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1st Atlantic Flood Mapping Conference

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Canada

1st Atlantic Flood Mapping Conference

Conference Report: Highlighting current practices in flood mapping in Atlantic Canada

Report prepared by CLIMAtlantic (Emma Poirier and Sabine Dietz)

for Natural Resources Canada

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Introduction

Flooding currently occurs across all Atlantic Canada and will continue to worsen in the coming years due to impacts from climate change (Gaur *et al.*, 2019). During high tides or storms, storm surges and additional wave run up caused by heavy winds can cause flooding along coastal areas. Current and projected sea level rise will worsen these effects as flood frequency and extent increase. Flood events and their impact on an area greatly depend on tidal conditions during storms as well as the elevation of the land itself (Dietz and Arnold, 2022). At times, the flooding impacts in Atlantic Canada can be catastrophic, as was the case at the height of the record storm surge event of January 21, 2000, December 21, 2010, and most recently post-tropical storm Fiona of September 24-25, 2022, which resulted in significant damages from flooding. The impacts from these storms range from the destruction of natural habitats, coastal infrastructure, institutional, residential and commercial properties. Flooding in inland areas can be caused by heavy precipitation, ice jams in rivers, and rapid snow melt. When the volume of water exceeds the capacity of rivers and streams, flood waters overflow onto land in areas close to the riverbanks or in areas with poor drainage. Fluvial flooding impacts can also be severe, such as those experienced along the Saint John River in New Brunswick in 2018. With proper knowledge and understanding of what areas are in hazardous zones, Atlantic Canadians can better prepare and adapt to flooding impacts.

Flood maps are a tool used to help prepare for floods and reduce their impacts. They identify areas covered by water during actual or potential flood events. They can identify the probability of floods and its impacts on structures, people, and assets. By outlining flood hazards, flood maps help decisions makers with flood preparedness and mitigation, land use planning, emergency management, and public awareness of flood risk (Natural Resources Canada, 2022a).

On October 5-6, 2022, the first Atlantic Canada Flood Mapping Conference was held in Halifax, Nova Scotia, hosted by Natural Resources Canada (NRCan) and CLIMAtlantic. The goal of the conference was to "address some of the key challenges concerning flood hazard mapping methodologies applied in the Atlantic provinces". The objectives of the conference were to share and explore flood mapping approaches used across the region, as well as to identify good practices when planning and implementing flood mapping. This document includes a summary of the event, an overview of current flood mapping programs in the region, and a summary of recommendations formulated by conference participants.

Context

Managing the impacts of flooding in Canada is a shared responsibility, and federal, provincial, and territorial partners work together to address these impacts. The Flood Hazard Identification and Mapping Program (FHIMP) is a federal program led by NRCan, with support from Environment and Climate Change Canada (ECCC) and Public Safety Canada (PS), to help Canadians plan and prepare for floods. FHIMP works in collaboration with provinces and territories to support the production of accessible flood hazard maps in areas at highest risk. In Budget 2021, the Government of Canada committed $63.8 Million to the FHIMP over 3 years, until 2024, with a recent announcement extending funding to 2028, as part of Canada's National Adaptation Strategy. FHIMP is aligned with the Emergency Management Strategy for Canada and coordinates with other federal programs such as Crown-Indigenous Relations and Northern Affairs Canada's (CIRNAC) First Nations Adapt. To be eligible for the FHIMP, projects must incorporate climate change considerations within their flood mapping efforts. At the time of the conference, there were 97 projects being supported by the FHIMP across Canada.

NRCan is the federal department leading flood mapping initiatives in Canada. Together with Public Safety Canada, NRCan develops the Federal Flood Mapping Guidelines Series (The Series). The Series includes a flood mapping framework, guidance on LiDAR (Light Detection and Ranging) acquisition, hydrologic and hydraulic procedures, flood risk assessment guidelines, as well as a land use guide for flood risk areas. The Series aims to strengthen flood mapping across the country by providing consistent guidance at different stages of the flood mapping framework across provinces and territories. NRCan is also in the process of releasing a public version of the National Flood Hazard Data Layer, which is an up-to-date inventory of flood mapping studies across Canada. Recently released datasets include the Historic Flood Events layer, a record of flood events dating back to the 1600's, as well as High Resolution Elevation Data.

CLIMAtlantic is the regional climate services hub for Atlantic Canada. CLIMAtlantic facilitates access to regionally relevant climate information and supports its effective use in planning and decision making. CLIMAtlantic is user driven and focuses on creating a strong Atlantic network generating a wealth of information sharing and collaboration in this space, in addition to supporting specific unique place-based work. By connecting people and jointly developing tools; engaging in assessing ongoing needs; and providing support through building local capacity, CLIMAtlantic exists to make adaptation accessible to Atlantic Canadians.

Conference content

The two-day event hosted presentations from both flood mapping practitioners and flood map users followed by interactive discussions to share knowledge across academia, government, non-profit organizations, Indigenous communities, and consultants. The targeted outcome was to bring more clarity on the various flood mapping methodologies and their uses for stakeholders, as well as to highlight best practices in the region.

During day one of the conference, participants received an overview of federal flood mapping activities, presentations from provincial representatives on flood mapping in the four Atlantic provinces, as well as a number of presentations on flood modelling methods and uses. Presentations on communicating with flood maps and a session on public perception and regulatory aspects, as well as equity considerations in flood mapping, were also part of day 1. Table 1 lists the presentations during the morning session.

Table 1: Presentations during the morning of Day 1.

Topic	Presenters and Presentations
Welcome	Elder welcome
Panel: the Role and Uses of Flood Mapping	Maxim Fortin (Natural Resources Canada) Cheyenne MacDonald (Confederacy of Mainland Mi'kmaq) Gordon Smith (Government of Nova Scotia) Jillian Mullowney (Red Cross)
Flood mapping - a federal overview	Overview of the role of flood mapping, what is happening across Canada, NRCan's program (Jean-Samuel Proulx-Bourque, Natural Resources Canada)
New Brunswick - flood mapping	New Brunswick approach (Don Fox, Government of New Brunswick)
Prince Edward Island - flood mapping	Prince Edward Island approach (Hope Parnham, Government of Prince Edward Island)
Newfoundland & Labrador - flood mapping evolution	Newfoundland and Labrador approach (Haseen Khan, Government of Newfoundland and Labrador)
Flood mapping in Indigenous communities	An Indigenous approach (Charlene Labillois, Gespe'gewaq Mi'gmaq Resource Council)

The second day of the conference was by invitation and included a broad cross-section of individuals involved in research, planning, developing, and implementing flood maps as well as users of flood mapping products. Participants were divided into groups and given discussion questions, first centering around flood mapping methods, then questions focusing on equity issues and flood hazard communication (See Annex).

Overview of flood mapping practices in the region

The identification of existing and potential flood prone areas has a long history in Atlantic Canada. All provinces have and are working on identifying at-risk areas through flood mapping programs, depending on provincial priorities, and many municipalities have conducted various flood risk or hazard assessments, and infrastructure planners and managers are conducting assessments throughout Atlantic Canada in the planning of new infrastructure, as well as in the on-going management and adaptation of infrastructure at risk of flooding.

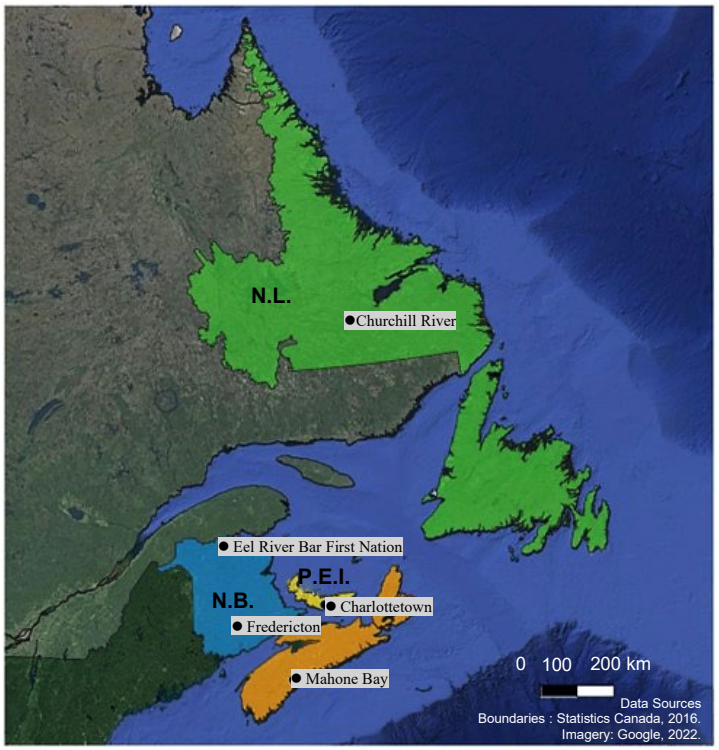

Figure 1: Region of Atlantic Canada showing four provinces and some examples of location specific projects presented during the conference. Many of the presentations encompassed province-wide initiatives.

Box 1 Annual Exceedance Probability (AEP).

Annual Exceedance Probability (AEP), a term used in this report, essentially refers to the likelihood that an event will happen in any given year. An AEP of 1% means there is a 1% probability that this value (or flood level) will be exceeded in any given year. It is important to note that even though 1% AEP is also referred to as a 1 in 100-year event, the event has a 1% probability of being exceeded every year, therefore it could happen two years in a row, or it could also not happen in the span of 100 years.

New Brunswick

The province of New Brunswick (NB) has a history of considerable river and coastal flooding. As a result, this Province created its first flood maps in the 1970's, indicating areas where floods have occurred (Government of New-Brunswick, 2022a). Currently, New Brunswick's online flood mapping tool "Flood Hazard Mapping " (Government of New-Brunswick, 2022a) is accessible to the public and presents educational resources as well as an interactive map showing coastal, and inland flood hazard areas (for several of the province's rivers, especially those that are heavily populated). The underlying Digital Elevation Model (DEM) is derived from LiDAR data collected between 2015 and 2020. The following hazard scenarios are viewable for both inland and coastal flooding events:

- Present day and Year 2100 flood, 1 in 20-year (5% AEP).
- Present day and Year 2100 flood, 1 in 100-year (1% AEP).

Additionally, Year 2100 coastal Higher High Water Large Tide (HHWLT) is provided. For the coastal modelling, the province is divided into 14 zones with quasi-homogeneous HHWLT and storm surge values. The resulting flooding scenarios imply that the peak storm surge event would coincide with a very high portion of the tide cycle. Sea level rise and storm surge estimates were developed by Daigle (2020) using storm surge calculations from Bernier (2005) and local sea level rise estimates from James *et al.* (2014). The coastal flood hazard mapping also assumes that dykes have been breached and coastal waters can travel inland when water levels rise above them. For the inland rivers, flood maps include peak water levels and flooded areas for events caused by rainfall and/or snowmelt. Ice jams do occur but are complex to model and are not included in this tool yet. The province also has a flood forecasting center, and has been undertaking inland flood forecasting for 50 years. The River Watch program provides observed and predicted water levels at stations along the Wolastoq (Saint John) River (Government of New-Brunswick, 2022b).

The web portal also presents work related to wave run-up studies in coastal areas of New Brunswick in partnership with the National Research Council of Canada.

The Province's climate action plan (Government of New-Brunswick, 2022c) includes an action for flood education and awareness. This will include public engagement on flood hazard mapping with demonstrations and discussions, including sea level rise.

Prince Edward Island

The Province of Prince Edward Island (PEI) has a public portal called Coastal Hazards Information Platform (CHIP). CHIP includes coastal flooding and storm surge projections and provides three hazard scenarios: the 1 in 100 year-flood (1% AEP see Box 1) for 2020, for 2050, and for 2100. There is also inclusion of an extreme scenario representing the 1 in 1000 year-flood (0.1% AEP) plus 65 cm of sea-level rise due to melting ice sheets. CHIP uses joint probability of tide and storm surge distributions (of present day and future sea-level rise), based on historic Charlottetown storm surge data, which is then extrapolated to the remainder of the PEI coastline using Bernier-Thompson modelling (Bernier and Thompson, 2006). Wave set-up and run-up are calculated with the SWAN model. As a supplement to CHIP, the government of PEI provides coastal hazard assessments upon request which help residents to better understand flood risk.

In addition to CHIP, more detailed flood hazard mapping is under development for Charlottetown using a heavy precipitation modelling method (Wang *et al.*, 2019). This method is based on precipitation accumulating in all locations on the land where it is falling, instead of assuming that all precipitation drains into the river, as some inundation models do. It can be used for purposes of real-time emergency management and building long-term climate resiliency in communities. This method also has the potential of being expanded to include the complete province of PEI.

PEI is taking flood hazard information into account when making important decisions, as demonstrated by its recent use in the construction of a new Mental Health and Addictions Emergency and Short Stay Unit in Charlottetown. This groundbreaking 8,000 square foot facility is the first of its kind in Atlantic Canada and began construction in the fall of 2022 adjacent to the existing Queen Elizabeth Hospital Emergency Department.

By utilizing flood hazard maps, the project team was able to make informed decisions about the final siting of the facility, resulting in reduced flood hazard potential for this critical infrastructure asset. This demonstrates PEI's commitment to using data-driven approaches to improve public safety and resilience in the face of natural hazards.

Newfoundland and Labrador

Flood mapping in the province of Newfoundland and Labrador (NL) has evolved since 1981 through various programs, such as the Canada-Newfoundland Flood Damage Reduction Program, National Disaster Mitigation Program, and now FHIMP. Flood hazard maps in NL (referred to as flood risk maps in this province) are being used for community planning, emergency management, and public awareness.

The province of Newfoundland and Labrador does not yet have province-wide flood maps for either the coast or inland areas. The Province has undertaken detailed river flood mapping and forecasting for 38 communities, viewable on the provincial Flood Extent Mapping application (Government of Newfoundland and Labrador, 2022). This tool shows 4 layers for these communities: the 1 in 20-year return period (5% AEP) and the 1 in 100-year return period (1% AEP), for both current day and climate change scenarios. The 1 in 20-year flood risk area is delineated as the floodway and the additional area outside of the floodway but included in the 1 in 100-year flood risk area is delineated as the flood fringe.

The Province has limited LiDAR coverage for portions of the Humber River, the Exploits River and portions of the Avalon Peninsula. Since 2012, all flood risk maps require that the DEM used for the floodplain be developed using LiDAR (Khan, 2022). Therefore, LiDAR acquisition will continue to increase within NL, as more flood mapping is planned.

In addition to these flood maps on the Flood Extent Mapping application, the Province performs flood forecasting for several rivers prone to flooding (i.e., Churchill River and Humber River, (McArdle, 2022)). Going forward, NL will continue to use real time forecasting systems where feasible; will move into more coastal flood risk mapping; and will continue to develop flood risk studies on watersheds with climate change in consideration (Khan, 2022).

Nova Scotia

The province of Nova Scotia (NS) does not yet have province-wide mapping available, although flood mapping has been undertaken for a number of communities (e.g., Halifax, Sackville Floodplains (Halifax Regional Municipality, 2022)). There are plans for flood mapping, and up-to-date flood maps were highlighted as a major need in many Municipal Climate Change Actions Plans released between 2012 and 2014. The first phase of plans (2017-2020) focused on acquiring LiDAR for the entire province, and now LiDAR data is freely available through the provincial open data portal. Concurrently with LiDAR collection, the Province developed climate standards and technical specifications for flood mapping. The Province is now poised to begin a program to complete flood mapping in all primary watersheds by 2026 with support from the FHIMP. These maps will focus on more developed areas of the watersheds, or on areas of potential growth as indicated in Municipal Planning Strategies (MPS). Municipalities are required to impose development restrictions through their MPS for areas corresponding to 1 in 20-year and 1 in 100-year return period floods. Going forward, municipalities will need to update their MPS at least every 10 years to reflect any new flood hazard areas (Bryce, 2022).

Nova Scotia's climate change plan (NSECC, 2022) has several actions related to understanding and acting on flood risk. These include improving the water-resource data needed to create flood maps, for example, water monitoring; helping residents understand and deal with flooding; strengthening responses to flood risk; and implementing the Coastal Protection Act. Implementation of the Coastal Protection Act (which was passed in 2019) is planned for 2023 and will restrict development in a protected zone to mitigate new properties' risk of flooding. This protection zone will create a vertical setback consisting of a minimum building elevation under which no building permits will be issued. This minimum building elevation will be greater than the Higher High Water Large Tide in 2100 (accounting for relative sea level rise) added to the elevation for a 1 in 100-year flood event (NSECC, 2021).

Flood Mapping Categories

Flood mapping can be used for a range of applications and for various audiences, from a homeowner who is interested in knowing if their home could experience flooding in the future, to an engineer who is undertaking a detailed flood hazard and risk assessment for specific infrastructure. Which flood mapping method to use depends on the purpose and the audience, as well as the required resolution and scale. Scale and resolution are important to take into consideration when choosing how to develop any flood maps. Looking at areas at a smaller scale, i.e., focusing on a small geographic area rather than a large area, allows the opportunity to use higher detail (or resolution) which may not be possible at larger scales because of costs and availability of data.

A classification is proposed in this section to facilitate the discussion around the flood mapping methods presented at the conference. Flood mapping methods can generally be categorized in three groups based on their level of detail (Table 2). The least amount of detail is most appropriate for use cases which are looking at hazards in the broad sense, such as hazard screening, prioritization, and public awareness. A medium level of detail can be used at a geographical scale that's finer but still regional. Use cases for the medium level category can overlap with the low detail category and include cases for preliminary planning. For highest detail, the geographical scale is typically the most local, and includes high resolution input such as detailed bathymetry, complete infrastructure information, and detailed hydrological data. Use cases for this category are often site-level assessments and they can be used to inform infrastructure decisions, as well as regulatory land-use planning.

Examples of presentations from day one are organized into these categories in Table 3. It is important to note that these are preliminary and broad categorizations and in practice there is fluid overlap between categories. Even though some use cases fall under lower resolution products in level 1 and 2, if the data and products aligned with level 3 are available, they can certainly inform those use cases (e.g., if wave run-up information is available for emergency response planning, then it makes sense to use it). Presentations which focused on incorporating flood maps into planning decisions (not specific to flood mapping categories), are shown in Table 4.

Table 2: Flood Mapping Methods Categorized by Level of Detail. Note that in practice there is overlap between categories.

Level of detail	Description of potential fluvial / pluvial flood hazard assessment	Description of potential coastal flood hazard assessment	Geographical scale	Potential use cases
Level 1 – Low detail	- High-level analysis using low-resolution DEM (satellite-derived), no data on bathymetry and hydraulic structures, and broad assumptions for hydrological analysis - Machine-learning susceptibility estimates	- Mapping using only the elevations from changes in relative sea level rise scenarios	Large area (i.e., one or multiple provinces)	Hazard screening and prioritization, public awareness, emergency response planning, preliminary land use planning
Level 2 – Medium detail	- Hydrological and hydraulic modelling with some data on bathymetry and structures, regional hydrological analysis methods - GIS-based or hydro-geomorphological with high-resolution DEM - Some degree of validation with historical flood event data	- Making use of storm surge models (e.g., Bernier and Thompson, 2006; Zhang and Sheng, 2013), in addition to the use of relative sea level rise	Regional area (i.e., one or multiple watersheds)	Emergency response, preliminary infrastructure and site-level assessments, preliminary hazard assessments, public portal, preliminary land use planning
Level 3 – High detail	- Engineering-level hydrological and hydraulic modelling using high-resolution DEM, detailed bathymetry and structures, and detailed hydrological analysis - Detailed validation and calibration of model parameters	- Detailed assessment including a wave run-up component in addition to the storm surge modelling and sea level rise scenarios	Local area	Detailed regulatory land use planning (by-laws, zoning, etc.), detailed hazard, infrastructure and site-level assessments

Table 3: Presentations categorized by level of detail, purpose, and audience. Links to presentations are available by clicking on the title. Where level of detail varies, the level of detail in the analysis depends on data input.

Presentation Title	Session	Purpose/Potential use cases	Audience	Level of detail
Flood modelling for ungauged watersheds (Anne-Marie Laroche, U de M)	Methods	Land-use planning, emergency response, infrastructure and site-level assessments, public portal	Province, municipalities, Emergency Management Office, public, infrastructure managers	Medium/high
Development of Ensemble Flood Forecast Community Risk Model for Situational Awareness (Steven McArdle, 4DM)	Methods	Emergency response	Emergency Management Office	High
Fredericton City-Wide Flood Risk Profile (Graham Waugh, CBCL)	Methods	Detailed hazard, infrastructure and site-level assessments	City/municipality, infrastructure managers	High
Flood Prediction Under Heavy Rainfall (Xander Wang, UPEI)	Methods	Preliminary hazard assessments	City, municipalities, infrastructure managers	Medium/high
Promoting evidence-based approaches to coastal flood risk assessment (Nicky Hastings, NRCan)	Uses	Hazard assessments, risk assessments	Provinces, municipalities, Emergency Management Office, planners, public, infrastructure managers	Medium/high
Flood Susceptibility in Canada (Virtual) (Heather McGrath, NRCan)	Uses	Hazard screening and prioritization	Practitioners Land use planning, municipalities	Low
Flood mapping in land use planning (Daniel Bryce, Government of NS)	Uses	Land-use planning and regulations, emergency response	Planners, municipalities, Emergency Management Office	Medium/high

Presentation Title	Session	Purpose/Potential use cases	Audience	Level of detail
Flood mapping for coastal risk assessment (Vincent Leys, CBCL)	Uses	Detailed hazard, infrastructure and site-level assessments	Municipalities, infrastructure managers	High
Mahone Bay 3D flood visualization (Barry Stevens, SS&D Inc.)	Communicating	Public education, emergency response	Public, municipalities, Emergency Management Office	Varies
Maritime coastal flood risk map (Tim Webster, Applied Geomatics Research Group, NSCC)	Communicating	Public education, emergency response	Public, Emergency Management Office, municipalities	Medium
Flood risk assessment under future climate (Virtual) (Andrew Smith, Fathom)	Communicating	Hazard assessments, risk assessments	Public, municipalities	Low/medium
Visualizing flood modelling in GIS for the Southeast Regional Service Commission (Virtual) (Marc-André Long, DFO)	Communicating	Hazard screening, emergency response, public awareness, land use planning	Municipalities, Emergency Management Office, planners	Medium
What are you really looking at? Scenarios in flood risk assessments (Nicky Hastings, NRCan)	Incorporating	Hazard assessments; risk assessments	Provinces, municipalities, Emergency Management Office, planners	Varies
Flood Mapping in NL: Challenges and Opportunities (Paula Dawe, Government of NL)	Incorporating	Land-use planning, site-level assessments, emergency response	Municipalities, planners	Medium/high

Table 4: Presentations which focused on incorporating flood maps into planning decisions (not specific to flood mapping categories).

Presentation	Session
Flood risk mapping in Nova Scotia: perceptions and concerns (Samantha Howard, Dalhousie U)	Incorporating flood maps
Impacts and consequences of mapping decisions (Virtual) (Omeasoo Wahpasiw, Carleton U)	Incorporating flood maps

What we heard/workshop outcomes

On day two, the conference organized a workshop with questions and discussion on best practices for flood mapping. The questions covered topics including the level of detail and accuracy needed for different audiences, as well as communication and equity considerations. Recommendations from these discussions are presented in Table 5. These recommended best practices fall into four categories. The first two (audience and purpose; climate change scenarios), are recommendations to help determine what type of approach is best for a particular project and situation. The subsequent two categories in Table 5 (communication and engagement; equity and justice) are recommendations aimed at ensuring inclusivity and good communication.

Overall, the group found that the best possible map products are those created using established guidelines following a comprehensive scan of available data and expected user base. These maps are best communicated clearly, with links to relevant events, throughout the entire planning process. Practicing justice-centered flood mapping from project initiation also ensures that different perspectives are included throughout the process.

Table 5: Recommendations from Participants

Audience and Purpose	
Link the type of method used to the intended purpose	It is important to clearly identify the purpose of the flood mapping project. Depending on the purpose, different methods apply, and different levels of resolution and accuracy are required. At the beginning phases of planning, a coarse resolution and simple approach for a large area may be sufficient.
Link the type of method used to the intended audience	It is important to assess the needs of the intended audience. Is this for use by the public, engineers, municipal staff? Depending on the audience, different methods apply, and different levels of resolution are required.
Link flood mapping to policy implementation	Linking flood maps to policy implementation means taking current policies into consideration when developing modeling scenarios and thinking forward to new policy implementation scenarios.
Climate Change Scenarios	
Use a number of climate change scenarios consistently & transparently	Given the variety of emission scenarios possible for our future, different scenarios can be chosen as a basis for flood maps. For example, for SSPs (Shared Socioeconomic Pathways), the use of SSP2-4.5 and SSP5-8.5, would provide a “middle” and “high” emission scenario option. Scenario choice needs to be clearly and transparently identified in any flood mapping project, and should align with provincial guidelines or standards when available.
Communication and Engagement	
Use prior events as reference	People remember storms that impact them and their communities. Make reference to these storms for people to relate to the hazards and impacts. Recent noteworthy storms in Atlantic Canada include Fiona, Dorian, Juan, and heavy rainfalls associated with an atmospheric river in November 2021.
Define terminology	Clearly define the terms being used. For example, the difference between hazard and risk should be clarified. Another example would be clearly defining the scenarios being used.
Provide a public online viewer/portal, with links, infographics, and educational materials	An online publicly accessible portal with flood hazard maps is useful where there are broad audiences for the flood maps. A portal (e.g., New Brunswick Flood Hazard Maps portal (Government of New-Brunswick 2022a)) can include interactive maps with different flooding possibilities, explanatory text, education materials, infographics, and links to relevant resources.
Communicate probability clearly	The concept of return period has to be explained in a way that people understand that there is a chance of events occurring every year, not just at the interval of the return period. The probability of an event occurring can be expressed in different ways, one of which is Annual Exceedance Probability (AEP, see Box 1).
Communicate the uncertainty	Inevitably, there will be uncertainty in flood maps because of a wide range of factors. It is important to communicate this uncertainty for people to understand the possibility of actual flooding situations to be different from the scenarios presented in the flood map. It is also important to communicate that although uncertainty is unavoidable, it is important to act now on the best current understanding.
Provide information on how to adapt to the impacts	In public purpose flood mapping applications, it would be beneficial to include information on adaptation. This allows for users to consider how they can adapt to the potential flooding that is presented to them.
Engage early and incorporate different perspectives	Engaging early and incorporating different perspectives of experts and end users (e.g., decision makers) is vital. Have knowledge transfer between different levels of experts, decision makers, and training professionals to identify how best to communicate risk to different audiences. Including Indigenous perspectives early is very important.

Communicate and engage throughout planning & implementation	If the flood mapping project is intended for public use, engagement with end users is essential from the onset and throughout the project. • Engagement needs to be prioritized as it leads to better outcomes. Understand what the community wants from early engagement prior to planning. • Use local champions to foster trust, as ambassadors of change. • Bridge public engagement theory (social science) with technical expertise on project teams. • Respect social systems of individual groups. • Establish a set of agreed upon principles at the start, in an equitable and collaborative way.
Equity and Justice	
Practice justice-centered flood mapping	Centering justice in flood mapping faces several challenges. Past and current flood maps do not always address systemic issues nor prioritize inclusivity: • Include different and wide perspectives in developing maps as tools. • Understand different perspectives, consider them, then make decisions. • Co-develop maps and solutions. • Recognize different ways people access information and make maps and information easily accessible to all. • Adopt culturally-appropriate strategies in flood mapping and risk communication to strengthen socially-just outcomes. • Acknowledge historical injustices and resulting consequences in flood risk.
Practice broader, more inclusive participation	Broad participation by academics, government, industry, and users has been a known gap in flood mapping. While there has been some advancement in this area, significant room for improvement exists in which groups are being included in these co-development processes. The limitations of the map makers' ability to cater to different needs may further restrict the project scope, which creates barriers in engagement and participation. • Utilize a broad range of communication channels to reach individuals. • Establish new pathways of information. • Leverage storytelling. • Ensure meaningful engagement with Indigenous communities. • Build relationships by understanding what challenges a wide range of individuals experience, and being open with each other, tackle their challenges. • Research and incorporate anti-colonial approaches.

Conclusion

Flood maps are essential tools to help inform the public of potential hazards, make evidence-based decisions on land use planning, and help prepare for flood events and emergencies. The Atlantic Flood Mapping conference provided a forum for provincial flood mapping programs, with presentations on methods, uses, communications, and planning. Participants also formulated best practices through discussions had during the workshop portion of the conference. Participants urged for further assessment of the intended purposes of flood mapping projects and their intended audiences.

In addition to best practices, participants identified several open questions and gaps for further work around flood hazard mapping:

- How do we communicate scenarios and return periods in a way that is clearly understood?
- How do we ensure that all the information being generated gets to the people who need to use it?
- How do we determine when a flood map is accurate enough for an intended purpose?
- What is the most efficient way to determine what areas are more at risk and need detailed mapping?
- How do we incorporate verbal, historical knowledge into maps?
- How do we create new understanding and capacity to progress towards justice-centered flood mapping?
- How do we strike a balance between ambition and practicality for flood mapping programs?

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Annex

Agenda

Agenda for Day 2

Day 2 - October 6, 2022	
9:00	Welcome Debrief: highlights from Day 1 • What struck you as really important to retain? • What were the highlights? • Where do you see the challenges with flood mapping coming out of yesterday?
9:30	**Questions Session 1:** • How are flood maps used for this purpose? • What level of accuracy is needed? • Who is the target audience? Is this internal or public facing? • Will municipal staff or municipal councilors need to rely on the maps to make decisions? If yes, what level of detail will they need? • How does this audience communicate and share flood maps? • If there are different audiences, is there a difference of accuracy between their needs?
10:15	BREAK
10:30	Facilitators from each table report back
10:45	**Questions Session 2:** • What level of accuracy & detail do you require? Is a LiDAR DEM needed? • What is the level of certainty you need? • Time frame is important - what do you need for future considerations? (speak to uncertainty) • Which flood modeling approach would/ could work? (e.g., large-scale modeling and base-level hazard assessments, depth to water table, regional flood modeling, coastal modeling, localized & detailed engineering hydrological and hydraulic modeling, etc.) • Which visualization and presentation tools do work better among different stakeholders? • How is data sharing facilitated among stakeholders?
11:30	Facilitators from each table report back
11:45	LUNCH

12:45	**Session 3** Participants are invited to circulate and add stickies and notes to what is on the walls at this time.
13:15	Facilitators report back on any significant changes or additions
13:30	**Session 4** Equity Considerations for Flood Mapping • How could the different dimensions of accessibility apply? • Which guiding principles should flood mapping follow? • What current gaps exist that prevent equitable mapping? • What compromises do map makers and users face?
14:30	**Session 5** Communicating flood risk and building trust • What would be best practices to communicate flood maps?
15:15	Afternoon wrap up

Equity topics discussed during Session 4

Topic	Sample guidance questions
Dimensions of accessibility, useability, inclusion	• How can flood mapping address issues of accessibility, approachability, availability, affordability, acceptability, and appropriateness?
Be ambitious	• What futures are considered? • In what ways are systemic issues addressed? • How can flood mapping increase resilience of social systems and resources?
Achieve just outcomes	• Which dimensions of injustice can be considered during decision-making/mapping? • What anti-oppressive considerations/approaches are integrated? • How do practices/opportunities create equitable partnerships, outcomes, and power dynamics?
Leverage ways of knowing	• How does flood mapping engage different worldviews, perspectives, and ways of knowing? • How are conflicting ways of knowing addressed? • How are local groups involved in the scoping, design, resource allocation, implementation, outcomes, evaluation, staffing, training, communication, outputs, etc.?