



# Framing the Canadian Centre for Climate Information and Analytics to advance municipal flood management

**A 2020 STUDY BY CANADIAN WATER NETWORK  
SUPPORTED BY INSURANCE BUREAU OF CANADA**




## Executive Summary

The impacts of climate change are being experienced by Canadians more and more frequently, and with more severe consequences. Flooding from severe storms and overflowing waterbodies has caused significant damage to Canadian communities over the past two decades. Insurance Bureau of Canada (IBC) says flooding is the “dominant climate peril facing Canada today.”

To make effective decisions about adapting to climate change (including flood management), municipalities, provincial/federal levels of government and the private sector need relevant, timely and reliable climate data. Canada’s Expert Panel on Sustainable Finance recommended the establishment of a Canadian Centre for Climate Information and Analytics (C3IA) as an authoritative source of climate information and decision analysis.

Canadian Water Network, with support from IBC, undertook a study on how to best frame the new C3IA so that it will be useful for, and used by, municipal decision makers. The study commenced with a series of group meetings and one-on-one discussions with expert advisors on key areas of overlapping interest. The findings that emerged from this process were then used to shape the study’s preliminary recommendations, which were then validated with municipal decision makers using a questionnaire.

The C3IA needs to deliver **three key functions** to support effective decision-making on flooding:

-  The curation of relevant data and information
-  The curation of different kinds of data and information products from different sectors
-  Expert analysis of the data to advance flood risk assessment and hazard mapping

The curation of data generated by other sectors would enable municipalities to compare similarities and differences with how flood risk is identified and assessed by other sectors, resulting in a more complete picture. The provision of data analytics and expertise would also have strong value for municipalities — for example, municipalities would benefit from expertise on how to downscale precipitation information from global and regional climate change models to inform local analysis. The C3IA could introduce each of the three key functions consecutively, using a phased approach. Initially, data curation would address some critical gaps, but the strongest potential to support municipal decision-making lies in curating data from other sectors (phase 2) and the provision of data analytics expertise (phase 3).





### **Curate relevant data and information**

*Getting a better handle on our collective knowledge base and opportunities that could be facilitated by data and information curation*

Data and information curation from various sectors or 'spokes'.



### **Curate different kinds of data and information products from different sectors**

*Determining how a more holistic picture of risk can be created to better inform decisions*

Includes access to different data uses and products for municipalities to use to compare their assessment of flood risk with that of other sectors' assessments.



### **Provide advanced expertise on data analytics that could advance flood risk assessment and hazard mapping**

*Generating the knowledge that tangibly supports climate-informed decisions*

Includes supporting the creation of data/information products, providing tools for data analysis, and contributing to the generation of new methods of analyzing data and information.

The study highlighted several key outcomes that the C3IA should consider:

- The C3IA's success is tied to the willingness and ability of multiple sectors to share data, information and knowledge. It must achieve buy-in from the various sectors from the earliest stages of development. Also, the framing and structure must clearly reward contributors by providing access to dependable, quality data, information and knowledge that can tangibly advance decision-making on flooding and other impacts from climate change. An important factor in ensuring productive cross-sector discussions is the identification of a shared goal or outcome to guide discussions as the C3IA evolves.
- The C3IA must be viable, stable and sustainable to warrant the municipality's investment, both in terms of time and effort, into the development and implementation of the C3IA.
- Establishing an overall data governance framework at the outset of the C3IA will be important to ensure data quality and support data analytics capabilities. The development of a robust data governance framework to guide and establish minimum requirements for the sending and receiving of data, information and knowledge between the spokes and the central hub of the C3IA is an important next step in the design process. The data governance framework would help translate the overall framing to a practical



implementation approach that informs and dictates the structure of how the C3IA would be delivered. Efficient, effective and sustained functioning of the C3IA's proposed hub and spoke model would also be strengthened by establishing a data governance framework with both intra- and inter-organizational policies, procedures and processes.

There is a clear opportunity for a nationally relevant approach like the proposed C3IA to advance and elevate the success of Canadian municipalities with their task of protecting people, the environment and local economies from the impacts of climate change. This study highlights the critical importance of accurately framing well-informed objectives at the outset before developing the C3IA's structure. Ultimately, understanding the needs of municipal decision makers, as well as exactly what data, information and knowledge will need to be shared or accessed is a key factor in successful implementation. Seeking clarity from potential contributors and users from the outset will greatly increase the C3IA's ability to deliver genuine value and tangibly inform decision-making over the long term.

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## Glossary

For the purposes of this report, the following definitions were employed:

- **Stormwater management:**  
The activity of managing drainage and impacts of precipitation on communities that encompasses municipal flood protection of homes, buildings and other infrastructure.
- **Fluvial flooding:**  
River flooding occurring when excessive rainfall, heavy snowmelt or an ice jam causes a stream or river to exceed its capacity and overtop its banks.
- **Pluvial flooding:**  
Overland flooding resulting from intense rainfall, prevalent in urban areas with a high occurrence of impervious surfaces.
- **Data:**  
Discrete and objective facts or observations (e.g., daily rainfall volume).
- **Information:**  
Processed, organized data presented within a context that enables the data to provide meaning (e.g., chronological presentation of daily rainfall volumes for the year 2019).
- **Data and information curation:**  
Activities involved in processing, organizing or structuring data and information in a way that facilitates access, interpretation and/or more readily informs specific analyses.
- **Knowledge:**  
The result of extracting insights from data and information in a way that enables the user to inform analyses and decisions; may include contextual interpretation of data and information (e.g., generation of a flood hazard map that aggregates and interprets various pieces of data).
- **Hub-and-spoke platform:**  
A method of structuring data and information flow whereby each individual/organization wanting to share and use data and information ('spokes') has a connection point with a central 'hub' which acts as the mediating platform between senders and receivers/users of the data and information.

## 1. Introduction

Climate change impacts are being experienced by Canadians more frequently and with more severe consequences. Extreme weather events such as storms and droughts are increasing in frequency and severity and now represent a significant challenge for Canada's people, environment and economy. Climate change is now costing Canadian taxpayers, businesses and governments significantly each year – in the order of billions of dollars (Insurance Bureau of Canada, 2019). Reducing the risk of costly impacts for extreme weather events requires strategic climate change adaptation – actions that reduce the impacts of climate change to communities – which is critical now for Canada and Canadians. A recent study by the Federation of Canadian Municipalities (FCM) and the Insurance Bureau of Canada (IBC) emphasized the urgent need for investments in local climate adaptation and found that “avoiding the worst impacts of climate change at the municipal level will cost an estimated \$5.3 billion per year”, a cost that would be shared among municipal, provincial and federal governments in Canada (FCM & IBC, 2020).

Flooding, both fluvial and pluvial, has caused significant damage to communities in Canada over the past two decades. Flood-related damage to communities includes impacts to human health and safety, damage to private and public infrastructure, and environmental and ecological impacts. IBC has found that flooding is the “dominant climate peril facing Canada today” (IBC, 2019). Losses from flooding have, over the past two decades, become the main source of property claims for the Canadian insurance sector.

For climate change adaptation to be both feasible and effective, decisions must be informed by reliable and consistent climate data, information and knowledge. These are the essential foundational elements needed to ensure that Canada effectively tackles climate change impacts. Recognizing this, Canada's Expert Panel on Sustainable Finance proposed Recommendation #4 on establishing the Canadian Centre for Climate Information and Analytics (C3IA) as an authoritative source of climate information and decision analysis. The Expert Panel envisioned the C3IA as a “multi-stakeholder hub and spoke platform” with the ability to provide the following functions (Government of Canada, 2019):

- Access to complete, authoritative, decision-useful and inter-operable climate information
- Access to practical climate-oriented financial, economic and corporate analysis

An integral part of the proposed C3IA's mandate is its ability to provide broad access to reliable and consistent climate data. In addition, the C3IA is needed to address an important competency gap: the current lack of existing tools and experience to translate climate change data into “tangible impacts to a business, city or portfolio” (Government of Canada, 2019).





For all sectors, responding to climate change requires the development of effective approaches to better identify, understand and respond to the risks involved. In supporting the framing and structuring of the C3IA, an opportunity exists to make more effective use of the data, information and knowledge we already have and are currently generating to better inform decisions. Data and information are currently generated for a wide variety of reasons, typically in response to individual needs and mandates. Effectively leveraging the various data and information generated to meet a variety of objectives, such as evidence-informed flood management decisions, is a key opportunity for multiple sectors.

Municipalities, provincial and federal levels of government, and the insurance sector all conduct activities that involve identifying and mitigating risks posed by extreme weather events, including floods, to communities. As a result, they all hold key elements of the knowledge base needed to effectively identify and prioritize flood mitigation actions and investments. As such, an important near-term goal is developing an approach that maximizes the collective value of the knowledge sources by more effectively leveraging and curating the data and information that is already being generated by each sector to better inform risk evaluation.

## 2. About the Study

Canadian Water Network (CWN) is partnering with IBC and Smart Prosperity Institute (SPI) to generate recommendations on the successful structuring of the C3IA as an authoritative source of climate information and decision analysis (Government of Canada, 2019). CWN is developing objectives and framing for a made-in-Canada solution for improved data, information and knowledge curation that is useful for municipalities to improve flood risk evaluation, identification and mitigation in Canadian communities. While CWN is leading this municipal sector needs assessment, SPI is leading a needs assessment for the financial sector. Both assessments will ultimately generate recommendations that will help inform the successful framing and structuring of the C3IA.

### Objectives

Canadian municipalities are on the frontlines of climate change impacts and are key players in the prioritization and implementation of adaptation measures considering that they own and operate approximately 60% of public infrastructure (FCM & IBC, 2020). Ensuring they can participate in and use the C3IA is critical to advancing climate adaptation in Canada.

The overall aim of this study is to generate recommendations for objectives that the C3IA needs to have in place for it to be useful for and used by the municipal sector. Early discussions with Advisory Group members and municipal leaders contributing to this study reinforced the importance of defining the exact level and nature of the recommendations that would be

targeted by the study to inform the structuring of the C3IA. CWN wanted to ensure that the study focused on a well-articulated, foundational element of the C3IA in order to deliver tangible and concrete results. Generating recommendations for objectives that would ensure the C3IA is of pragmatic value to municipalities is a critical goal with the potential to engage municipalities in benefiting from the C3IA in the long-term.

### Scope and framing

For this study, CWN has used the climate issue of flooding to frame its research, discussions and analysis. Given the prevalence of flooding as both a difficult and costly challenge for Canadian municipalities, CWN is using it as the 'lens' through which to assess the framing of the C3IA's objectives to ensure it is useful for and used by municipalities.

Through discussions with Advisory Group members, CWN confirmed that an effective understanding of municipal data, information and knowledge needs relies on first establishing a firm understanding of the decisions that municipalities need to make in their management and mitigation of flood risk. As such, CWN structured discussions with Advisory Group members in a way that investigated:

1. The decisions that need to be made by each participant in their role and sector, including how key risks from flooding are defined and managed
2. The key elements of knowledge relative to municipal conditions and urban flooding potential and impact needed to make the above decisions
3. The degree to which each sector (or subsector) has access, or needs access to, data, information and knowledge to enable risk-based decisions on flooding

CWN acknowledges that not all sectors and not all municipalities will use the data, information and knowledge in the same way. Ultimately, the data, information and knowledge that have the potential to benefit decision-making for multiple sectors are foundational in defining the initial requirements and objectives for the C3IA.

In addition to providing a useful framing for Advisory Group discussions, the above three categories have also been used to guide the structuring of a questionnaire CWN developed to engage municipal leaders across Canada and investigate their data, information and knowledge needs with respect to flood risk assessment and mitigation. The questionnaire, titled *Assessing Municipal Knowledge Needs and Curating Data to Advance Decisions on Flood Management*, was distributed to Canadian municipalities across all 10 provinces. It targeted senior managers of municipal stormwater systems across Canada to gather input on 1) decisions municipalities make



related to flood risk assessment and mitigation, 2) data and information municipalities need to make decisions on flood risk assessment and mitigation and 3) data, information and knowledge curation needs required to ensure that the C3IA is useful for and used by municipalities.

## Methodology

Study findings and recommendations for objectives that the C3IA needs to have in place for it to be useful for and used by the municipal sector were primarily shaped by discussions and consultation with Advisory Group members. The Advisory Group comprised a leading group of experts covering the key areas of overlapping interest and expertise required for this study. Findings and recommendations were then validated using the questionnaire, which was structured based on both in-depth one-on-one discussions and group meetings with Advisory Group members. CWN's institutional knowledge of the municipal sector played a key role in vetting the findings and recommendations validated in the questionnaire.

The questionnaire was completed primarily by municipalities who have responsibility for stormwater management. Roughly two-thirds of respondents indicated that they service both urban and rural populations and one-third indicated that they service a predominantly urban population. In terms of geographic representation, 35% of responding municipalities were based in Ontario, with equal representation (12%) for each of British Columbia, Alberta, Saskatchewan, and Québec. Manitoba and Nova Scotia each accounted for 6% of municipal responses. Almost half of questionnaire respondents indicated that they serviced populations between 250,000 to 750,000 and almost one-third of respondents serviced populations between 100,000 to 250,000.

## 3. Municipal Decisions on Flood Risk Assessment and Mitigation

This section summarizes the kinds of decisions that municipal leaders need to make with respect to flood risk assessment and mitigation. The first subsection discusses decisions on the design and implementation of municipal assets. These asset-management decisions dominate flood-related decision-making at the municipal level. The second subsection presents findings on other types of decisions related to flood management, including decisions on the engagement and collaboration with organizations external to the municipality. Finally, the third subsection discusses how decision-making processes for the management of fluvial versus pluvial flooding differ and the insights this provides for the effective structuring of the C3IA.

### Decisions on the design and implementation of municipal assets

In general, decisions relating to the design and implementation of municipal assets dominate the resources that municipalities and stormwater utilities dedicate to flood risk assessment and mitigation. These decisions range from relatively simple decisions with a clear analysis pathway,



to decisions involving a complex number of criteria, with little established policy or guidance in terms of how to assess and prioritize these criteria. When it comes to municipal stormwater management, the lack of regulatory and clear policy guidance continues to pose a challenge to Canadian municipalities.

CWN's questionnaire asked respondents to comment on the categories of decisions that strongly reflect the kinds of decisions that their municipality/utility makes with respect to flood risk assessment and mitigation. Through responses to the questionnaire, and as corroborated by CWN work with municipal utilities, most municipal leaders highlighted the following decisions on the design and implementation of municipal assets as *strongly* reflecting the kind of decisions they make:

- Deciding on how best to prioritize where infrastructure upgrades are implemented to reduce/mitigate flood risk.
- Determining an acceptable level of flood risk to public health and safety in the design of municipal infrastructure.
- Determining an acceptable level of flood risk to the environment in the design of municipal infrastructure (e.g., receiving water impacts).
- Deciding on appropriate expenditures for capital and operational flood risk reduction interventions, including cost-benefit analyses.
- Determining storm patterns and intensities that need to be assessed and incorporated in local modelling.

Other decisions relating to municipal assets that were highlighted by a smaller number of respondents include determining appropriate land use decisions in floodplains, determining potential future impacts of sea level rise and climate change on local stormwater systems, and deciding on an acceptable level of risk reduction and residual risk for areas in need of flood mitigation measures.

#### Other decisions related to flood risk assessment and mitigation

Other decisions that municipalities/utilities need to make include decisions relating to where engaging or collaborating with organizations outside the municipal utility is required to achieve flood management goals. Questionnaire respondents highlighted the following specific decisions on engagement and collaboration as *somewhat* reflecting the kinds of decisions their municipality/utility makes:

- Determining where relevant data or information exists outside the utility, including other municipal departments, or other sectors, that could better inform decisions.
- Deciding on the most effective ways to share municipally held flood risk information, including which information to share with utility customers and the broader public.
- Deciding on how to effectively communicate and collaborate with other sectors (e.g., the insurance sector) so that shared costs of and benefits from potential or completed municipal flood reduction and mitigation measures are recognized/acknowledged.

CWN's institutional knowledge of the municipal sector suggests that the above decisions are not necessarily less important in enabling an effective decision process context for Canadian municipalities/utilities than decisions on municipal assets. However, in terms of how these decisions are being made by municipal utilities, the fact that they reported them to be only somewhat reflective of municipal decision-making priorities may suggest that the more complex nature of these decisions often acts as a 'barrier to entry' for municipalities and utilities.

#### Fluvial versus pluvial flood management decisions

Most questionnaire respondents indicated that their municipality/utility is responsible for managing both fluvial and pluvial flooding. Roughly two-thirds of those who manage both types of flooding indicated that they employ different decision-making approaches to manage fluvial versus pluvial flooding.

Questionnaire responses reflect that decisions on the management of fluvial flooding are more straightforward and generally less complex than pluvial flood management decisions. For the most part, municipalities and utilities have sufficient information and knowledge to make decisions on the management of fluvial flooding. These decisions typically involve gathering information on floodplain topography and modelling fluvial flood levels, assessing potential impacts to assets based on modelled and/or historic flood levels, and monitoring and periodically assessing the need to upgrade dike networks. One potential source of information that municipalities indicated would elevate fluvial flood management decisions is the availability or access to high-resolution floodplain topography. In general, higher-resolution topographic mapping would advance flood risk identification and assessment for multiple sectors (CWN & IBC, 2019).

Decisions on the management of pluvial flooding are more complex and layered by comparison. CWN's questionnaire revealed that pluvial flood management decisions are varied and are driven by local conditions and priorities. A few common elements among a number of pluvial flood management approaches include focusing mitigation measures on areas that have previously experienced pluvial flooding, assessing the conveyance and storage capacity of minor and major

drainage systems, determining system-specific risks, and using hydrologic and hydraulic modelling of various storm events to evaluate health and safety and infrastructure impacts. Despite these common decision-making elements, a proprietary study conducted by CWN that compared stormwater approaches from seven large municipalities across Canada revealed that: 1) the specific assessment methods used vary from one municipality to the next and 2) the extent to which these and other decisions are made using explicit or codified assessment methods varies. In many cases, these foundational decisions are layered with additional decision-making criteria, such as if and where to implement green infrastructure or low impact development, whether coordination with other municipal departments or external organizations is needed, etc.

Overall, CWN has observed that the degree to which decision-making is formalized or codified varies greatly from one municipality to the next. So, although there is general agreement among municipalities regarding the types of decisions that need to be made with respect to flood management and mitigation, the approaches they use to make these decisions are varied and often dictated by local conditions and priorities (e.g., city council priorities, availability of funding, etc.). This is a key factor to be considered in the framing and structuring of the C3IA if it is to be of pragmatic value in providing or enabling generation of relevant and usable knowledge to municipalities and utilities.

## 4. Municipal Data and Information Needs

The following section discusses the data and information currently used by municipalities for flood risk assessment and mitigation, as well as the data and information municipalities need to further inform their decision-making, but to which they do not currently have access.

### Data and information currently used to assess and mitigate flood risk

Most questionnaire respondents indicated that they use the following data and information to identify, evaluate and mitigate flood risk:

- Information on municipal assets, including asset condition and operation and maintenance requirements
- Historical flood locations
- Historical flood frequency
- Information on the location of low-lying areas or basins
- Size of area directly affected by flooding impacts
- Land use, including property type and location

- Information on the location of critical infrastructure (e.g., hospitals, rail lines, water/wastewater treatment plants)
- Health and safety impacts of flooding
- Impervious surface area
- Scenario modelling of the predicted severity of impact of various flooding scenarios

The following data and information were less frequently selected by questionnaire respondents, but were still selected by more than half of the respondents:

- Environmental impacts of flooding
- Socio-economic service impacts of flooding
- Socio-economic equity impacts of flooding (e.g., identification of impacts to more vulnerable populations)

The above categories point to the critical pieces used to inform municipal decisions on flood risk assessment and mitigation. However, although these categories represent essential data and information used by municipalities, they do not provide an exhaustive list of all the data and information used. Additional data and information municipalities use to make decisions on flood management include those needed to inform decisions dependent on specific geographic location and regional climate or factors (e.g., tidal surge information).

#### Data and information needed to further inform municipal decisions

In addition to assessing the data and information currently used by municipalities, the questionnaire also asked participants to identify data and information that would further inform their decision-making but to which they do not currently have access. The responses provided indicated that a wide range of additional data and information is needed by municipal decision-makers to further inform their assessment and mitigation of flood risk. The following is a summary of the key insights into municipal data and information needs.

Many respondents highlighted the need for better information on storm cell characteristics and patterns and knowledge of how to represent storm cells more accurately in flood risk models. There is general agreement among municipalities that the accurate representation of storm cells in flood risk modelling is a key need to advance the assessment and mitigation of flood risk.

Respondents from east and west coast municipalities indicated that storm surge and tidal information is critical to advancing flood risk assessment and mitigation but is often not available to them. In addition, municipalities highlighted that they do not have access to information on sea level rise and its impacts at the local level.



Respondents also indicated that reliable precipitation data that is appropriately and effectively “downscaled” from global or regional climate change models to represent and reflect local conditions could further support their decision-making, especially in terms of ensuring their flood mitigation efforts are accounting for the impacts from the increasing occurrence of extreme weather events. To make informed decisions on climate change adaptation, municipalities and utilities would benefit from analytical expertise that uses information from regional or global climate change models and downscales it appropriately so that municipalities could use it to inform local decisions on adaptation.

How climate change might influence local precipitation patterns is just one piece of information that would advance adaptation-driven decision-making for Canadian municipalities. Considering that flooding now costs Canadians more than any other climate issue (IBC, 2019), a critical piece in advancing municipal responses to flooding is providing the analytical expertise necessary to achieve reliable downscaling of precipitation data from global or regional climate change models to generate precipitation data that is based on local conditions/parameters.

Municipalities also commented on the need for optimization tools that would support them in determining the combination of infrastructure upgrades that would produce the highest risk reduction for the best cost. Providing ready-to-use optimization tools might not be an immediate priority in the early stages of the C3IA. However, this need highlights the potential value that the C3IA could have for municipalities if it were to provide advanced expertise on data analytics and assessment tools that could advance flood-related decision-making.

**A key finding is that most respondents indicated it would be helpful for their decision-making if they are able to access data products (e.g., flood hazard maps) produced by other sectors, including those developed to meet different objectives.**

Sectors producing these other relevant data products could include the insurance sector, provincial and federal governments, and academia. Municipalities and utilities see great value in being able to compare their assessments of flood risk with assessments completed by other sectors. Respondents indicated that this would support their flood mitigation efforts and enable them to focus their efforts more appropriately and, in some cases, help them identify higher-risk areas that were not previously known. Overall, the access to and comparison of data and information products generated by other sectors is a critical function that the C3IA could provide that would benefit the municipal sector.



## 5. Considerations for Data, Information and Knowledge Curation

A critical aspect of the study is identifying the key elements of data, information and knowledge curation that could be embedded in the C3IA structure's mandate to ensure that it will be useful for and used by Canadian municipalities. The Expert Panel on Sustainable Finance highlighted the importance of *curating* and not just sharing data and information through the C3IA (Government of Canada, 2019). Curation is a means of managing and presenting data and information that ultimately makes it more useful for the users of the C3IA by more readily supporting analysis and decision-making. In the case of the C3IA, curation would ensure that the data, information and knowledge that is accessed and considered by the hub from diverse sources (i.e., 'spokes') would be integrated by the C3IA (i.e., the 'hub') in a way that maximizes the pragmatic value of these pieces for multiple sectors. This section examines what the hub's integration and curation process would have to achieve to ensure that the C3IA is useful for and used by Canadian municipalities.

Questionnaire respondents were asked to comment on the elements of data, information and knowledge curation that they perceive to be important in ensuring the C3IA's usefulness and usability for their municipality/utility. Municipalities identified the following elements as either essential or very important to making the C3IA a relevant and trusted source of practically useable knowledge:

- Established protocols to ensure that the data, information and knowledge is up to date (i.e., actively integrated and updated where necessary)
- Established protocols to ensure that a minimum standard of data and information quality is maintained
- Established protocols to ensure data, information and knowledge is securely transferred and protected
- Established protocols to ensure that data ownership, stewardship, and custodianship is clearly listed and maintained
- Curation protocols that ensure the limitations of data, information and knowledge from disparate sources are clearly specified through the incorporation of metadata (e.g., precision of data, level of uncertainty associated with the data)

The following curation elements were identified as only moderately or slightly important:

- Established protocols that favour curation that is clearly realistic and achievable in the context of the sectors contributing data, information and knowledge to the C3IA
- Establishing a neutral third-party organization to responsibly manage the C3IA

Most of the above elements could be addressed through the creation of a data governance framework to guide the sharing and curation of data, information and knowledge through the C3IA.

### **Data Governance**

“A cross-functional framework for managing data as a strategic enterprise asset. In doing so, data governance specifies decision rights and accountabilities for an organization’s decision-making about its data. Furthermore, data governance formalizes data policies, standards, and procedures and monitors compliance.” (Abraham et al., 2019)

A data governance framework is essentially the collection of principles and practices that ensure the continued high quality of an organization’s or initiative’s data (Abraham et al., 2019). Although the above definition of data governance focuses on an organization’s data, a data governance framework could be established for an entity such as the C3IA. Establishing an effective data governance framework for the C3IA will require identifying how each of the following components will be addressed: 1) governance mechanisms, 2) organizational scope, 3) data scope, and 4) domain scope. These four components form the cornerstones of effective data governance frameworks.

This report speaks to what should be considered in terms of framing the components of what a successful structuring and implementation of the C3IA needs to include. Table 1 (adapted from Abraham et al., 2019) presents these key decision-making parameters within each component that will need to be considered in the development of a data governance framework. The early stages of the C3IA’s development should apply such organizational thinking, including determining which of these parameters are integral to, and therefore incorporated in, the platform’s data governance framework by consulting with stakeholders interested in participating in and contributing to the platform.

**Table 1.** Components of effective data governance frameworks and key decision-making parameters within each component (adapted from Abraham et al., 2019)

Component	Decision-making parameter
Governance mechanisms	Structural mechanisms (e.g., identifying roles and responsibilities)
	Procedural mechanisms (e.g., creating a data strategy, developing policies, standards and processes, defining how performance is measured and how issues are managed)
	Relational mechanisms (e.g., training requirements, stakeholder communication methods and tools)
Organizational scope	Intra-organizational (i.e., data governance within the C3IA)
	Inter-organizational (i.e., data governance between organizations and sectors contributing to the C3IA)
Data scope	Traditional data
	Big data
Domain scope	Data quality
	Data security
	Data architecture
	Data lifecycle
	Data storage and infrastructure
	Metadata (summarizing basic characteristics or properties of data shared through the C3IA, including data owner, date created, data quality/resolution, description of data)

The Expert Panel on Sustainable Finance proposed that the C3IA be structured as a hub and spoke model (Government of Canada, 2019). A hub and spoke platform is a method of structuring data and information flow whereby each individual/organization wanting to share and use data and information ('spokes') has a connection point with a central 'hub' which acts as the mediating platform between senders and receivers/users of the data and information. This type of platform enables two-way communication (i.e., sending and receiving) between individual spokes and the central hub. Structuring the C3IA as a hub and spoke platform creates a more efficient workflow structure, especially considering that the data, information and knowledge being shared through the platform would originate from a number of organizations/sectors and would then be used to inform the decisions of other organizations/sectors. However, the efficient and effective functioning of the hub and spoke model will strongly rely on establishing a robust data governance framework with both intra- and inter-organizational policies, procedures and processes.

At its core, the data governance framework must be practical and achievable by those that are contributing to and using the C3IA. It is critical that the data governance framework maintains quality, currency and ownership of data and information while ensuring that it does not create a barrier to participation for municipalities and other sectors. It is important to note that a robust data governance framework is a critical first step in supporting advanced data analytics as part of the C3IA.

## 6. Objectives for Framing and Structuring the C3IA

This section presents the critical objectives that the C3IA must have in place based on the findings that CWN has presented in sections 2.0, 3.0 and 4.0.

### Ensuring the C3IA is useful for and used by Canadian municipalities

To be useful for and used by Canadian municipalities, CWN recommends that the C3IA fulfill the following functions:

- Curation of relevant data and information:  
*Data and information curation from various sectors or 'spokes'.*
- Curation of different data/information products that are being produced by different sectors:  
*This includes access to different data uses and products for municipalities to use to compare their assessment of flood risk with that of other sectors' assessments.*

- Provision of advanced expertise on data analytics that could advance flood risk assessment and hazard mapping:

*This includes supporting the creation of data/information products, providing tools for data analysis, and contributing to the generation of new methods of analyzing data and information. Note: Establishing a data governance framework in the early stages of the C3IA's implementation will support data analytics capabilities in later stages as it would ensure that data and information is reliable, organized and up-to-date.*

The Expert Panel on Sustainable Finance recommended that the C3IA's mandate should "begin with a limited scope and plan for expanded functionality over time" (Government of Canada, 2019). A strong implementation strategy could address the above three functions as consecutive phases of the C3IA, whereby the first phase involves the curation of data and information and the final phase involves providing more complex functionality such as advanced expertise in data analytics. Figure 1 (below) depicts the above three functions as potential implementation phases.



### **Curate relevant data and information**

*Getting a better handle on our collective knowledge base and opportunities that could be facilitated by data and information curation*

Data and information curation from various sectors or 'spokes'.



### **Curate different kinds of data and information products from different sectors**

*Determining how a more holistic picture of risk can be created to better inform decisions*

Includes access to different data uses and products for municipalities to use to compare their assessment of flood risk with that of other sectors' assessments.



### **Provide advanced expertise on data analytics that could advance flood risk assessment and hazard mapping**

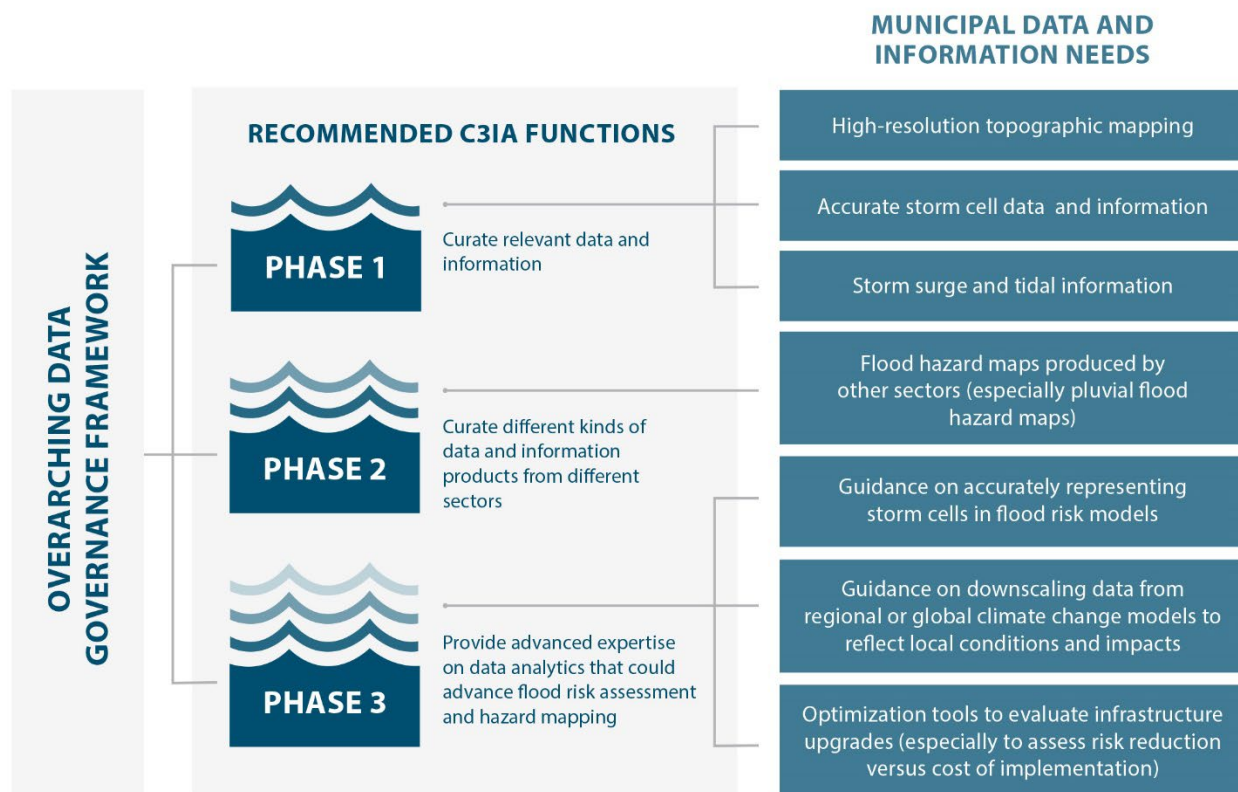
*Generating the knowledge that tangibly supports climate-informed decisions*

Includes supporting the creation of data/information products, providing tools for data analysis, and contributing to the generation of new methods of analyzing data and information.

**Figure 1.** Proposed three phases of implementation for the C3IA based on the functions that it must meet to ensure it is useful for and used by Canadian municipalities

Study findings presented in sections 2.0, 3.0 and 4.0 have illustrated concrete needs that would be of value to municipalities. Figure 2 (below) presents these needs as extensions of each of the three functions, thereby linking each need to the function under which it is classified.

Based on study outcomes, we note that although curating data and information (function/phase 1) would address some critical gaps, likely the strongest potential of the C3IA to support municipal decision-making on flood management lies in implementing functions/phases 2 and 3.



**Figure 2.** Overall framing for the C3IA, including needs under each C3IA function that would be of pragmatic value to Canadian municipalities and utilities. Note: The needs summarized here reflect those that would tangibly support municipal decision-making related to the management of the most prevalent and costly climate risk for Canadian communities: flooding.

In addition to the above functions and needs, it is critical to ensure that there is commitment to ensuring the long-term viability of the C3IA as a sustainable entity that can be reliably accessed by the municipalities who invest time and effort into its development and implementation. Firstly, the framing and structure of the C3IA must clearly ‘reward’ (i.e., provide real value to) those municipalities – and other sectors – that contribute to its development and implementation by providing access to dependable, quality data, information and knowledge that tangibly advance decision-making on flooding and other climate change impacts. Secondly,

the C3IA itself must be reliable and sustainable as an entity. This emphasizes the importance of ensuring that the objectives the C3IA has in place ahead of its implementation contribute to the sustainability and long-term viability of the Centre. If municipalities and other sectors invest time and resources in their contribution to the C3IA, it will be crucial that 1) the entity (or entities) overseeing the platform do not abandon the initiative within a few months or years of its inception, and 2) the C3IA produces clear value for those using it. For municipalities participating in and contributing to the C3IA, producing clear value involves ensuring that the curated data, information and knowledge can tangibly support decision-making on flood management as well as other climate risks. The above echoes CWN's observation that the structuring of the C3IA is of less immediate importance than the accurate framing and placing of well-informed objectives at its forefront.

### Considerations to ensure the C3IA's usefulness to other sectors

Although this study focused on identifying the data, information and knowledge needs of the municipal sector that should be incorporated into the structure of a C3IA, the CWN study provided insights into considerations that the C3IA's overall framing and structure must consider to ensure its usefulness to other sectors (i.e., in addition to municipal use) as well.

Discussions with Advisory Group members highlighted that the C3IA's success will be tied to the willingness and ability of multiple sectors to share data, information and knowledge. In general, CWN acknowledges that it is not possible for all sectors to share *all* data and information, but it is important that sectors begin to genuinely assess the potential for sharing at least some data and information. In the case of the Norway Pilot Project (Climate-ADAPT, 2020), one of main challenges was the need to create a new exemption under the European Union's General Data Protection Regulation (EUR-Lex, 2016) to ensure that the insurance sector could legally share asset level loss data with Norwegian municipalities. In the Norway Pilot's case, the insurance sector's loss data was not considered 'sensitive' per the Regulation but was considered sensitive in that it is commercially competitive data for insurance companies involved. Although the specific types of data, information and knowledge shared through the C3IA have yet to be finalized and regulations requiring organizations to share data are not required at this stage, it is important that sectors who are interested in participating in the C3IA approach discussions with a collaborative mindset.



### **Norway Pilot Project**

When it comes to the rising cost and challenges from flooding, Norway has been facing similar circumstances to those in Canada. From 2008 to 2017, Norway's annual insurance claims for urban and river flooding rose 114% to annual costs of over 2 billion Norwegian Krone (300 million \$CDN). Furthermore, pluvial flooding has dominated those increasing costs. Statistics collected by Finance Norway from their insurance members show that insurance payouts from weather-related water damages in Norway are higher than combined payouts for damages caused by river flooding, storms and landslides (personal communication, Mia Ebeltoft, Deputy Director, Finance Norway).

A pilot project was undertaken by Finance Norway—the first of its kind in the world—with the city of Trondheim (population 198,000) to determine whether access to better asset-level insurance loss data could strengthen the city's ability to determine and respond to climate-related risks. The pilot project pointed to the need for improvements in data quality and sharing and underscored the importance and value of collaboration. It also raised awareness of climate change and led to additional research projects, including funding from the Norwegian Environment Agency. The pilot led to a national collaboration between the Norwegian Directorate of Civil Protection, the National Flood Agency, the State Road Directorate and Finance Norway with the intent to establish a national Knowledge Bank that will extend access to data across all cities in Norway.

One of the key findings of the project was the value of collaboration. Open dialogue between the insurance industry, municipalities and various authorities, building trust and understanding of various challenges and opportunities was a key success factor. The need for sharing of better quality data and addressing the challenges of data sharing and open data, while appropriately protecting data privacy and safeguarding competition in the insurance sector, have been key elements of the work (Climate-ADAPT, 2020).

In terms of approaching discussions collaboratively, CWN has found that an important factor in ensuring that cross-sector discussions are productive is identifying a shared goal or outcome to guide discussions. For example, based on the composition of the study's Advisory Group, CWN found it useful to identify the shared goal/outcome of better serving the common customer among the sectors involved: the Canadian homeowner or property owner. The approach of identifying shared goals and outcomes is an important one to consider moving forward as the C3IA proceeds through the development and implementation stages.



## 7. Insights and Recommendations

Canadian municipalities are on the front lines of making key decisions that impact Canadians every day, including how to best manage risks and adapt to the impacts of extreme weather such as flooding. In carrying out this important task, Canadian municipalities — and their municipal utilities in particular — have a strong interest in accessing better and more reliable data, information and knowledge to inform decisions on flood risk assessment and mitigation.

There is a clear opportunity for creation of a nationally relevant approach, like the proposed C3IA, to advance and elevate the success of municipalities across Canada in their task of protecting Canadians, our communities, environment and economy, as well as sharing knowledge to help others contribute to these goals. For the C3IA to fill this important need and opportunity, it will be critical to ensure that it is framed and structured in a way that is clearly of pragmatic value to municipalities. In keeping with CWN's approach to ensuring that structure and practice are well-matched to the needs and realities of municipalities' decision-making environment, the most important ingredient to successful structuring and implementation is an accurate up-front framing for the C3IA. That framing should be built around well-informed objectives that effectively guide and shape subsequent design and action.

### *Applying a 3-phase framing to the C3IA*

To effectively frame the C3IA to ensure that it is useful for, and used by, municipalities, the following three functions are suggested to ensure the C3IA will have pragmatic value to Canadian municipalities and support decision-making on flooding and, more broadly, climate adaptation:

- Curation of relevant data and information:  
*Getting a better handle on our collective knowledge base and opportunities that could be facilitated by data and information curation*
- Curation of different data/information products that are being produced by different sectors:  
*Determining how a more holistic picture of risk can be created to better inform decisions*
- Provision of advanced expertise on data analytics that could advance flood risk assessment and hazard mapping:  
*Generating the knowledge that tangibly supports climate-informed decisions*

One of key insights from this study is that the *curation of data products* generated by other (i.e., non-municipal) sectors is clearly desired by, and would be of value to, municipalities. This would allow them to compare similarities and differences in the way that flood risk is assessed and hazards are identified by other sectors, resulting in a more complete 'picture' of risk.

There is also strong potential for the *provision of data analytics and expertise* that could be centrally accessible through the C3IA to be of value for municipalities (e.g., expertise/support on

the downscaling of precipitation information from global and regional climate change models to suit local analysis/modelling).

### *Elements for success*

The study highlighted the strong degree to which the C3IA's success is tied to moving beyond the theoretical goal of universal and beneficial data-sharing to embracing a need to establish both a willingness and ability of multiple sectors to share data, information and knowledge. This will require that those groups with an interest and ability to participate in the C3IA invoke a collaborative mindset for both discussions and participation. To sustain the momentum needed to achieve a collaborative approach and effective knowledge sharing, two things need to happen. First, it will be critical to ensure that the C3IA provides clear value for participating sectors. Secondly, to achieve both the engagement and trust needed to make this happen, the relevant sectors need to be both heard and effectively engaged in the up-front development of the C3IA.

CWN holds that an important factor in ensuring that cross-sector discussions are productive in leading to beneficial outcome is in first identifying a shared goal(s) or outcome(s) around which the subsequent discussions and initiative design can be clearly structured. For the C3IA to work, it is also critical that it is seen from the outset by the municipalities—and indeed those from all the relevant participating sectors whose investment of time and effort are required to develop and implement it—as something that will be both viable and sustainable.

### *Priorities for making data, information and knowledge useful and useable*

For the C3IA to be a relevant and trusted source of practically useable data, information and knowledge, municipalities prioritized the following curation objectives:

- Established protocols to ensure that the data, information and knowledge is up-to-date (i.e., actively integrated and updated where necessary)
- Established protocols to ensure that a minimum standard of data and information quality is maintained
- Established protocols to ensure data, information and knowledge is securely transferred and protected
- Established protocols to ensure that data ownership, stewardship, and custodianship is clearly listed and maintained
- Curation protocols that ensure the limitations of data, information and knowledge from disparate sources are clearly specified through the incorporation of metadata (e.g., precision of data, level of uncertainty associated with the data)



### *Translating C3IA framing to implementation through a robust data governance framework*

Taking the next steps in the design of the C3IA — moving from the curation objectives to implementation — could be achieved through the development of a robust data governance framework to guide and establish minimum requirements for the sending and receiving of data, information and knowledge between the spokes and the central hub. The data governance framework would help translate the overall framing and objectives to a practical implementation approach that informs and dictates the structure of how the C3IA would be delivered. By developing a data governance framework based on the curation objectives that municipalities highlighted as essential or very important, the C3IA will be much more strongly positioned to ensure it provides a relevant and trusted source that practically informs decision-making. Development of the framework would provide an important first step in supporting the provision of data analytics as a key outcome of the C3IA. Efficient, effective and sustained functioning of the C3IA's proposed hub and spoke model will also be strengthened by establishing a data governance framework with both intra- and inter-organizational policies, procedures and processes.

### *Leveraging a strong desire by municipalities to engage in effective data sharing*

Many municipalities across Canada have embraced open data in many parts of their management systems over the past decade. In parallel with their own in-house data generation and use, there is a growing interest in accessing and sharing data, information and knowledge with others outside the municipality, particularly to inform decisions on flood risk assessment and mitigation. Throughout this and other projects, CWN has observed that it is not necessarily a lack of willingness to share data, information and knowledge, nor the oft-repeated moniker of 'risk averse culture' assigned to municipalities that poses the major hurdle. Rather, in terms of the implementation of ideas like the C3IA, it is the need to understand what the data needs of on-the-ground decisions actually are, and exactly what data, information and knowledge will need to be shared/accessed as a result that is key. Providing clarity on this from the outset through the C3IA will greatly increase its ability to deliver value to Canada and Canadians. Maintaining an understanding of this distinction will necessitate and benefit from ongoing discussions among the key stakeholders involved in C3IA during its development and implementation.

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## Appendix A:

### Summary of key themes to inform cross-sector discussions on the C3IA

#### CWN-IBC Study — Advancing Flood Mapping through Successful Engagement of Municipalities and Effective Data Curation

The following section summarizes key insights and common threads that Canadian Water Network (CWN) gathered from ongoing one-on-one conversations with individual Advisory Group members from February 27 to March 20, 2020. These calls enabled CWN to take a “deeper-dive” on the bounding issues with members following the initial team kick-off call. A significant slow-down in these discussions occurred in mid-March as a result of the COVID-19 crisis. CWN re-engaged members to continue these discussions in mid-April to better inform the shaping and resulting recommendations from this study.

Key bottom line from initial discussions to inform framing:

The key elements shaping more effective cross-sector discussion and discovery involve addressing the needs of a common customer and common task of better risk identification, while recognizing that risk is identified and risk assessment is conducted differently.

Overall, through these discussions, CWN has clarified that:

- The different sectors (i.e. insurance, government, municipal utilities) have an ultimate customer in common – property owners
- All sectors are interested in better assessing flood risk in a way that informs their particular decisions, making an approach that achieves a common baseline risk characterization useful
- The nature of how each sector assesses or defines risk and how they apply/fund/account for measures to mitigate, reduce, or spread risk differs, and that element/difference must be fundamentally recognized in discussions about the use of data and knowledge to inform risk management. It may, to a certain extent, also vary within the sectors.

Starting in mid-April, discussions were structured around these basic tenets in order for the full Advisory Group to approach the task in a way that more effectively recognizes and shares both differences and common interests.

The study’s objective is to generate recommendations on which objectives the C3IA must achieve to ensure that is useful for and used by the municipal sector.



Discussions with the Advisory Group members have reinforced the importance of defining exactly which part of generating recommendations for structuring the C3IA this study will be addressing. Many elements are required to essentially ‘build’ the C3IA and this study must focus on a well-articulated, foundational element in order to deliver tangible and concrete results. Following its initial more divergent discussions with Advisory Group members, CWN pivoted to ensure there is a better cross-sector understanding of the issues, but the ultimate focus of the study is on generating recommendations for objectives that the C3IA needs to have in place for it to be useful for and used by the municipal sector (per IBC’s scope for this study).

Note: Results will be combined with observations from a parallel requirements project focusing on the financial sector.

### [The importance of defining a shared goal/shared space to guide discussions](#)

Advisory Group members highlighted the importance of better understanding each participant’s objectives and goals for participating in the study. This would allow CWN to facilitate group discussions in a way that is informed by the objectives and goals of each participant. More importantly, discussions with Advisory Group members highlighted the need to identify a shared goal to guide productive discussions and course-correct if discussions went off-topic.

Based on discussions with Advisory Group members, CWN determined that the shared goal of all participants is to better serve their common customer: the Canadian homeowner/property owner.

### [Better understanding the decision-making needs of the various sectors to guide the discussion on data and knowledge requirements](#)

The task of identifying data and knowledge requirements can be nebulous when not bounded by specific criteria. Through its discussions with Advisory Group members, CWN confirmed that understanding each participant’s data and knowledge requirements relies first on establishing a firm understanding of the decisions that each participant needs to make in the process of risk management within their role. As a result, CWN structured ongoing discussions with Advisory Group members in a way that addresses:

1. The decisions that need to be made by each participant in their role/sector, including how key risks are defined and how they are managed
2. The key elements of knowledge relative to municipal conditions and urban flooding potential, and the impact needed to make these decisions
3. The degree to which each sector (or subcomponents of them) has access or needs access to information to enable their risk-based decisions



These three categories will also guide the structuring of the municipal survey/consultation tool that CWN is developing. Ultimately, understanding the data and knowledge that various sectors need to make decisions will lead to a better understanding of how the provision and curation of the data and knowledge would benefit decision-making for multiple sectors and will be foundational in defining the initial requirements for the C3IA.

CWN acknowledges that not all sectors will use the data and knowledge in the same way. Therefore, the overall goal is to develop a baseline understanding of the data and knowledge needed to improve decision-making, and which data, when shared, could improve decision-making for multiple sectors. The study output will include key design goals and elements that the C3IA must therefore achieve to be of pragmatic value to municipalities and insurers in addressing pluvial flood risk.

**Given that data and knowledge needs will vary across and within sectors, the study will focus on the data and knowledge needed to inform proactive, resilience-driven decision-making**

Discussions with Advisory Group members highlighted that even within a given sector, the decision-making needs driving data and knowledge requirements may vary and the realities of evolving conditions is that future behaviour is uncertain or difficult to predict or model. As a result, CWN will focus group discussions on the data and knowledge required to inform long-term and proactive decisions on community resiliency that embrace effective, agile and adaptable responses to the fundamental difficulties in designing to well-predicted outcomes.



## Appendix B:

### Questionnaire — Assessing municipal knowledge needs and curating data to advance decisions on flood management

#### Background

Canadian Water Network (CWN) is partnering with the Insurance Bureau of Canada (IBC) to generate recommendations on the successful structuring of a Canadian Centre for Climate Information and Analytics (C3IA) as an authoritative source of climate information and decision analysis ([Expert Panel on Sustainable Finance, June 2019](#)). Specifically, the study focuses on generating a useful set of objectives and framing for a made-in-Canada solution for improved data and information sharing to improve our ability to achieve flood risk evaluation, identification and mitigation in Canadian communities.

Municipalities, provincial and federal levels of government and the insurance sector all conduct activities that involve identifying and mitigating risks posed by major storms and flooding to communities. As a result, they all hold key elements of the knowledge base needed to effectively identify and prioritize locations within the community in need of action. The current study will highlight opportunities to maximize the value of existing information sources by more effectively leveraging and curating the data that is being generated by each sector to better inform risk evaluation.

#### Questionnaire

We are engaging senior managers of municipal stormwater systems from across Canada through a questionnaire to gather input on:

- What *decisions* municipalities make related to flood risk assessment and mitigation
- What *data and information* municipalities need to make decisions on flood risk assessment and mitigation
- The data and information *curation needs* required to ensure that the C3IA is useful for (and will be used by) municipalities

Responses will inform the development of recommendations on the objectives that the C3IA must achieve to ensure that it is useful for and used by the municipal sector in Canada.



### Special instructions

- This questionnaire is aimed at senior managers who are responsible for overseeing stormwater management at their municipality/utility. If you do not oversee stormwater management, we kindly ask that you forward the questionnaire link to a colleague who is responsible for stormwater management within your municipality/utility.
- For the purposes of this questionnaire:
  - **Stormwater management** – the activity of managing drainage and impacts of precipitation on communities that encompasses municipal flood protection of homes, buildings and other infrastructure
  - **Data** – discrete and objective facts or observations (e.g., daily rainfall volume)
  - **Information** – processed, organized data presented within a context that enables it to provide meaning (e.g., chronological presentation of daily rainfall volumes for the year 2019)
  - **Data and information curation** – activities involved in processing, organizing or structuring data and information in a way that facilitates access, interpretation and/or more readily informs specific analyses
  - **Knowledge** – the result of extracting insights from data and information in a way that enables the user to inform analyses and decisions; may include contextual interpretation of data and information (e.g., generation of a flood hazard map that aggregates and interprets various pieces of data)
- To inform our analysis, respondents will be asked to provide general demographic information on their stormwater systems and their overall role as a stormwater manager. All responses will be confidential, and the responses will be anonymized and aggregated.
- The questionnaire is expected to take **25 minutes** to complete. Please ensure you have enough time to complete the questionnaire before you begin, as you will not be able to save your responses and come back later.
- The questionnaire is best completed from a laptop or desktop computer, and will be available until **Thursday, July 16**.

Thank you for your contribution to this important project.

## Section I: Demographic Information

1. What is the nature of your organization? Please select one.
  - Municipality
  - Drinking water/wastewater/stormwater utility
  - Other (please specify)
2. Does your municipality/utility have responsibility for stormwater management?
  - Yes
  - No
  - Other (please specify)

**If no:** *You answered no. Please explain your interest in this questionnaire's topic area.*
3. In what province or territory is your municipality/utility physically located?
  - British Columbia
  - Alberta
  - Saskatchewan
  - Manitoba
  - Ontario
  - Quebec
  - New Brunswick
  - Nova Scotia
  - Prince Edward Island
  - Newfoundland and Labrador
  - Nunavut
  - Northwest Territories
  - Yukon
4. What size of population is serviced by your municipality/utility?
  - Under 5,000
  - Between 5,000 and 10,000
  - Between 10,000 and 50,000
  - Between 50,000 and 100,000
  - Between 100,000 and 250,000
  - Between 250,000 to 750,000
  - Over 750,000

5. What type of population is serviced by your municipality/utility?
  - Entirely urban
  - Predominantly urban
  - Both urban and rural
  - Predominantly rural
  - Entirely rural
  - Other (please specify)
  
6. Which of the following best describes your role within the municipality/utility?
  - Senior management
  - Middle or front-line management
  - Non-management
  - Other (please specify)
  
7. What is the primary focus of your role within the municipality/utility? Please select one.
  - High level oversight and management
  - Operations/maintenance
  - Planning and design
  - Finance
  - Policy
  - Research and innovation
  - Other (please specify)

## Section II: Decisions on Flood Risk Assessment and Mitigation

### Establishing Flood Mitigation Goals, Needs and Priorities

**Q1:** Indicate to what extent each of the following categories reflect the kinds of decisions your municipality/utility makes with respect to flood risk assessment and mitigation.

Answer options for each: *Strongly reflects the kinds of decisions we make - Somewhat reflects the kinds of decisions we make – Does not reflect the kinds of decisions we make* (optional comment box at the end for all)

- ***Decisions on the requirements for design and implementation of municipal assets and infrastructure:***
  - Determining an acceptable level of flood risk to public health and safety in the design of municipal infrastructure
  - Determining an acceptable level of flood risk to the environment in the design of municipal infrastructure (e.g., receiving water impacts)

- Determining an acceptable level of flood risk to the local economy in the design of municipal infrastructure
- Determining storm patterns and intensities that need to be assessed and incorporated in local modelling
- Deciding how best to prioritize where infrastructure upgrades are implemented to reduce/mitigate flood risk
- Deciding on appropriate expenditures for capital and operational flood risk reduction interventions, including cost-benefit analyses
- Enter another option
- Enter another option
- Enter another option
- ***Decisions on where direct engagement or collaboration with groups outside the municipal utility are needed to achieve stormwater management goals:***
  - Determining where relevant data or information exists outside the utility (other municipal departments or other sectors) that could better inform decisions
  - Deciding how to effectively communicate and collaborate with other sectors (e.g., the insurance sector), so that shared costs of and benefits from potential or completed municipal flood reduction and mitigation measures are recognized/acknowledged
  - Deciding on most effective ways to share municipally held flood risk information, including which information to share, with utility customers and the broader public
  - Enter another option
  - Enter another option
  - Enter another option
- ***Other decisions on flood risk assessment and mitigation:***
  - If needed, add a key decision not found on the above list that strongly reflects the kinds of decisions your municipality/utility makes with respect to flood risk assessment and mitigation.
- ***Additional comments (optional):***
  - [Comment box, 200 words]

### Specific Decisions on Managing Fluvial and Pluvial Flooding

The next questions focus on decisions that are relevant to your specific flood management programs and mandates, which may naturally include some of the broad decision areas captured in the previous question. You may refer to any of the previously listed decisions or list additional ones as appropriate for your municipality/utility.

*(Note: You can click the 'back' button below to review the full list of decision categories without losing your responses.)*

**Q2:** Is your municipality/utility responsible for managing fluvial flooding (riverine), pluvial flooding (from intense rainfall events), or both?

- Fluvial flooding only
- Pluvial flooding only
- Both
- Other

**[pipe] If 'other':** Please specify.

[Comment box, 200 words]

**[pipe] If 'both':** Does your municipality/utility employ different decision-making approaches for fluvial versus pluvial flooding?

- Yes
- No
- Other (please specify)

**[pipe] If 'fluvial flooding only' or 'both':** What are the key decisions your municipality/utility makes with respect to assessing and managing **fluvial** flood risks?

[Comment box, 500 words]

**[pipe] If 'pluvial flooding only' or 'both':** What are the key decisions your municipality/utility makes with respect to assessing and managing **pluvial** flood risks?

[Comment box, 500 words]

### Desire/Perceived Need for More Explicit Connection to Insurance Sector Information

**Q3:** To what extent would it support your municipality/utility's decision-making to understand and connect to how municipal flood mitigation efforts are or could be incorporated into flood risk models used by insurers?

- Essential
- Very useful
- Somewhat useful
- Minimally useful
- Not useful

[Conditional: Only display if 'essential', 'very useful', or 'somewhat useful' is selected]:

Please specify how this understanding would support decision-making at your municipality/utility.

[Comment box, 300 words]

**Additional comments (optional):**

- [Comment box, 200 words]

**Q4:** In general, would it be helpful to your decision-making if data products (e.g., flood hazard maps) produced by other sectors, potentially to meet different objectives, are accessible through the Canadian Centre for Climate Information and Analytics (C3IA)?

- Yes
- No

**Additional comments (optional):**

- [Comment box, 200 words]

### Section III: Data and Knowledge Needs

The following section will ask you about the data and knowledge that is required for your municipality/utility to make the decisions on flood risk assessment and mitigation identified in Section II.

**Q1A:** Which of the following categories of data and information does your municipality/utility currently use to identify, evaluate and mitigate flood risk? Select all that apply.

- Information on municipal assets, including asset condition and O&M requirements
- Information on the location of critical infrastructure (e.g., hospitals, rail lines, water/wastewater treatment plants)
- Information on the location of low-lying areas/basins
- Health and safety impacts of flooding
- Socio-economic equity impacts of flooding (e.g., identification of impacts to more vulnerable populations)
- Socio-economic service impacts of flooding
- Environmental impacts of flooding
- Size of area directly affected by flooding impacts
- Cost of flooding impacts to homeowners and/or the municipality
- Frequency of flooding
- Land use, including property type and location
- Impervious surface area (those areas that are paved or covered such that water cannot infiltrate through the soil)
- Population density
- Historical flood locations
- Historical flood frequency
- Scenario modelling of the predicted severity of impact of various flooding scenarios
- Other (please specify)
- Other (please specify)
- Other (please specify)

**Q2 [pipe selected categories]:** To what extent are these categories of data and information required to help inform your decision-making?

Answer options for each piped category: *Essential – Very useful – Somewhat useful – Minimally useful*

**Q3:** What data and information would further inform decision-making at your municipality/utility that you do not currently have access to?

*In your response, consider the kinds of data and information listed previously, as well as broader and more nuanced information such as:*

- *Better knowledge of storm cell patterns and how to represent them in flood risk models*
- *Knowledge of city council and public appetite for levels of capital/operating expenditures*
- *Knowledge of liability incurred from sharing flood risk data with customers*
- *Knowledge of how municipal flood reduction/mitigation actions could be incorporated into flood risk models used by the insurance sector*
- *Maps of areas at high risk of flooding developed by other sectors (e.g., insurance sector, provincial or federal governments, academia)*

[Comment box, 500 words]

#### Section IV: Data and Information Curation and Knowledge Sharing Needs

The final section of the questionnaire focuses on key elements of the data and information curation process that could be embedded in the C3IA structure's mandate to ensure that the C3IA will be useful for and used by Canadian municipalities. Ultimately, it is critical for the success of the C3IA that the data and information are curated, not just shared.

**Q1:** To what extent are the following elements of how the C3IA could conduct data and information curation important to make the C3IA a relevant and trusted source of practically useable knowledge for your municipality/utility?

Answer options: *Essential – Very important – Moderately important – Slightly important – Not important*

- Established protocols to ensure that the data/information is up to date (i.e., actively integrated and updated where necessary)
- Established protocols to ensure data/information quality is maintained
- Established protocols to ensure data/information is protected
- Established protocols to ensure that data ownership is clearly listed and maintained
- Established protocols that favour curation that is clearly realistic and achievable in the context of the sectors contributing data and information to the C3IA
- Curation protocols that ensure the limitations of data/information from disparate sources are clearly specified (e.g., precision of the data, level of uncertainty associated with the data)
- Establishing a neutral third-party organization to responsibly manage the C3IA
- Other (please specify)
- Other (please specify)
- Other (please specify)
- Other (please specify)
- Other (please specify)





**Q2:** If you had to select up to three elements of C3IA's curation approach from the above, which would you say are absolutely necessary to ensuring the C3IA is effectively supporting or advancing your municipality/utility's ability to make flood management decisions?

[Comment box, 500 words]

#### Section V: Contact Information (Optional)

Volunteering your contact information is optional but useful to inform the questionnaire analysis. Your name and organization will be held in confidence and all responses will be anonymized and aggregated.

Name of your municipality/utility: \_\_\_\_\_

Municipality/utility's postal code: \_\_\_\_\_

Your name: \_\_\_\_\_

Your position/title: \_\_\_\_\_

**Thank you for completing this questionnaire.**



**FOR MORE INFORMATION,  
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