Institute for Catastrophic Loss Reduction
Institut de prévention des sinistres catastrophiques

MEOPAR

WESTAC

Addressing Climate Risk for Coastal Transportation Infrastructure: Opportunities Moving Forward

A Report on the Expert Forum conducted by the MEOPAR Network Centre of Excellence, the Institute for Catastrophic Loss Reduction, and the Western Transportation Advisory Council on May 16-17, 2018.

About the Marine Environmental Observation Prediction and Response (MEOPAR) Network

Established in 2012 through Canada's federal Networks of Centres of Excellence Program, the Marine Environmental Observation, Prediction and Response (MEOPAR) Network is a national network of academic researchers and students, government scientists, and partners in the private, NGO and community sectors working together on marine issues. MEOPAR is hosted at Dalhousie University in Halifax, Nova Scotia. An independent not-for-profit, MEOPAR funds research, trains students, mobilizes knowledge and communicates results in the area of marine risk and resilience.

In its first Cycle (2012-2017), MEOPAR established organizational and network structures and programs, built new tools and cores for observation, prediction and response, created expert capacity and developed new partnerships. In March of 2017, the federal government announced that MEOPAR would receive funding for an additional cycle (2017-2022). In Cycle II, MEOPAR is building on its first Cycle through meaningful research with a potential for real-world impact. MEOPAR is working to create and develop our programming in the areas of training, research and knowledge mobilization, to strengthen national and international partnerships, and to increase its capacity in marine risk and resilience.

About the Institute for Catastrophic Loss Reduction (ICLR)

The Institute for Catastrophic Loss Reduction, established in 1997, is a world-class centre for multi-disciplinary disaster prevention research and communications. ICLR is an independent, not-for-profit research institute founded by the insurance industry and affiliated with Western University. ICLR staff and research associates are recognized internationally for their expertise in wind and seismic engineering, atmospheric science, risk perception, hydrology, economics, geography, health sciences, and public policy, among other disciplines. The International Council for Science established ICLR as an International Centre of Excellence in Integrated Research on Disaster Risk.

ICLR's mission is to reduce the loss of life and property damage caused by severe weather and earthquakes through the identification and support of sustained actions that improve society's capacity to anticipate, mitigate, withstand, adapt to and recover from natural disasters.

About the Western Transportation Advisory Council (WESTAC)

The Western Transportation Advisory Council has been navigating the challenges of promoting system-wide, strategic advancement of transportation and goods movement in Western Canada for over forty years. WESTAC's mission is to be the destination for forward-thinking business, government and labour leaders in search of insights, discussions, and solutions that contribute to the long-term success of transportation across Western Canada. WESTAC members representing the private sector, government, and labour have demonstrated their leadership by working collectively to resolve the constraints and inefficiencies that undermine the performance of Western Canada's supply chain and transportation sector. WESTAC operates as a not-for-profit, non-partisan forum.

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Executive Summary

This report summarizes discussions that took place during the Expert Forum on Addressing Climate Risk for Coastal Transportation Infrastructure hosted by the Marine Environmental Observation Prediction and Response (MEOPAR) Network, the Institute for Catastrophic Loss Reduction (ICLR) and the Western Transportation Advisory Council (WESTAC) on May 16-17, 2018, at the Morris J. Wosk Centre for Dialogue in Vancouver.

Defining the Discussion
Climate change is projected to increase the frequency and intensity of weather conditions that negatively impact Canada's coastlines. Sea levels will rise and amplify storm surges in coastal areas, and precipitation will be more intense. The impacts on supply chain reliability, capacity and cost may be extreme - not just at the coast but across land-based, air and marine transportation systems. How should transportation stakeholders manage these risks? Can supply chains build, adapt and prepare for them? The expert forum on coastal transportation infrastructure was created to address these issues and was built around three core questions:

1. **Can the lower mainland transportation infrastructure handle current extreme weather?**
   BC's lower mainland is home to Canada's largest port. The terminals, warehouses, railways, roadways and other supporting infrastructure keep Canada's economy moving. However, the nature of supply chains means damage to one link will have cascading impacts. In particular, recent global experience shows extensive economic disruption and losses as a result of coastal disasters. Business leaders and public officials must take action to reduce the risk of damage to transportation infrastructure from current climate hazards.

2. **How should we manage the current transportation risks for remote and island communities?**
   Coastal communities outside of the Lower Mainland, including Vancouver Island, are particularly vulnerable to disruption due to a greater dependence on ferries and a primary access road. Where transportation alternatives are few, service is infrequent, and distances are long, it is essential that coastal transportation systems do not fail or can be restored quickly.

3. **What should be done to better prepare for future climate and rising sea levels?**
   Climate change is already impacting BC's transportation infrastructure. Higher temperatures, more extreme weather events, rising sea levels, and higher storm surges put our coastal transportation systems at risk. Moreover, these challenges are expected to increase over time. Taking action now to design and adapt infrastructure and services to future climates and sea level rise will build our resiliency in the face of climate change and reduce the risk of loss, damage and disruption.

The Expert Forum discussed the current state of knowledge about these issues and explored possible actions by private industry, governments and others to reduce the risk of loss and damage from disruption of coastal transportation infrastructure. In particular, the science community sought direction about research that would support the current and longer-term needs of decision makers addressing coastal transportation infrastructure issues.

Next steps

Discussions that took place during the workshop allowed for the development of recommendations in this area. Considering the vast interest in the three main topics that were discussed during the Expert Forum, it was recommended to establish a platform where a network of researchers and practitioners could discuss and reflect on the impact of climate risks on coastal transportation infrastructure. More specifically, a **Community of Practice on Climate Risks for Coastal Transportation Infrastructure** would allow for the development of an action plan to advance the resilience of transportation infrastructure and, as such, reduce the potential impact of climate risks they are facing.

Several initiatives could be pursued by this Community of Practice. Examples of initiatives include:

1. **Collaboration with the Fraser Basin Council**: During the Expert Forum, Steve Litke, Senior Program Manager, Watersheds and Water Resources at the Fraser Basin Council, discussed initiatives in place at the Council to address river and coastal flood risk. A collaboration between the Fraser Basin Council and the Community of Practice would strengthen the work pursued on the transportation side through discussion and advice coming from practitioners and researchers.

2. **Assisting coastal communities in their effort to protect transportation infrastructure**: Several initiatives are currently being implemented by Canadian coastal municipalities to protect their transportation infrastructure. For instance, the port of Nanaimo has developed an emergency management strategy to deal with coastal issues, with the objective to eventually come up with a joint transportation strategy for the town, the region, and the airport. The community of Powell River has completed an analysis to better understand how climate risks could affect the community and is moving toward the implementation of specific adaptation actions. By taking advantage of the expertise of researchers and practitioners, the Community of Practice will learn how it can assist communities to understand their risks and can also provide them with strategies for adaptation. Coastal communities are also reflecting on how to best protect tourists visiting their communities who might be unfamiliar with specific climate risks. The Community of Practice could also assist municipal leaders in reflection on these matters.

3. **Sharing best practices and lessons learned:** Several organizations are leading strong initiatives to reduce the risks faced by coastal transportation infrastructure from climate risks. A Community of Practice will provide the opportunity to share stories and case studies with a great level of detail so that others can learn from them and move forward.

The Institute for Catastrophic Loss Reduction, with the support of MEOPAR, is keen to move forward and establish this Community of Practice so that researchers and practitioners can work collectively around these questions. This forum would allow those interested to discuss specific initiatives, share our visions, and provide support to those who are seeking action in this space.

List of Presenters

Paul Kovacs (Executive Director, Institute for Catastrophic Loss Reduction)
Ron Pelot (Associate Scientific Director, MEOPAR Network)
Oksana Exell (President and Chief Executive Officer, WESTAC)
Becky Denlinger (Deputy Minister, Emergency Management British Columbia)
Derek Stewart (Director, Safety, Environment & Emergency Management, TransLink)
Don Ehrenholz (Vice President, Engineering and Environment, Vancouver Airport Authority)
Willy Yung (Director, Engineering and Maintenance, Vancouver Fraser Port Authority)
Terry Duggan (President and CEO, BC Maritime Employers)
Gary Fast (Vice President, Domestic Transportation Operation, Canadian Tire)
Mayor Lois E. Jackson (City of Delta)
Bob Dhaliwal (Secretary-Treasurer, ILWU Canada)
Maryam Golnaraghi (Director, Extreme Events and Climate Risk, The Geneva Association)
Dirk Nyland (Chief Engineer, BC Ministry of Transportation and Infrastructure)
Gregg Clackson (Director, Operations & Security Centre, BC Ferry Services Inc.)
Ewan Moir (President and CEO, – Nanaimo Port Authority)
Ryan Thoms (Manager of Emergency Services, Powell River Regional District)
Tanya Patterson (Emergency Program Coordinator, City of Victoria)
Steve Litke (Senior Program Manager, Fraser Basin Council)
Thomas James (Research Scientist, Natural Resources Canada)
Trevor Heryet (Executive Regional Director, Issues & Program Management, Transport Canada)
Deborah Harford (Executive Director, Adaptation to Climate Change Team)
Pamela Kertland (Program Manager, Natural Resources Canada)
Tugce Conger (Researcher, University of British Columbia)
Anne Goodchild (Professor, University of Washington)

Summary of Presentations

Welcome Address

Paul Kovacs – Executive Director, Institute for Catastrophic Loss Reduction (ICLR)
Paul Kovacs first welcomed all participants. He highlighted that our climate has changed, and that significant further change is expected. Change has the potential to disrupt transportation systems for coastal communities and, as such, it is imperative to proactively manage climate risk.

Three distinct objectives were set for the Expert Forum: First, we seek to better understand risk and the tools that are emerging to model and map the risk of loss and damage due to climate impacts on coastal transportation. Second, we aim to identify what actions are underway to reduce the risk of loss to existing systems. Third, we want to better understand what options are available to eliminate the creation of new risks, through emerging standards and by prohibiting new investments in areas of high risk.

Ronald Pelot – Associate & Scientific Director, MEOPAR
Ronald Pelot focused his address on how we can collectively make better use of methods and research to improve responses and change. Several changes are currently happening with regards to the ocean. Not only is the ocean itself changing because of climate change, but the uses for the ocean are also changing (shipping in the arctic, shipping in BC, marine spatial planning, and more aquaculture). It is difficult to find the right approach to manage coastal issues, but with better data becoming available through various organizations, we now have the ability to better manage risk.

Oksana Exell – President & Chief Executive Officer, WESTAC
Oksana Exell presented the Expert Forum as an opportunity to exchange information and knowledge among transportation executives. WESTAC believes in the fundamental importance of shared information to make it successful.

For 45 years, transportation stakeholders have worked together to resolve the many issues that constrain Western Canada's supply chain and the transportation sector. The core principle in the Council's work is to strive for the reliability of the Western transportation system and to ensure that Canada remains globally competitive as a trading country. The discussion of climate risks for coastal transportation infrastructure is important in maintaining that reliability.

WESTAC ran its first survey on business concerns in 2017, and respondents took this opportunity to highlight that climate change is impacting WESTAC members. Climate change is affecting ship schedules, causing a ripple effect on the rest of the supply chain. Captains are reporting more frequent and violent storms that are becoming harder to predict, which shows that we, as representatives from the transportation sector, should be doing more to understand the climate change issues facing us and the supply chains we serve.

Sea levels are expected to rise two metres by 2100 and harsh weather events will increase in both intensity and frequency. WESTAC knows this will affect transportation providers. More specifically,

coastal rails flooding, flooding in tunnels under sea level, landslides, airports being damaged by flood and wind, port elevation and fortification, loss of capacity due to bridge heights, and damage to the Canadian economy are all listed as possible risks involving flooding and coastal changes.

In 2017, Western Canada accounted for 36% of Canada's GDP and 55% of Western Canadian GDP (403 billion dollars) is derived from international trade in goods and services. If this supply chain is disrupted, there are huge implications. The problems of climate risk for coastal transportation infrastructure are just too big for WESTAC to handle alone. The organization is looking for partners to collaborate in helping them better understand and adapt to climate change. Members of the transport industry are going to speak at this forum about the progress that has been made, and note that they also need the support of science and academia to help define the problems, enhance industry's understanding of risk, and find different technologies and approaches to assist with climate change resilience.

Setting the Scene: Current Climate Risks in the Lower Mainland and BC

Becky Denlinger – Deputy Minister, Emergency Management British Columbia
All senior levels of the BC public service believe in the importance of considering the whole picture in the realm of climate change and climate adaptation. In order to properly respond or plan for risk in any area, it is crucial to understand what is happening in the connected areas. As such, Emergency Management BC is currently working to improve its mindset by looking for synergies in various areas to reduce the social, economic, and environmental impacts.

Emergency Management BC deals with several types of hazards, including changing weather, changing climate, flooding, wildfire, landslides, and drought. Hazards are being seen in new and constantly changing cycles. In the past, clear patterns could be seen for weather cycles and showed when hazards might arise, which allowed for planning ahead by looking at historical data. This way of planning no longer works, and Emergency Management BC must now learn how to address the risk while they are facing it. This calls for a new model with data that can be understood and put to use in real time.

Emergency Management BC encourages government to contribute to projects like SIREN (MEOPAR research group focused on shipping-related questions), understanding that the more that can be researched ahead of time, the more the change in the hazard patterns can be understood. This can help with foreseeing new problems and future adaptation.

Emergency Management BC has a planning scenario for extreme heat and rain in the central interior part of the Province, which would bring flood levels in the lower Fraser River similar to those seen in 1948. There are defence structures in place that should help prevent flooding. The issue faced at this time is that the responsibility for maintaining these structures lies with different groups (more than a dozen different local authorities), and all it takes is one structure failing for issues to arise. The system is only as strong as its weakest link, so bringing people together for discussion and planning is very important.

The lower mainland is home to Canada's largest port and the transportation infrastructure that supports it. A study was done that estimated that there would be 20 to 30 billion dollars lost if a flood like the one in 1948 happened today. In 1948, there were fewer than 15,000 people residing in this flood plain. Now the population is estimated at just under 250,000 people. Hundreds of businesses and critical infrastructure are also at risk.

In addition, it was reported that 71% of dikes in the lower Mainland area are at risk of failure if there is any overtopping. This fact, together with current forecasts in sea level rise and increased storm surge activity have led to the realization that more will be required of the diking system if it is to address these risks. There are over 100 km of dikes that need to be updated and it is currently estimated that only 10% of current dikes meet the standard for future sea level rise.

Across the spectrum of organizations working to adapt to climate change, we need more data to be able to make sense of, predict, and plan for the complex environment that is emerging, and we need to work together—emergency management is a shared responsibility. We are all in this together.

Theme 1: Current Transportation Infrastructure Risks in the Lower Mainland

Derek Stewart – Director, Safety, Environment & Emergency Management, TransLink
TransLink operates the public transit services in Vancouver, but also looks after transportation for the whole region. The organization has a lot of long-standing infrastructure (subway, bridges, etc.) that needs maintaining to last into the future. For TransLink, a big part of emergency management and adaptation is linked planning. In the past, planning only focused around specific points in time, but moving forward, planning will be integrated into everything the organization does.

TransLink's emergency plan is used in the organization's environmental and safety programs, but they are also working to integrate emergency planning into all their existing programs. TransLink wants to create an understanding of the hazards they face and associate individual risk levels for those hazards. Once a hazard is identified, a short-term or long-term program is put in place to address it. The length of the program depends on the type of risk and what is needed to address it. All potential hazards, programs, and emergency systems need to be reviewed regularly. The goal is to keep the business running, and to make sure the organization prepares for any emergency that may disrupt the business.

High winds
Wind storms in the lower mainland have been responsible for large power outages which lasted for several days. High winds can shutdown the sky train, maintenance facilities, and streetlights, and can disrupt communications. The organization has seen a lot of assets damaged due to high wind. TransLink tries to reduce damages from high winds and keep operations going by trimming trees back from the sky train lines and monitoring alerts of impending wind alerts. In the event of a service interruption, TransLink has a diverse fleet of vehicles that are often able to bridge transit service. On a day-to-day basis, this is how the organization adapts to disruptions in service. Back-up power and customer alerts are other tools used to help in these situations.

Flooding (Rain and Freshet)
Several of the rail lines run by TransLink are vulnerable to flooding. Other examples of potential flooding impact for TransLink include flooded facilities and roads, rail and bridge damage, and power disruption, all of which can result in reduced driving safety, reduced customer safety, and service disruption for customers.

In order to take the right adaptation actions, it is important to understand what the risks are to TransLink. For instance, it is important to know if the Fraser River will breach the dikes, and to make time to look at flood maps and understand what assets TransLink has and if they are vulnerable. It is also key to have a short- and long-term flood plan and to communicate risks and inconveniences to customers when needed. Communicating operational issues with stakeholders and other connected transportation groups also must be considered when dealing with flooding.

Adaptation on the infrastructure side is primarily about keeping water out and allowing water to drain. TransLink is currently in the process of updating storm drainage in all their facilities. Actions like this are not only beneficial for the environment, but also allow them to plan for future rainfall projections under climate change. Moving forward, other actions will need to be considered, such as elevating the

storm drainage and elevating at-risk transit routes because of ocean levels rising. The ability for people to get around and between communities in a high-water state is at the centre of TransLink's planning.

Extreme Heat
Extreme heat causes less of an impact on Vancouver than some other areas in Canada. However, longer and hotter heat waves have been monitored and they do impact the employees of TransLink. Vancouver buses don't usually have air conditioning, but that is changing as temperatures increase in the area. During the hot season, buses without air conditioning are a safety concern for workers and are a comfort concern for passengers. Other areas of the country may have other concerns, such as road and rail damage due to the intense heat.

Operational adaption for TransLink during extreme heat includes communicating the risk to its workers and customers, ensuring that water is available for all workers, having uniforms made from breathable materials, and increasing the number of air conditioned assets. TransLink is also adapting its infrastructure by focusing on adequate building design. Having green or white roofs to help absorb or reflect heat, building windows directionally with the idea of keeping more sun out during hot days, and having trees on properties as well as large overhangs, are all adaptation options that can help reduce the risk of overheating.

Drought and Interface Fires
When it comes to drought and interface fire, the main areas of concern faced by TransLink are air quality, staff booking off due to health (respiratory) issues, and water restrictions. In most years, TransLink's uses most of its stored water has been used up near the end of the year, and they must cut back on things such as bus washes. For interface fires, transit in areas located in the direct line of the fire must deal with issues such as the evacuation of the service area, and sometimes assets being damaged or lost. Monitoring air quality, landscaping, communication, and planning for evacuation of at risk areas is a key priority for TransLink.

Don Ehrenholz – Vice President, Engineering & Environment, Vancouver Airport Authority
Vancouver International Airport (YVR) is Canada's busiest airport. Its mission is to connect British Columbia with the world, and its vision is to become a world-class sustainable hub for air traffic. Last year it handled 24.2 million passengers.

YVR is located on Sea Island, at sea level, and is surrounded by water. This makes the airport particularly vulnerable to climate change impacts, especially sea level rise and storm surge. In addition, it is important to note that aircraft movement is heavily impacted by conditions that can negatively impact flight.

Emergency Management
YVR does a lot of planning to avoid problems with operations and their facilities. They have developed many plans for different risk situations and run full-scale exercises with their partner agencies. This helps them be prepared in the event of a full-scale incident. The airport relies on external support when there is an emergency at the airport.

YVR has a continuity plan, an emergency management plan for many different natural disasters (including earthquake and flood), a flood response plan, a storm-water management plan, and a dike upgrade plan. They have also recently completed a climate change adaptation plan, which systematically looked at all the risks that could affect the airport due to climate change, and explains what could be done to mitigate these risks. The plan used the Metro Vancouver Climate Change Projections from September 2016, and broad-based climate change forecasting, to establish predictions about hazards that are of concern to the airport.

YVR completed a new master plan and capital plan that runs to the year 2037. Both will be influenced by the Climate Change Adaptation Plan. With this system, all new designs will be developed with future risks and adaptation taken into consideration. It is assumed that the frequency and severity of hazards that affect the airport will increase.

Sea level rise
Sea level rise is a major risk for the airport. YVR has been using the British Columbia Ministry of Environment Recommendation Plan, which reports a projected .5-metre increase in sea level rise by 2050. This level of sea level rise was used when the airport updated their dike upgrade plan five years ago. Two sections of the dike have gone through the upgrade process, with a third starting this summer. YVR is working to upgrade all the other dike systems in the next 10 years. Some areas that remain challenging include considerations for float planes and boat ramps. In these areas, YVR may have to use alternative mitigation methods such as flood gates to ensure protection.

Changes in precipitation patterns
Precipitation change is another risk. In recent years, the airport has seen more unusual and extreme precipitation events, including a hail storm mixed with rain in 2017 that caused localized ponding and flooding. Sea Island is very flat, and during low tides water will drain off the island into the Fraser River because of gravity. When the tide is high, flood gates need to be closed so that the water doesn't flow back in over the island. When the gates are closed and the tide is high, pumps are needed to keep the island dry. In the past five years, the island pumping capacity has been doubled, and it is expected that more improvements will be needed moving forward.

Extreme Heat
Another area the airport must monitor is air temperature. The expected rise in air temperature has the potential to impact several areas of the airport. The first area of concern is energy demand, which is primarily driven by having to heat or cool areas of the airport. It is expected that the number of days requiring cooling will increase by five times by 2015. An increased number of people working and using the airport will also contribute to a higher cooling demand in the future.

To address the additional cooling needs, YVR has just started to build a new Central Utilities building. It is expected to provide the airport's heating and cooling capacity until 2037 and beyond. It will use a geo-exchange field of wells that will extract heat out of the ground to heat buildings in the winter, and will take heat out of the buildings and put it into the ground in the summer. This building will be operational by 2022 and it is expected to create a 33% reduction in the airport's greenhouse gas emissions

The increase in air temperature also affects airplane performance. Hotter air is less dense and provides less lift for aircraft. An airplane's takeoff weight is affected on days hotter than 30 degrees Celsius. Planes also take longer to take off during hotter days, and sometimes even require longer runways. YVR should not be affected too harshly by this because they are at sea level and have long runways.

Longer and hotter summers will also affect the amount of usable water. In recent years, near the end of summer, YVR had to turn off water features and reduce irrigation. With longer hotter summers coming, the issue of water conservation will continue to grow. The airport already has systems in place to conserve water, but with 100,000 people travelling in the summer months, this issue can become very challenging. Reducing the airport's water consumption by 30% from 2012 levels is the most difficult goal they are trying to achieve. The airport built their first large-scale collection system a couple of years ago. There is also a new rainwater collection system that the airport plans to install on its existing parkade. It will collect 30,000 cubic metres of water, and the airport already has the facilities to treat it. This rainwater collection also supplies water for emergency firefighting in the event of an earthquake.

Wind
Changes in wind direction and speed are a huge factor in take-offs, landings, and aircraft flight. Transport Canada is in the process of regulating an extra 150 metres of runway end safety area just in case a flight overshoots or undershoots a runway.

Fog
Fog is very difficult to model. In the past, the airport experienced around two to three weeks of fog a year, usually in the fall or early winter months. This pattern is changing and we are now seeing fog in the later winter season. Instrument landing systems are very important to an airport during fog. YVR has a backup power system in place for the instrument landing system as a safety measure.

In summary, YVR's Climate Change Adaptation Plan identified 28 climate change risks for the airport. This presentation highlighted the key risks identified in the plan and some of the mitigation taking place to address these risks. This Climate Change Adaptation Plan will be incorporated into all projects at the airport going forward.

Willy Yung, Director, Engineering & Maintenance, Vancouver Fraser Port Authority

Port of Vancouver Authority Adapting to Climate Change
When it comes to adapting to climate change, the Vancouver Fraser Port Authority asks what hazards they may encounter. Some examples include scenarios involving sea level rise, harsh wind conditions, and storms. What is the probability of any of these risks happening at the same time?

The port of Vancouver Authority runs many flood hazard scenarios, and uses the information gathered from these scenarios to figure out what assets are at risk. They then gauge the level of risk for each asset and prioritize accordingly. Business impacts and infrastructure life expectancy also factor into their decisions. Once an asset is identified as needing improvement, a strategy is developed.

Mitigation techniques generally tell you to protect, accommodate, retreat, or avoid. For the Port of Vancouver, the choice must be to protect. One of the main challenges for the Port is sea level rise. Historical data for sea level rise is no longer a valid form of information. The current value that is being used is 3 mm sea level rise per year, but that value may increase in future years.

Regional Works

In-house, the Port of Vancouver Authority recently developed Green Infrastructure Guidelines. This provides guidelines for embedding sustainability best practices in the development of infrastructure and considering all aspects of the asset's life cycle (i.e., concept, design, construction, operation, decommissioning). The guidelines are currently being piloted on VFPA-led infrastructure projects. The pilot program will inform whether guidelines should ultimately be applied to tenant-led infrastructure projects. The guideline is integrated in every step of a project from its concept to its commissioning.

As the Port of Vancouver Authority works on improving its policies, it is also working with its tenants. If any terminal is planning major work, the Vancouver Port Authority talks with them about implementing mitigation efforts. They are currently speaking with Neptune Terminal to see what can be done about flood risk to its south-west corner. Minimum flood slabs and a questionnaire for the terminals enquiring about sea level rise impacts are some of the techniques used.

Stakeholder Perspectives

Terry Duggan, President and CEO, BC Maritime Employers

Climate Change is affecting three key areas of the BC maritime industry: rising sea level, air quality, and extreme weather.

Rising sea level is something that cannot be changed. Ports in BC and around the world need to be aware and attuned to the hazards caused by rising sea level.

Extreme weather is responsible for creating unpredictable sailing times and disrupting arrival schedules. Missed arrival dates and the subsequent bunching of vessels creates availability shortages with BC Maritime recruitment, training, and dispatch. Part of trying to adapt to this situation has led to the creation of a fairly sophisticated data collection and analysis system. The system requests demand forecasting from all companies they supply labour to. They also look for forecasting on things such as retirements, demographics, promotions, and other aspects. A new electronically assisted dispatch system has also been created to combat staffing issues. This enables longshore workers to be notified electronically the night before which port and vessel they will be assigned to. This helps address the issue of availability during weather disruptions, and helps improve air quality by eliminating hundreds of daily automobile trips to the dispatch hall for placement.

The member companies that work with BC Maritime Employers have invested in green initiatives. Many terminals are green roof certified, some terminals have moved to diesel electric locomotives for rail operations, and vessels are burning low-sulfur fuels when they reach North American waters.

BC Maritime has a clear goal of pursuing a global advantage for Canada's West-Coast ports. The electronic dispatch, and being prepared and aware of hazards, has helped them address the areas where they feel they can make an impact. What are the disruptions? What specific disruptions will impact our long-term goals? What is the considered likelihood and impact of these disruptions? Once a key issue is located using these questions, they then focus on that area to try and address the problem.

Gary Fast, Vice President, Domestic Transportation Operation, Canadian Tire

Canadian Tire owns a very large brand portfolio which enables significant global sourcing. Over 40% of Canadian Tire's inbound volume comes from regions outside of North America. They import over 60,000 TEUs (Twenty-Foot Equivalent Unit), which makes them North America's 26th largest importer of containerized goods. They are trying to convert this to Canadian Tire freight, which would help them get the goods into their distribution network more efficiently and then into their stores. The Vancouver gateway supports nearly 85% of that flow into Canada. The Vancouver gateway has an enormous opportunity to be an enabler for a large shipper like Canadian Tire, but it also has the chance of being a huge bottle neck.

Canadian Tire transports most of its freight using rail services and then trucks once it is in its distribution network. In the distribution network, they process the goods then send them for delivery to their stores. An interesting fact is that over 90% of the population lives within a 15-minute drive of

one of Canadian Tire's retail locations. This is important because in many cases Canadian Tire is the last outpost for a Canadian. There are many remote locations where communities rely on goods and services supplied by Canadian Tire.

Unlike many retailers, Canadian Tire operates under a pull system. They don't push inventory to their stores, most stores are franchises, and they operate under the concept of "just in time". Things like Climate Change and extreme weather can cause huge disruption and cost to Canadian Tires supply chain because of this system. Consistency and reliability is truly critical to running Canadian Tire's business.

How Climate Change Risk impact Canadian Tire

The impact of climate change expands beyond the lower mainland. It affects regions all the way to the Port of Logan. Fog is an issue here in Canada, but it is even more of an issue in China, where fog is practically a season. This fog causes vessels to depart from China two to three days late, and causes disruptions and vessel bunching. This creates further issues with bottlenecks in distribution and congestion in Vancouver. The Vancouver gateway has only a finite capacity, and when demand hits the ports all at once, it creates chaos and cost.

When ships get to Canada they also deal with floods, washouts, snowfalls, ice storms, and wind storms, which shut down terminals, highways, bridges and rail. In 2017, there were over 3800 disruptions to the Canadian Tire distribution line, which caused delayed deliveries to stores. That was a 40% increase over the prior year. The increase in extreme weather events causing infrastructure damage and delaying distribution is becoming more of an issue for Canadian Tire every year.

When a shipment is delayed, Canadian Tire enacts their mitigation tactics. Canadian Tire not only has to be good at moving a container across Vancouver, but if there is a disruption they must be creative on how to move containers across Canada. They have alternate ports and terminals listed with all their carriers to be sure goods can come in even if a port or terminal is shut down. This sometimes leaves them trying to figure out how to move freight from an alternative site into the proper distribution system. This situation is usually costly for Canadian Tire, and it is starting to happen with a higher frequency.

To try to avoid these types of situations, Canadian Tire works closely with their partners to offer visibility and forecasting. Forecasting is knowing what amount of product is needed so it can be reliably shipped. It also means knowing where all the ships, trains, and trucks are in the system, the date they are expected to arrive, and what freight is being transported. They then share this information across the system. This forecasting gives Canadian Tire priority for space on vessels and trains and means that their freight gets moved first in the event of a disruption.

Canadian Tire also uses technology and software for route optimization. This helps them move the most goods for the least cost. They meet regularly with transport partners, like Port of Vancouver and government, to talk about aspects of their supply chain. They give these partners the same visibility that Canadian Tire has, and work with them on trials to test new ways of doing things. It is important to

try new things. As an example, Canadian Tire is participating in an off-time delivery trial in the Peel region. They also give GPS data to Transport Canada to help them understand traffic and congestion.

Mayor Lois E. Jackson, City of Delta
The Intergovernmental Panel on Climate Change Released its Fourth Assessment Report in 2007, presenting evidence that global average air and ocean temperatures were rising. In response to this warning, the City of Delta developed a dynamic comprehensive Climate Change Action Plan that moved beyond what was currently being developed for local municipalities across Canada. They also established a Climate Action Office to tackle the short- and long-term implications of climate change in Delta's community.

While Delta tries to find ways to mitigate the impact of climate change, they also address the ways they can adapt. Adaptation is particularly important when dealing with the impact of climate change on transport systems and infrastructure. The transport systems in Delta are critical. The City is an important stakeholder for transportation, being a major Canadian transportation hub. Delta is close to the United States border and to Vancouver, and it has an extensive network of road and rail networks. It holds a strategic position as a gateway to the Asia Pacific, and is home to the largest container terminal in Canada. The community is also home to the largest coal terminal on the West Coast of North America, the fifth-busiest airport in terms of movement in Canada, and two of the largest industrial parks in Canada. These are all at sea level.

The City of Delta is surrounded by 62 km of dikes. It is comprised of dikes, sea walls, drainage pump stations, and flood boxes, all of which work to protect Delta's transportation and industrial infrastructure from coastal flooding. Because Delta, and Canada, rely so heavily on transportation networks, the implications of climate change must be considered when designing municipal infrastructure.

The City of Delta's diking system was upgraded in the late 1970s as part of the Provincial Fraser Flood Control Program. The dikes were raised between 3.4 metres and 4.2 metres. However, there are still areas around Delta with private dikes that have lower elevations.

Over the last 10 years, Delta and the Province of British Columbia have done several studies to understand flood risk associated with climate change in the Metro Vancouver Region. It is recognized that sea level rise is a slow process, but the city of Delta sees that it needs to incorporate sea level rise adaptation planning into their corporate policies, procedures, and by-laws. This means making new development meet future dike height requirements, designing and building Delta's diking system to a new flood construction level, and reviewing and updating the City of Delta's official community plan to possibly include higher flood construction levels (in low lying areas).

The City of Delta is currently undertaking a flood risk assessment utilizing Engineering Canada's PIEVC Protocol (Public Infrastructure Engineering Vulnerability Committee Protocol). This protocol was created to assess the vulnerability of infrastructure to extreme weather and future changes in Canada. Its goal is to enable better planning and design of climate-resilient infrastructure. When the PIEVC

assessment is completed in Delta, the city will have to make tough decisions about how to pursue adaptation options.

Delta already sees how extreme weather impacts the city. Stronger storm surges are happening more frequently in winter, snowpack levels in the freshet are now the focus of Delta's spring, and wildfire and drought are now a part of summer. Delta also must deal with the gradual increase of sea levels. The municipality is working to adapt to these changes through the implementation of mitigation and adaptation strategies.

Bob Dhaliwal, Secretary-Treasurer, ILWU Canada
The International Longshore and Warehouse Union represent 6000 workers in British Columbia. Their members work in the areas of cargo handling, retail, and wholesale, and represent workers at the Fraser Port Authority. Some workers are involved in programs and topics mentioned by other speakers at this forum. The "I" in ILWU stands for International. This is because they have agreements with the International Transport Workers Union and have connections all over the world, including the United States, Europe, and Australia.

The term Longshoreman comes from the phrase "man along the shore". For over 100 years we have traded on the Vancouver waterfront and along the coast of British Columbia. Waterfront cities around the world are at risk from sea level rise and climate change. Infrastructure, industry, and people are all located in this danger zone. This coastal infrastructure is the livelihood of ILWU's members. The fact that nothing major has happened is leading to a false sense of security. He sees that locals and workers alike are focused on daily life and the current situation. They are not planning for the issues that will be seen in the future.

As a port community, individual workers, terminal operators, port authorities, and governments need to make climate change the top priority. Individuals need to stop denying the reality and start to make incremental changes to adapt. Actions for individuals need to be simple, so that they will be easy to implement, and measurable, so that progress can be monitored. Positive stories need to be created so that other communities are more likely emulate improvements.

Early Warning Emergency Response and Critical Infrastructure Resilience

Maryam Golnaraghi, Director, Extreme Events and Climate Risk, The Geneva Association
Coastal infrastructure can be a huge economic driver. Cooperation and coordination engaging government (federal, provincial, local), private sector, local communities, developers, engineers and scientists are necessary to identify opportunities to build resilience. There is a window after a disaster when you can step in to ask what can be done to prevent, reduce, and prepare for these disasters. When news is out in the media, then you can really get traction to make those changes. The question to discuss now is: how do you build societal and financial resilience to these disasters? Do we really understand the scope and scale of these risks?

The first discussions around disaster risk reduction started in the 1960s, when several countries experienced massive disasters that they could not handle. These countries came to the UN and asked for help. This led to the development of UN coordinated post-disaster humanitarian response from the late 1960s to the 1990s to support governments asking for help.

The second discussion began in the 1990s, after a major earthquake in Japan leading to the adoption of the Yokohama framework for Disaster Risk Management, Hyogo Framework for Disaster Risk Reduction and ultimately the SENDAI Framework for Disaster Risk Reduction by over 190 nations, changing the discussion around disasters from a humanitarian debate to a prevention and risk-based action. Furthermore, following the establishment of IPCCC and UNFCCC, climate change discussions lead the Kyoto Accord Framework for Action, then the Pars Agreement in 2015. Since then the climate change dialogue has also been refocused from a scientific and environmental dialogue to an economic, development, trade and job creation with strong focus on risk management.

If we look at the era from the 1950s to almost 2000, the whole field of extreme events and risk management was centred on humanitarian response. This approach was debated by risk responders and other members of the community, which led to new strategies being put forward around 2000 to 2005. Indeed, more developed countries began modeling the forecasts of storms and introducing levels of preparedness, which resulted in lives being saved. For many tropical storms, there is still an increase in loss of life, but that is because of increased development in at-risk areas. More recently, at the government and policy level, we are starting to see risk-based prevention and risk reduction. Critical infrastructure is an important part of this new discussion.

There are three levels of negotiations: disaster risk management sits with the Ministry of Public Safety and Emergency Management, climate change sits with the Ministry of Environment, and sustainable development is starting to get to the Ministry of Development and Infrastructure. These conversations are making governments and organizations realise that in order to address these economic issues they need to work together and across the country.

What is it that we need to be able to do to reduce the risk? A framework began to form since the early 2000s. When countries implement effective risk management of extreme events, a component of that is that they can assess disaster risks. They can identify how much they are at risk and can run different scenarios to figure out specific hazards.

Once they know the risks, they develop a coherent plan to address these risks. They begin to look at the underlying cause of that risk and reduce it through new policy, standards, and regulation. Early warning is another important aspect of risk reduction. It saves lives, and we need to make sure that more countries around the world have access to it.

A new addition to risk reduction is financing and risk transfer. Even in our own government, we need to look at post-disaster. A significant portion of taxpayer money in the form of post disaster aid is spent on fixing uninsured public infrastructure. Ideally, this money should be used to retrofit and enhance resilience of infrastructure in a preventive mode. It seems that, as we build more structures, resilience is not sufficiently being built in. This means that taxpayer money is being used more often to fix the damaged infrastructure. Risk financing and risk transfer also could allow governments themselves to protect their budget from these types of disasters. This takes planning. You can't continually divert funds for disaster response. The final point is to build back smarter or don't build at all in high-risk zones. This can be a difficult decision for a government to make.

Disaster response measures should be drilled and exercised so that they can be activated properly in the event of a disaster. We need to get people to see that disasters create financial risk. They need to see the damage to infrastructure and economy so that they become a part of the next movement in risk reduction. This financial aspect also brings the insurance industry to the table. If a piece of infrastructure is insurable, it has been assessed for many of these risks by an insurance company. The challenge is that infrastructure has stages and it must be handled by a number of different parties and organizations. The questions now revolve around resilience, operating standards, and looking at the risks to infrastructure across different stages. A new debate is forming because of these types of discussions.

At the provincial level, Canada is taking a number of critical actions. The country is putting a great deal of money into critical infrastructure, even after the recession of 2008, but there remains a large investment gap. Private capital needs to be raised to meet Canada's infrastructure financing gap. However, investors (e.g., life insurers, asset managers, pension funds) need risk-adjusted returns and appropriate risk allocation. Risks must be assessed and properly allocated between governments and the private sector. The government plays a key role in implementing risk reduction and preventive measures: Need for land-zoning; upgrading and enforcing building standards; natural infrastructure a buffer. Public policy and related regulatory actions are needed to make resilience a prerequisite for the infrastructure project life cycle. This should be an integral part of the national to local adaptation strategy. Non-Life (NL) insurers offer expertise in risk pricing and de-risking infrastructure. There are opportunities for leveraging non-life insurer' expertise in risk modelling and pricing tools for infrastructure projects. Investing in climate resilient and green infrastructure allows scaling up response to climate change goals and targets.

Theme 2: Remote & Island Communities

Dirk Nyland, Chief Engineer, BC Ministry of Transportation and Infrastructure
The BC Ministry of Transportation and Infrastructure is responsible for all the Gulf Islands and several of the Northern Gulf Islands in terms of roads. Climate Change Adaptation is a priority for the BC Ministry of Transportation and Infrastructure. Changes in the climate have an impact on how the BC Ministry of Transportation and Infrastructure design their engineering, how they operate, and how they maintain their roads. For adaptation, they are trying to make sure that their highway system is resilient, reliable, efficient, effective, and safe.

The Ministry's adaptation initiatives began with several pilot projects to determine what vulnerabilities the highway systems have to climate change, using the PIEVC process. The PIEVIC process consists of five steps with ancillary processes to do triple bottom lines. This allows them to look at the impact of any solution being considered. It looks at the economic, social, and environmental requirements.

The conclusions reached by the BC Ministry of Transportation and Infrastructure are that for the most part their highway system is resilient, with one major exception: drainage. Most of the drainage infrastructure was designed years ago and many of the systems do not meet today`s criteria. These systems become overwhelmed by water produced from modern intense rainstorms.

Design Implications
The BC Ministry of Transportation has a code on the design life of the different components and subcomponents of their system. Pavements are generally repaved between 10 and 20 years. Culverts have a life of 75 years or longer. Bridges generally last 50 to 100 years. When infrastructure is replaced, it must take into account higher temperatures and precipitation. This is particularly important for structures where expansion and contraction becomes an issue. Understanding the vulnerabilities all components have to these hazards is also very important.

Climate and product specification changes are in the works for the BC Ministry of Transportation and Infrastructure. This process takes time and the Ministry has chosen to try to address this issue when the opportunities arise and in an orderly fashion. Climatologists are only able to give a signal, direction, or a trend that tells you about how things might be going. For engineers, this can be problematic because they want an exact number. This means engineers must make sure they are using more engineering judgement, and use sensitivity analysis. Sensitivity analysis gives them a better feel for the risk uncertainties they must deal with when designing for the future and climate change. Be aware, have a climatologist explain the science, and make sure you check the models and other resources you use.

All design work done for the Ministry must show how climate change and adaptation were taken into account. It must show the numbers originally used, then the numbers used after considering climate change. The engineering association in BC (EGBC) has supported this work with a practice guide. There is a lot of good information to help guide engineers deal with climate change.

Places like the Gulf Islands, which are more remote, have maybe one or two roads. Any issue with these roads will become a big issue. Hazards to roads can include damage from extreme weather, climate change, and other variables. It is very important for the BC Ministry of Transportation and Infrastructure to understand what type of road infrastructure each island has. For maintenance, it is crucial to know the road's age and how it may respond to things such as extreme climate events. One issue the Ministry runs into is roads built on hillsides. These hillsides become unstable at times when exposed to large flows of water and this causes part of the road to collapse.

Landslides represent a critical risk for roads. The BC Ministry of Transportation and Infrastructure has maintenance contractors on all the islands who will respond as fast as they can to these incidents. Typically, with landslides the Ministry sends a technical engineer to look at the situation. This is to make sure that nothing else will drop down on workers as they are cleaning up the road.

In remote and island communities, it becomes more important to look for the signs that something is going to happen. It is key to recognize the signs of a natural hazard. Islands often don't get extra maintenance or extra work on infrastructure so they don't often have the luxury of focusing on the design.

Extreme precipitations are also generating more debris torrents. It is important to know the indicators if you live on an island or in a remote area. It is hard to prevent debris flows and they don't happen all the time, but when they do they cause problems. After the debris is cleared away that area could be stable for 5 to 10 years. People forget about the situation in that time and then it happens again.

Any work being done when it comes to climate change adaptation needs to be discussed, and not just used by one industry. For instance, the BC Ministry of Transportation and Infrastructure is currently working in partnership with the City of Surrey on a study they are doing on sea level rise. Through its environmental approval process, the BC Ministry of Transportation and Infrastructure does what it can to make sure people are not building in areas that are known natural hazard areas. However, it is not in charge of zoning, which is the responsibility of the regional district or municipalities.

Gregg Clackson, Director, Operations & Security Centre, BC Ferry Services Inc.
For BC Ferries, Tsawwassen is an important gateway. Around 7% of all ferry traffic to the island, and 9% of all BC Ferries commercial traffic, goes through Tsawwassen Terminal. BC Ferries may be more prepared for hazards on some of the remote islands than they are at Tsawwassen Terminal. Most of the smaller terminals have been self-reliant in the past. Any new terminals being built are being created as a fixed structure or a floating pontoon structure. The floating pontoon structure is still anchored to the shore, but is a lot more flexible. It is adjustable because the raft structure floats with the tide. Many of the new fixed structured terminals are being built and designed with an allowance for at least one metre of sea level rise. The one metre is the new standard for BC Ferries. This means that when they replace older or existing docks, the docks are built up to meet this requirement. All ramps, docks, marine structures, and ships have a 40- to 50-year life expectancy, so building them to meet future standards is very important. Recently, BC Ferries has gone to most of the North Gulf Island Terminals and has rebuilt to meet the new standards.

All the terminals are equipped with things such as stand-by generators and can be quite self-reliant. They could be shut down from hydro for more than a week, and will still be able to supply their own power.

Extreme Weather
Weather can be a huge issue for BC Ferries, particularly high winds. Wind is the only thing that can really shut BC Ferries down. This happens particularly often on the smaller northern routes. In the past, the storm season was around the last week of October and into the first week of December at the latest. November was the month when BC Ferries would lose the most sailings throughout the year. The storm season now seems to be from Thanksgiving weekend in October to the beginning of April. Last year, BC Ferries even had a few shutdowns in April, which is unusual.

The storm intensity and frequency has been increasing during the last few years. Some remote areas are seeing some routes shut down more frequently because of storms. The storm intensity has increased dramatically, the wave height has gone up, the seascape has gone up, and winds have gotten more intense. These shut-downs have a trickle-down effect. Vancouver Island only has a three-day supply of food on the island, and most small communities are in a similar or worse situation. If BC Ferries cannot sail for two or more days that could have a dramatic impact on these communities. It is truly a just-in-time economy.

Ewan Moir, President & CEO, Nanaimo Port Authority
The Port of Nanaimo has hired a new Health Safety and Environmental Manager, who is responsible for their Emergency Response and Recovery Programs. The Port of Nanaimo is also building its business plan for the next five years.

What are the plans and policies in place for a potential shutdown during a catastrophic event? There are just under 800,000 people living on Vancouver Island and it truly is a just-in-time economy. In the event of a major disaster, the Island will very quickly run out of fuel and food because very little is stored on the island. Part of the Port of Nanaimo's business plan is to look at how they could integrate and bring a distribution system to Vancouver Island. This will not only reduce cost, but it could also help during a catastrophic event. If BC Ferries are unable to sail because of extreme weather, the question of how to get food to the island becomes crucial.

The role that the Port of Nanaimo and BC Ferries plays in Vancouver Islands emergency planning is key. They are critical to the supply chain.

Geography
Vancouver Island is the largest island on the west coast of North America, and is the second most populated island in Canada (Montreal is the first). The population of Vancouver Island is approximately 775,000 and predicted to grow to 1.5 million people over the next 15 to 20 years. The Vancouver Island highway on the East Coast is the major road to most of the island's communities and in many cases it is the only road. If blocked, the only alternative is to go by boat or to hike over the mountain. Nanaimo is in the southern part of Vancouver Island, and 80% of the island's total population lives within an hour's drive of the city. This is great from the perspective of distributing food and medical supplies.

Nanaimo is 27 nautical miles from Vancouver and this location makes it very easy to bring emergency supplies. The question is, what if Vancouver is also having catastrophic problems? How can we get people and equipment to Vancouver and then bring them across to Nanaimo?

Climate Risk

Vancouver is the 10th most likely city in the world to suffer from flooding (statement made by The Guardian in 2015). The island has similar risks to Vancouver and has the same potential for flood. Vancouver Island also has many fault lines that add another dimension to the problem.

Tsunami is also an important hazard to Vancouver Island. In the event of a Pacific tsunami, there are many small communities on the west coast of Vancouver Island that would need support. Nanaimo, Victoria and other communities will have to become a support network for these communities.

Plans and Policies

The Port of Nanaimo`s Emergency Response plan is currently being updated. Nanaimo is well protected by plenty of smaller islands around it. These islands act to protect the harbour from things like tsunami going east to west. The water around Nanaimo is also naturally deep. This deep water, without the use of dredging, allows the port to accept large vessels for emergency purposes.

Nanaimo Assembly Wharf's Berth C is built on reclaimed land. Log exporting is done there and it's the location of the Ports head office. A big source of concern is what would happen to this wharf in the event of an earthquake. The Port needs to think about the risks to their properties from different disasters and how they can deal with these risks. How could they supply support if they lost the Nanaimo Assembly Wharf?

The port of Nanaimo also accommodates incoming cruise vessels. For instance, the vessel that was in the Port on the day of the Expert Forum had approximately 3,200 passengers onboard. These people would be coming off the ship and spending time in Nanaimo and the surrounding area. This is not counting the 2,000 to 2,500 members of the ship's crew. What happens if a natural disaster happens when there is a cruise vessel in the Port? Are we ready to help? Are they going to help us? Are they going to sit there because the captain is responsible for the passengers? He may decide he cannot stay in this dangerous area and leave. By law he cannot leave unless he has a pilot. What happens if the Port can't get him a pilot? Is the Port supposed to stop the captain? Can he leave on his own accord? What if 10 or 20 other vessels decide to leave and none of them have pilots? What happens now if there is a disaster in the Salish Sea because none of them have a pilot on board? These are examples of the questions the Port is asking itself while it forms its Emergency Plan. These are all scenarios that need to be thought out and explored. Nanaimo only has a population of 90,000. If a large cruise ship comes to the city and needs assistance, it could be overwhelming.

Duke Point is the BC Ferries docking area in Nanaimo. This area acts more as a container barge and is used for short sea shipping to and from Vancouver. This would be the point of entry for food, water, and supplies in a possible emergency.

Emergency Planning
When building their Emergency Response and Recovery Program, Port of Nanaimo looked at the British Columbia Emergency Response System. They looked at BC's main goals and continue to work with the local community to develop goals of their own. It is useless to have an Emergency Plan if it is separate from the Plan for City of Nanaimo. The airport and regional district also need to be included when the Port creates its plan.

The Ports Emergency Response and Recovery Plan will be in place by the end of 2018.

- The Regional District is developing a Neighbourhood Emergency Response Plan that will activate in Fall 2018.
- The Nanaimo Airport already has a plan, and the Port is trying to integrate with this plan.

Communication is an important topic when it comes to emergency planning. As mentioned before, cell phones are a waste of time in a disaster most of the time. The Port has been using UHF radio for communication between all its offices, which can also connect them to the fire department. For crafts on the water, the Port has VHF radio or UHF radio communication (Patrol craft). Having a matrix of communication is important to the success of any emergency program.

Ryan Thoms, Manager of Emergency Services, Powell River Regional District
Disasters know no boundaries. The Regional district operates a Regional Emergency Service as a best practice. Most of the Powell River District is the original territory of the Tla'amin people.

Past presentations have spoken about supply chain. Powell River is a collection of small local governments. MEOPAR has worked with them and has brought them incredibly crucial information when it comes to supply chain. Things like the distribution of fuel, gas, health care supplies, and diesel, which comes to these communities from distant places. MEOPAR helped them understand the intricacies and potential disruptions of the supply chain. While the Powell River region is resilient like other small communities, they don't develop, build or supply any of the fuel supplies or medical supplies that they need.

When it comes to wildfires, the volume has been increasing yearly and full community evacuations have increased significantly. In the middle of 2017 Powell River District was asked to develop not only an evacuation plan within the region, but to also develop a full community evacuation plan that would extend beyond the region of Powell River. This plan is currently in development.

The Powell River district is about 100 km North of Vancouver. The district is beautiful to live in but it comes with some major logistic challenges. Like many coastal communities, the population, infrastructure, and almost everything else is very close to the water.

The seasonal and tourist population estimates are very conservative and some research suggests this number may be double. Currently, Powell River is planning for a 25,000-person evacuation in a worst-case scenario. There are some places like Savary Island, whose populated is listed as 100 residents, but after the May long weekend, the number will start to climb. By the middle of July there will be around

2,000 or 3,000 people in that area. This is a real logistical nightmare when it comes to emergency planning and evacuation.

Powell River is currently learning from a small community in New Zealand that has been affected by an earthquake. This area had very remote coastal communities with exposure to mountains and ocean. The only real difference was the transportation infrastructure, as the area had no ferries and used roads and tunnels. Within moments of the earthquake striking, this area of New Zealand lost all its roads and the community only managed to get its highways back one year later. This earthquake happened in New Zealand during the summer, and one of the first things the community had to deal with was evacuation of all the tourists. They had about 1,000 tourists and were fortunate that Navy ships located nearby could help with this evacuation.

Powell River Region's evacuation plan relies on the use of ferries. The lack of capability with the airports means the evacuation must rely on marine transport. If you add up the capacity of the vessels that operate in the Powell River Region then you get approximately 1,343 people. This brings up the question, how fast can we move all our people? If you divide this amount into 25,000 people with a three-hour turnaround time, it will take two to three days to evacuate everyone. This is a best-case scenario, assuming that all three vessels are operating, there is sufficient staff, and the terminals are in good shape. There are restrictions and this is a slow process, but it is a good starting place. In the Region, there are other marine services not operated by BC Ferries. Private vessels are among them. During stormy seasons, vessels like these are not able to go out to sea safely and this must be considered. These privately owned vessels are very hard to track and to rely on in times of emergency.

Hazards in the Region

A report published in 2006 shows that the area is not at great risk of tsunami, but a small risk is there. Research has found over 300 landslides into the Salish Sea, which could cause tsunami-sized waves in the sea. A community wildfire plan was developed in 2009, and another one is ongoing. In 1994, the mill suffered one of the largest chlorine dioxide spills in Canadian history. The chlorine gas from that spill fortunately blew offshore. This could have been disastrous.

The Powell River Region engaged a team from Tetra Tech that had oceanographers, coastal engineers, geotechnicians, emergency planners, and risk assessors that provided an overview and understanding of what sea level rise will mean for Powell River. They did this study as an overview, and decided to go with the Provincial recommendation for sea level rise (.5 metres in 2050 and 1 metre in 2100). One key issue with the sea level rise study is the lack of ability to gain access to the geology. About 50% of the Powell River Region is quadrille sand deposits. The way the land will shift and change with sea level rise is completely different than if the land below a cliff is made of bedrock or sand. The main issue is that people have built their houses on those cliffs. Powell River Region is looking into this issue and is pushing for some information on this to be added to their next study.

Stakeholder Perspectives

Tanya Patterson, Emergency Program Coordinator, City of Victoria
Hazards from sea-level-rise climate change such as windstorms, extreme weather events, and issues due to snow are all challenges faced by the Victoria community. One priority of the Emergency Program Coordinator is to communicate the importance of being prepared and having an emergency kit ready. Emergency kits on the island should exceed the 72-hour suggested limit because of the transportation issues they will face as an island. Emergency kits should be prepared to last a week or longer. This is especially important for water (4-litres per person per day). Victoria is a very old city with aging infrastructure and they want to try to do what they can to be sure people have enough water.

Victoria started a Connect and Prepare Pilot Project, which is a similar program to Vancouver's 100 Resilient Cities program. Vancouver's program starts at the neighbourhood or community level, and the City of Victoria is starting at the block or building level. This pushes people to understand the importance of being connected with their neighbours in preparedness. Resilience is not just about getting a kit, it is about how we can work together to help each other within our communities in a disaster. Victoria's program aims to start at the grassroots building or block level, and then expand to the neighbourhood level, eventually to the entire community. This will lead to an understanding of how we can all work together in emergencies by knowing our unique hazards, strengths, challenges, assets, and resources. Connected communities are far more resilient than isolated individuals.

Issues faced by climate change often overlap with emergency management issues. The city of Victoria recognizes this. The planning department has completed a seismic vulnerability study that looked at three different earthquake scenarios that Victoria is at risk of and how these scenarios will affect different areas of the city based on soil type, age of building construction, and type of construction (i.e. wood frame, concrete, unreinforced masonry, pre or post 1960 or 1972, etc.). From this study, maps were created based on the different scenarios of what the city would look like after one of these seismic events. The study showed that there would be between 4,000 and 6,000 buildings with moderate to severe damage. The city is using the information from this study to help guide future planning decisions such as which locations can apply for the Tax Incentive Program for undergoing seismic retrofits. This tax incentive program allows people to make seismic retrofits to their buildings and rewards them with a 10-year tax break.

The City of Victoria has a Climate Adaptation team who works closely with all City departments, including the Emergency Management Division. This team recently completed a climate leadership plan taking into account buildings, mobility, waste, municipal operations and adapting Early – and the important role that all Victorians must play in working together to towards a prosperous, low carbon future. This plan takes into account the City of Victoria's Hazard, Risk, Vulnerability Analysis (HRVA) and emergency plan. The City works with stakeholders such as the school district, regional partners, hospitals, airports, harbour, tourism, etc. to ensure coordinated and collaborative planning.

Theme 3: Sea Level Rise & Climate Change Impacts

Thomas James, Research Scientist, Natural Resources Canada (NRCan)
Canada's Marine Coasts in a Changing Climate
NRCan conducted a National Coastal Assessment focused on changes in sea levels. Projections of sea level change are based on the Intergovernmental Panel on Climate Change's Fifth Assessment Report (AR5, 2013). James's presentation is about the science of sea level and does not provide new guidelines or new details. The coastal assessment was a rigorous process with an advisory committee and credible reviewers. The goal was to produce a credible report that is not intended to be policy prescriptive, but that raises awareness, gives background information to justify recommendations, and helps determine priorities or policy direction.

There were two key findings in the report that are relevant to the Expert Forum. One of them relates to extreme water level events. More specifically, how many years go by before you reach a particular water level? What are the implications for water levels in a high emissions scenario? The report highlights that what used to be a one in every 50-year event is becoming a one in every 2-year event. The implication of sea level rise is that more extreme high water events are going to become more common.

The second key finding is that projections show that sea level will rise by many metres under a high emissions scenario, and this will become more and more of an issue past the year 2100. With mitigation of CO2 emissions, we can keep global sea level rise to something that is much more manageable.

BC Guidelines
Global sea level rise is in essence asking how are the ocean basins filling up. If the surface level of the ocean is warming, the sea level rises. This is in reference to the centre of the earth. What we really care about is relative sea level change, which is relative to the solid surface of the earth. To measure relative sea level change we need to know what vertical land motion is. An example is if global sea level rises by 100cm, but someone is in a location that has risen by 60cm in the same time frame, the relative sea level changes by 40cm.

BC guidelines describe the flood construction level, which is the sum of several things. The guideline recommends planning for 50cm sea level rise by 2050, 100cm by 2100, and includes adjustment and correction for local vertical land motion. Currently, a Global Positioning system instrument is located on Quadra Island near Campbell River. NRCan has monitored this instrument for the past four years and has seen the land rising by 4 mm a year. This means the area will rise by 20 cm in 50 years, and 40 cm in 100 years. This makes the local sea level allowance 30 cm in this area in 50 years, and 60 cm in 100 years (2050: 50 cm-20 cm=30 cm). This is an extreme example, as Campbell River in British Columbia is one of the monitored areas that has been seen to be rising the fastest.

Sea level projections
It is important to keep in mind that the guidelines were developed based on science that dates back to

2008. The AR5 was released in 2013, and that adds an additional 5 years of science. The question is: are the guidelines still going to provide the protection that we would want?

Much of the Maritimes is sinking a little bit. Around the Hudson Bay the land is rising at 10 mm a year or more. In BC the land is rising by just a few millimetres a year. This land uplift reduces the relative sea level projections by a little bit. Around the Hudson Bay, the land is rising so quickly that it projects rising relative sea level fall for this area, even in the high emissions scenario. The Maritimes have some of the highest sea level rise projections in Canada. In BC, sea level is expected to rise by 40 cm or over a metre depending on which location of BC you are in.

Sea level projections are the same up to 2050 or 2060. It doesn't matter what scenario you choose. If you stop to look at more recent results, these numbers still hold. This means we have a good idea of what will happen with sea level up to 2050. The one issue is the extreme Antarctic melt scenario. This extra 65 cm of sea level rise brings water levels to about the BC guidelines. If future science points toward these large amounts of water then the guidelines would need to be updated. The guidelines are designed to be revised when new information comes to light.

Most publications agree with the AR5 projections for 2050, and the few tenths of a metre extra due to Antarctica. There is one predominant exception, which has recently received a lot of attention. The upper model shows that we could get more than an extra metre of water from Antarctica by 2100. All these results are shown for the years after 2050. This just shows that we don't know what to expect after 2050, but we seem to have a good idea before that date.

What has been going on in the United States
The United States climate projections tend to focus more on what the extreme projections might be. They look at publications that lean towards higher levels of sea level rise to create results. Their maximum sea level rise scenario goes to 2.5 metres, which has a very low probability (.1%). We need to be cognisant of the single study bias. View these extremes as expanding the scientific understanding, but don't view it as a firm projection of what is really happening. The IPPC provides a really important service in synthesising all recent scientific findings.

Trevor Heryet, Executive Regional Director, Issues & Program Management, Transport Canada
This presentation provided an overview of the Federal Government and Transport Canada's roles in policy development.

Some key transportation infrastructure in Canada includes:

- Over 1900 certified airports, 26 airports in the national airport system, 11 Arctic airports, 13 remote airports;
- 1.3 million km of two-lane-equivalent public roads, 38,000 km of roads on the national highway system;
- 46,000 km of rail system track owned by different companies;
- 18 Canadian Port Authorities, 550 public ports, and 1035 small craft and fishing harbours.

In Canada, the transportation infrastructure is quite complex. It is spread over a large geographic area, and a lot of it is susceptible to sea level rise.

British Columbia is an important player because they currently deliver about 13% of Canada's GDP (based on 2017 numbers). The marine ports are major economic drivers. The port of Vancouver is the third largest port in North America in tonnage. Prince Rupert is the third busiest port with regards to container traffic. British Columbia also has YVR, which is a major hub for air traffic. YVR is reaching around 25-million passengers a year and that is expected to increase in the future. However, YVR is one of four airports on the coast that is susceptible to, and must deal with, sea level rise. British Columbia also has the fifth largest commercial crossing into the United States. This economic linkage is estimated to generate about 26 billion dollars in trade.

It is very important to keep our transportation system running effectively and efficiently. Climate change impacts and extreme weather events can disrupt the movement of both freight and people. These events put the economy and the Canadian people at risk. Adaptation is important and represents a strategic response.

Issues and risks to BC coastal transportation infrastructure include:

- The flooding of rail lines located in flood plains. This could cause lack of access to ports;
- The failure of diking systems around things such as railyards. (This is a current issue as a railyard is closed due to flooding because flood waters exceed the dikes capability). It would not only disrupt transport but also cause major damage to assets.
- Rural coastal communities could become cut off because of flooding to major highways. (An example is the current flooding on the East Coast, which has caused the Trans-Canada highway to be shut down.)
- Some airports at lower elevations are exposed to an increased chance of flooding because of sea level rise and storm surge.
- Extreme weather events can disrupt ferry services. Service changes and disruptions to service are currently becoming more frequent. Strong wind is a particularly big issue in BC.

There are several jurisdictions and stakeholders that play a role in transportation adaptation in Canada. Transport Canada recognizes that these groups are at varying stages of readiness. Some are at the pre-planning stages and are identifying and getting a better understanding of climate risks, some are doing research and testing, and others are implementing active solutions and monitoring progress.

It is important to understand the role Transport Canada plays in overseeing the transportation network. Transport Canada does not own many assets. They have divested most of their assets over the last 30 years. Transport Canada oversees the operations and assets that are being used by transportation operators. They are also responsible for the Government of Canada's transportation policies and programs. They develop regulatory frameworks and construct transportation oversight through legislation, regulators surveillance, and enforcement. While not directly responsible for all aspects of all modes of transportation, Transport Canada plays a leadership role to make sure all areas of transport can work together effectively.

Transportation Canada does have sole responsibility for some transportation activities. Aviation safety, including all aspects of aviation security, is just one example. For other matters, they share responsibility with other levels of government (provincial, territorial, etc.). They also work closely with their trading partners and other international organizations to develop harmonized policies and territory frameworks. Transport Canada does not have direct responsibility for the building and maintaining of road networks. They leverage partnerships and sometimes use strategic funding to promote the safe, efficient, and environmentally friendly movement of people and goods around the country.

Climate change adaptation is becoming an increasingly important international and domestic priority. It is a complex issue that does not respect geographic or political boundaries. Adapting to climate change requires a global effort, and reducing greenhouse gasses has been the cornerstone for many years of climate change efforts. In recent years, adaptation has become an important priority on the global stage.

Domestically and Internationally

Climate change is a significant driver of disaster risk. There are synergies that can be gained through stronger engagement with this issue. There are also linkages between adaptation and disaster risk reduction in communities. Transport Canada is starting to see positive motion in the movement to reduce risks.

Transportation Canada is working collaboratively with other federal departments, other levels of government, and indigenous people, to deliver on key climate change commitments. The federal government, through many different departments, has multiple roles in climate adaptation. The Federal Adaptation Policy Framework defines Transport Canada's role in climate change adaptation as generating and sharing knowledge, building adaptive capacity, responding to help communities take action, and integrating adaptation into federal policy and planning.

Including Adaptation in Transport Canada's programs

Adaptation is included in several programs at Transport Canada. Transportation 2030 is a strategic plan for transportation in Canada. It has five themes: the traveler, safe transportation, green and innovative transportation, waterways coasts and the north, and trade corridors and global markets. Adaptation work is being done in many of these areas.

The National Emergency Management Framework is a shared responsibility between all the sectors of society. It aims to guide and strengthen the way governments and partners assess risks and how they can work together to mitigate, prepare for, respond to, and recover from, threats.

The Pan-Canadian Framework on Clean Growth & Climate Change was developed to help meet our emissions and reduction targets, grow the economy, and to build resilience to the changing climate. There are four pillars in this framework. The fourth one has measures to adapt to the impacts of climate change and to help build resistance.

The Federal Sustainable Development Strategy centres on 13 goals, with supporting targets and actions. Three of these goals directly relate to climate change adaptation. These include effective action on climate change and modern and resilient infrastructure.

The Government of Canada Greening Government Strategy sets targets for Federal operations to help reduce greenhouse gas emissions, and to help them build their own resilience.

Climate Risks and Adaptation Practices for the Canadian Transportation Sector recognized the need to enhance the understanding of climate risks and adaptation practices for the transportation sector.

The National Trade Corridors Fund was designed to support and help fund current owners of infrastructure. It could help them build new infrastructure, or enhance existing infrastructure. This fund was Transport Canada's first infrastructure funding initiative where the applications included options to build or adapt for climate change. Climate change adaptation is a key focus when they choose which projects to fund.

Applicants are asked to describe how their project considered risks associated with changing climate.

- They are asked if, and the degree to which, the project takes into account vulnerabilities associated with climate change and extreme weather.
- They must demonstrate or describe their approach to identifying risks and vulnerabilities. (Examples: the use of climate projections, experts, research or publications.)
- They are asked to present the findings that gave them the highest level of vulnerability or greatest concern.
- They are asked what, if any, adjustments in design, operation, or monitoring of the infrastructure would be made as a result of the funding.

British Columbia's transportation industry has had a high interest in this fund.

Transport Canada's Transportation Asset Risk Assessment Initiative was established to look at what Transport Canada is doing about vulnerabilities in their federally owned assets. One of the first projects being taken up with this assessment is the Sandspit Airport. This airport has suffered damage due to flooding. The study on this airport should wrap up in 2019, and then they will set goals for improvement.

Steve Litke, Senior Program Manager, Fraser Basin Council
The Fraser Basin Council has a flood planning initiative that is currently underway. The Lower Mainland Flood Management Strategy aims to reduce flood risk for communities and infrastructure along the Fraser River and south coast, with aims to help with resilience.

The Strategy is focused on two significant regional scale flood hazards. One is the Fraser River Freshet, which is involved in the water level issues the Fraser River is currently facing. The other is coastal storm surge, which typically happens in the winter. The initiative also looks at what effect climate change will have on both types of flooding hazards.

The Alex Fraser bridge is at that transitional point where downstream coastal surges create higher water levels and upstream water levels are higher because of the Fraser Freshet. With sea level rise, that coastal influence travels up the river, which means that the transitional point may change. There are also interactions between the coast and the river. For example, at times there are high tides when large river flows are coming down and stack up on top of each other. Climate change is currently projected to increase the magnitude and frequency of both major flood hazards focused on in this initiative. The Fraser Basin Council is a non-profit, non-government organization, and they have no regulatory or legislative function. This situates them very well as an impartial facilitator and leader. The strength in their initiative is through a broad-based partnership and collaboration.

Phase 1 of the strategy was focused on building the group's knowledge base. They wanted to improve their understanding of three areas:

- Flood hazards, and the influence of climate change on them,
- The ways that this region is vulnerable to those hazards;
- The status of the region's approaches to flood mitigation. The different system, infrastructure, policies, etc.

The Fraser Basin Council is currently on Phase 2 of the strategy. What will emerge from this will be a regional scale action plan. They are working to base this plan on the consensus of all the different parties involved. There are three types of content they are focusing on, the first being regional priorities. They look at the key flood reduction options the Fraser River region traditionally relied on, which are diking systems, flood construction levels, and policies. Second, the Fraser Basin Council also wants to look more broadly. They want to look at what other jurisdictions are doing and other approaches that have been taken. They want to evaluate those options and give recommendations for things that make sense to use in this region. The third area is around funding and governance. More specifically, what are some recommendations in terms of funding models and cost sharing arrangements? What can we implement in terms of strategy?

There are two parallel processes to develop all this information and the strategy itself. One is a process of technical information, analysis, and improving the science. The other is around engagement and consultation, focusing on what we can learn from the experience and perspectives of decision-making organizations, stakeholders, and the public.

A piece of work around flood hazards was developed in Phase 1. A consultant created four flood scenarios using information gathered from the region. These scenarios are the basis for a regional scale vulnerability assessment. Two of the scenarios represent coastal flooding, one during present day, and one in 2100. The two other scenarios represent Fraser River flooding, one during present day, and one in 2100.

On the coastal side, they added a metre of sea level. On the river side, the Fraser Basin Council looked at how climate change will affect the hydrology of the Fraser Basin and the peak flows of an equivalent flood. These are approximately a one in five-year return period, or a .2% annual exceedance probability. There is some cohesion to the scenarios, but much more work needs to be done as the

science continues to evolve. The Fraser Basin Council thought that this was a good starting point for looking longer term, so that they could incorporate this regional strategy.

For simplicity's sake, the water was stretched along the landscape until it hit high ground. The maps and values assume that no systems are in place to prevent inundation of flood plains. They also didn't look at the variability due to wave and wind affects, the relative sea level rise, or different shoreline geometry. (Which could all affect the different water levels.)

The vulnerability assessment took the four scenarios and estimated what would be impacted and what would be the losses associated with this type of flooding. They looked at populations being displaced, the number of communities that would be affected, damage to building inventory and select infrastructure (including transportation), agriculture, and cargo shipping delays.

There are several inter-dependencies or cross-dependencies with infrastructure that affect supply chains. A lot of infrastructure is at risk and issues with one area, such as highways or hydro-electricity, can directly affect another. This results in a cascading effect and makes this a regional issue. If your home survives the flood, you will still be affected if the roads are flooded and you can't get to work, for example.

The Fraser Basin Council is trying to figure out priorities for flood mitigation using the information gathered under the vulnerability assessment. Several things need to be protected, and the Council is trying to identify projects that protect the most important things in the best possible way. They have an interest in looking at critical infrastructure, impacts, and cascading effect. Given the importance of this task, a consultation process has been set up to help with prioritization. This consultation is with local governments and organizations who have experience with this type of initiative.

The Fraser Basin Council is also looking to access some of the current funding programs, and seeing what they can find for the future, but there are some gaps. They are looking to establish a new fund specifically for implementing the flood strategy. They are also looking to see if there is a role for the private sector or infrastructure providers to help with cost-sharing for this program as this could benefit their assets and business continuity.

What you can do as people involved with transportation infrastructure
People in this area should learn more about their vulnerabilities to flood. There are many different hazards that create flood risk (tsunami, coastal flood, etc.). A group should look at all flood hazards to figure out which ones they are at risk for. Then they should figure out what they can do to avoid or mitigate their risks and make sure the plans you create do not increase the flood risk.

Stakeholder Perspectives

Deborah Hartford, Executive Director, Adaptation to Climate Change Team
Increasingly the Adapt to Climate Change Team is looking at emissions reduction. It is important to note that Canada in 2014 was 13th out of 192 countries in terms of the per capita emissions. In 2015, Canada was the 93rd out of 192 countries on country emissions. We are a leader in emissions. There is some concern that countries that are developed, and have a lot of resources, see emissions change as imperative. The Adapt to Change Climate Change Team is increasingly trying to work on low carbon resilience (also called Climate Change Adaptation Mitigation, Mitigation Sustainable Development, and other terms in literature). The team was not seeing this converging as much in practice, which led the Adapt to Climate Change Team to work on developing tools, from policy, planning, and processing tools, as well as looking at professional best practices on how you can create a lens for integration. This would be from the outset right through to the implementation of projects.

There are a lot of co-benefits that the Adapt to Climate Change Team has been discovering that could be achieved through working together to improve emissions. Extreme weather events are high emissions intensive, and if you effectively adapt you can reduce these emissions. An example given is a water conservation program implemented by the governor of California. It not only saved billions of gallons of water, but also saved emissions to the equivalent of 100,000 cars off the road. There are also sometimes co-benefits that you might not expect such, as social licence for projects. It also may give more sources for funding, with more funding options becoming available for adaptation and emissions reduction. Another key co-benefit for adaptation is biodiversity and species health.

Municipal Natural Assets Initiative, for example, is looking at the flood mitigation dollar value of things like forests, foreshores, and aquifers. It asks what you would have to pay if you took that forest away to replace that infrastructure, and reduce the flood risk you are introducing. It also looks at the carbon reduction value of that ecosystem component. For sea level rise, there is an initiative called Green Shores, which looks at how you can reinforce your coastline in a way that is ecosystem based.

How can we roll everything together to reduce our emissions, build our resilience, and benefit ecosystems and other species where possible? The team wants to introduce more tools and assistance to help people think this way, so they can develop sustainable solutions.

Pamela Kertland, Program Manager, Natural Resources Canada
Natural Resources Canada has been operating the Climate Change Adaptation Program for the last 20 years. They currently support Canada's National Climate Change Adaptation Platform, which brings together national organizations, all levels of government, indigenous nations, professional and industrial organizations, and academia, to collaborate and address some of the priority issues they face with adaptation.

Natural Resources Canada supports projects that help advance adaptation. It works with partners in the Adaptation Platform to identify activities or topics that need to be addressed to accelerate action. For instance, one current issue they are looking at is financial disclosure. They also deliver knowledge/science assessments, with the next one being released in 2021. The assessment process is

evolving. The next one will have a regional focus, and will invite more diverse people to be involved in the review process. More information on how to get involved with this is available online at (https://www.nrcan.gc.ca/environment/impacts-adaptation/19918)

Natural Resources Canada recently completed a survey of decision makers from communities and businesses in natural resource sectors. The results show that the communities are a little bit ahead of the businesses when it comes to awareness. They both show some degree of awareness on climate change impacts that could affect them, and of adaptation as a response strategy. This is a change from the past survey done in 2009. Communities are ahead of business on adaptation by about 20%. Most adaptation actions underway are based on extremes and issues such as flooding. This survey looked at where both groups get information about climate change and what barriers they are facing. Both groups get about 50% of their information from the media. This shows that one way for you to get information out is through media. The number one barrier to action always seems to be cost. Some other barriers include communities looking for local impacts information, and businesses needing climate data.

During the workshop, several questions came to mind. How we can bring forward this information and share beyond this workshop in a way that is efficient? How can we do this on a consistent basis in an efficient way so that everyone can still do their day job? There is a lot of data and information: how can we share it in a way that is easily understood?

For smaller organizations and communities, how can we build and maintain capacity? There were some good examples provided at this workshop. One challenge is that when one key person leaves a project, they often take the information with them. This is good for the person's new project, but it generally leaves the former organization with less capacity and slows or stops ongoing projects.

Tugce Conger, Researcher, University of British Columbia

Tugce Conger's work focuses on the use of coastal green infrastructure and how to utilize these natural resources to build resilience in coastal communities. One of the main challenges is getting coastal communities to prepare for adaptation. The challenges in this area could be from funds and economy, figuring out responsibilities, institutional capacity challenges, disconnect between different government organizations, support and sharing of information, environmental challenges, the question of prioritization, and socialization challenges between different groups. The challenge for coastal communities is that they need to communicate the impact of sea level rise to their residents. This is a challenge because if you go to a homeowner and tell them their property will be underwater, they will probably react with anger and demand for action.

The work Transport Canada is doing is very encouraging. The fact that there is federal level financial and institutional support is certainly positive. However, smaller coastal communities don't know that these resources are available, or they lack the institutional capacity to write for grant applications. It is great that resources are available, but we need some people to help smaller communities do the analyses.

The Fraser Basin Flood Mitigation Initiative is especially important, being a non-profit organization that is in a position to take a leadership role in this region, and help bring communities together.

Anne Goodchild, Professor, University of Washington
Over the last 15 years, Anne Goodchild has worked with Alaska, BC, and Washington on a variety of resilience planning projects for freight transportation. One of her goals is to bring knowledge of the private sector's behaviour into the regional freight models.

Supply chains, commodities, and industries really use infrastructure differently. It is good to be at the point where we realize the importance of business continuity planning, but this type of planning will look very different in different types of industries.

Recently, Goodchild's group modeled the distribution of potatoes around the state of Washington. Largely they are grown in the eastern part of the state and then distributed around the state. They studied some closures in the Cascade Passes, and what that would mean to the potato industry. They modeled this on a very detailed level, and what they found was a disaster for the potato industry if the Cascade Passes were closed anywhere from one to three days. This would occur for a few reasons. One is that potatoes must be transported from where they are grown to where they are consumed. The profit margins on potatoes are very small, so the extra cost of that delay takes away from both the profit and the incentive they had to move the potatoes in the first place. During this study, they also looked at the distribution of diesel fuel in the state of Washington, and that is largely unaffected by the closure of the Cascade Passes. Diesel moves into the state by water, refineries, or through pipelines that are generally on the edge of the state. Only the last mile is completed by trucks and they usually don't have to go over the Cascade Mountains for delivery. This study shows that more work needs to be done to understand how different industries use infrastructure. In the event of a road closure, for example, different industries will be affected very differently.

Goodchild looked at the forestry and cranberry industries because of their differences. Cranberries must be grown in very marshy areas of the coast, which get inundated, and that isn't moveable. Forestry is largely away from the coast, in higher areas, with a large network of roads to work with. What we learn by seeing these differences can help us prepare for the various impacts and disruptions we may see.

There is a gap in how we see preparedness in the private sector. The public sector tends to focus on very significant events, and worst-case scenarios. These scenarios at times are outside of what is feasible for the private sector to plan for or deal with. It sometimes isn't rational to plan for that ultra-extreme event. We sometimes accuse the private sector of not being prepared for extreme events. In reality, they are prepared for the issues they have to deal with. It is rational for them to prepare for these minor disruptions. The market generally rewards cost reductions in transport, and low-cost products. They are generally put off by anything that would involve increasing cost in the short term when it isn't effective. To bring these transportation communities together, forums like the present one need to talk about the more regular disruptions, and less about the unlikely catastrophic ones. Preparation for more regular events are more likely to happen in this industry without government

intervention, because the benefit to the industry is immediate and ongoing. There is a place for long-term planning by groups like this as well.

Things like supply chain management and logistics focus on new measurement, implementing sensors, automating decision making, and increasing transparency. These is of benefit to people like us who want to know what is happening so we can react and modify. We are on the edge of being able to shift from a planning point of view to an adapting point of view. We can't always predict events, but we know we must be ready for them. With the aid of technology, we are better able to know how things stand now, which allows us to make further necessary changes more quickly than in the past.

Closing Thoughts & Next Steps – Paul Kovacs – ICLR

Paul Kovacs – Executive Director, ICLR
Paul Kovacs concluded the Expert Forum by thanking everyone for their participation, which was essential to the success of this workshop.

Special thanks went to Ron Pelot, whose idea it was to hold an Expert Forum on climate risks for coastal transportation infrastructure. Ron and his team at MEOPAR provided financial and administrative support that was critical to the success of the event. Special thanks also went to Oksana Exell and her team at WESTAC, who brought us the vision to address coastal transportation in Western Canada. Her unwavering focus on how this forum could advance a better understanding of the climate risks for coastal transportation and how to develop an action plan to advance resilience and reduce the climate risks was instrumental to the success of this initiative.

Turning the discussion into action
Most participants indicated that if we were to keep this conversation going, they would make time to be part of continuing to discuss climate risks and coastal transportation. How can we keep this conversation going and ensure that everyone has an opportunity to remain involved? One of the thoughts we have is that MEOPAR, with Stephanie Chang's leadership, is funding a resilient shipping project. This project will address one element of coastal transportation – shipping. The SIREN project was mentioned earlier, so those interested in shipping issues can approach Stephanie to learn more about the project and the potential for you to contribute.

Moving forward, another way to keep the discussion going would be to create a community of practice, a community of researchers and practitioners seeking to work together to understand and address weather and other challenges to coastal transportation infrastructure. MEOPAR has provided resources to ICLR to develop a community of practice, and we can choose to direct these resources to addressing coastal transportation issues. We could meet one or twice a year to discuss emerging findings about climate risk for the coastal transportation sector and options to address these risks to build a more resilient system. We could add regular phone calls, where we get together and talk as a community as issues emerge. The goal is to build a community of those interested in facilitating change.

One exciting way to move forward would be to rally around particular projects. Steve Litke shared an overview of the plans for the Fraser Basin Council, including actions to address river and coastal flood risk. The Council has established a network of people supporting this work. To build from some of the expertise here, we can support initiatives like the Fraser Basin Council's work to advance their transportation efforts. This community can provide the Council with feedback, advice and comments to help the Council move forward with its important work.

We heard about exciting initiatives elsewhere, including efforts underway in Nanaimo. The port has developed an emergency management strategy to deal with coastal issues, and a goal is for the actions of the port to be integrated with the town, the region and the airport, to come up with a joint transportation strategy. That is an initiative that our emerging coastal transportation community of

practice can work to support. For Powell River, we heard about a community that has completed research and analysis to better understand the climate risks they face and is moving toward implementation. Decision makers in Powell River are going to have many questions as their efforts advance, and we can make ourselves available to support this effort. One of the questions we heard raised was what some of the best practices are to reduce the risks facing tourists. There are established mechanisms to deal with people who live in the community, but it was not clear how to best deal with the influx of tourists each summer. Perhaps by working together as a group we will be able to support initiatives like these and help them move forward from the perspective of coastal transportation infrastructure.

There are several initiatives in British Columbia that have embraced the growing importance of addressing climate risk. Most are planning what they should do, while a few are moving beyond planning to implementation. We learned about actions taking place right now, at the individual level. At the collective level, there are conversations that have started, but I did not hear as many decisions on implementation happening yet in the collective dialog. I think that, working as a group, we can support moving these plans into action, share stories of success and support other opportunities. I also think that, by working together, we will be able to support more of transitioning from the excitement of seeing individual action and watching the launch of discussions about the prospect of collective action, toward increased cooperative action to build a resilient society better able to cope with climate risks.

There are various climate risks affecting coastal infrastructure in British Columbia right now, and prioritization is difficult. Deciding who to help first means that others will need to wait, and that is not an easy conversation. I think that by having the kind of group we have here, we can support the dialogue to come up with a non-partisan, scientifically rigorous way to say “This is the right place to start.” Society cannot address everybody’s needs immediately, and we may be able to help determine who should come first, and why. I think we will be very helpful in this. That is one of the challenges moving forward: Where do you move first?

We heard several organizations during this forum say “This is what we are doing and how we are moving forward.” Many of you were taking notes, because many of these exciting stories are not well known. By forming a community of practice, we will give ourselves an opportunity to share stories and case studies. Even those entities that are ready and wanting to move, and have a process that allows them to move forward, are still looking for specific ideas on how to do that. I think we are going to be able to share some ideas together. There will be an opportunity to collect some of those exciting stories and share them with a level of detail that others can learn from and move forward. I think that is an important element that can come out of our choosing to work together going forward.

I do believe that there will be intriguing funding opportunities. MEOPAR, for example, brought us together here and has given some core support to allow us to continue this conversation, but as specific research opportunities come up there will be opportunities to come back to various different places to look for funding, to move ideas forward. The question of funding comes up frequently when you have a good idea. Where do you find the funds to be able to move on your idea? For me, as a researcher, sometimes it’s a research question. How do you fund a particular idea? I think that by

working collectively we will open more doors, and I would like us to see that as another reason for us to come together.

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