

Setting the Stage for Climate Change Risks – Current Knowledge & Opportunities

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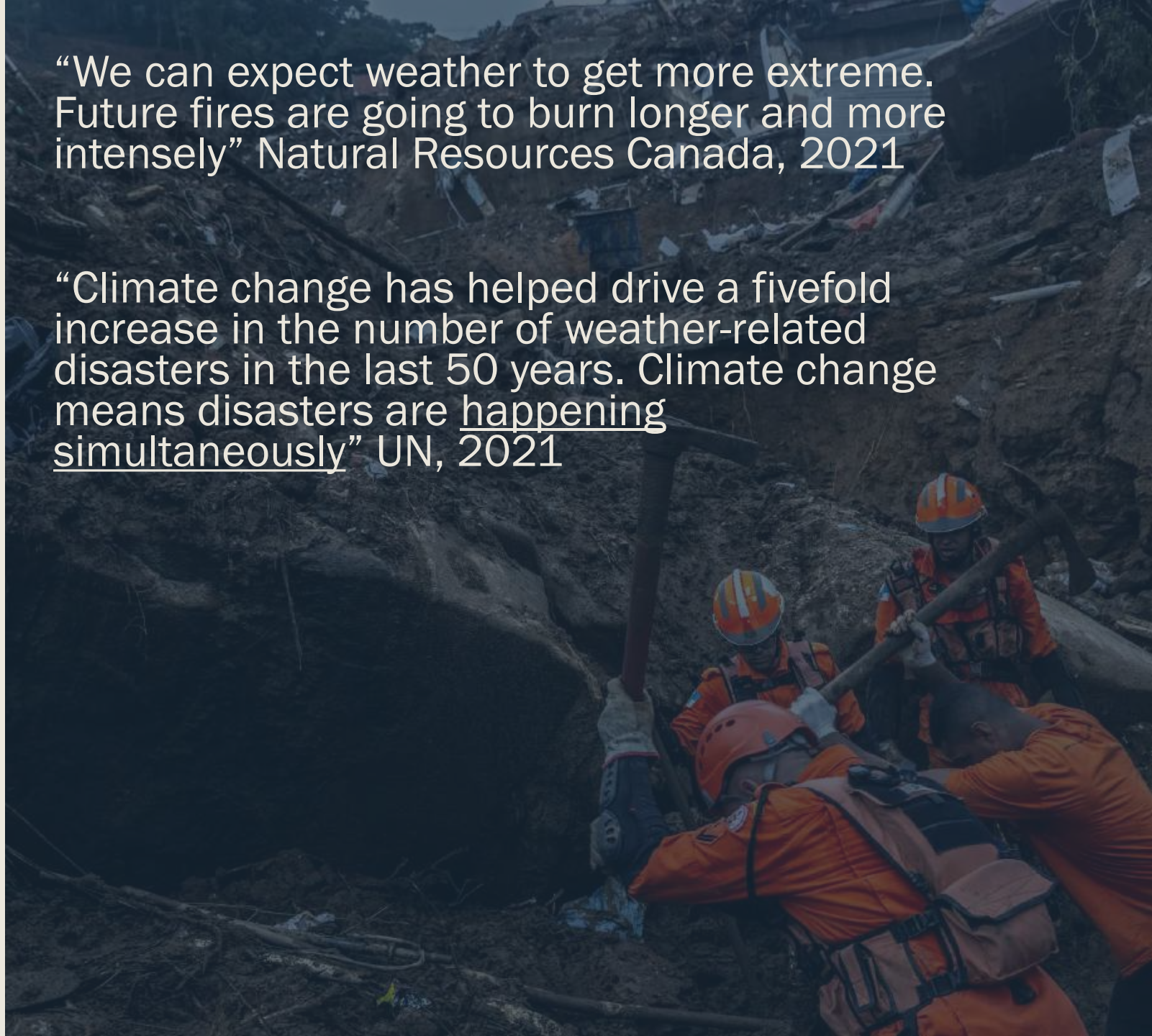


CLIMATE CHANGE & NATURAL DISASTERS



“We can expect weather to get more extreme. Future fires are going to burn longer and more intensely” Natural Resources Canada, 2021

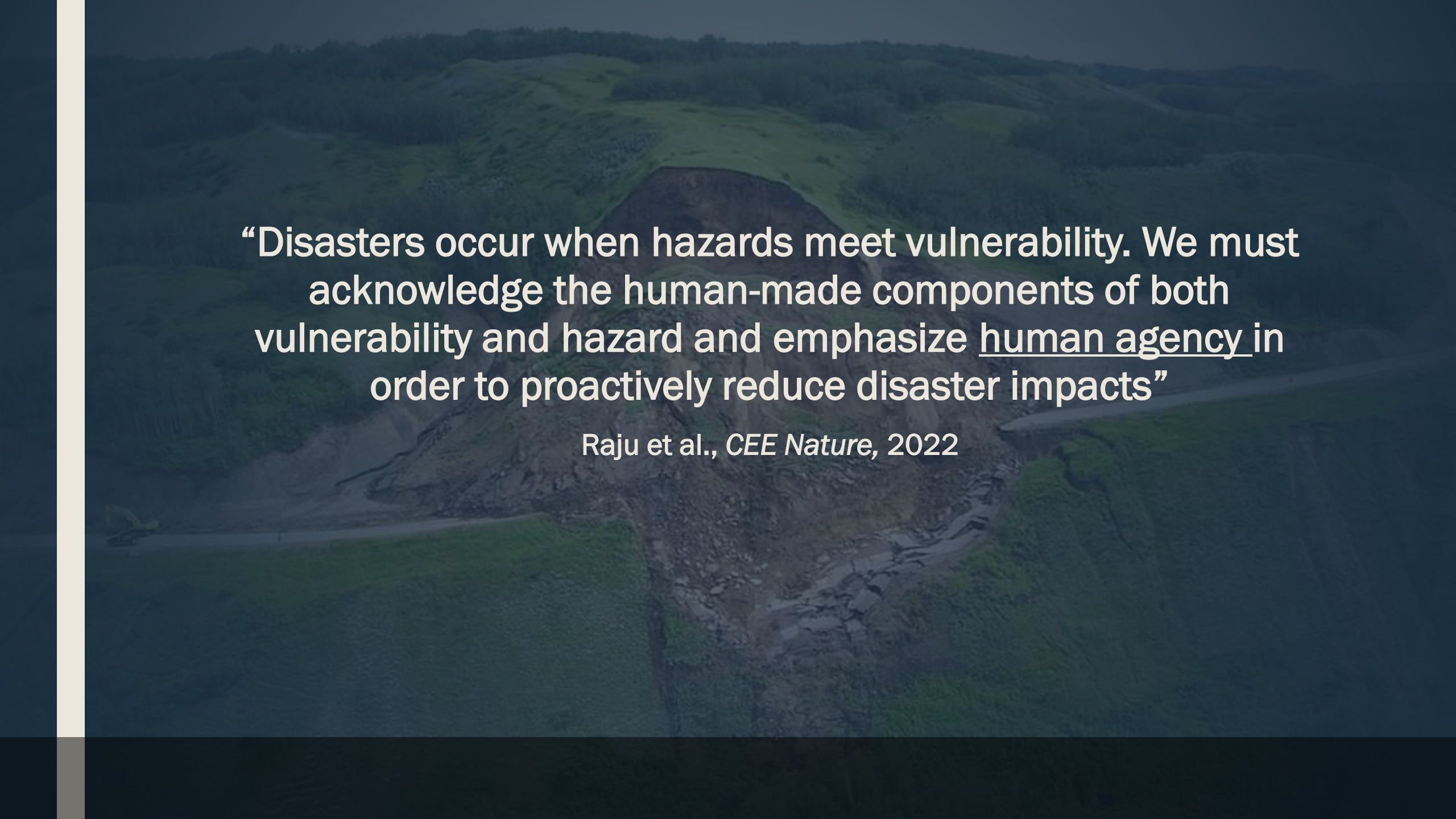
“Climate change has helped drive a fivefold increase in the number of weather-related disasters in the last 50 years. Climate change means disasters are happening simultaneously” UN, 2021





UNITED IN SCIENCE 2022:
 a multi-organization high-level compilation of the most recent science related to climate change, impacts and responses

“WE ARE HEADING IN THE WRONG DIRECTION” WMO, 2022

An aerial photograph of a landslide on a green hillside. The landslide area is a large, dark, irregularly shaped mass of earth and rock that has slid down the slope. The surrounding area is covered in green grass and vegetation. The image is overlaid with a semi-transparent dark blue filter.

“Disasters occur when hazards meet vulnerability. We must acknowledge the human-made components of both vulnerability and hazard and emphasize human agency in order to proactively reduce disaster impacts”

Raju et al., *CEE Nature*, 2022

Climate Change Hazards and Contaminated Site Management

- **Vulnerability:** The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change
- **Resilience:** A capability to respond to and recover from hazards with minimal damage to a system
- **Adaptive Capacity:** The ability of a system to adjust to climate change and to moderate impacts

Modified from: Environment Canada, EPA, and IPCC

Questions

How have natural disasters and climate change impacted contaminated sites you work on?

Do you have existing tools and resources for climate change adaptation in contaminated site management? What would help?

Federal Contaminated Sites Action Plan (FCSAP)

Integrating Climate Change Adaptation Considerations into Federal Contaminated Sites Management

Version 1.0

e.g., drought, rain, wind)

e.g., flooding, damage to buildings)

HAZARDS

Increased precipitation
Sea-level rise
Drought



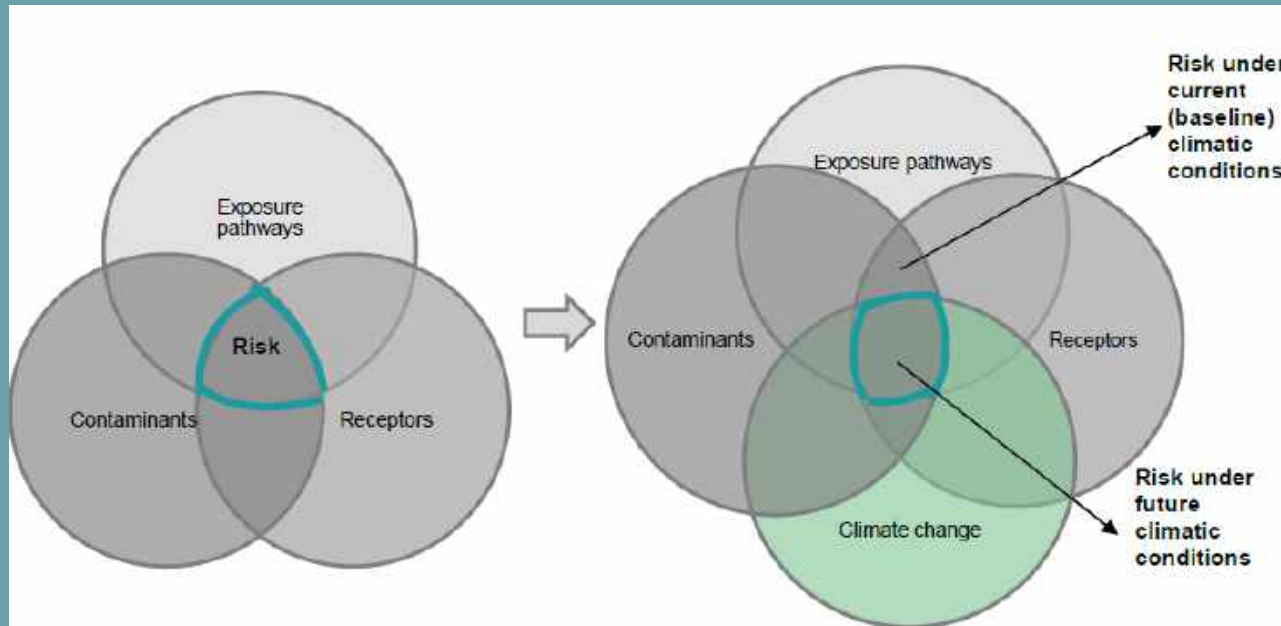
IMPACTS

- Submerged contaminated site
- Cracking of a cap

Table 1: Potential Climate Change Hazards and Impacts on Contaminated Sites in CanadaFCSAP, Environment and
Climate Change Canada, 2022

Potential Climate Change Hazards	Potential Changes	Geographic Area of Canada at Greatest Risk	Examples of Impacts on Contaminated Sites
Ambient Air Temperature Changes	<p>Ambient temperatures in northern Canada have changed by as much as 1-2 °C per decade since the 1980s. Further increases in temperatures of 2-4°C by 2050 and 5-10 °C by 2090 are predicted for North America as a whole.</p> <p>In the Arctic, average annual temperatures are expected to increase by 3-4°C by 2050 and more than 15°C by 2090.</p>	Northern Canada	<ul style="list-style-type: none"> • Increase in biodegradation and phytoremediation rates • Increase in the length of the season for bioremediation and phytoremediation • Increased efficiency in some pump and treat technologies due to increased rates of volatilization and solubility • Increased potential of biofouling of pump and treat systems
Permafrost Melting	Permafrost has warmed by as much as 2 °C in recent decades, with accompanying loss or degradation of permafrost already underway in some regions of Canada. The southern limit of permafrost is projected to shift northward by several hundred kilometres during this century.	Northern Canada	<ul style="list-style-type: none"> • The loss of permafrost could cause lakes and wetlands to drain, ground surface subsidence and the loss of infrastructure • Increased risk of damage to R/RM infrastructure and site access • Loss of integrity of containment and disposal sites (e.g. solidification/stabilization, or landfill covers) resulting in the release of contaminants • Changes in groundwater flow rate and direction affecting pump and treat systems, permeable reactive barriers, and groundwater containment systems
Changes in Precipitation Regimes	Predicted changes in precipitation patterns will vary regionally.	Northern Canada; Great Lakes Region; and St. Lawrence Valley Region	<ul style="list-style-type: none"> • Impacts may include increased or decreased river flows, increased runoff and reduced infiltration of precipitation, terrain subsidence, and increased surface erosion • Breach of cover systems (e.g. subsidence/collapse of containment infrastructure and landfill covers) • Increased/decreased risk of contaminants leaching from containment systems • Changes in groundwater flow rate and direction affecting pump and treat systems, permeable reactive barriers, and groundwater containment systems • Positive and negative impact on phytoremediation depending on whether precipitation increases or decreases • Positive or negative impact on the mobilization of contaminated sediments • Range shifts in flora, leading to range shifts in fish and fauna

Climate Change Adaptation for Contaminated Sites



FCSAP, Environment and Climate Change Canada, 2022

- Risks identified for baseline conditions may not be representative of future climatic conditions
- Site-specific impacts of climate change should be added to the CSM to reflect possible future risks to receptors

Look at climate change in three timeframes:

- near-term 2020s [2011 to 2040]
- mid-term 2050s [2041 to 2070]
- long-term 2080s [2071 to 2100]

In these time frames:

- What changes in **contaminants** and contaminant concentrations, distribution, migration pathways and residency media are likely to occur at the site in the absence of active remediation, and if no adaptation measures are implemented against the identified climate change hazards?
- What changes in human and ecological **receptors**, and their exposure pathways are likely to occur at the site in the absence of active remediation, and if no adaptation measures are implemented against the identified climate change hazards?

Conceptual Site Model with Climate Hazards

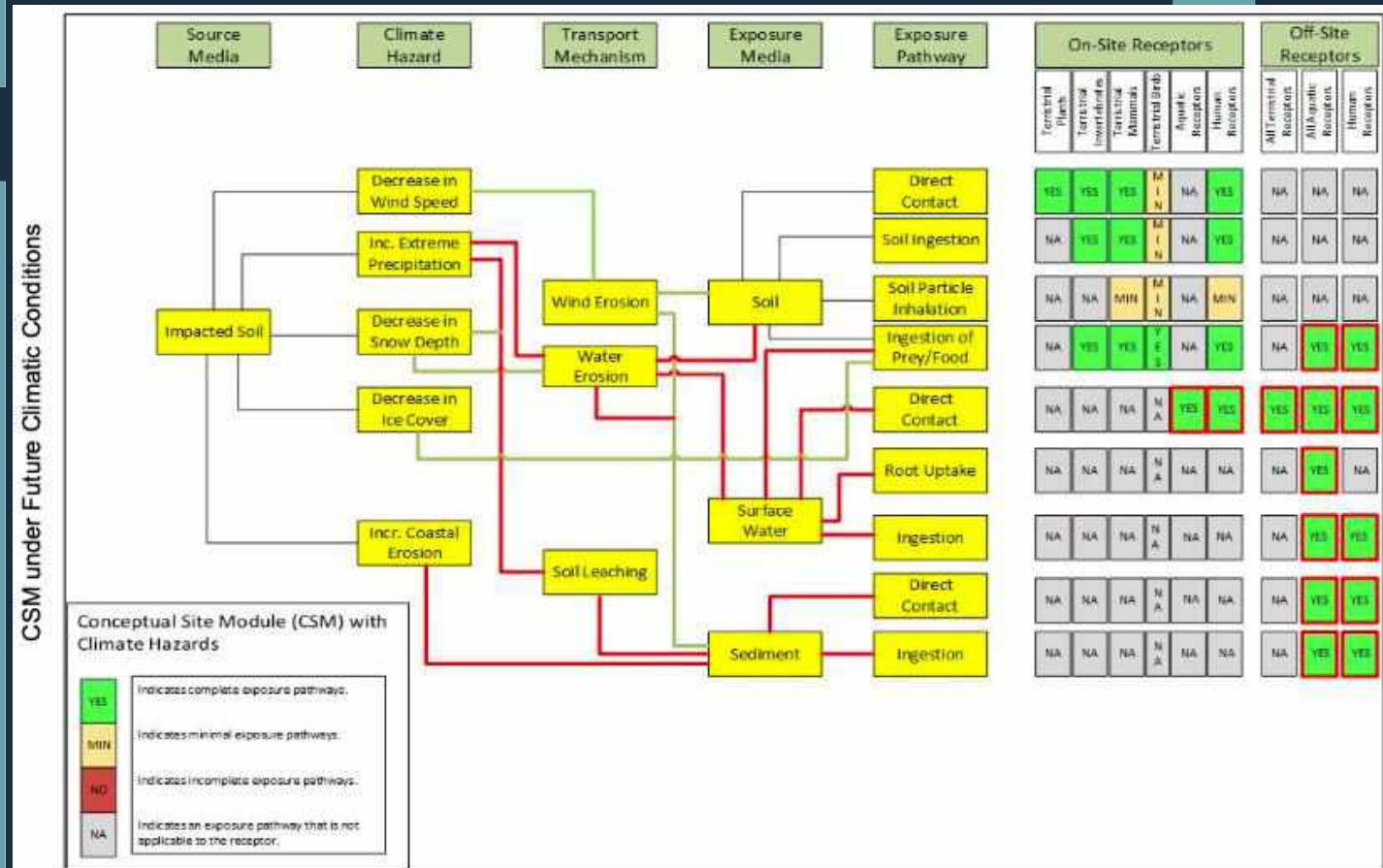


Figure 2 Part 2: Example of CSM under Future Climatic Conditions

The 10-step process

Step 1: Identify Suspect Site

Step 2: Historical Review

Step 3: Initial Testing Program

Step 4: Classify Site (optional)

Step 5: Detailed Testing Program

Step 6: Re-Classify Site

Step 7: Develop Remediation/Risk Management Strategy

Step 8: Implement Remediation/Risk Management Strategy

Step 9: Confirmatory Sampling and Final Reporting

Step 10: Long-Term Monitoring (if required)

During assessment (Steps 2 to 6), custodians are expected to address the following questions and undertake the following work in order to consider climate change at their sites:

- 1. What climate change hazards are relevant for the site?**
 - Using readily available information (see Section 3), identify climate change hazards that the site may be exposed to in the future.
- 2. What are the projections regarding those hazards under future climate scenarios?**
 - Using readily available information (see Section 3), compile qualitative and/or quantitative information on the magnitude and/or frequency of those hazards (and associated climate variables) based on climate projections for one or more timeframes under one or more emission scenarios.
- 3. How might those hazards influence contaminant distribution, exposure pathways, and receptors at the site?**
 - Starting with the conceptual site model (CSM) for current site conditions, create one or more CSMs for future climatic conditions that incorporate information on climate change hazards projected under future timeframes and climate scenarios and how those hazards may influence contaminant distribution, exposure pathways and receptors.

Federal Contaminated Sites Decision Making Framework



CANADA IN A CHANGING CLIMATE

Canada in a Changing Climate: Advancing our Knowledge for Action is the national assessment of how and why Canada's climate is changing; the impacts of these changes on our communities, environment, and economy; and how we are adapting.



CCCR2019

REPORT

Canada's Changing Climate Report



CCCR2022

SUPPLEMENT

Canada's Changing Climate Report

in Light of the Latest Global Science Assessment

CHAPTER 7 Changes in Oceans Surrounding Canada

CHAPTER 8 Changes in Canada's Regions in a National and Global Context.



Stories and explanations about climate change, and local climate data that can be explored using maps and graphs.



Climate Data Canada

High-resolution climate data to help decision makers build a more resilient Canada.



PAVICS

Advanced tools for academia, climate scenario developers, and other expert users.

Canadian Federal Resources on Climate Change

Environmental Protection Agency – Climate Change Adaptation

- **Superfund Climate Resilience**
 - *Vulnerability Assessments*
 - *Resilience Measures*
 - *Adaptive Capacity*

- **Climate Adaptation**
 - *Adaptation resources and toolkits*
 - *Virtual workshops*
 - *Climate Adaptation Action Plan 2021*

Other Resources

- IPCC Sixth Assessment Report (2022)
- ITRC Sustainable Resilient Remediation (2021)
- ASTM Standard Guide for Remedial Action Resiliency to Climate Impacts (2021)
- Sustainable Remediation Forum (SURF)
- U.S. Climate Resilience Toolkit
- U.S. Global Change Research Program
- NASA Applied Sciences Program



U.S. Climate
Resilience
Toolkit

ipcc

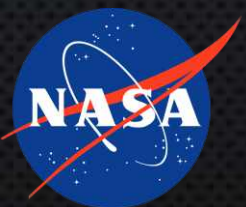


STORY

Evolving GIS Technologies Advance Disaster Management

PROGRAM AREA: **DISASTERS**

LOOKING FORWARD & OPPORTUNITIES



EARTH SCIENCE
APPLIED SCIENCES



THANK YOU

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