| I feel *my household* has taken actions to better prepare for a future tsunami warning *since the morning of the evacuation* | 26% | 30% | 19% | 14% | 12% | **452** |

**At 51%, most participants indicated that they felt the community had been provided with sufficient information about tsunami risk prior to the morning of the evacuation.** 72% of participants believed that they personally were reasonably well informed about tsunami risk, and 57% have become better informed about tsunami risk since the morning of the evacuation. Over half of the study participants indicated they were reasonably prepared to respond to a tsunami warning, and a similar number have taken actions since the morning of the evacuation to become better prepared to face a potential future tsunami alert.

## Public Perceptions of Tsunami Risk

We asked several questions related to how those living in the community perceive the risks associated with living in a community prone to tsunamis. Given the much larger than expected response to our surveys, we will address these issues in depth in the final report in October 2018.

## Perceptions of Official Response

With any precautionary large-scale evacuation, local governments are placed under additional scrutiny in the hours, days, and weeks following the event. Because these events are difficult or impossible to plan for and test, there are almost always going to be glitches in how these groups respond. This reality is, even more, the case when an evacuation needs to occur in the early hours of the morning.

We wanted to see how residents felt about the official response and the decision-making process behind it. We will discuss these questions in greater detail in the final report but wanted to present the basic numbers here for review (Table 16).

*Table 16: Public Perceptions of Official Response to Tsunami Warning*

| | Strongly Agree | Somewhat Agree | Neutral | Somewhat Disagree | Somewhat Disagree | *N* |
|---|---|---|---|---|---|---|
| I believe the City and Regional District were reasonably prepared | 23% | 35% | 10% | 21% | 11% | **446** |
| I believe that officials conducted the evacuation in an appropriate manner | 39% | 29% | 15% | 11% | 7% | **441** |
| I believe that evacuation instructions were clearly communicated during the evacuation | 23% | 23% | 15% | 23% | 16% | **441** |
| I believe that given the information available, the decision to evacuate was the correct choice | 68% | 19% | 7% | 4% | 3% | **441** |

Approximately 58% of participating residents indicated they felt that the City of Port Alberni and the ACRD were reasonably prepared to handle a tsunami warning and evacuation. When asked how they felt about how the evacuation was conducted, 68% indicated they believed the official response was appropriate. On the question of the clarity of communications during the event, responses were mixed, reflecting previous comments about how information was communicated during the event.

**The most important question related to perceptions of the official response was whether residents felt that the decision to evacuate the inundation zone by the Director of the EOC was the correct choice. At 86%, it is fair to say that the overwhelming response was that this was the correct choice.** Open-ended response questions on the online survey and discussions with residents during our door to door survey back this up. Most who elaborated on their answers felt that officials should evacuate the zone if there is any reasonable probability of a tsunami event in the community, even if this means there will be some 'false' alarms from time to time.

The final question we asked this area was what impact, if any, this event will have on the likelihood that residents would evacuate in the future. The results of this question are shown in Table 17.

*Table 17: Impact this Event had on Likelihood to Evacuate*

| | Much More Likely | Somewhat More Likely | Neutral | Somewhat Less Likely | Much Less Likely | *N* |
|---|---|---|---|---|---|---|
| If a future tsunami warning were to occur, what impact would this event have on your decision to evacuate? | 19% | 11% | 60% | 6% | 5% | **443** |

**For most people, this event did not appear to move the needle, either making them more or less likely to evacuate in the future. 60% of survey respondents indicated that this event would not change the likelihood that they would evacuate in the future.** 29% indicated that they would be more likely to evacuate in a future tsunami warning, while only 11% indicated they would be less likely to evacuate because of this event.

Overall, the public's perceptions of the official response were largely positive. The people we heard from in person and in our online survey rarely felt that this event was anything but a success, despite some foibles that are already being addressed by the City and ACRD. While we heard from some that the evacuation could have been called earlier and there were issues about official messaging, these issues do not appear to have had a major impact on local trust in emergency management or on participation in future evacuations. Both the City and ACRD have and are continuing to work together to identify issues that arose during the January evacuation and address shortcomings in their plans. Many of these changes have already been implemented or are in the process of being changed.

# Discussion

*Figure 6 : The Port Alberni Maritime Discovery Centre (the author)*

There is still a significant amount of work for us before we can complete our research and answer many of the questions we posed at the beginning of the study. However, one of our goals was to provide some information arising from our work to emergency planners and managers in the Alberni Valley as quickly as possible so that they can make informed decisions about their plans going forward. To this end, this report is largely a surface-level analysis of the information provided to us by the people of Port Alberni and the surrounding areas.

While we cannot yet answer all our questions in depth, there are several themes that have come out of the research to this point that we wanted to share. Additional work exploring risk perceptions, examining alternative evacuation plans, and tying things together will be taking place over the summer and should be finalized for October.

## 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?"*

We have addressed part of this question through our initial analysis of public responses from our door to door and online surveys. Our interviews with officials will need additional time to analyze but are generally similar to those of the public in identifying weaknesses in the official response and providing some context about the reasons behind official missteps.

## 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 survey respondents indicated that the community's tsunami warning broadcasts were the first sign they had that there was a tsunami warning and evacuation had been initiated. A small number reported first hearing about the event from friends or family by phone or text message, on social media or in news broadcasts and alerts on TV or the radio. Others were woken by the sirens and announcements on loudspeakers by RCMP and Fire Department staff driving through at-risk areas to supplement the official warning system. A very small number of individuals living in the inundation zone indicated that they did not hear about the evacuation until the evacuation had already ended.

Most residents living in the tsunami inundation zone opted to evacuate to safety on higher ground. The largest number of these residents found shelter with friends or family elsewhere in the community or in nearby communities. Many others came together in the parking lots of major businesses and restaurants. A minority of residents travelled to much higher ground at The Hump, while others continued their journeys to Cathedral Grove, Parksville or Nanaimo. Very few of our survey participants indicated travelling to the reception centre at the Echo Centre, though some of those who did indicated that they found it closed when they arrived.

Most study participants indicated that they were able to get to safety in under an hour, with around a third arriving at their destination within twenty minutes. A small, but significant, number indicated it took over an hour to leave the house and get to their safe spot. It may be possible to reduce this number through personal preparedness educational campaigns.

Very few residents who know they live in the inundation zone opted to remain behind. However, there was a small number of individuals living in the zone who mistakenly believed they lived outside the zone and thus decided not to evacuate. Likewise, there were some residents who live outside the inundation zone who mistakenly believe they are within its boundaries and opted to evacuate.

Very few residents reported evacuating on foot, and some of these received rides part way into their trips. The clear majority of household evacuating by vehicle used a single vehicle. Very few residents made stops along the way. Those that did were usually stopping to pick up friends, family, or pets. A small number indicated they stopped for supplies, including fuel for their vehicles.

While sleepy and grumpy children were kept home the next morning, many returned home at the end of the event and then began their day just like any other, though likely with a few extra cups of coffee.

## Evacuation Barriers & Difficulties Experienced by Residents

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

Over half of survey participants indicated that they did not experience any difficulties during their evacuations. Of those who did experience difficulties most identified traffic congestion, being unsure where to evacuate to, being unsure where to get information about the event, and that information was poorly communicated by officials. Approximately 8% of participants indicated that they did not hear the

tsunami warning system, and around 2% reported being unaware of the evacuation at all until it had already concluded.

Some of the issues encountered by evacuees may be addressed by local governments through structural or policy changes. Other issues can be addressed by community action, such as looking out for vulnerable neighbours. The remaining issues must be addressed at the individual and/or household levels and may benefit from assistance in the form of education and/or assistance.

## 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?"*

The last research question we wanted to explore as part of this study was the impact that this event has had on the community's perceptions surrounding tsunami risk, their trust in emergency officials, and their participation in future evacuations.

### *Changes to Community Tsunami Risk Perceptions*

This first part of the question will require a more in-depth analysis of resident risk perceptions. We plan to have this ready for the final findings report in October.

### *Changes to Public Trust in Emergency Officials*

There does not appear to have been a significant impact on the trust placed in the region's emergency planners, emergency managers, or first responders. Residents have pointed out that some planning efforts — especially as it relates to communication with the public — do need additional attention. Most residents appeared happy to give the City and the ACRD the benefit of the doubt that issues raised during this event will be addressed and improvements made to the region's tsunami response plan.

### *Willingness to Participate in Future Evacuations*

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 being nothing will 'turn off' or become desensitized to the threat and the warning messages.[17]

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

There is always a fear that an evacuation arising from a "non-event" threat could strain trust in emergency officials, resulting in some residents deciding not to evacuate again when some future warning occurs. The older academic literature focused on this topic is limited, with most references simply taking the theory as granted. More recent literature exploring the concept, becoming more popular with Breznitz in 1984,[18] have largely relegated the idea to myth status, with no 'smoking gun' evidence presented to directly show that repeated warnings resulted in warning fatigue.

**If we look at the study 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 11% indicating they are less likely to evacuate.

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

# Next Steps

*Figure 7 : The Port Alberni Harbour Quay (the author)*

There is still much work remaining for us before this research project concludes. We will be working over the summer to specifically address questions related to public and official perceptions of the event.

We will be using the information that residents and officials have provided to us to build some evacuation models customized to the public response observed during the January event. This will allow us to test several different evacuation scenarios and explore potential alternative evacuation plans.

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