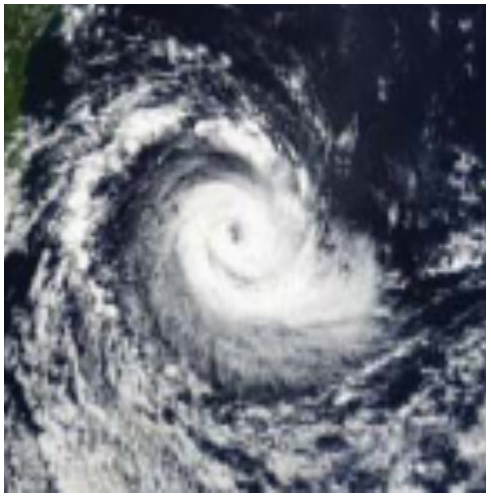
INTEGRATING CLIMATE CHANGE INTO ASSET MANAGEMENT :

A Path Forward



Jim Abraham
ClimAction Services Inc.

18 October 2018

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OUTLINE

* Climate change 101:
  * Global change
  * Resulting impacts
* Engineering and Municipal challenges
* Integrating Climate Change into Asset Management

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Global Change:
WHAT DO WE KNOW FOR SURE?

* Population has been growing exponentially
* We live in vulnerable areas and possess valuable stuff
* Infrastructure is aging
* People live longer; energy has enabled advances in technology for better food production, cleaner water, and better health care
* Energy use increases with the growth of population and the economy
* Fossil fuels release CO2 into the atmosphere; a greenhouse gas that remains for more than a century
* Greenhouse gases trap heat keeping it from being radiated back into space (otherwise we would be ~30C colder!)

Global Change: Significant Economic impacts

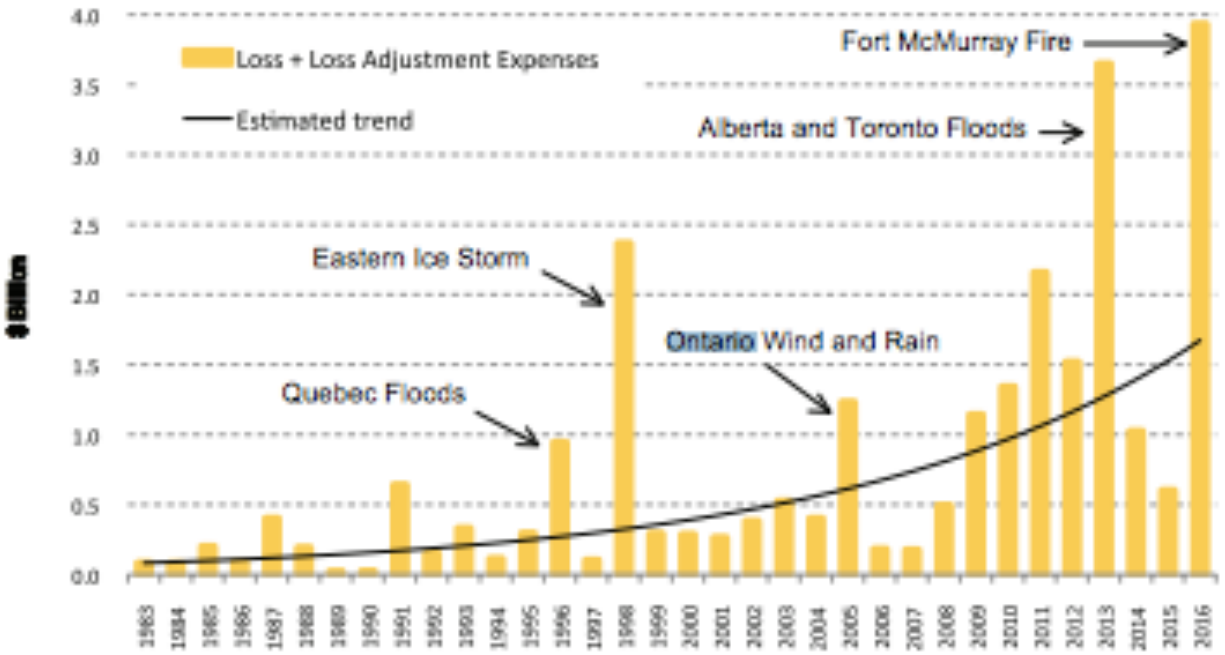

Figure 22: Catastrophic losses in Canada (in billion dollars) 1983-2016. Values in 2015$ CAN, except for 2016.

Source: Chart created by the ECO using information from the Insurance Bureau of Canada's *Facts of the Property and Casualty Insurance Industry in Canada 2016*, and preliminary data for the first seven months of 2016 as provided directly from the Insurance Bureau of Canada.

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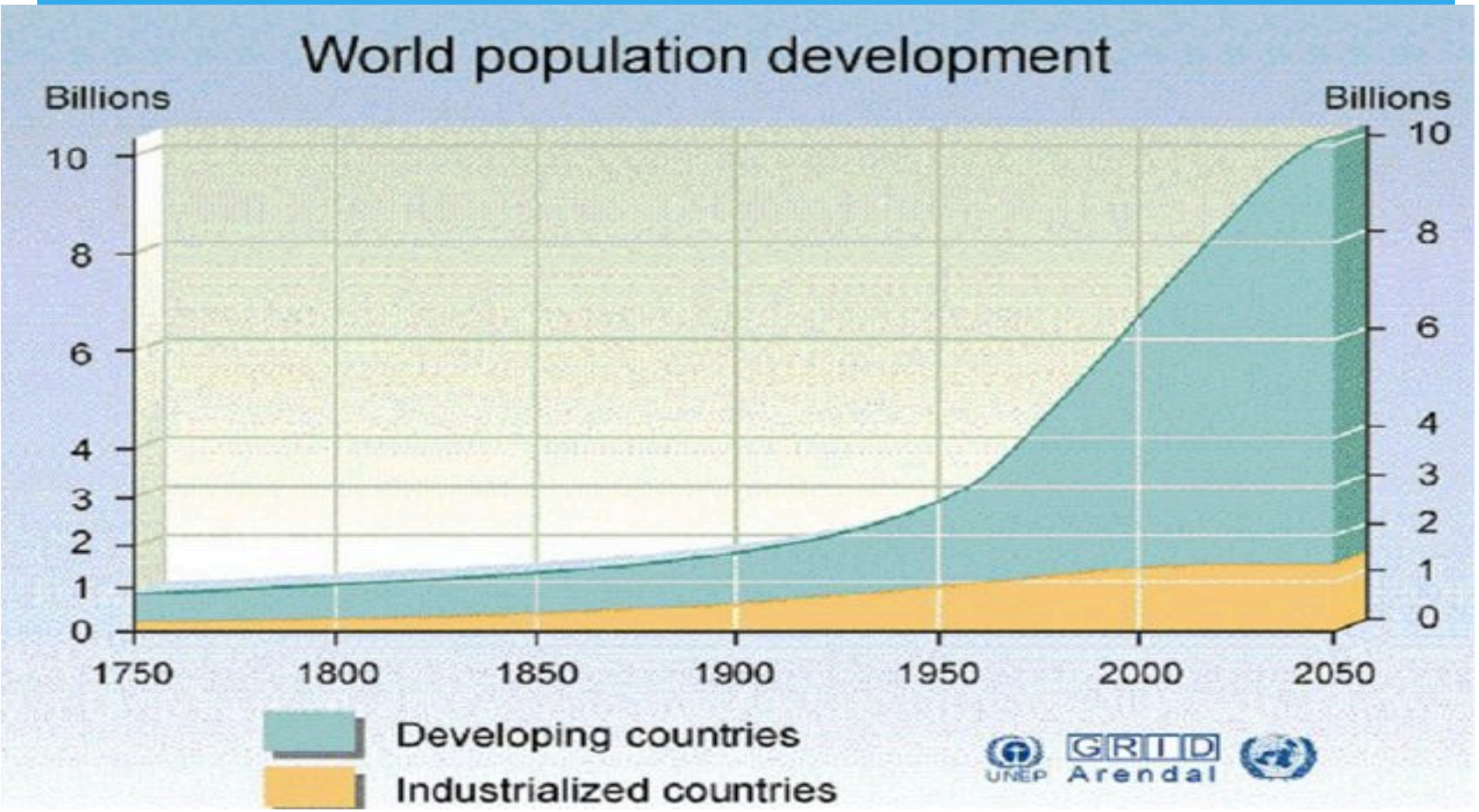
Global Change



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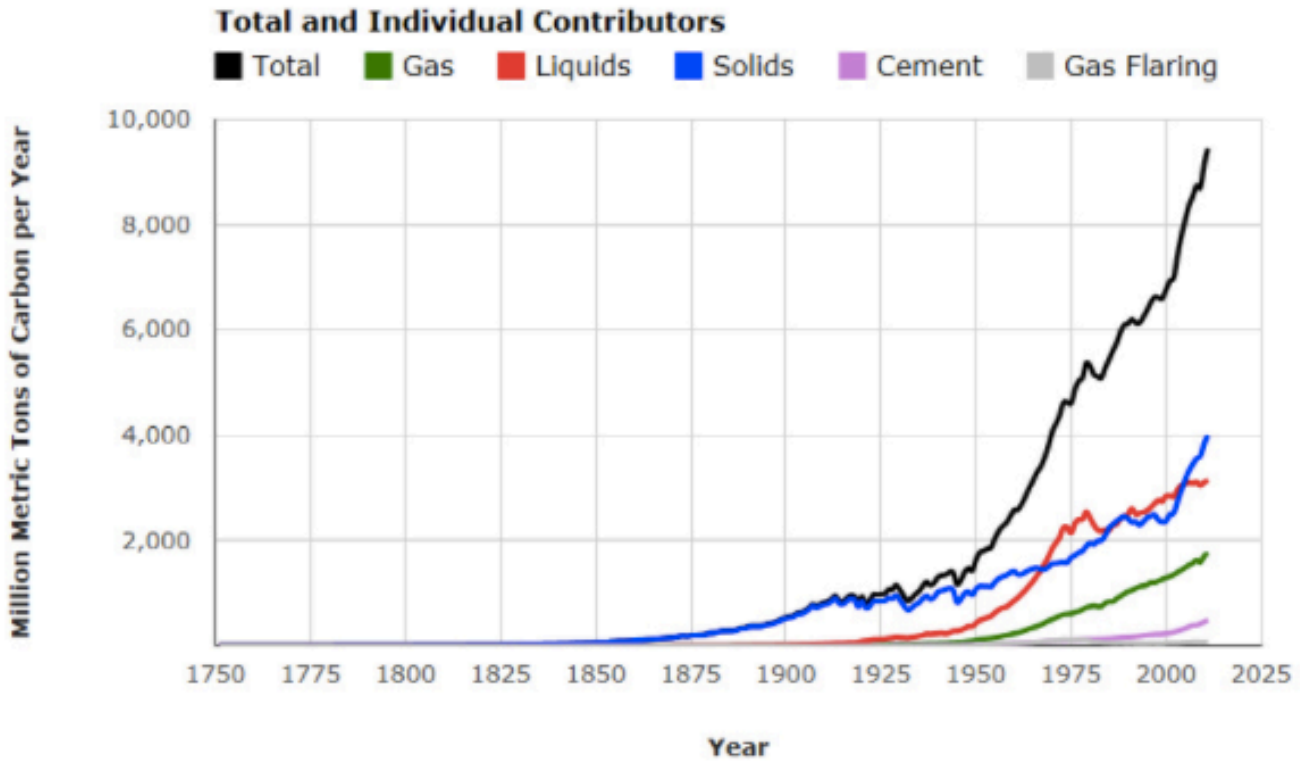
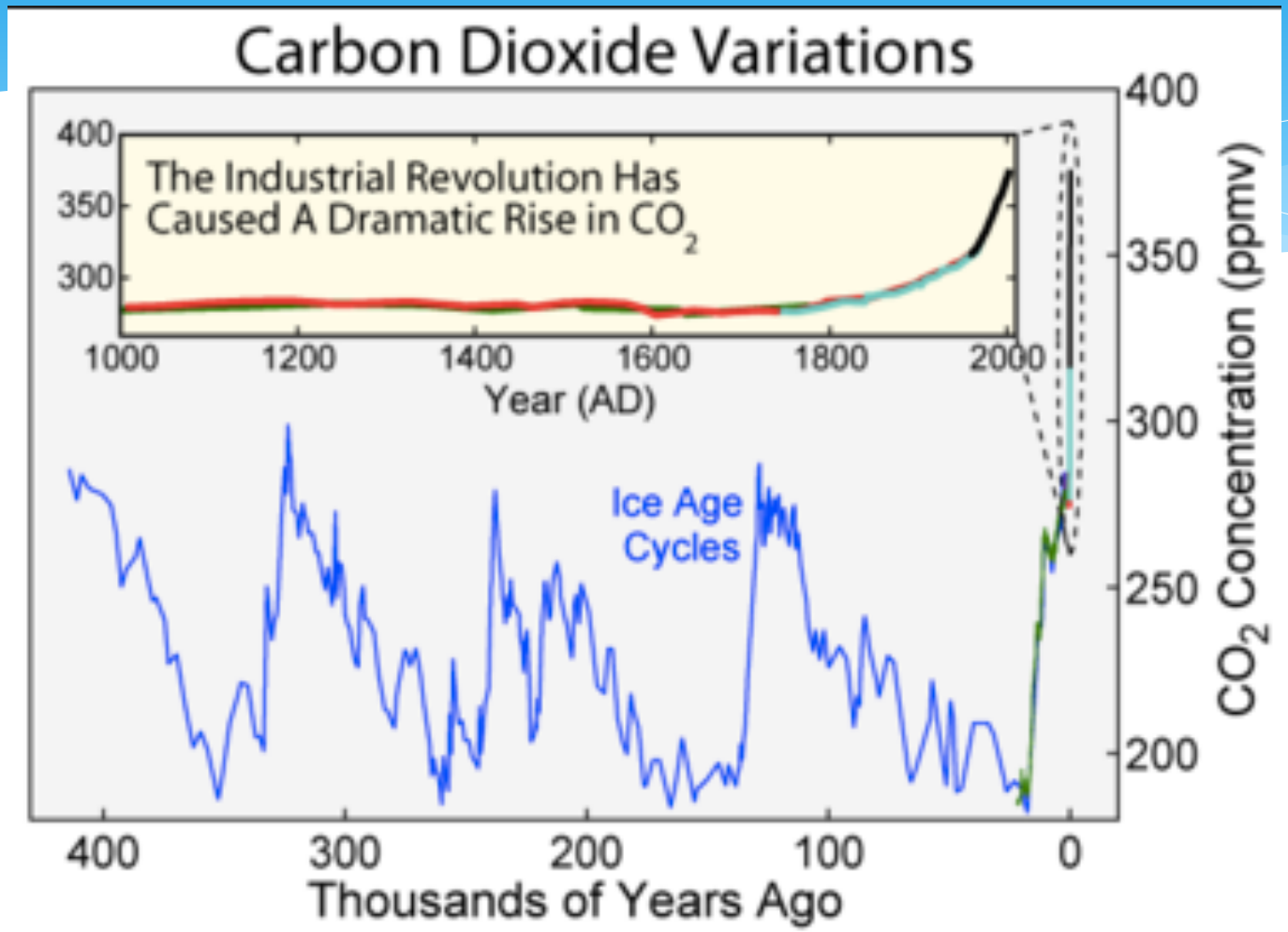
Global Change:
Growth in CO2 emissions



Source: Boden, T.A., G. Marland, and R. J. Andres. 2015. Global, Regional, and National Fossil-Fuel CO_2 Emissions. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tenn., U.S.A. doi: 10.3334/CDIAC/00001_V2015.

Global Change



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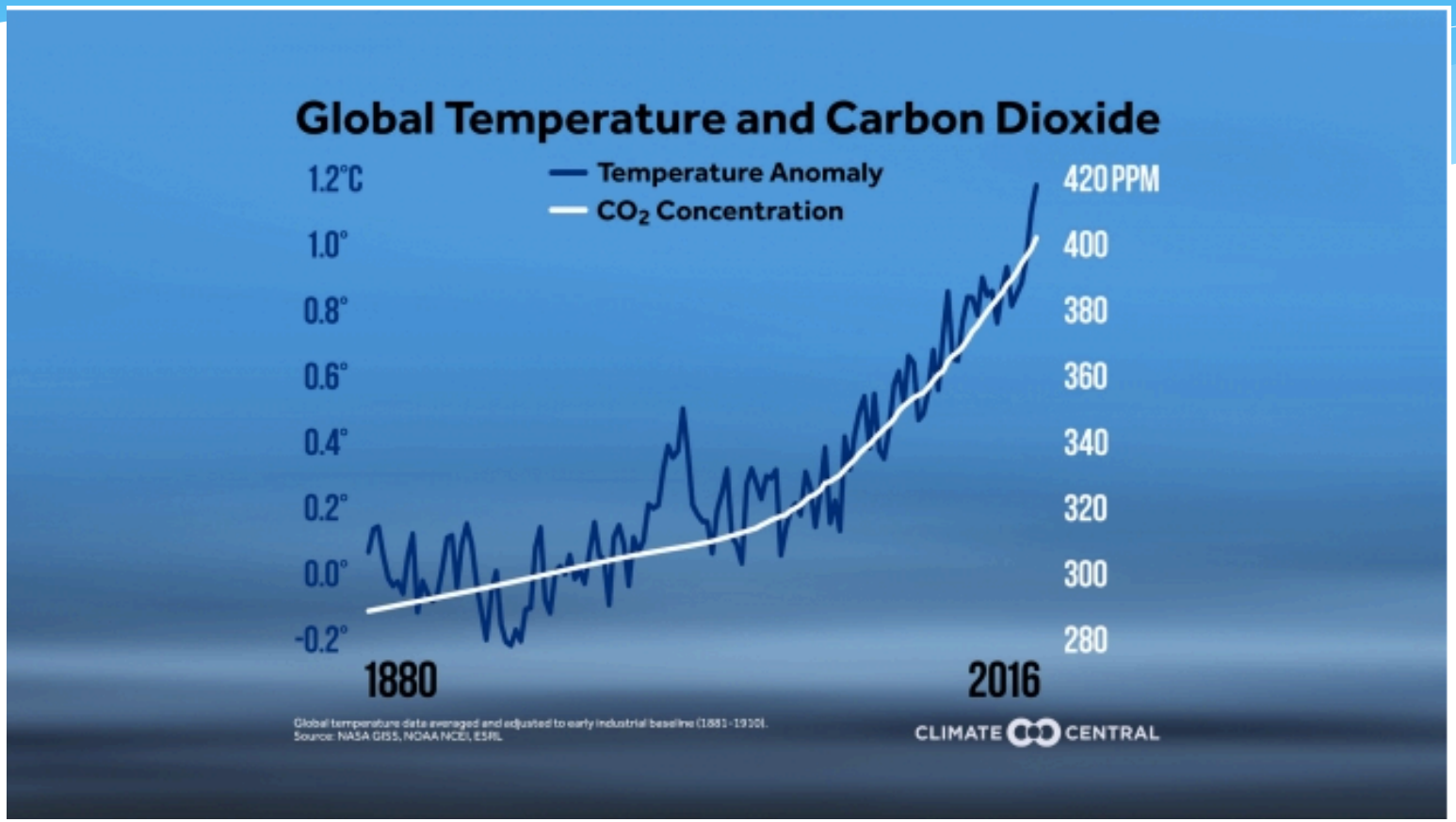
A Change in the balance

An Impact on the planet

Impact on temperature: 2-5C by 2100



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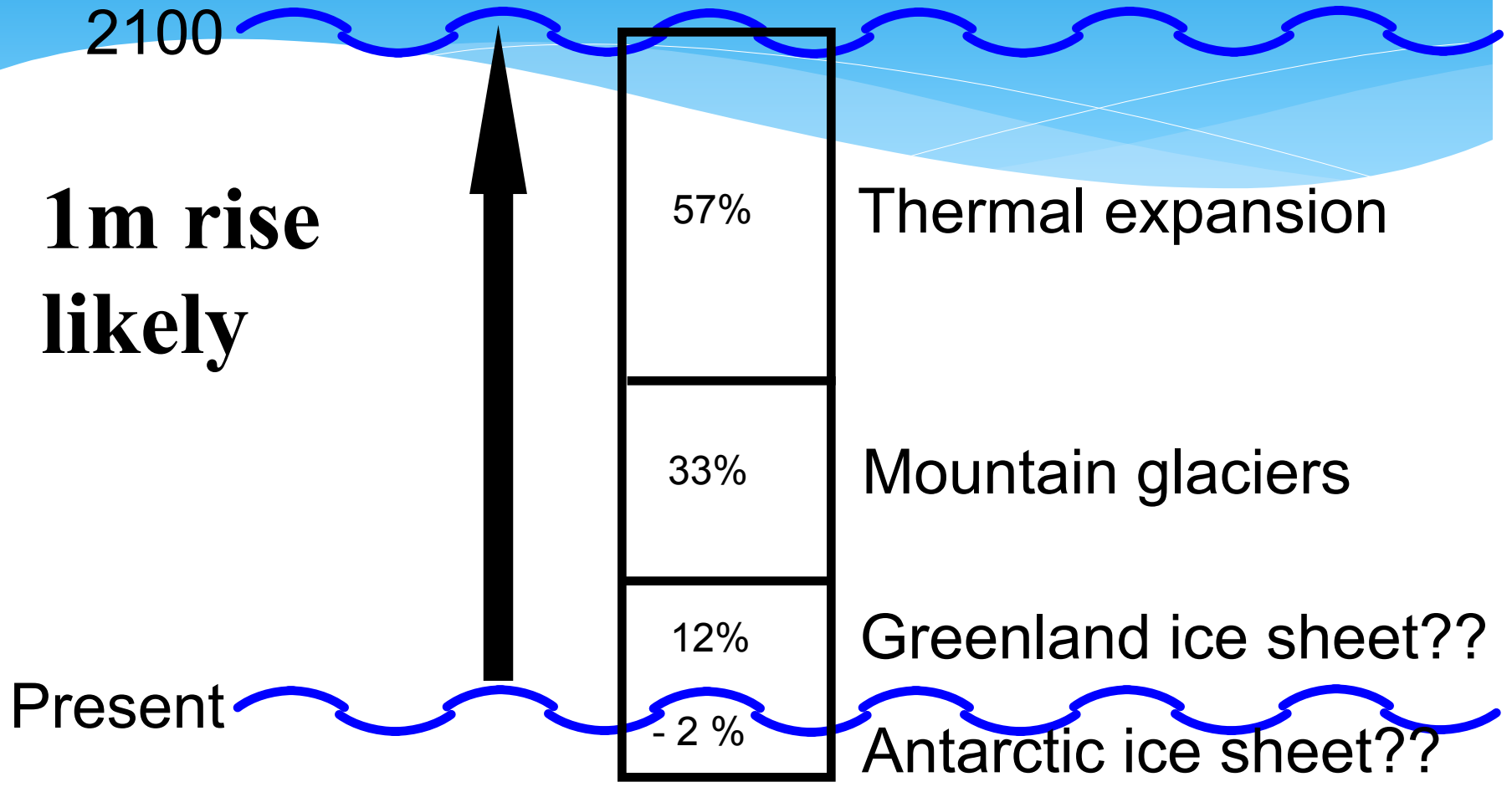
Impact on Sea Level: at least 1m by 2100



Further enhancement from ~20cm of land subsidence

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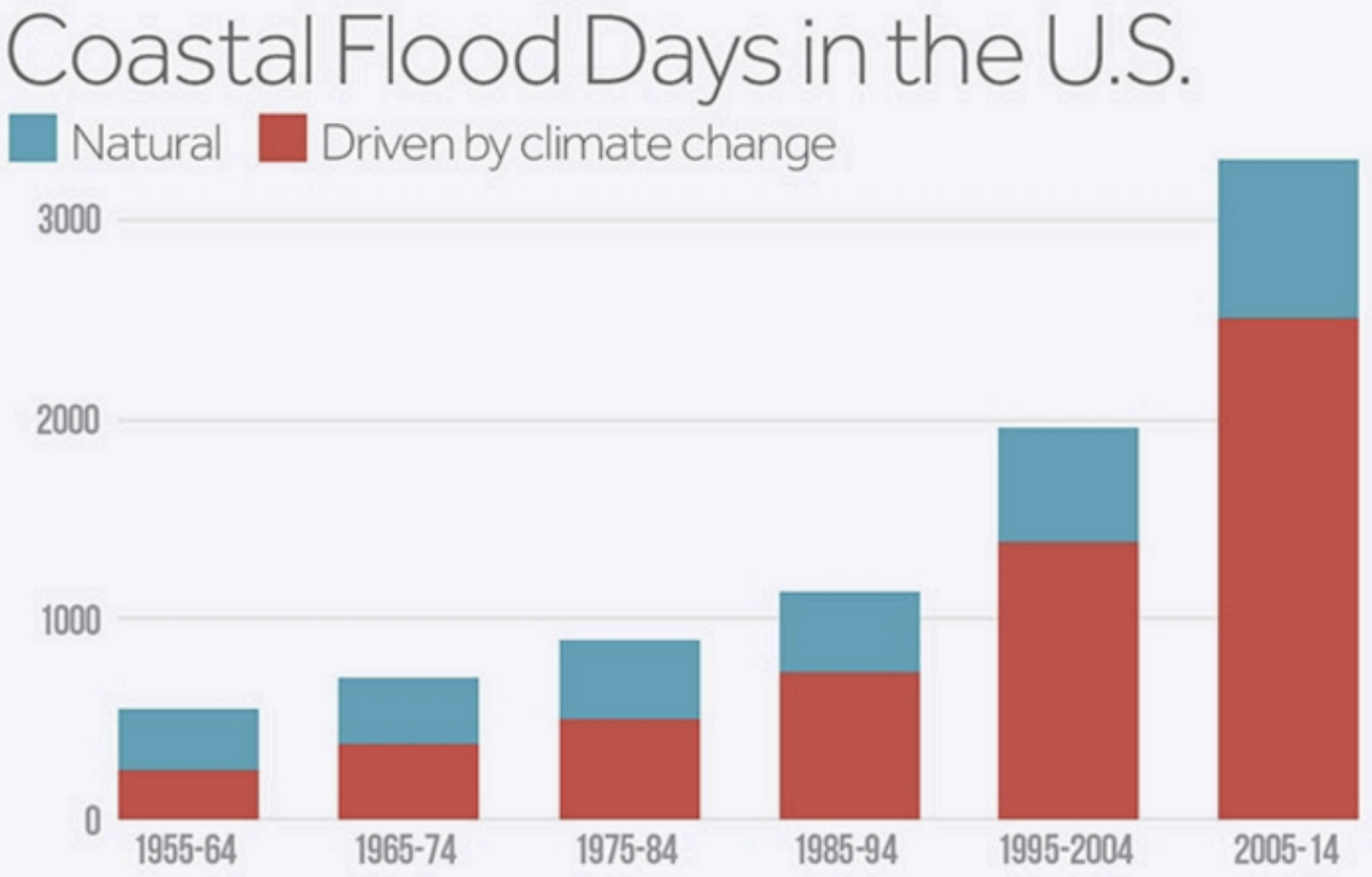
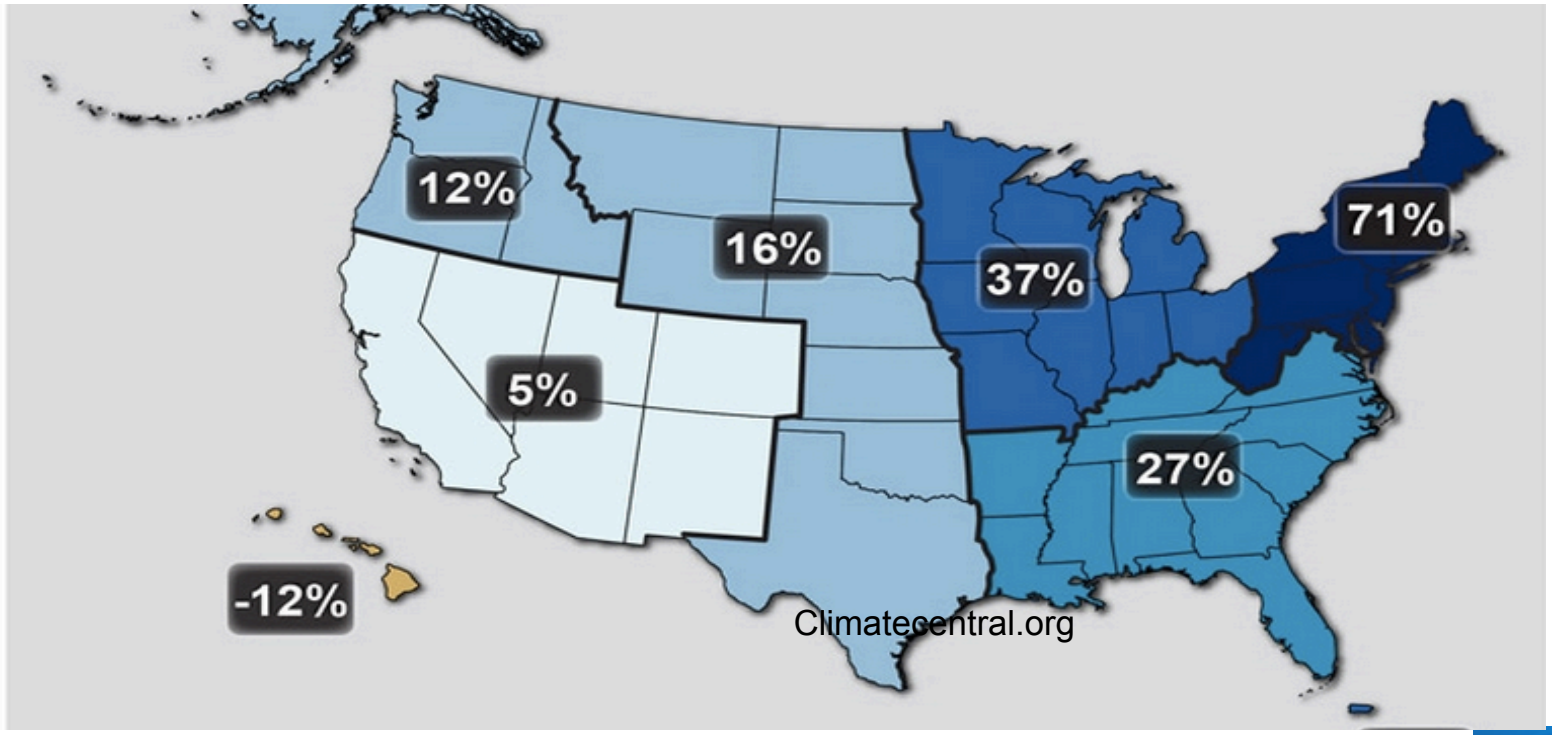
Impact already on Coastal Flood Threat



Impact already on heavy precipitation events



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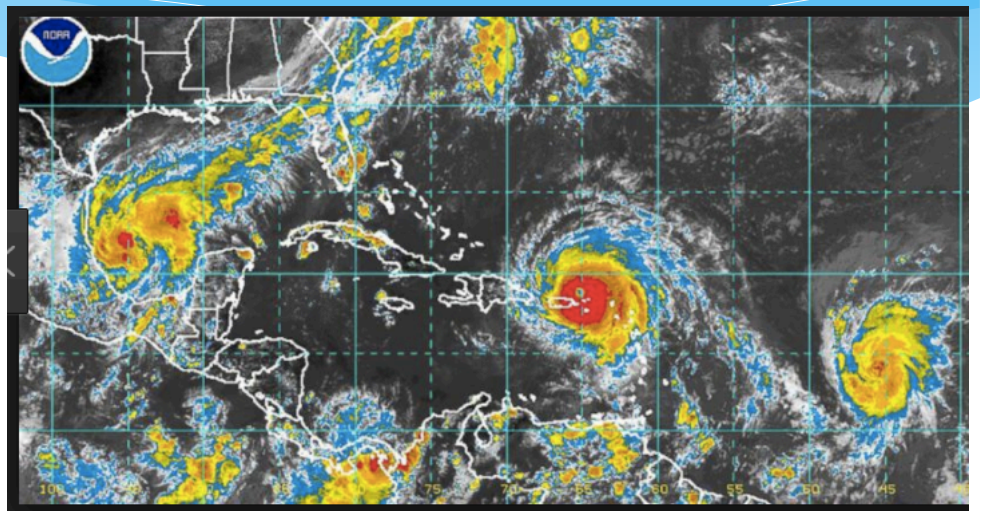
Impacts from Hurricanes

* Uncertain if there will be ***more*** hurricanes
* Consensus that the ***impacts*** will be ***worse***:
  * Warmer seas, more fuel, more intense storms
  * Higher sea levels: worse coastal flooding
  * More moisture: worse freshwater flooding
  * Systems move more slowly: higher impacts



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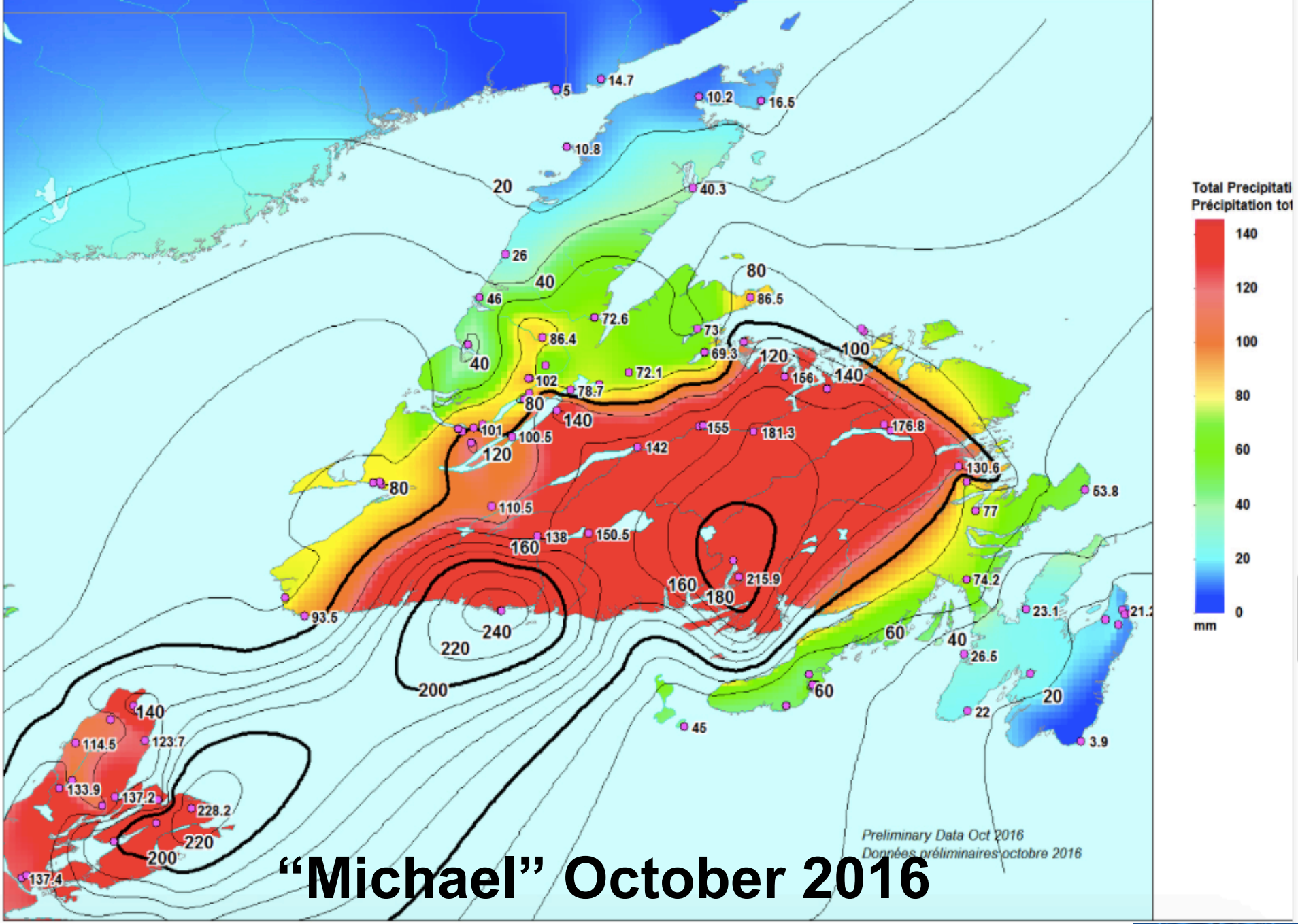
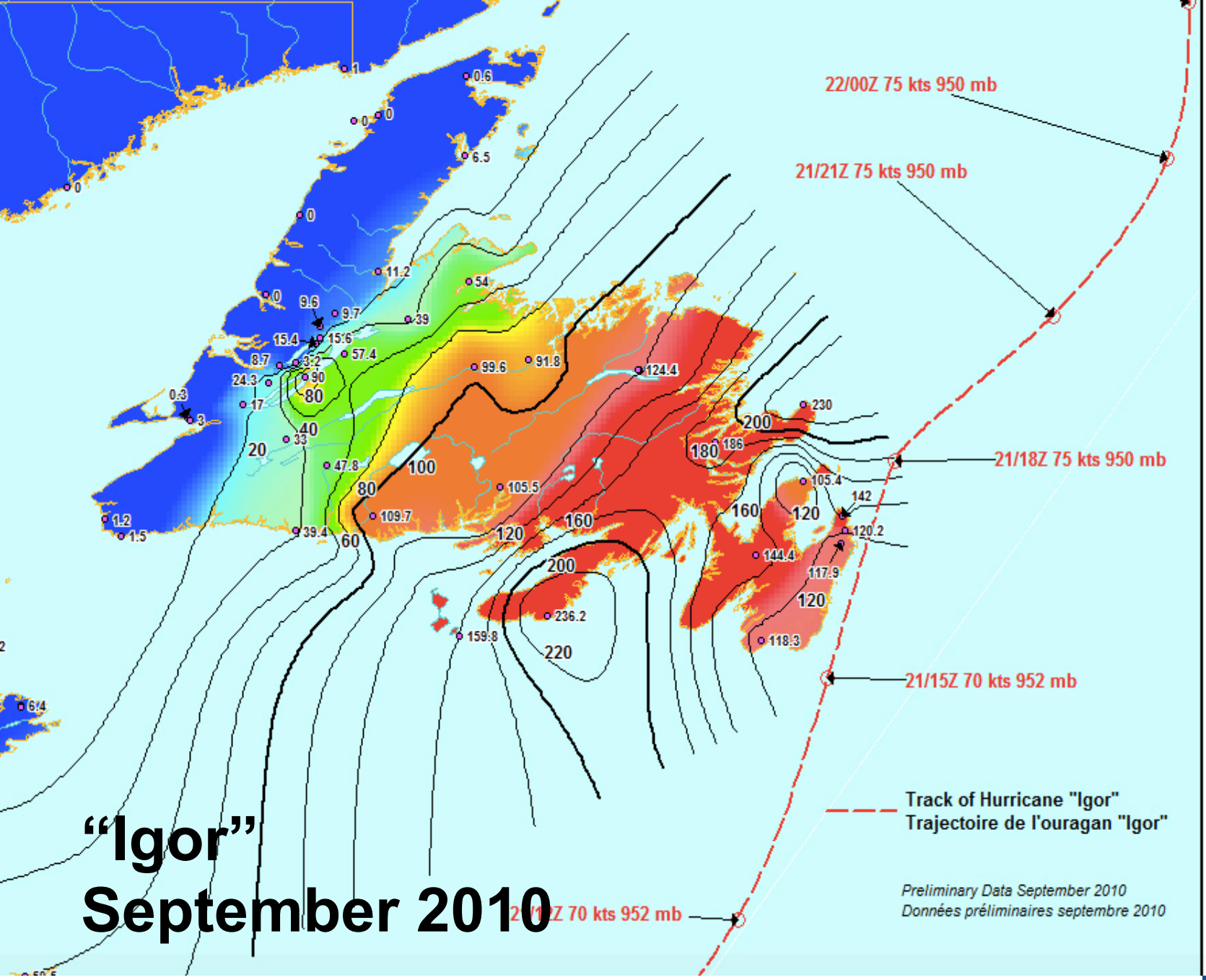


“Michael” October 2016



"Igor"
September 2010

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Impacts on Infrastructure

Land Transportation (roads, railways and bridges) **–**

* **Warmer winters**: deterioration more frequent freeze-thaw cycles
* **Warmer summers**: pavement softening, rutting and bleeding of liquid asphalt.
* **Increased frequency/higher storm surges**: damages and shortens the life span of coastal roads and bridges.

Building infrastructure (public and private)

* **Increased snowfall/rain on snow:** structural collapse,
* **More intense storms**: Severe wind damage
* **Increased precipitation**: flooding resulting in property damage.
* **Wildfire threat enhanced**

Impacts on Infrastructure

***Storm water management, Water Supply, Water & Wastewater Treatment Facilities**:*

* Floods (freshwater and coastal) damage and contaminate (saltwater or wastewater) systems.
* Coastal erosion (sea level rise and storm surge) threatens sewage treatment plants and undermines the integrity of outfalls
* Increasing number of high wind and freezing rain events affecting power reliability.
* Increasingly high temperatures and drought impacts water availability and enhances forest fire threat in watersheds..
* Treatment costs and the level of treatment are increased during droughts as the concentration contaminants are increased
* Water distribution system at risk from shift in freeze/thaw cycle.

Winter Rainfall Impacts

Residents reeling from 'unprecedented' flooding on Newfoundland's west coast

'I've never seen flooding like this,' says area MHA and Municipal Affairs Minister Eddie Joyce

By Meghan McCabe, CBC News Posted: Jan 13, 2018 8:24 PM NT | Last Updated: Jan 13, 2018 8:24 PM NT

There are vehicles underneath the water submerging the Jesso family's home and garage in Benoit's Cove on Saturday. (Submitted by Kyle Lowe)

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Winter Rainfall Impacts

Kent County still reeling from weekend storm, flooding

Roads washed away, basements flooded and power knocked out for days

CBC News Posted: Jan 15, 2018 10:50 PM AT | Last Updated: Jan 15, 2018 10:57 PM AT

A whole section of road is missing in McKees Mills after flooding over the weekend. (Kate Letterick/CBC)

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Storm Surge Impacts

Queensland Beach to be closed for storm damage repairs

Queensland Beach Provincial Park will be closed for over a week while crews repair damage caused by a winter storm

788 shares

Jun 20, 2018 3:13 PM by: HalifaxToday Staff

Conrads Road near Queensland Beach following a powerful winter storm on January 4, 2018 (Meghan Groff/HalifaxToday.ca)

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Summer Rainfall Impacts

Heavy rain damages Montague, P.E.I., streets

'I haven't seen rain like that in years and years'

By Shane Ross, CBC News Posted: Jul 24, 2016 4:54 PM AT | Last Updated: Jul 25, 2016 8:14 AM AT

Rain caused damage to this street in Montague on Sunday. (Submitted by Peter Metaxas)

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Winter Snowfall Impacts

Avon Valley Floral in Falmouth has lost close to 70 per cent of its plant production capacity

By Jennifer Henderson, CBC News Posted: Mar 03, 2015 5:15 PM AT | Last Updated: Mar 03, 2015 5:17 PM AT

Cathy Oulton, the head of Greenhouse Nova Scotia, said at least 10 growers in the province have experienced significant, uninsurable losses. (CBC)

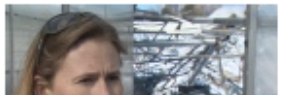
12 shares

Facebook

Heavy snow and ice have crushed nearly two hectares of greenhouses at Avon Valley Floral, a Nova Scotia supplier for florists and garden centres.

The Falmouth company has lost approximately 70 per cent of its plant

Latest Nova Scotia News Headlines



- 'Disastrous' Februrary storms shatter Nova Scotia greenhouses 3

ENGINEERING CHALLENGES

The International Institute of Sustainable Develop (2013) reported that infrastructure managers face challenges in ensuring that infrastructure is designed, built and managed to address climate change impacts. Meeting these challenges include the need to:

* Understand the complex relationship between climate and infrastructure in Canada in terms of their exposure and vulnerability to climate hazards.
* Integrate climate change priorities into engineering design of infrastructure projects (CSA Group 2012).
* Develop codes, standards and policies that inform engineering designs in the early planning of infrastructure projects.
* Increase the availability of information and resources on climate change risks to infrastructure and adaptation measures to counter those risks.
* Differentiate by region and type of infrastructure impacts and risks for key infrastructure initiatives throughout Canada.

The study concluded that:

* **Climate change has the potential to substantially affect the effectiveness and lifespan of infrastructure; e.g transportation, buildings, marine and water management infrastructure.**
* **Adaptive measures can be taken to limit costs and strengthen the resiliency of infrastructure.**

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MUNICIPAL CHALLENGES

* Cities growing and more densely populated; villages shrinking and losing their tax base
* Complex and aging infrastructure (”deficit” at $141B: 2016 Infrastructure Report Card)
* Climate change and extreme weather
* Valuable assets and tax-base in vulnerable areas
* Limited mitigation investments
* Flood maps outdated or not transparent (FDRP ended in late 90’s)
* Reduction in climate observing network
* Aging population with increased expectations: duty of care
* Limited municipal resources and/or expertise

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Municipal Challenges

Credit Rating Agency Issues Warning On Climate Change To Cities

December 1, 2017 · 5:10 PM ET
Heard on All Things Considered

NATHAN ROTT

Buildings are seen near the ocean in North Miami. Broward County and many communities in southeast Florida have been aggressive and proactive in preparing for the effects of climate change.

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Addressing Municipal Challenges: 100 resilient cities

About Us

100 Resilient Cities—Pioneered by the Rockefeller Foundation (100RC) is dedicated to helping cities around the world become more resilient to the physical, social and economic challenges that are a growing part of the 21st century.

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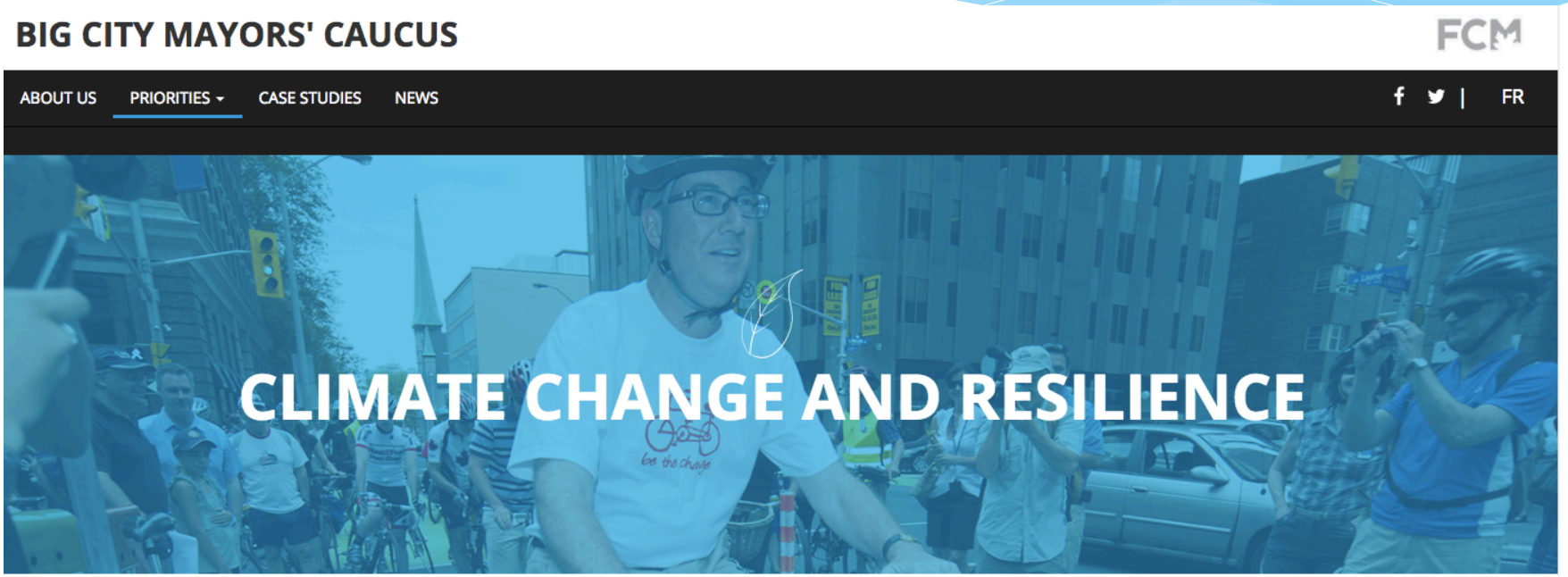
Addressing Municipal Challenges: Federation of Canadian Municipalities



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Climate Change & Asset Management
Key Drivers

Jurisdictions across Canada are featuring climate change as an important risk management challenge that must be addressed within the broader context of asset management. There are a number of factors that are driving this requirement

- Municipalities are now required to develop asset management plans as specified under the Gas Tax Agreements.

- The federal government announced (2018) that infrastructure projects seeking federal funding ($10 Million) must now consider climate change risks in the location, design, and planned operation of a project. The lens also must be applied to GHG mitigation and climate change resilience projects seeking support under:
  - the *Investing in Canada* plan,
  - the Disaster Mitigation and Adaptation Fund

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Climate Change & Asset Management
Key Drivers

- The Federation of Canadian Municipalities announced a $50 million Municipal Asset Management Program (MAMP) provides $50 million funding to help municipalities make informed investment decisions for infrastructure assets, such as roads, buildings, water supply and sanitation systems.
- The need to provide uninterrupted services in ways that support sustainable community objectives related to economic growth, health and well being of residents, and public safety.
- In response, jurisdictions are featuring climate change as an important risk management challenge that must be addressed within the broader context of asset management. Regulatory initiatives (e.g., Ontario), policy guidelines (e.g., New Brunswick) and government policies are used as the key tools and approaches used to guide the development of asset management frameworks.
- Nova Scotia is taking a number of significant steps to integrate climate change into the the development of asset management planning

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Integrating Climate Change into Asset Management: Nova Scotia

- ClimAction services and WSP- OPUS International are working with the Federation of Nova Scotia Municipalities to integrate climate change considerations into the development of asset management plans.

- A key objective is to help build municipal capacity and engage participants on options to incorporate climate change as an integral component of asset management planning.

- Two workshops are being planned; one in Halifax and one, potentially, in Middleton (November 2018).

Note: The project is funded by the FCM under the Municipal Asset Management Program.

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Integrating Climate Change into Asset Management

An Approach to Moving Forward

- Encourage the integration climate change into an asset management planning framework and all subsequent life-cycle phases
- Taking a step by step approach to applying a climate change lens across the project life cycle (e.g. project design, operations and maintenance and retrofitting and/or decommissioning of the asset).
- Developing of a flow chart to illustrate the application

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Integrating Climate Change into Asset Management

An Approach to Moving Forward

tools to incorporate climate change:

- A risk-based decision tool to model climate trends and projections (CCHIP).
- Forensic analysis of historical climate threats, how often they will occur in the future and their implications on the integrity infrastructure.
- Development of monitoring and adaptive management strategies.
- Flood risk and hazard vulnerability maps facilitate the design of resilient infrastructure and land-use plans (as well as emergency preparedness and response)..

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Integrating Climate Change into Asset Management

An Approach to Moving Forward

Assessing future climate threats to infrastructure

Risk-based approaches can be used to predict future threats to infrastructure and help answer key questions related to climate change such as:

- How is climate change going to impact the municipal asset infrastructure over the next 80 years?
- What assets are at particular risk and if so why?
- What are the key climate thresholds that will dictate the sustainability of municipal assets over time (e.g., temperature, extreme precipitation, sea-level rise) and how often will they be exceeded in the future?
- How should design and construction standards, and best practices, be modified to reduce future impacts by ensuring resilient infrastructure?

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Integrating Climate Change into Asset Management

An Approach to Moving Forward

Step 1: **Needs Identification**: An idea of a new service and required infrastructure is conceived or existing infrastructure has been identified as requiring an upgrade.

Climate Change Considerations: may be the motivator for a new asset (e.g., a washout requires a new segment of road, drought requires a new water source, or design of a flood mitigation infrastructure.) Remediation after the fact is costly and unnecessary is infrastructure is not designed to withstand extreme weather events and climate change impacts.

Step 2: **Infrastructure Planning & Design**: The asset is envisioned and designed to address identified needs.

Climate Change Considerations: Understanding potential climate change impacts over the lifecycle of the asset is essential. Having effective standards/codes designed to mitigate impacts associated with climate hazards enables resilient design.

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Integrating Climate Change & Asset Management
An Approach to Moving Forward

Step 3: **Construction:** The asset is built and opened for use.

Climate Change Considerations: Ensure design standards set during the planning process are implemented.

Step 4: **Operate & Maintain:** The asset is operated and maintained throughout its service life.

Climate Change Considerations: Impacts for built infrastructure are best assessed through monitoring and inspections to determine how a changing climate is affecting performance.

Step 5: **Refit or Dispose**: Major capital refit, or disposal of the asset. If major refit is selected, return to Step1.

Climate Change Considerations: Having a clear understanding of the potential climate change impacts is required when developing the business case to decide on whether to dispose or re-capitalize the asset. Given the risks related to climate change impacts, it may be more effective to dispose of asset.

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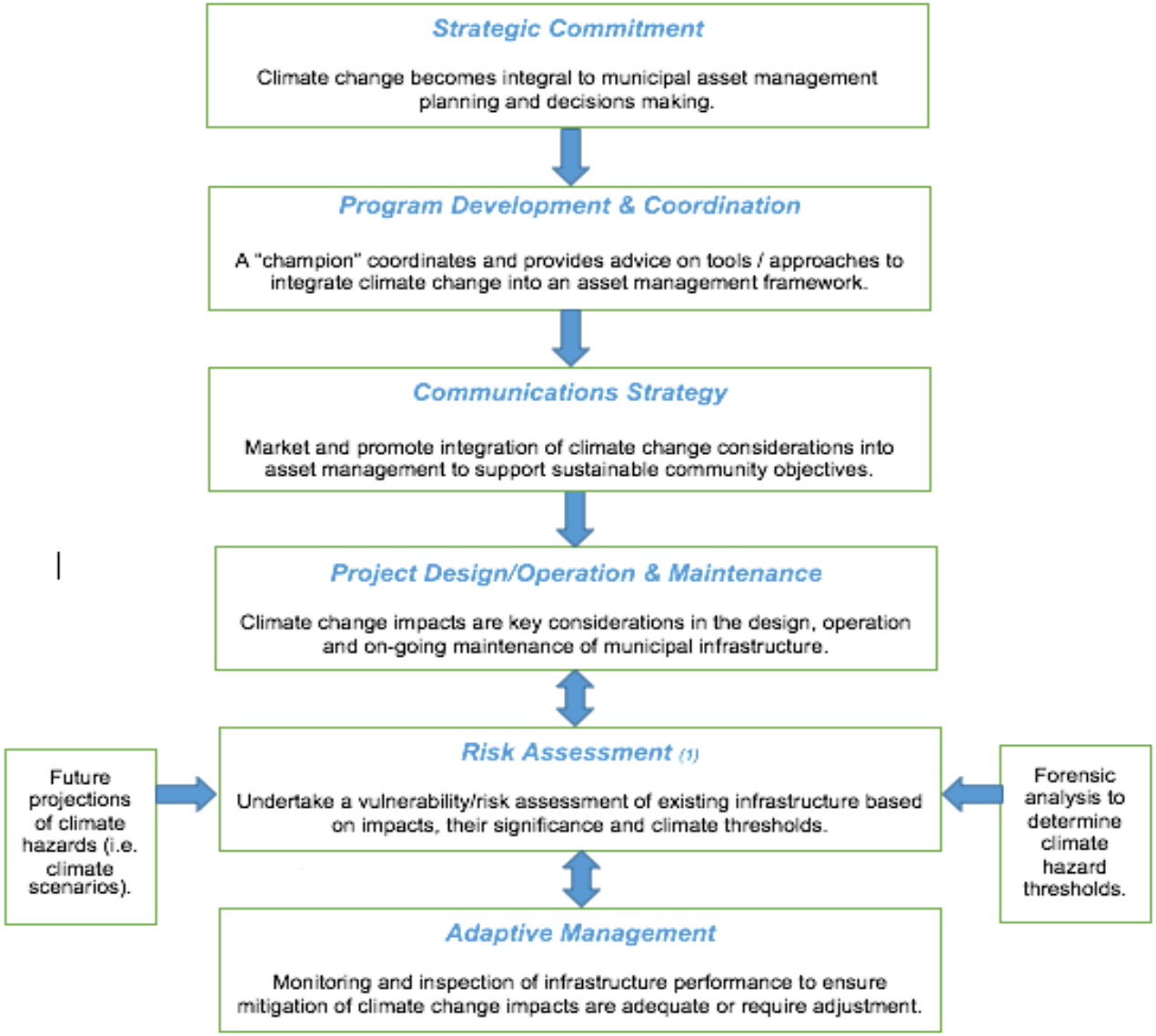
INTEGRATING ASSET MANAGEMENT AND CLIMATE CHANGE - FLOWCHART



1. Addressing climate change impacts on built infrastructure should be based on the operation and maintenance of the asset, how a changing climate is affecting performance and determining the climate hazard/event that results in underperformance and/or failure. Monitoring performance and stepping up inspections are key to assessing this issue.

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Summary

* Largest concentrations of CO2 since humankind
* Significant warming of the oceans and atmosphere
* Sea level rise and extremes in temperature and precipitation (drought/wildfire, flood, snow load and high winds)
* Contributes to higher losses from weather catastrophes
* Significant risk to municipal infrastructure and related services
* Asset and lifecycle management includes the need to assess the climate risk; monitor the changes and manage the risk to ensure communities are more resilient
* We are developing an approach to enable this in collaboration with FCM, NSFM, WSP-OPUS, and NS municipalities

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CLIMACTION SERVICES INC.

Gary Lines – David Kelly – Jim Abraham – Vikki Bewsher

www.climactionservices.ca
climaction@outlook.com

902-877-2981

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Questions??

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