

Bridging the Water Adaptation Gap (BWAG) - Pathways to Adaptation for Vulnerable Regions

Results from Canada's Objective Three Infrastructure Interviews

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April 14, 2025

EXECUTIVE SUMMARY

This executive summary provides a detailed overview of the challenges, risks, and opportunities related to infrastructure systems, focusing on hazards, impacts, vulnerabilities, adaptations, values, sustainability, and future trends. The findings draw upon key themes of resilience and sustainability, emphasizing the importance of adaptive management, stakeholder collaboration, and innovative approaches to ensure the longevity and functionality of critical infrastructure systems.

Critical infrastructure faces numerous challenges, including a significant expertise gap as experienced personnel retire. Municipalities struggle to recruit and train replacements due to long training periods and insufficient funding. For example, a respondent noted that municipalities often inherit aging infrastructure without adequate resources to maintain or replace it. Financial constraints exacerbate these issues, with communities unable to fund essential upgrades like wastewater treatment or healthcare facilities, leaving them vulnerable to system failures and environmental hazards.

Furthermore, public perception often undermines support for infrastructure projects. The benefits of long-term investments are not immediately visible to residents, making it difficult to secure the necessary resources for large-scale initiatives.

Water management systems, encompassing both grey (traditional) and green (nature-based) infrastructure, face increasing strain. Grey infrastructure, such as water treatment plants, often operates beyond its intended capacity due to financial and logistical challenges. For instance, facilities in some communities run at full capacity during maintenance, heightening risks of service disruption.

Green infrastructure, including measures like in-field berms and temporary water retention areas, offers cost-effective and environmentally friendly solutions. However, these systems require community buy-in and coordinated policy efforts to integrate effectively with traditional infrastructure.

Climatic risks, including freeze-thaw cycles, unpredictable rainfall patterns, and long-term climate variability, significantly impact infrastructure. The freeze-thaw cycle causes soil expansion and contraction, leading to structural damage in pipelines and roads. Similarly, high-energy rainfall events overwhelm drainage systems, increasing runoff and soil erosion. Decision-makers face the added challenge of planning infrastructure upgrades under uncertain climate conditions, with one respondent emphasizing the difficulty of designing systems for future events based on limited historical data.

Non-climatic hazards, such as vandalism, workforce shortages, and supply chain disruptions, compound the risks faced by infrastructure systems. Aging facilities are particularly vulnerable during maintenance or operational disruptions. Rising material costs and delays in acquiring essential components further strain municipal budgets and hinder timely repairs.

The intersection of aging infrastructure, workforce shortages, regulatory barriers, and financial limitations creates compound risks. These challenges are exacerbated by political turnover, inconsistent policies, and economic inflation, making it increasingly difficult for municipalities to address infrastructure vulnerabilities effectively.

Residents, first responders, and Indigenous communities are disproportionately affected by infrastructure vulnerabilities. Flooding events frequently lead to property damage, insurance claims, and emotional stress. Indigenous communities face compounded challenges due to pre-existing deficiencies in water infrastructure, which prolong recovery times and affect culturally significant areas.

Aging infrastructure is under constant pressure from environmental and anthropogenic factors. Flooding and erosion frequently damage transportation networks, drainage systems, and built infrastructure. Additionally, nutrient loads and pollutants from upstream sources pose significant challenges to water quality and treatment systems, increasing operational burdens.

Municipalities lack the resources and expertise needed to manage aging infrastructure. Recruitment challenges and lengthy training periods exacerbate workforce shortages, further limiting the capacity to address vulnerabilities. Additionally, regulatory and policy barriers hinder adaptive responses to emerging challenges.

Non-human systems, including water infrastructure and natural ecosystems, are highly sensitive to environmental changes. Hard water, excess runoff, and sedimentation threaten the efficiency of water management systems. Poorly maintained wetlands and marshlands also lose their capacity to buffer against extreme weather events.

Infrastructure failures are often linked to soil conditions and climatic stressors. Freeze-thaw cycles, rapid snowmelt, and flooding events repeatedly test the resilience of pipelines, roads, and culverts, leading to frequent service disruptions and costly repairs.

Farmers have proactively implemented green infrastructure measures, such as berms and temporary water retention systems, to manage water flow and mitigate flooding risks. Rural residents increasingly invest in backup power solutions to enhance resilience against power outages.

Municipalities have focused on creating redundancies in water treatment systems, such as installing natural gas backup generators. Strategic infrastructure projects, including constructed wetlands and drainage improvements, aim to balance environmental conservation with agricultural productivity. However, challenges persist in securing public support and financial resources for these initiatives.

Advancements in precision agriculture and infrastructure monitoring offer new opportunities to enhance efficiency and sustainability. For instance, precision mapping allows farmers to optimize fertilizer use, while automated monitoring systems improve the management of water control structures.

Stakeholders increasingly prioritize sustainability in infrastructure planning, emphasizing the need for long-term resilience and environmental stewardship. Retaining wetlands for aquifer recharge, implementing green infrastructure, and integrating sustainability requirements into engineering standards reflect a shift towards more adaptive and holistic approaches.

A growing recognition of climate risks has influenced public perception and policy directions. Stakeholders acknowledge the need for regional collaboration, improved governance, and proactive planning to address emerging challenges. However, funding uncertainties and political turnover remain significant barriers to progress.

Stakeholders envision a future where infrastructure systems are more resilient, equitable, and sustainable. This includes enhancing regional partnerships, increasing public awareness, and aligning policy frameworks with long-term environmental goals. Integrating expertise and fostering collaboration among municipalities are seen as critical steps toward achieving these objectives.

Infrastructure Upgrades (i.e. prioritize investments in water treatment plants, drainage systems, and transportation networks to address vulnerabilities), Green Infrastructure expansion (i.e. expand the adoption of nature-based solutions, such as wetlands and in-field berms, to enhance resilience and ecological benefits), Workforce Development (i.e. Implement training programs to address expertise gaps and ensure the continuity of critical infrastructure operations), Public Engagement (i.e. Increase community involvement and education to build support for long-term infrastructure investments and Policy Reforms (i.e. Simplify regulatory frameworks to reduce barriers and encourage innovation in infrastructure design and management).

Future infrastructure planning must account for uncertainties in climate projections, regulatory changes, and funding availability. Adopting flexible and adaptive approaches will be critical to navigating these complexities.

The sustainability and resilience of infrastructure systems are critical to supporting communities, economies, and ecosystems. Addressing the challenges of aging infrastructure, climatic variability, and financial constraints requires a coordinated effort among stakeholders, innovative solutions, and a long-term commitment to sustainability. By balancing immediate needs with future priorities, municipalities can build infrastructure systems that are more adaptive, equitable, and resilient.

We conducted 15 interviews with subject matter experts from various organizations responsible for infrastructure planning, construction, and maintenance. Interviewees INF_2, INF_3, INF_4, INF_11, and INF_13 shared insights from their work managing infrastructure across the province. INF_1, INF_8, and INF_12 contributed their expertise in urban infrastructure. INF_5 provided perspectives on infrastructure in Spy Hill, while INF_6 discussed challenges within the Upper Souris River Watershed. INF_7 highlighted key issues in the South Saskatchewan River Basin. INF_9 focused on large-scale infrastructure, such as dams, while INF_14 and INF_15 detailed the specific challenges faced by rural communities in the province.

KEY INSIGHTS

- Many municipalities struggle with deteriorating water treatment plants, wastewater systems, and transportation networks that require urgent upgrades. Financial constraints often prevent timely repairs, leading to system failures, increased maintenance costs, and heightened vulnerability to environmental hazards.
- The loss of experienced personnel due to retirements has created a shortage of skilled workers to manage infrastructure systems. Training new professionals takes years and is often underfunded, delaying project execution and increasing operational risks.
- Unpredictable rainfall, freeze-thaw cycles, and extreme weather events are placing significant stress on infrastructure. Roads and pipelines are frequently damaged by soil expansion and contraction, while heavy rainfall overwhelms drainage systems, leading to flooding and erosion. The uncertainty of future climate conditions complicates long-term infrastructure planning.
- Nature-based solutions such as wetlands, in-field berms, and temporary water retention areas provide cost-effective methods for managing water and reducing climate-related risks. However, widespread adoption is hindered by policy barriers, financial limitations, and the need for public support.
- Changing regulations, unclear policies, and inconsistent enforcement create uncertainty for municipalities and infrastructure planners. Bureaucratic hurdles slow down project approvals, and some policies inadvertently discourage sustainable infrastructure investments. Simplifying regulations could promote more innovative and adaptive infrastructure solutions.
- Municipalities face major funding gaps that prevent them from making necessary infrastructure investments. While government grants provide some relief, they are often inconsistent and inadequate. Rising costs of materials, supply chain delays, and inflation further increase the financial burden on infrastructure projects.

- Farmers and rural communities struggle with fluctuating commodity prices and increasing operational costs, which affect their ability to invest in sustainable land and water management practices. Access to financial incentives and funding support is crucial for widespread adoption of better water management solutions.
- Advances in precision agriculture, real-time infrastructure monitoring, and automated water management systems offer opportunities for improving efficiency and sustainability. Some municipalities are implementing backup power solutions, such as natural gas generators, to enhance resilience against power outages and system failures. However, financial and technical barriers limit broader adoption.
- Stronger regional partnerships, improved governance structures, and proactive planning are necessary to address infrastructure challenges. Collaboration among municipalities, conservation organizations, and private stakeholders can enhance water management and infrastructure resilience.
- Many infrastructure investments do not provide immediate visible benefits, making it difficult to secure public support. Raising community awareness and increasing engagement in long-term planning efforts will be crucial for gaining public buy-in and ensuring the success of sustainable infrastructure initiatives.
- Long-term infrastructure planning must be adaptable and flexible to account for climate uncertainties, regulatory changes, and financial limitations. Prioritizing sustainability strategies, such as wetland conservation and integrated green infrastructure, will be critical to ensuring resilient and equitable infrastructure systems for the future.