Costing Climate Change Impacts to Public Infrastructure

Project Overview

FINANCIAL ACCOUNTABILITY
OFFICE OF ONTARIO

Trustworthy

We support all MPPs in holding the government to account.


“Shed Light
Not Heat”
FAO
FINANCIAL ACCOUNTABILITY
OFFICE OF ONTARIO

The Role of the FAO

- The FAO was established in 2015, modelled on the federal Parliamentary Budget Office.
- An independent, non-partisan office that supports the Legislative Assembly by providing MPPs with balanced, timely and accurate economic and financial analysis.
- The FAO's formal mandate is to provide an independent assessment of the Province's finances, trends in the provincial economy and estimates of the financial costs or benefits of specific bills or proposals.

The FAO's Work

To support its work, the FAO has access to internal government information, including Cabinet records, with some limited exceptions.

The FAO presents its analysis through publicly available reports.

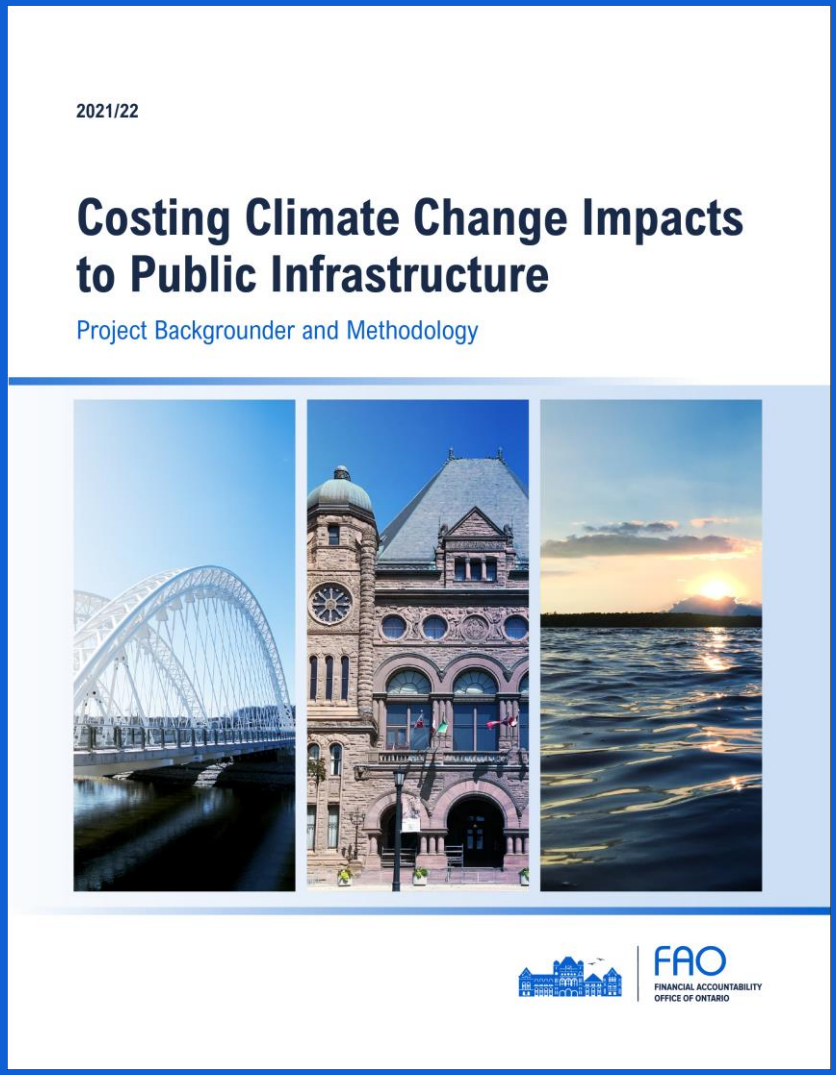
The FAO's work covers four basic areas:

1. Ontario's economic performance.
2. Province's fiscal position.
3. Ministry or sectoral spending plans.
4. Financial analysis of specific government policies.

The CIPI Project

- The FAO's Costing Climate Change to Public Infrastructure (CIPI) Project was launched in 2019 after a Member of Provincial Parliament asked the FAO to analyze the costs that climate change impacts could impose on Ontario's provincial and municipal infrastructure, and on the long-term budget outlook of the province.

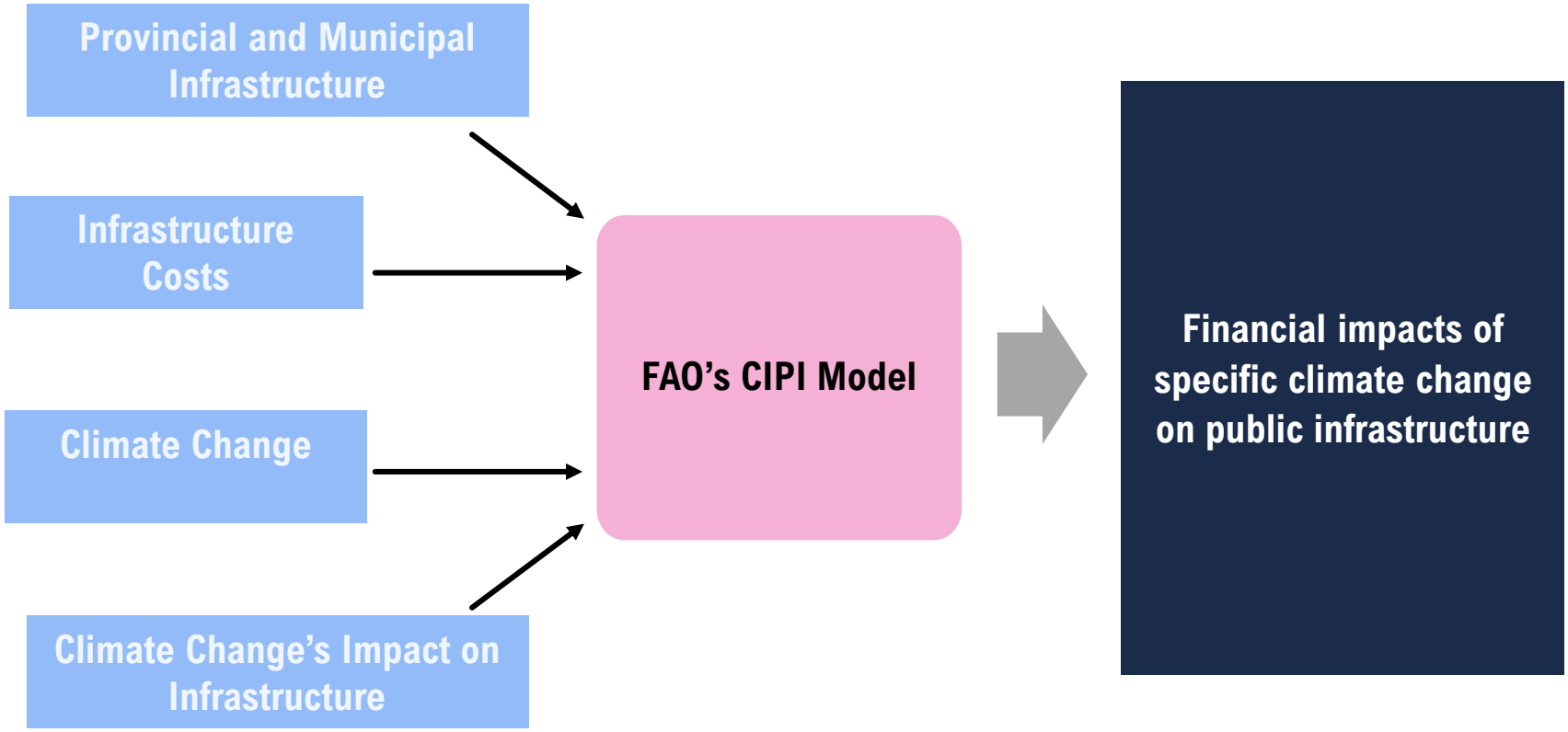
CIPI Methodology



How to estimate the impact of climate change on public infrastructure costs?

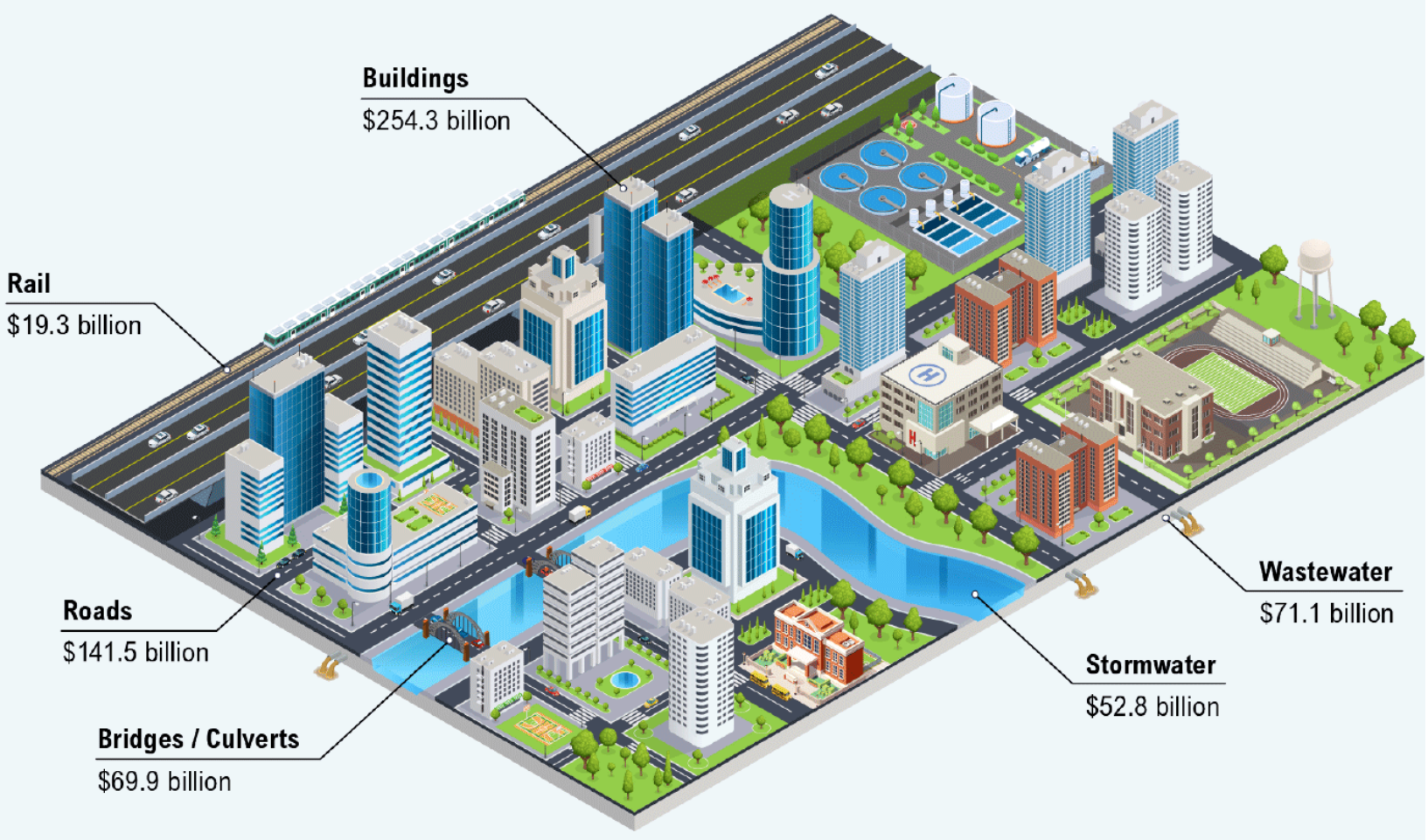
1. Provincial and Municipal Infrastructure?
2. Infrastructure Costs?
3. Climate Change?
4. Climate Change's Impact on Infrastructure?

The FAO's modelling framework

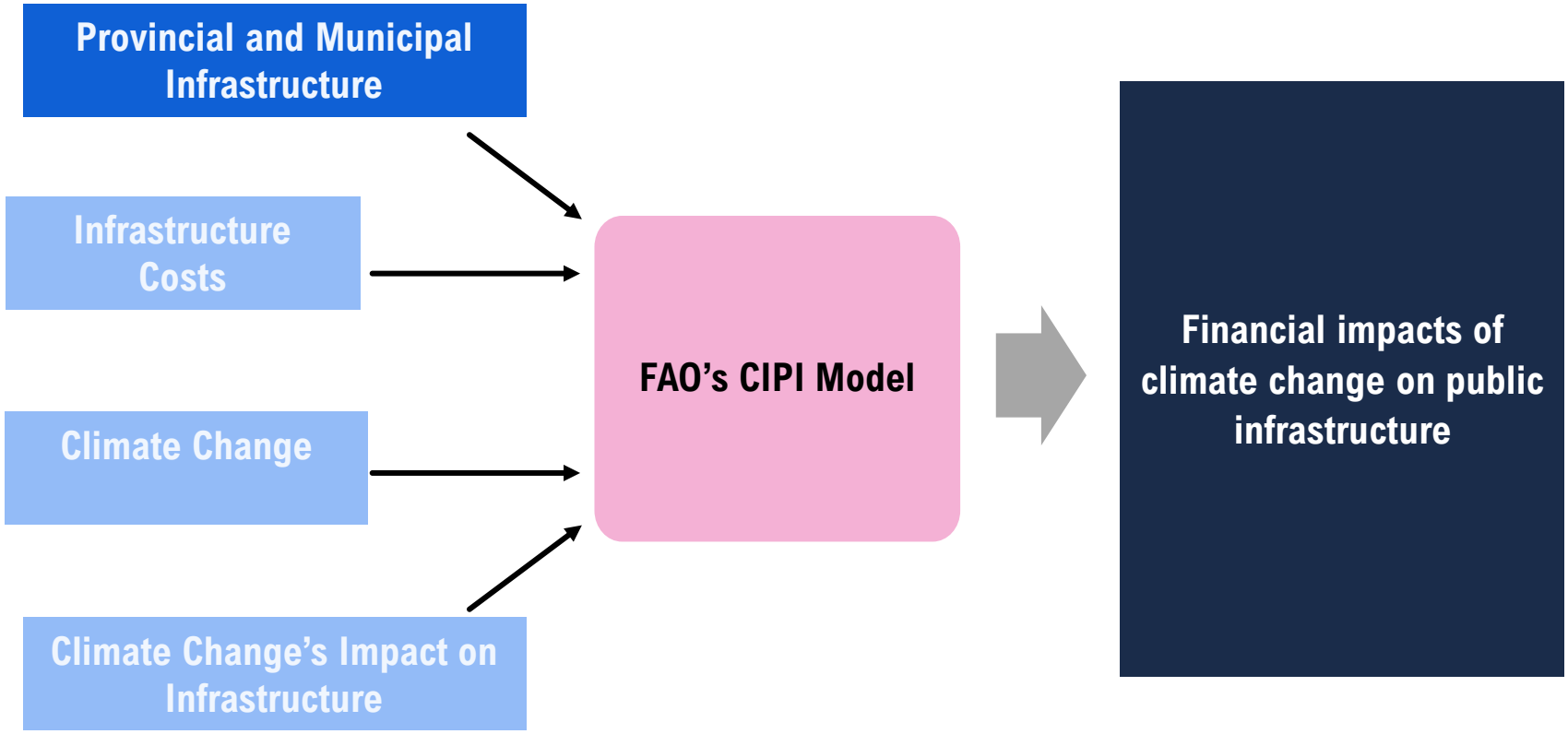


Provincial and Municipal Infrastructure

What infrastructure do municipalities and the Province own?



The FAO's modelling framework



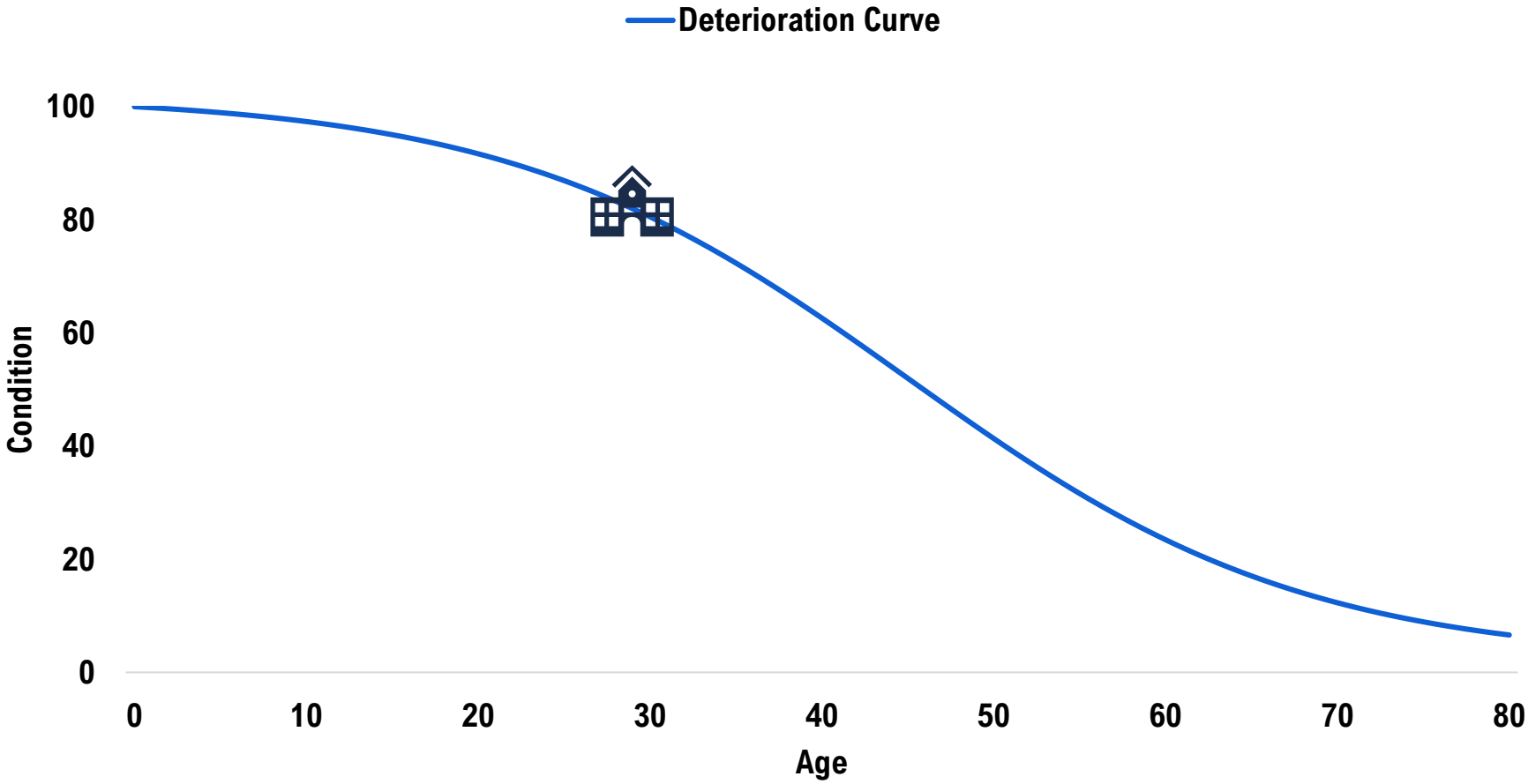
Infrastructure Costs

What are the usual costs of maintaining this infrastructure?

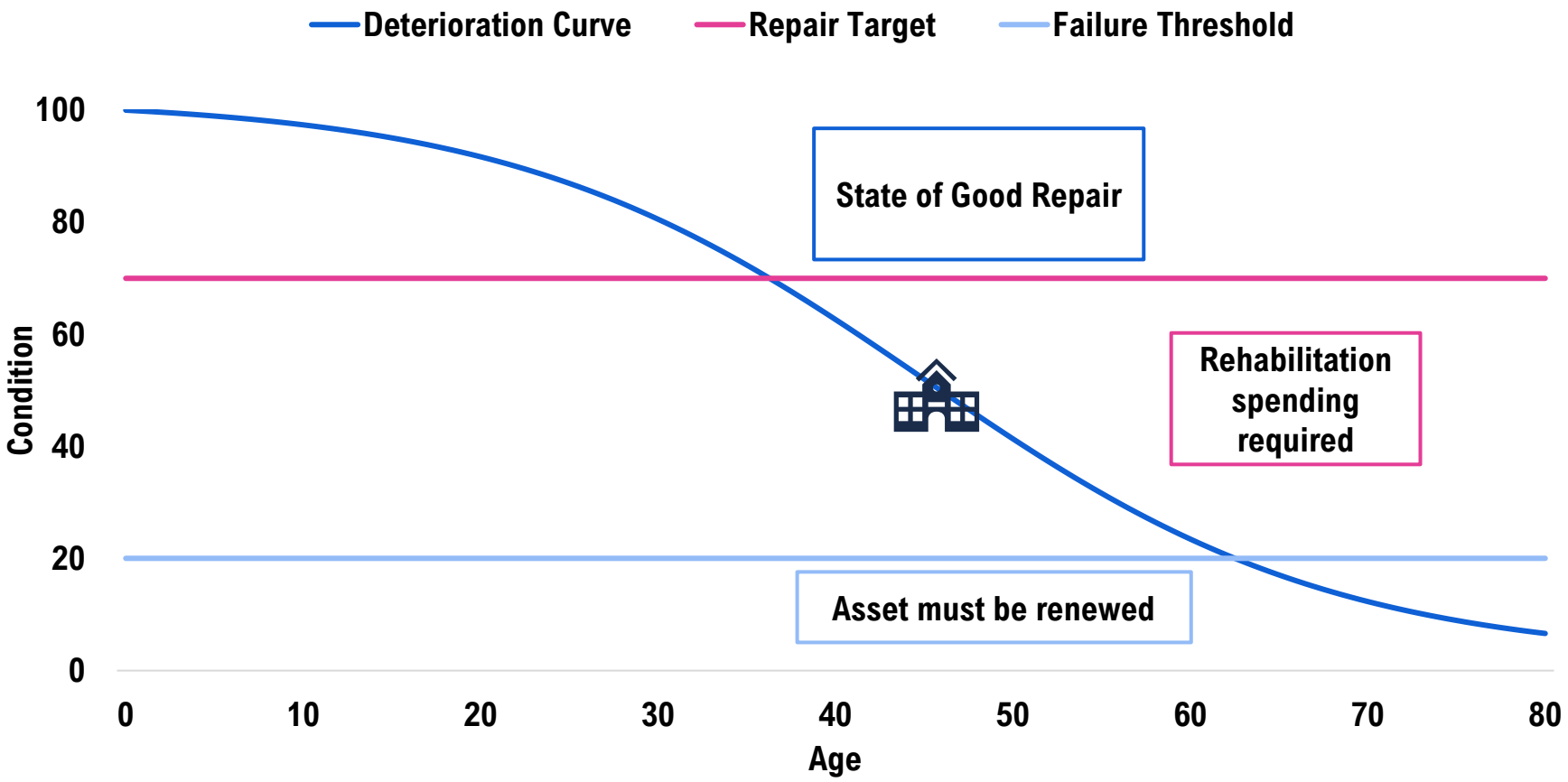
Annual Operations and Maintenance Expenses

Intermittent Capital Expenses including Rehabilitation and Renewal

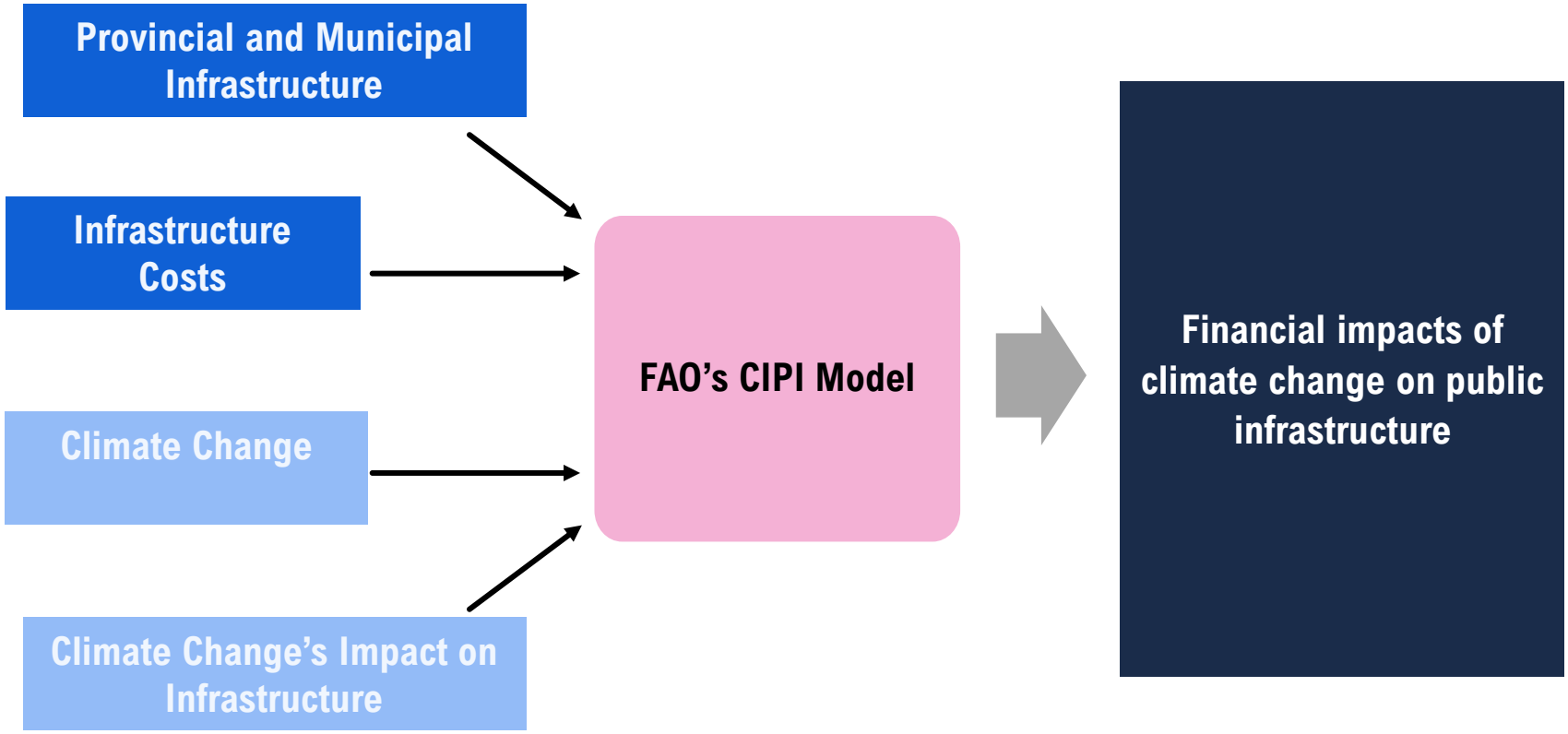
The FAO's infrastructure model



Incorporating performance standards



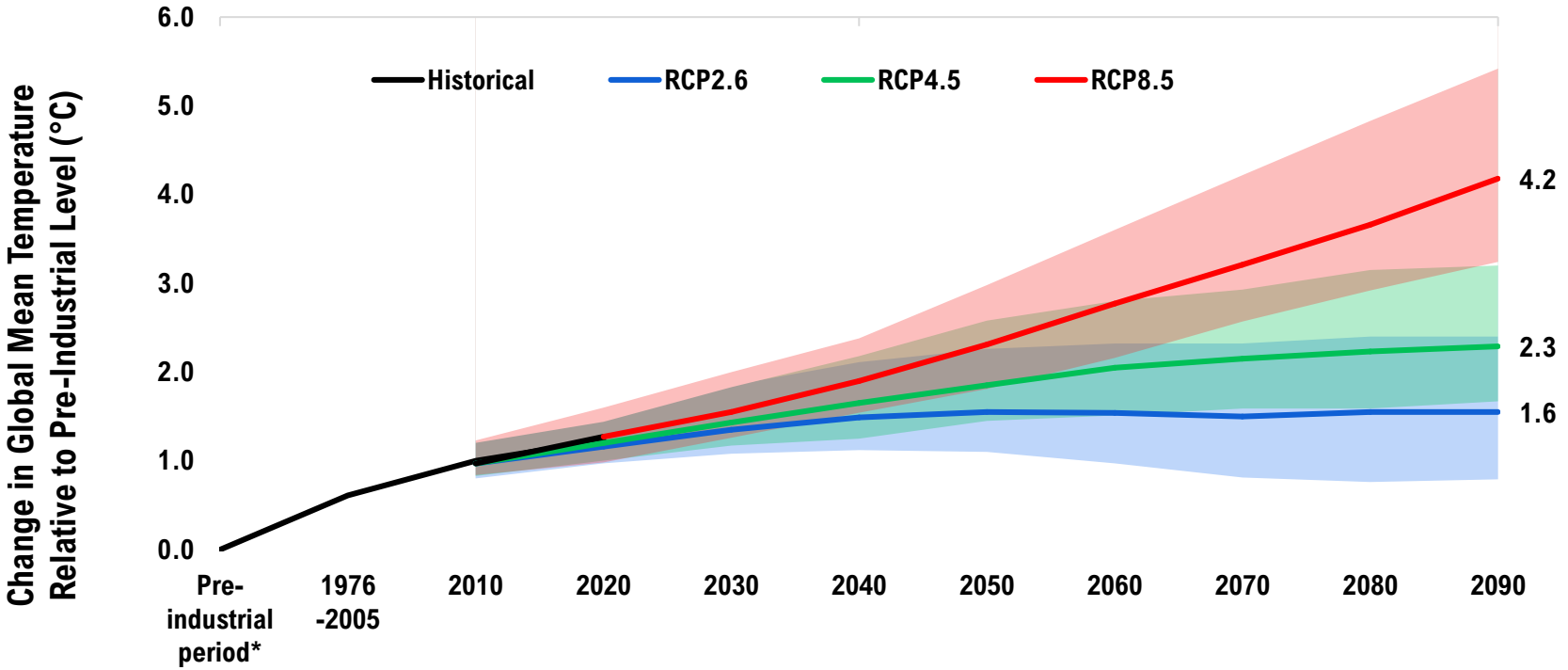
The FAO's modelling framework



Climate Change

How is the climate changing?

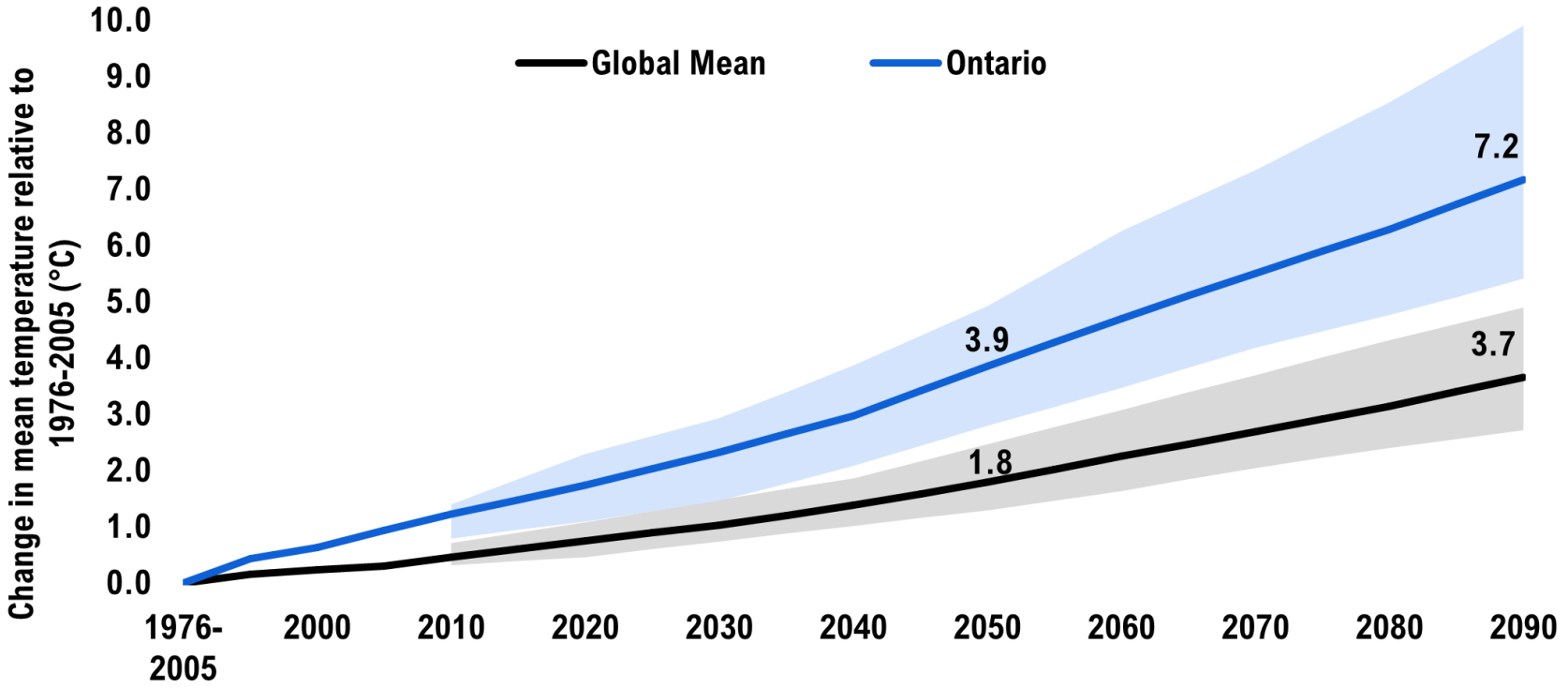
Increase in global mean temperature relative to 1850-1900



*1850-1900 base period.
Note: Lines indicate the median estimate and the shaded areas show the range of 5th and 95th percentile projections.
Source: Intergovernmental Panel on Climate Change

Ontario will experience climate change differently

Ontario's mean temperature projected to rise faster than global mean temperature under RCP8.5

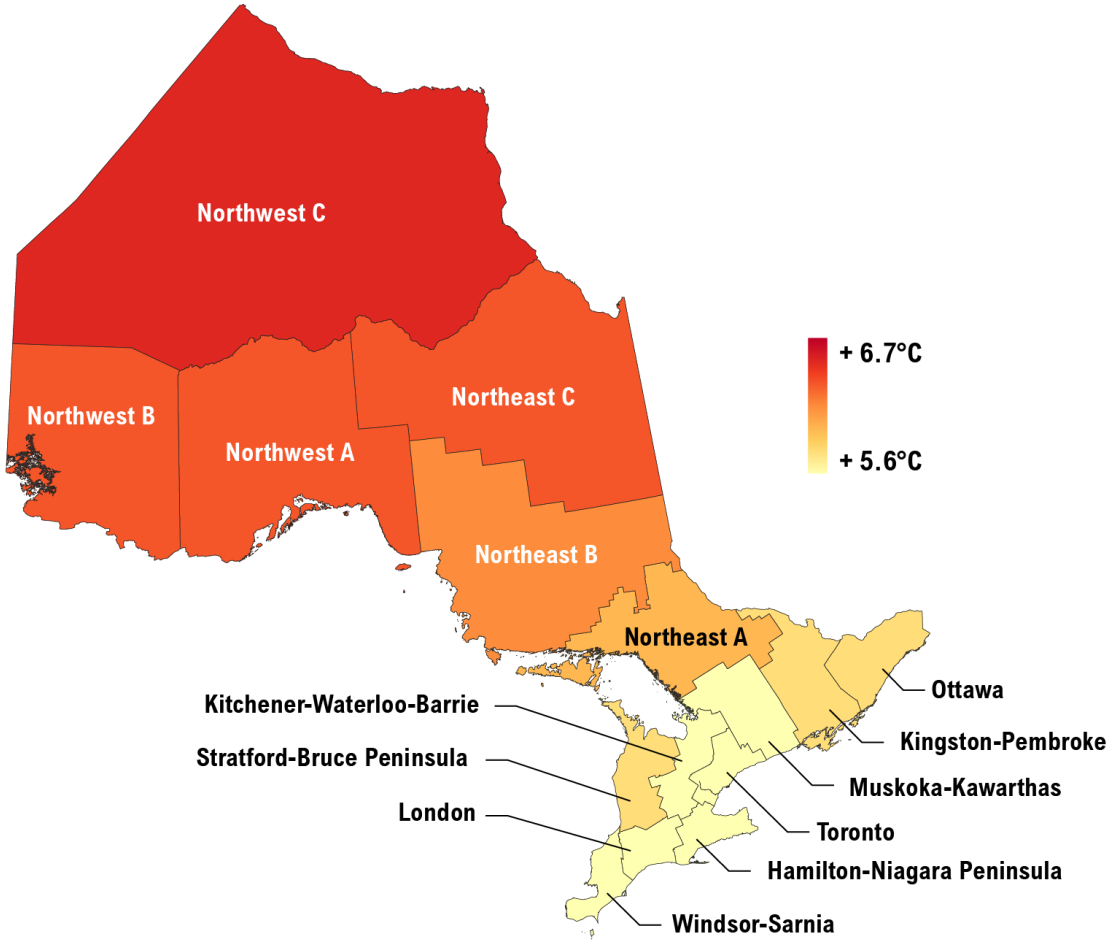


Note: Shaded areas show the range of 5th and 95th percentile projections for the global mean, and the range of 10th and 90th percentile projections for Ontario.

Source: Intergovernmental Panel on Climate Change67 and Canadian Centre for Climate Services.

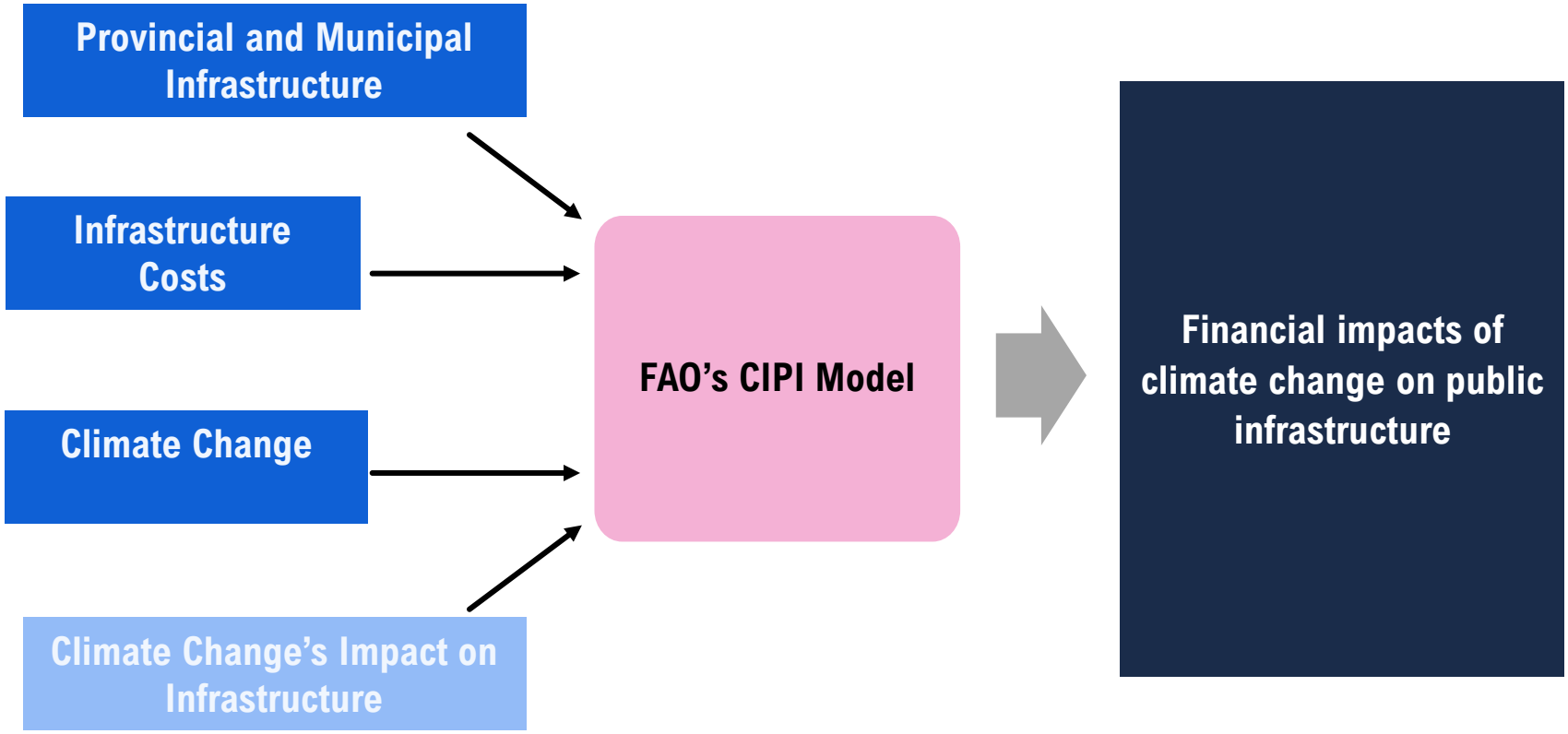
Regional climate change projections were obtained from Environment and Climate Change Canada

Median projected change in annual mean temperature from 1976-2005 to 2071-2100, RCP8.5



Note: Colour distribution is based on the multi-model median projection
Source: Canadian Centre for Climate Services.

The FAO's modelling framework



Climate Change's Impact on Infrastructure

How will climate change impact infrastructure?

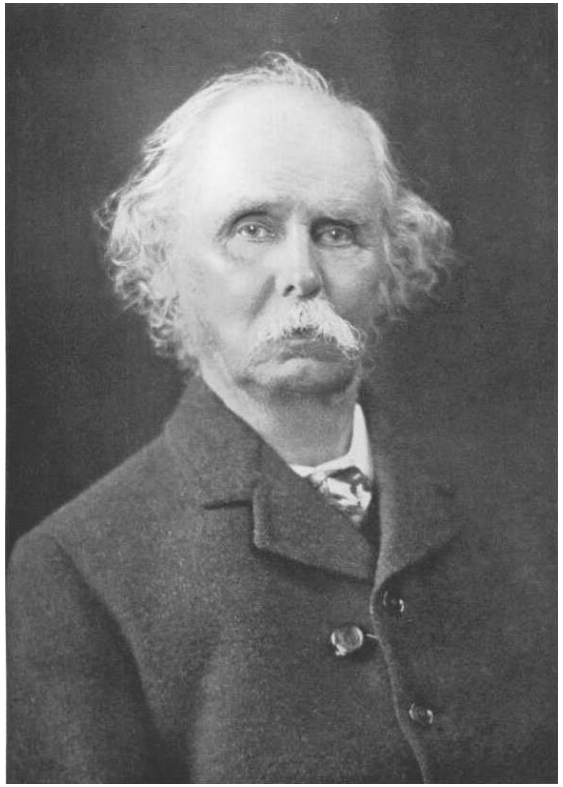
Damage Costs

Changing O&M expenses and deterioration rates caused by climate change

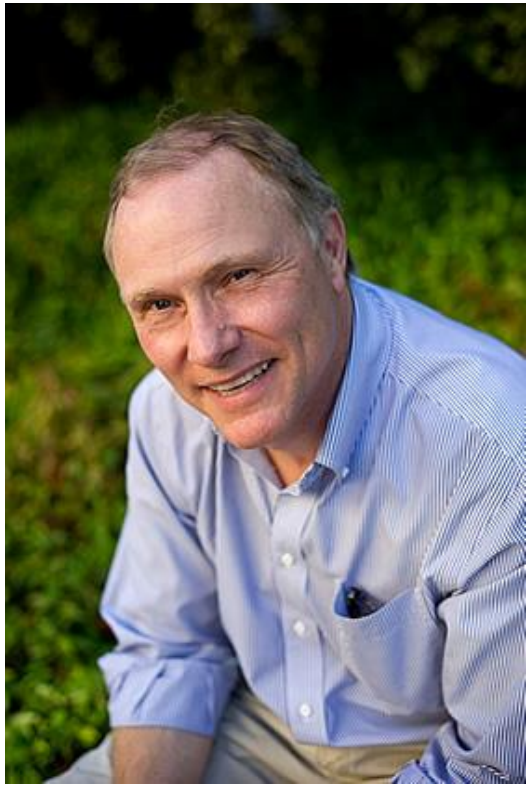
Adaptation Costs

Adapting assets via retrofits or renewals to eliminate damage costs from changing climate

How to translate changing climate hazards to infrastructure costs?



Source: The Economic Journal



Source: UC Berkeley Economics

Estimating Climate Cost Elasticities

Given the change in the climate indicator from the late 20th century, what would be…
…the change in the component's **useful service life (USL)**?
…the change in the annual **operations and maintenance (O&M) expense**?
..the **cost to design a climate resilient component (renewal adaptation)** with the same functionality?
…the **cost to retrofit** the component to be resilient to the climate hazard?

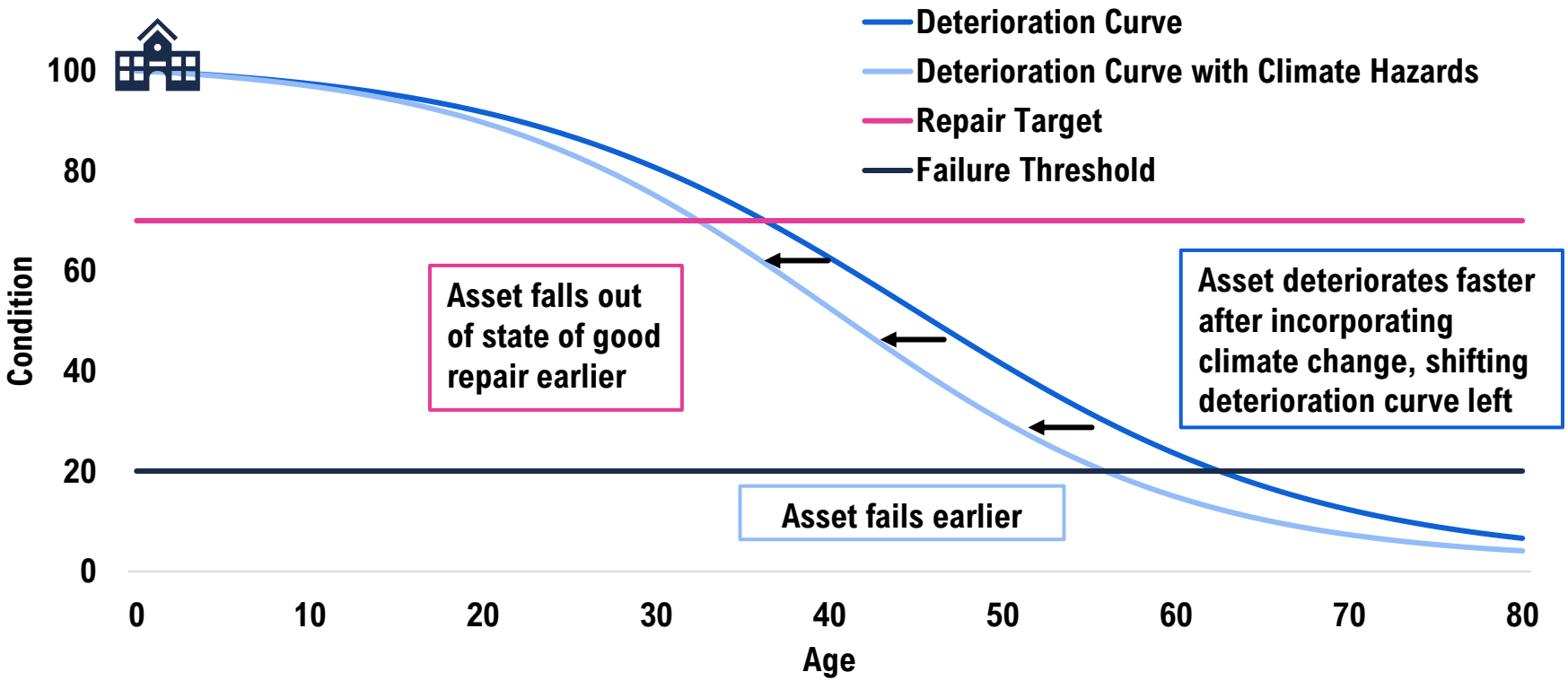
Source: WSP Global

Climate cost elasticity estimates

Climate Hazard	Building Component	Climate Indicator	Climate Change (Δc)	USL (Δp) (%)			O&M Costs (Δp) (%)			Renewal Costs (Δp) (%)			Retrofit Costs (Δp) (%)		
				Pessimistic	Most-likely	Optimistic	Pessimistic	Most-likely	Optimistic	Pessimistic	Most-likely	Optimistic	Pessimistic	Most-likely	Optimistic
Extreme heat	Civil and Landscaping	Mean July daily maximum temperature	7.4°C	-1.4	-0.9	-0.5	0.1	0.1	0.0	1.9	1.8	1.8	2.8	2.5	2.2
	Structure	N/A	Negligible climate impact												
	Envelope	2.5% July daily maximum temperature	7.1°C	-1.8	-1.3	-0.8	0.1	0.1	0.1	2.7	2.6	2.6	4.0	3.5	2.9
	Equipment and Finishing	N/A	Negligible climate impact												

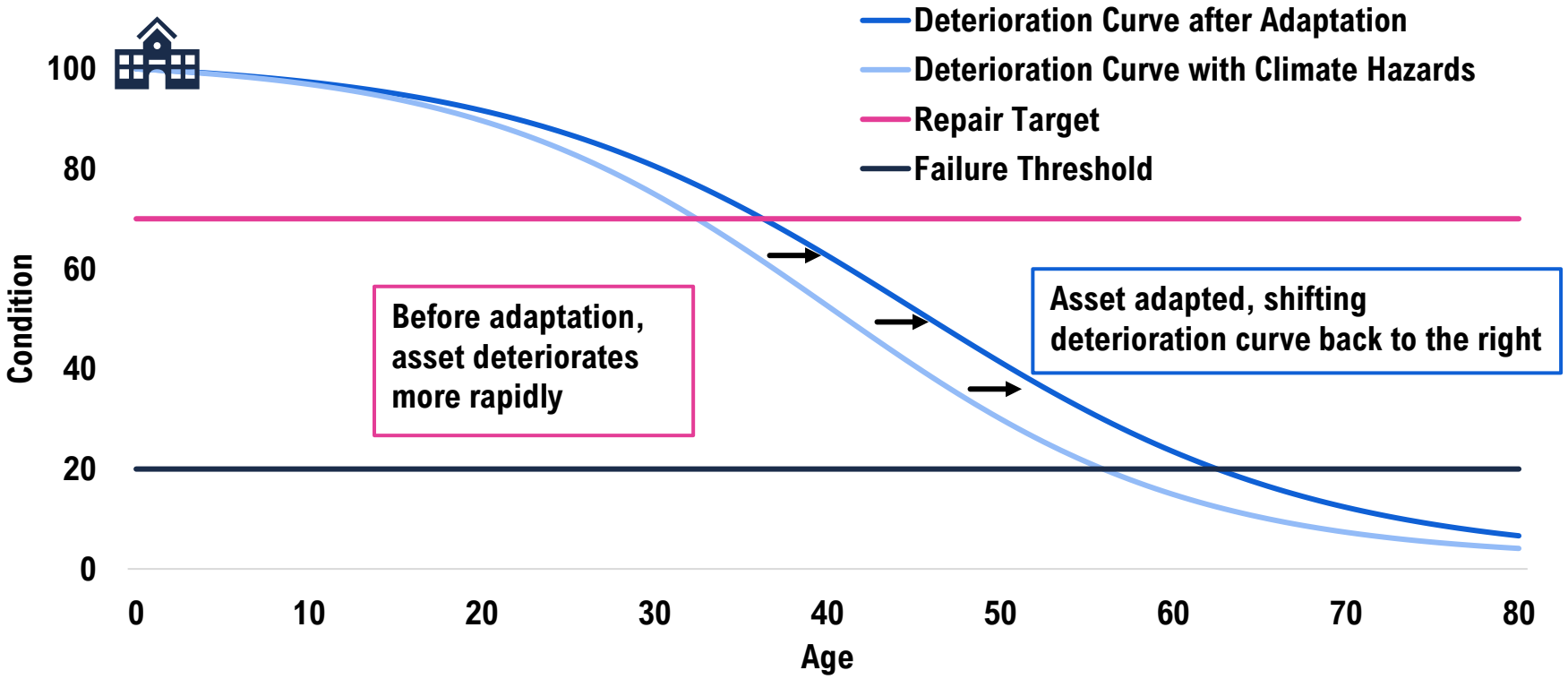
Source: WSP, 2021, Costing climate change impacts and adaptation for provincial and municipal public infrastructure in Ontario, Deliverable #10 – Final Report

Estimating damage costs



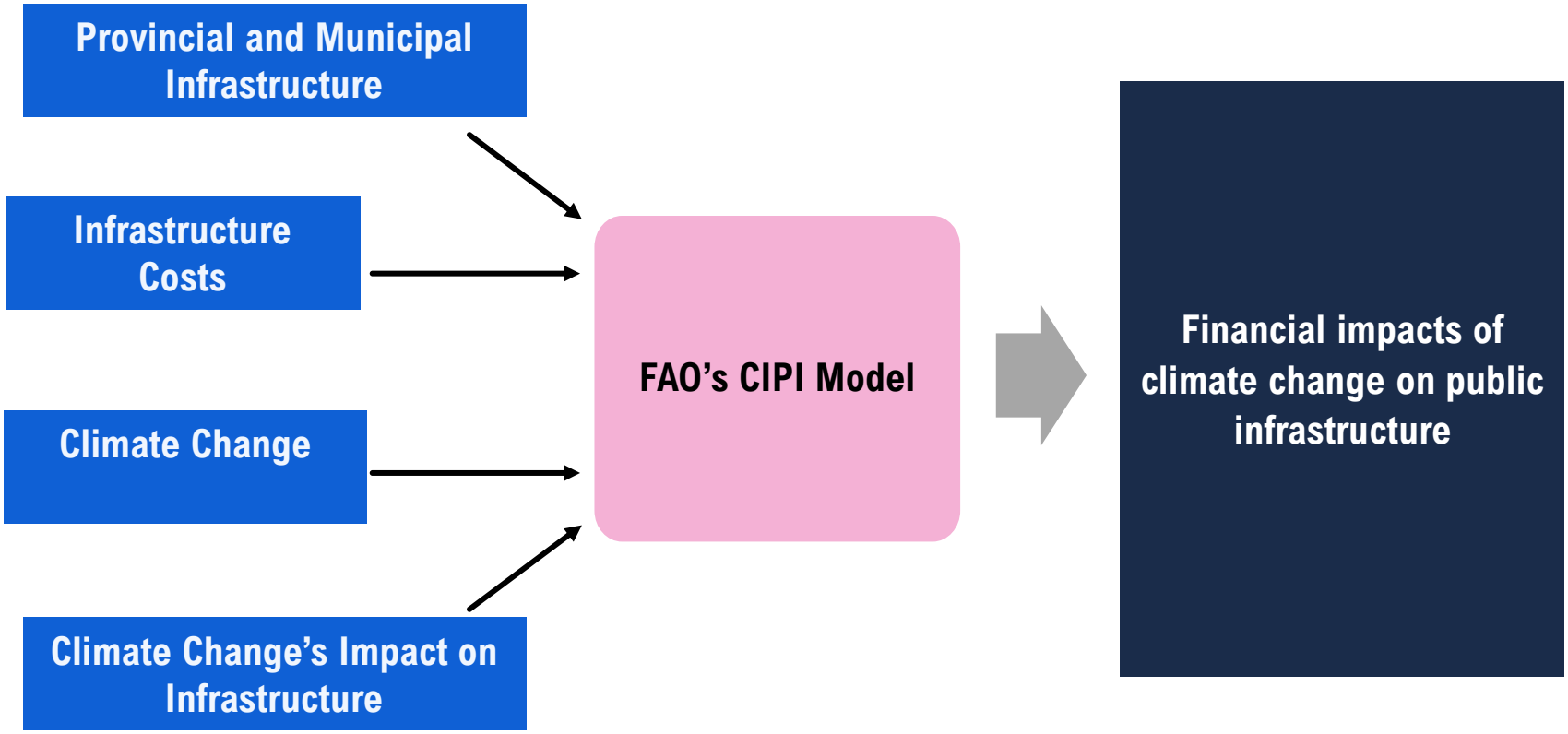
Source: FAO.

Estimating adaptation costs

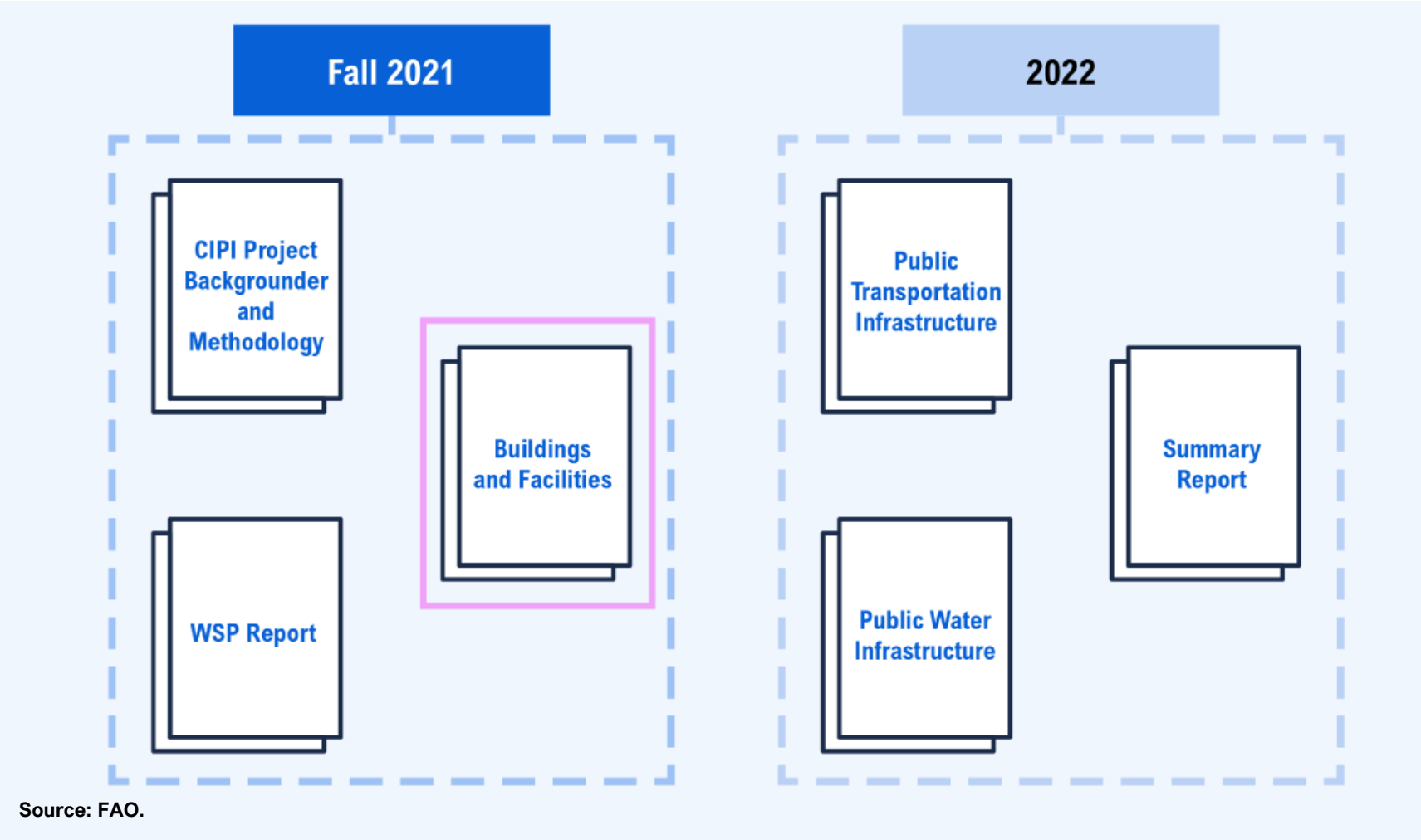


Source: FAO.

Incorporate all these aspects in a model that captures the costs of climate change

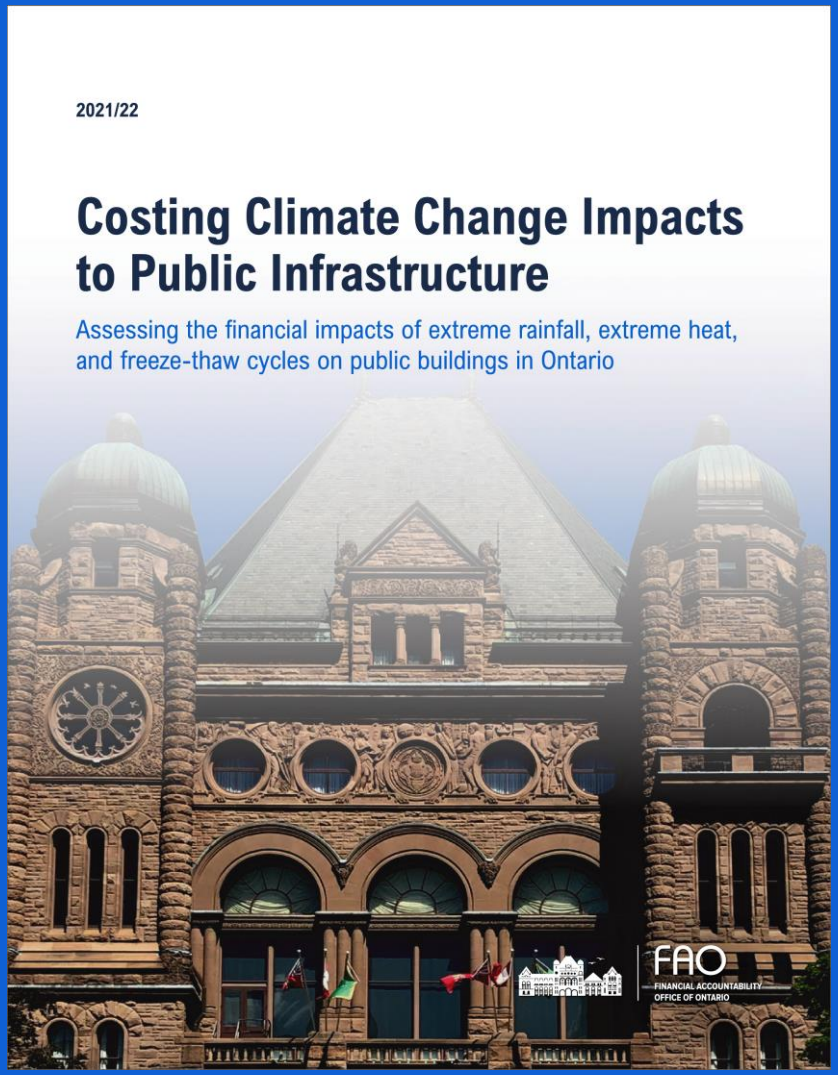


CIPI Project Structure

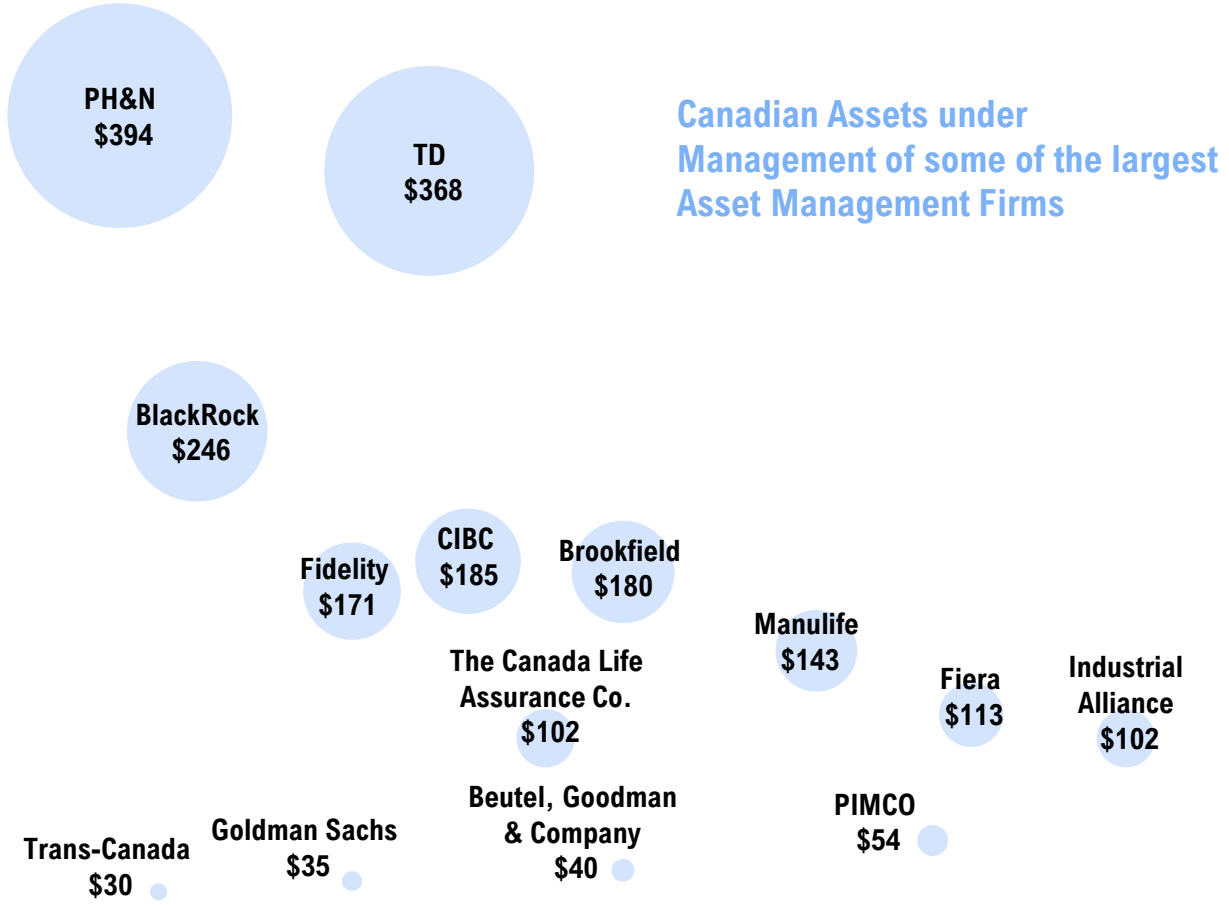


Source: FAO.

Results from CIPI Buildings Report



Ontario has a large portfolio of public buildings and facilities

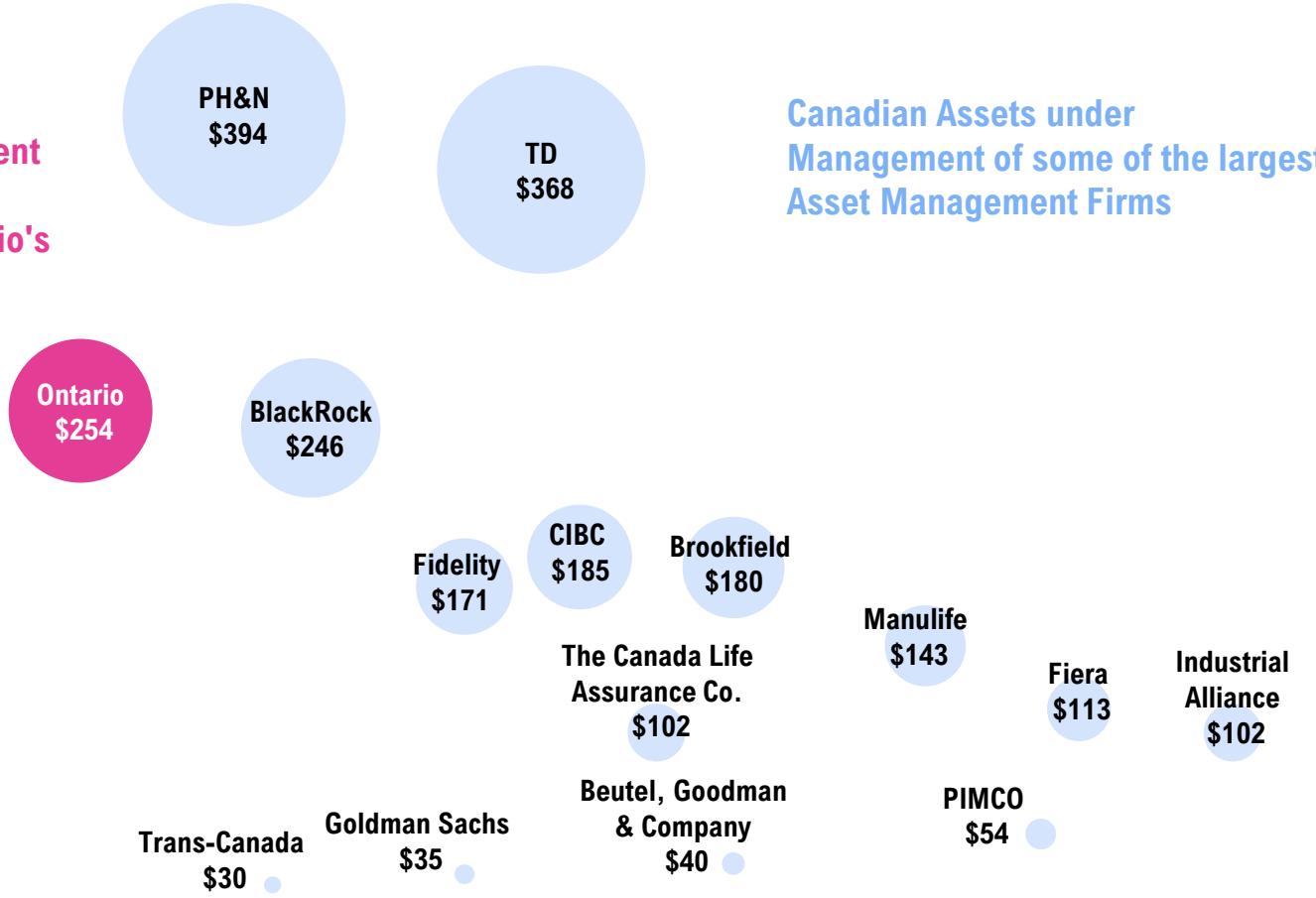


Ontario CRV Values in 2020 Billion $.
Source: FAO & 2021 Top 40 Money Managers Report.

Ontario has a large portfolio of public buildings and facilities

Current Replacement Value of buildings managed by Ontario's Provincial and Municipal governments

Canadian Assets under Management of some of the largest Asset Management Firms



Ontario CRV Values in 2020 Billion $.
Source: FAO & 2021 Top 40 Money Managers Report.

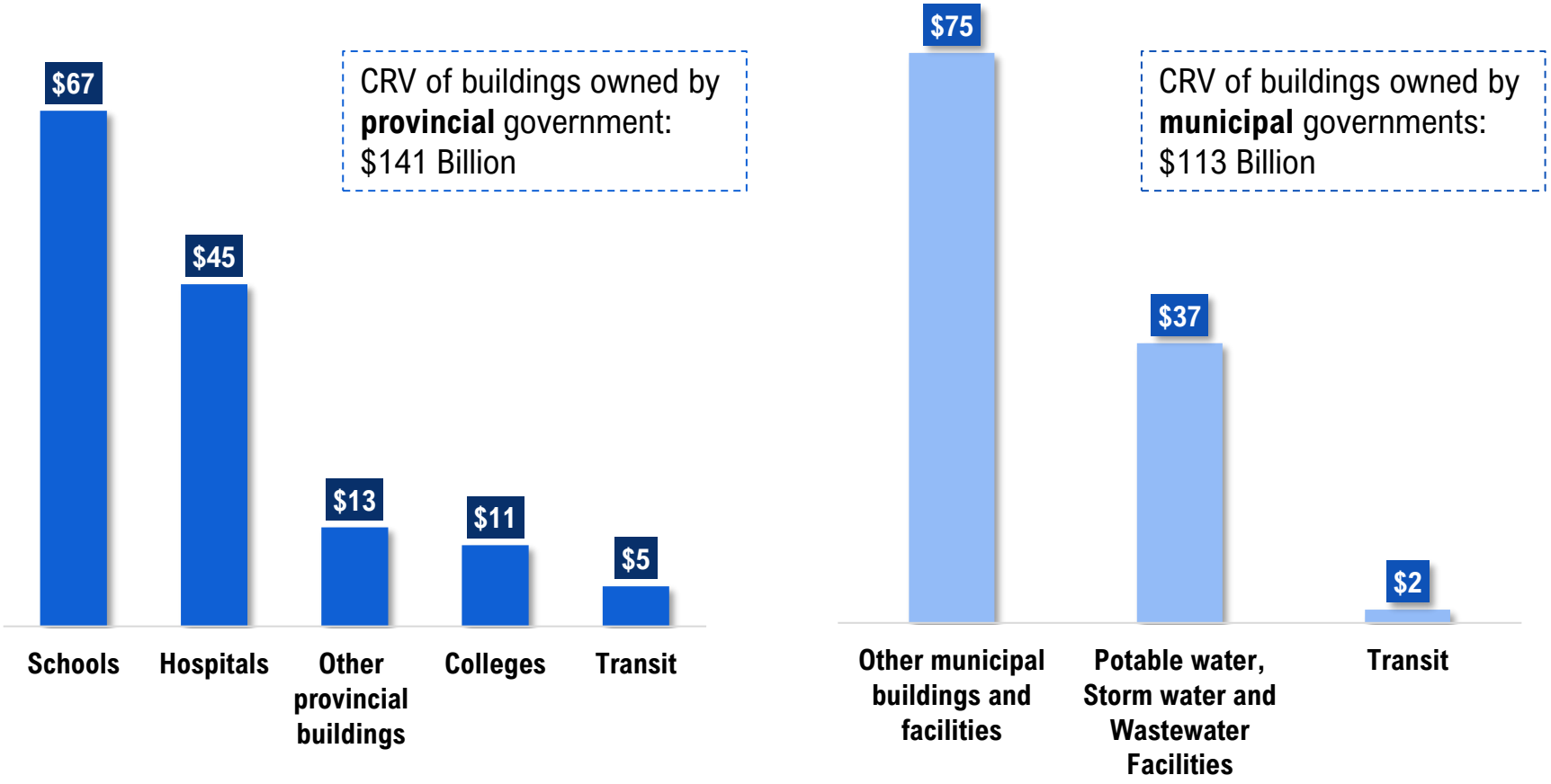
The CIPI buildings report examines the following questions in the context of this portfolio

1 | Baseline Cost in a stable climate

2 | Impacts of climate change on baseline cost in absence of adaptation

3 | Impact of climate change on baseline cost if adaptation actions are undertaken

The $254 billion includes critical building infrastructure



2020$, Billions.
Percentages are share of total building CRV. Federal infrastructure was excluded.
Source: FAO.

These assets need regular spending, even if the climate remained stable*

Total cost of bringing and maintaining Ontario's buildings portfolio into a state of good repair 2022-2100

$799 billion
($10 billion per year)

Total cost by spending type 2022-2100

Operations and Maintenance Expense
$296 billion
($4 billion per year)

Rehabilitation and Renewal
$503 billion
($6 billion per year)

*** A "stable climate" means that all climate indicators remain unchanged from their 1975-2005 average levels over the projection to 2100.**

Note: All values presented in real 2020 dollars.
Source: FAO.

The CIPI buildings report examines the following questions in the context of this portfolio over the 2022-2100 period

1 | Baseline Cost of maintaining Ontario's public buildings in a stable climate

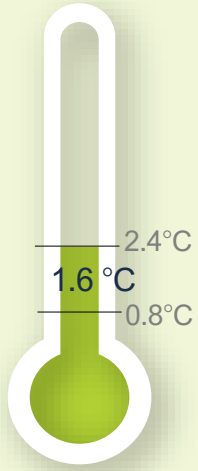
Baseline
$799 Billion

2 | How climate change impacts baseline cost in absence of adaptation

3 | How climate change impacts baseline cost if adaptation actions are undertaken

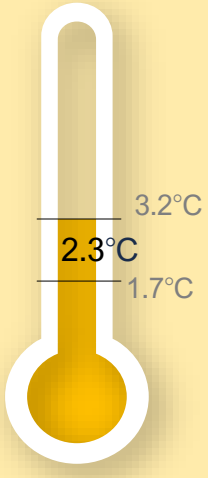
The climate has changed, and the global mean temperature is rising

Low Emissions Scenario



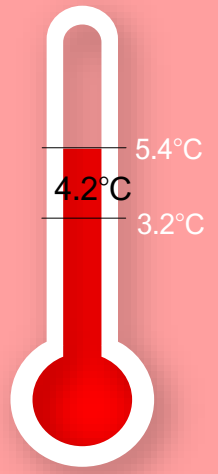
Major and immediate turnaround in global climate policy

Medium Emissions Scenario



Global emissions peak in the 2040s

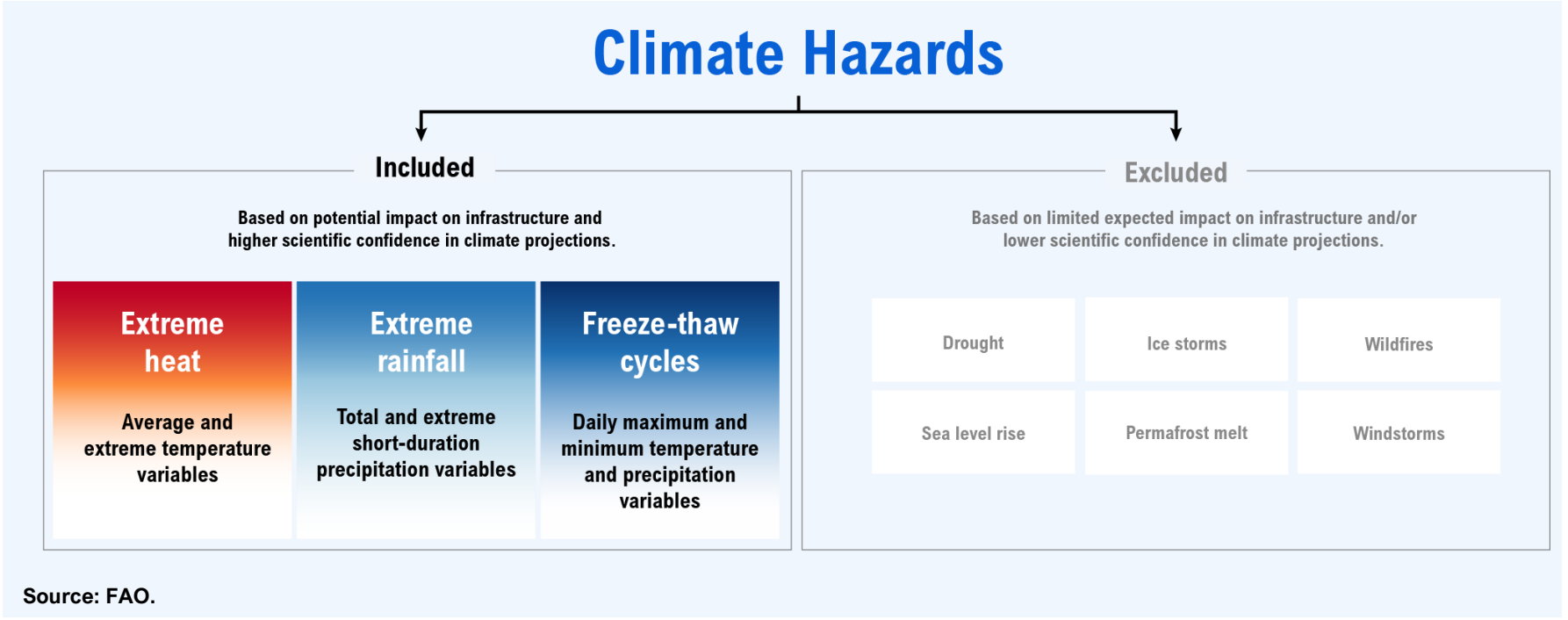
High Emissions Scenario



Global emissions continue to grow for most of the century

*To account for uncertainty in climate projections and in line with common practice in climate science, the median (50th percentile) projections of climate variables are presented, followed by ranges in parentheses. Ranges for the global mean surface temperature represent the 5th percentile to the 95th percentile projections of models used (Intergovernmental Panel on Climate Change, 2013, Table AII.7.5.)

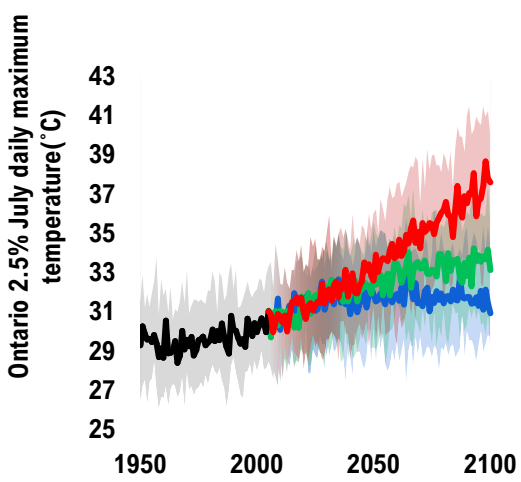
Not all climate hazards are included in the FAO's study



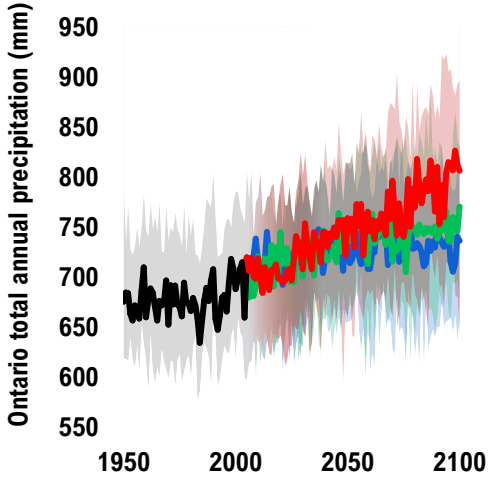
Source: FAO.

Climate change will bring more extreme heat and extreme rainfall, but less freeze-thaw cycles in Ontario

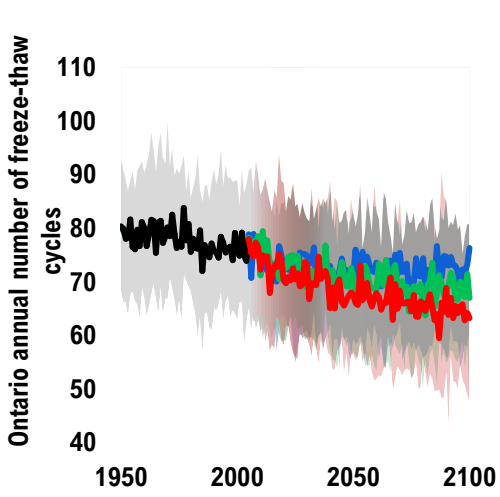
More Extreme Heat



More Extreme Rainfall



Less Freeze-Thaw Cycles



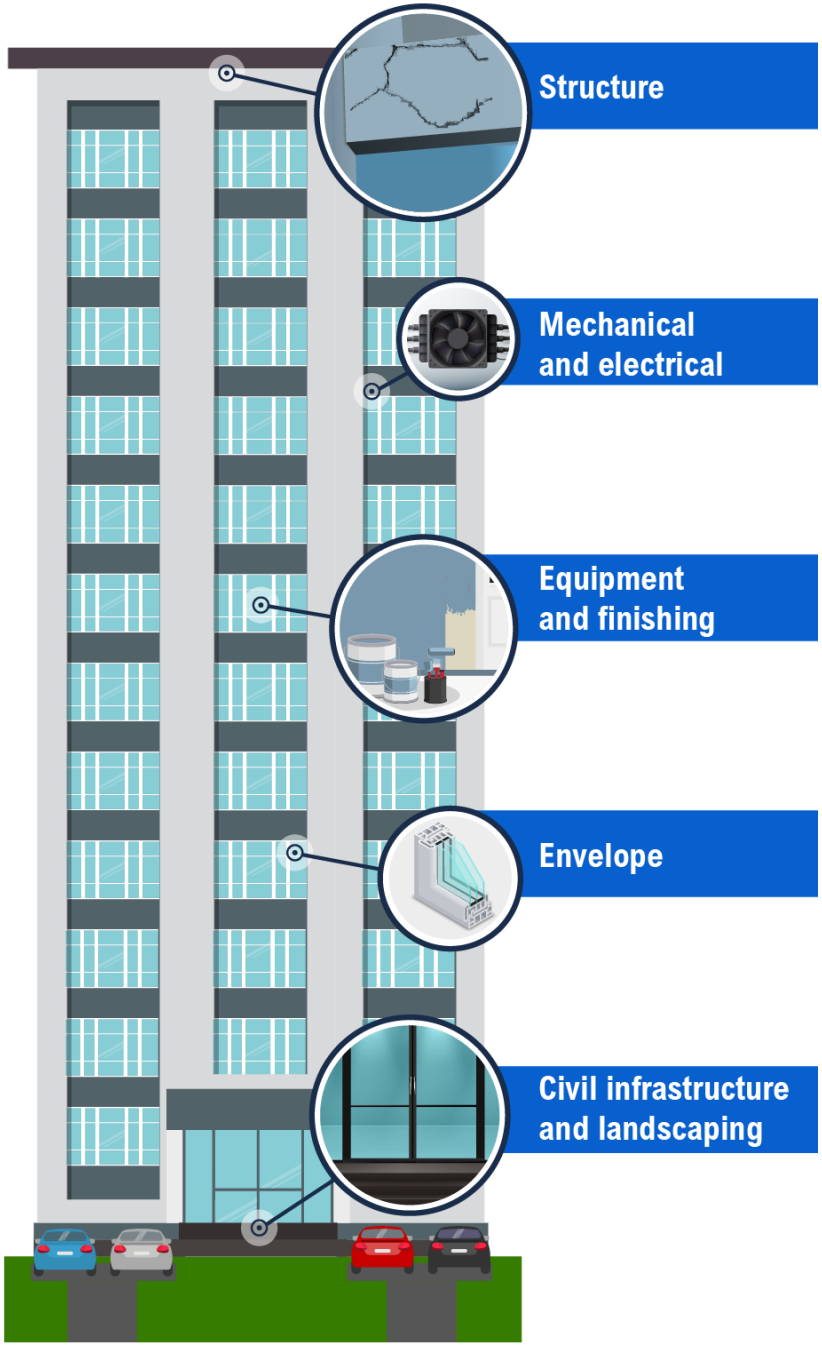
Low emissions scenario | Medium emissions scenario | High emissions scenario

Source: Environment Canada, Canadian Centre for Climate Services.

And this change will impact key components of public buildings

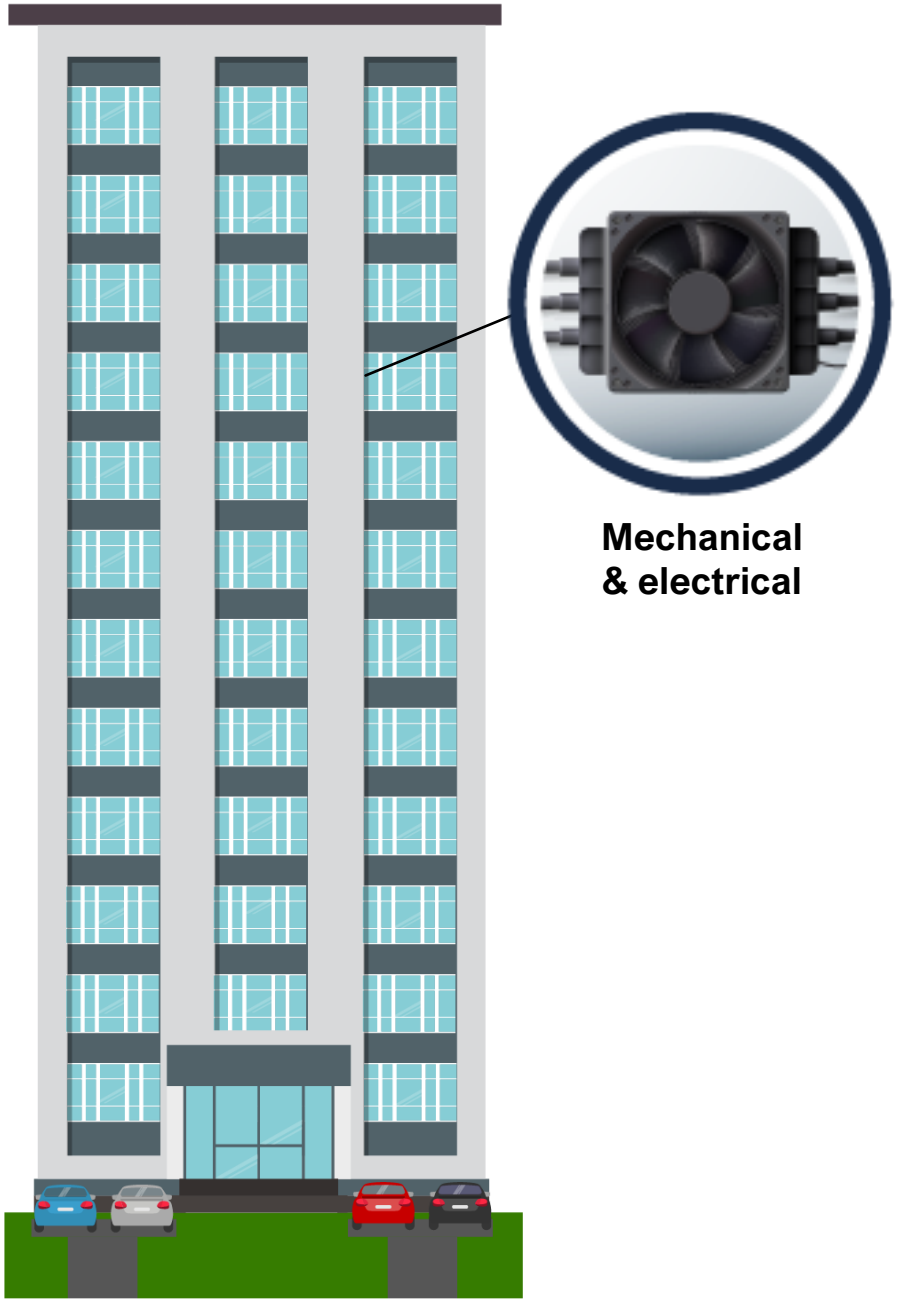
Note: For more examples of how these climate hazards impact building components, see WSP 2021.

Source: WSP.



Example of impact of climate hazard on building component

Extreme heat could put pressure on the capacity of mechanical systems to maintain ambient air in specific conditions.



Note: For more examples of how these climate hazards impact building components, see WSP 2021.

Source: WSP.

Real-life example of impact of climate hazards on building components

VANCOUVER | News

Heat leads to closure of all public schools, some post-secondary in B.C.'s Lower Mainland

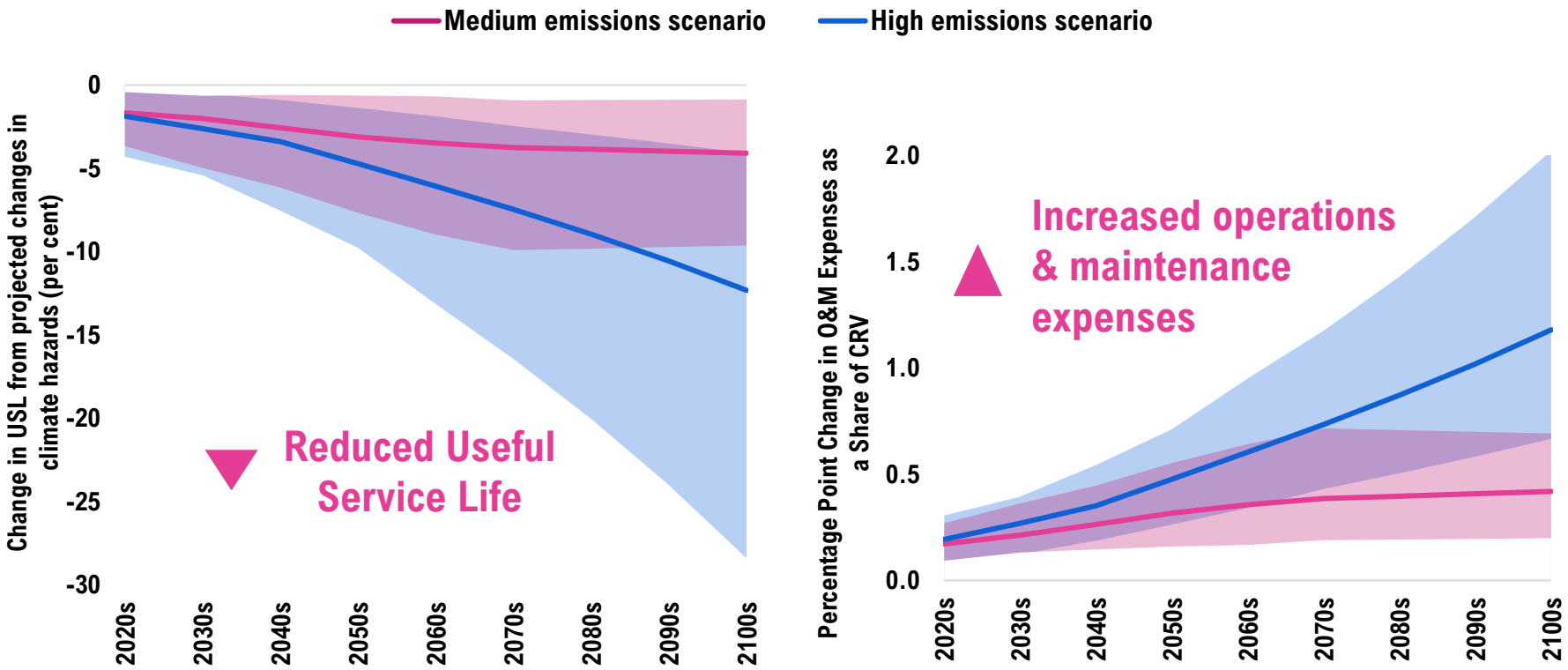
Extreme Heat

Mechanical and electrical component

"Please note that with this heat wave, cooling systems will be challenged and buildings with air conditioning may be warmer than usual, so please dress accordingly. If you must be on Burnaby campus, ensure your supervisor knows and knows where you are working and that you check in regularly to ensure your personal safety."

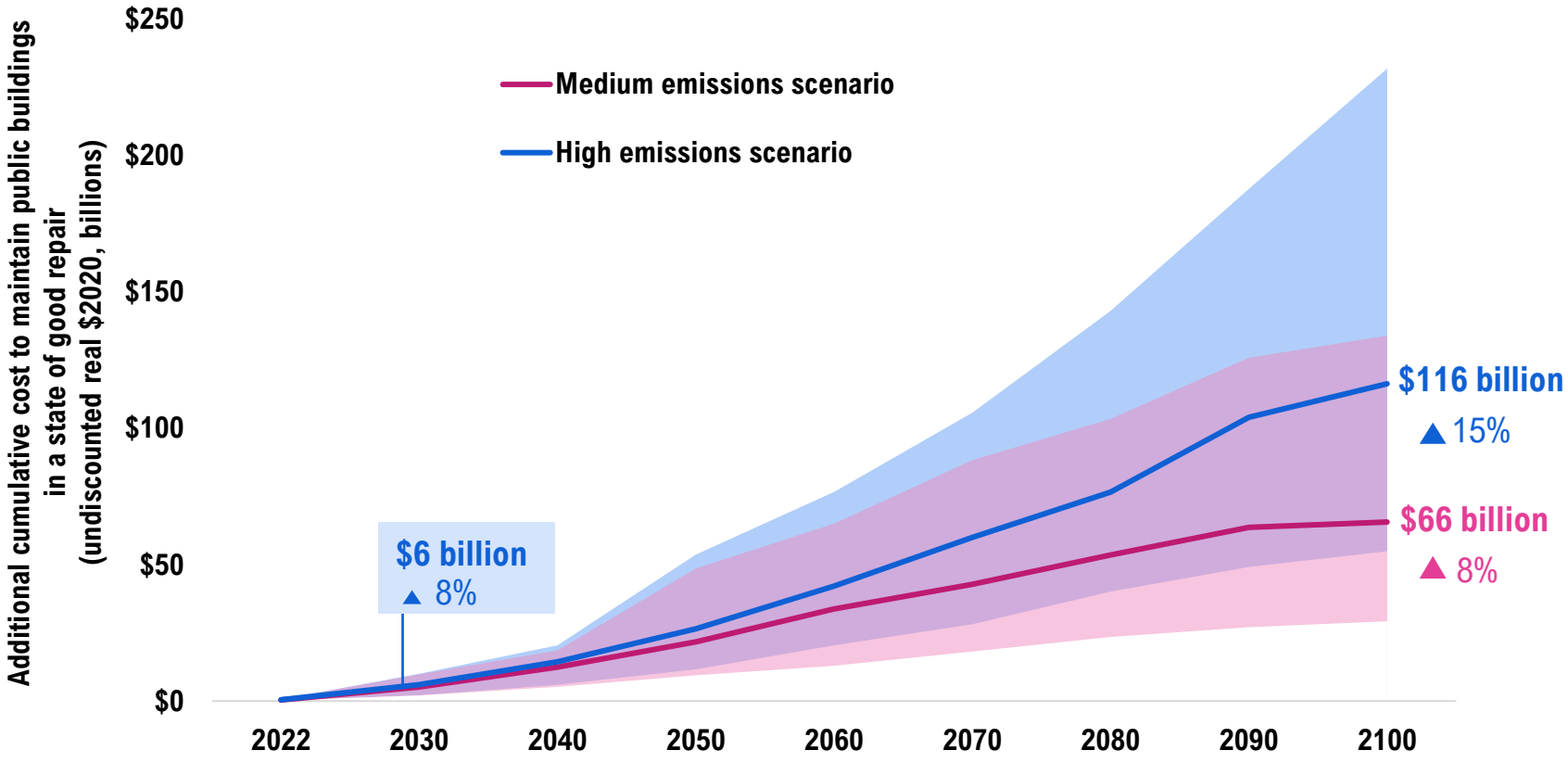
Source: https://bc.ctvnews.ca/heat-leads-to-closure-of-all-public-schools-some-post-secondary-in-b-c-s-lower-mainland-1.5488278

All these damage impacts are modelled through two channels



Note: The solid line is the median (or 50th percentile) climate projection using "most likely" engineering outcomes. The coloured bands represent the range of possible outcomes in each emissions scenario given climate and engineering uncertainty.
Source: WSP and FAO.

Without adaptation, maintaining public buildings under climate change is becoming more expensive



Notes: The solid line is the median (or 50th percentile) projection. The coloured bands represent the range of possible outcomes in each emissions scenario. The costs presented in this chart are in addition to the projected baseline costs over the same period. The per cent changes are the changes relative to baseline costs over the same period.
Source: FAO.

The CIPI buildings report examines the following questions in the context of this portfolio over the 2022-2100 period

1 | Baseline Cost of maintaining Ontario's public buildings in a stable climate

2 | How climate change impacts baseline cost in absence of adaptation

3 | How climate change impacts baseline cost if adaptation actions are undertaken

Baseline
$799 Billion

Medium emissions scenario
$66 Billion
▲ 8%

High emissions scenario
$116 Billion
▲ 15%

Many climate adaptation actions are being considered and implemented

Updating infrastructure design parameter

Source: https://publications.gc.ca/collections/collection_2021/eccc/En4-415-2020-eng.pdf

Many climate adaptation actions are being considered and implemented

Updating infrastructure design parameter

Local jurisdictions in Ontario exploring adaptation options

Ontario

ASSET MANAGEMENT PLANNING FOR MUNICIPAL INFRASTRUCTURE (O.Reg.588/17)

Consider actions to address vulnerabilities caused by climate change

Source: https://www.ontario.ca/laws/regulation/r17588

Many climate adaptation actions are being considered and implemented

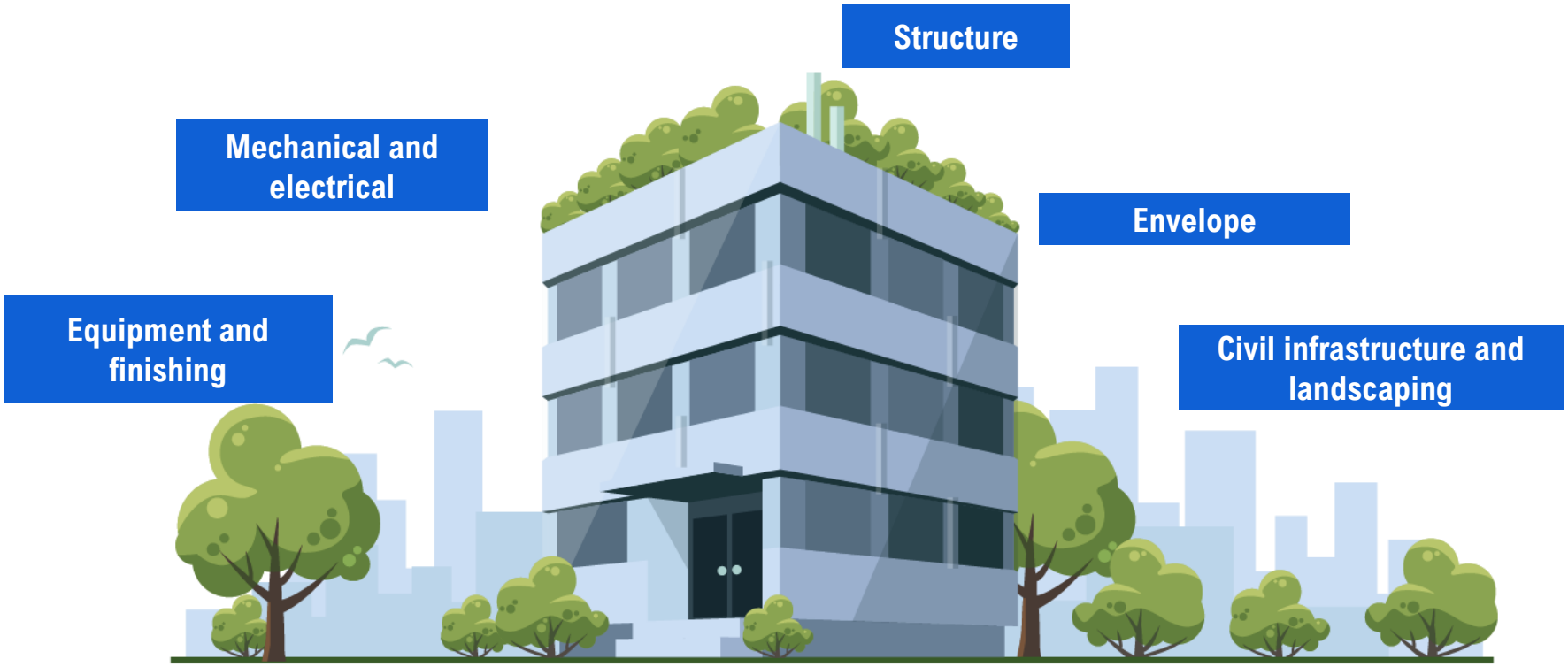
Updating infrastructure design parameter

Local jurisdictions in Ontario exploring adaptation options

Enhancing surrounding environment of vulnerable area

Source: https://portlandsto.ca/wp-content/uploads/FINAL-PIC-Deck-PLFP-Aug-5-reduced.pdf

And building components can be adapted in different ways to extreme rainfall and heat



Note: For more examples of how these climate hazards impact building components, see WSP 2021.
Source: WSP.

And building components can be adapted in different ways to extreme rainfall and heat

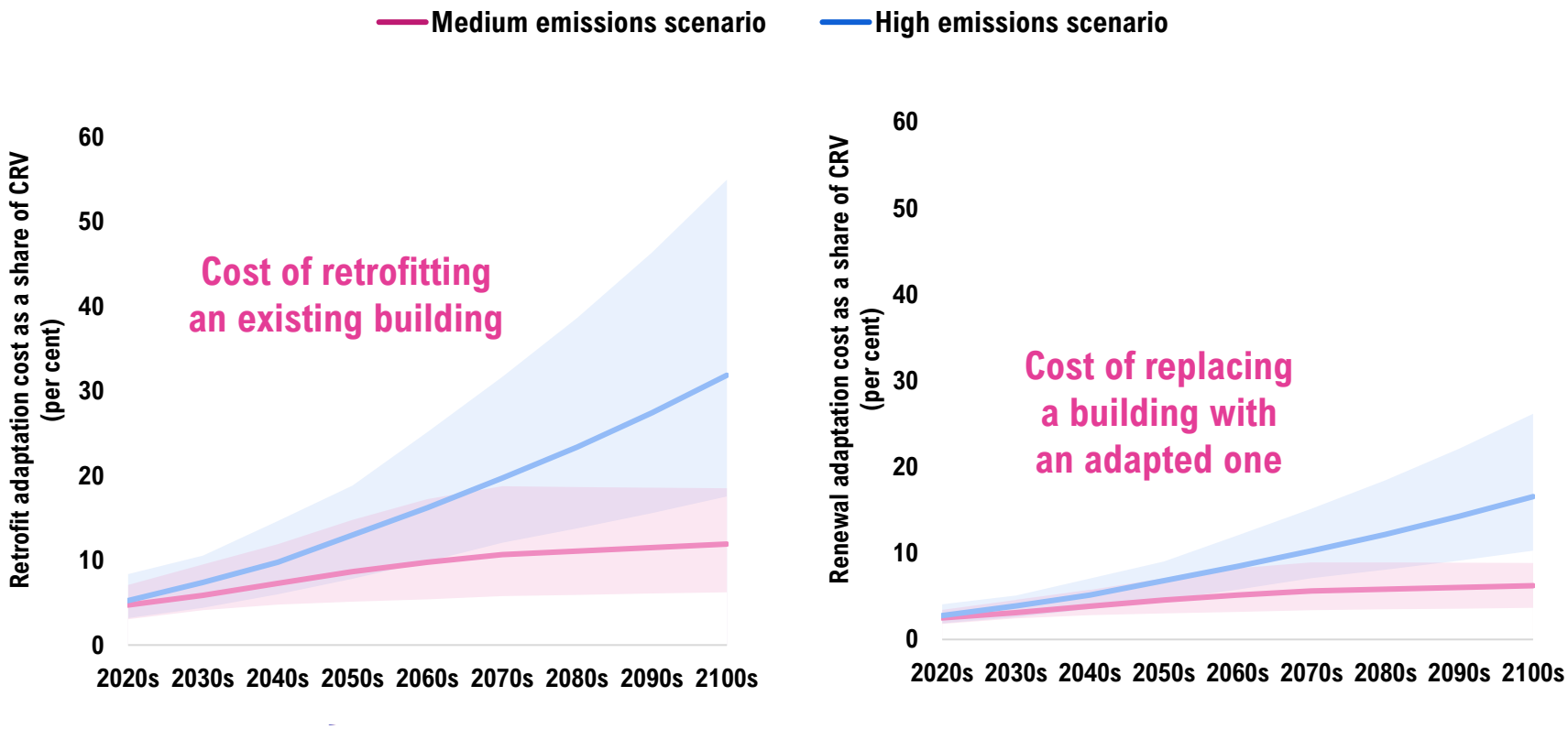
Mechanical & electrical

Examples

Added cooling capacity

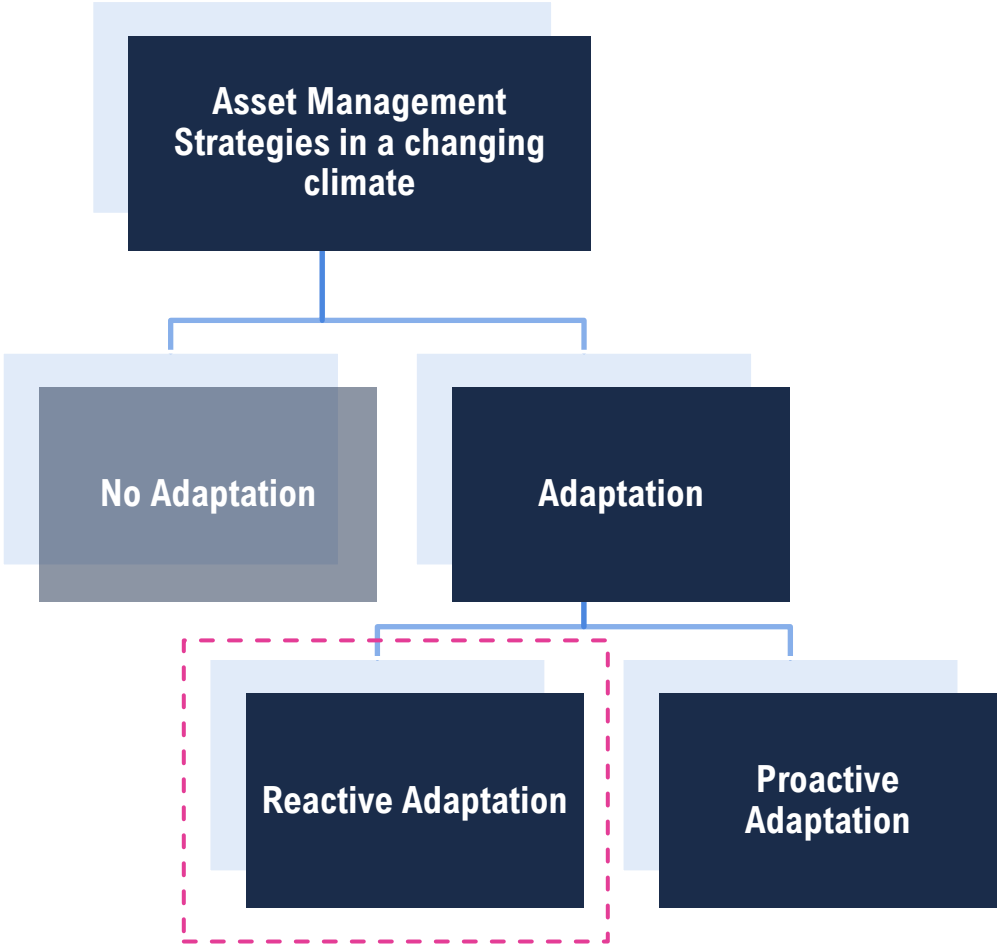
Note: For more examples of how these climate hazards impact building components, see WSP 2021.
Source: WSP.

Cost of adapting a building to extreme rainfall and heat were estimated by WSP



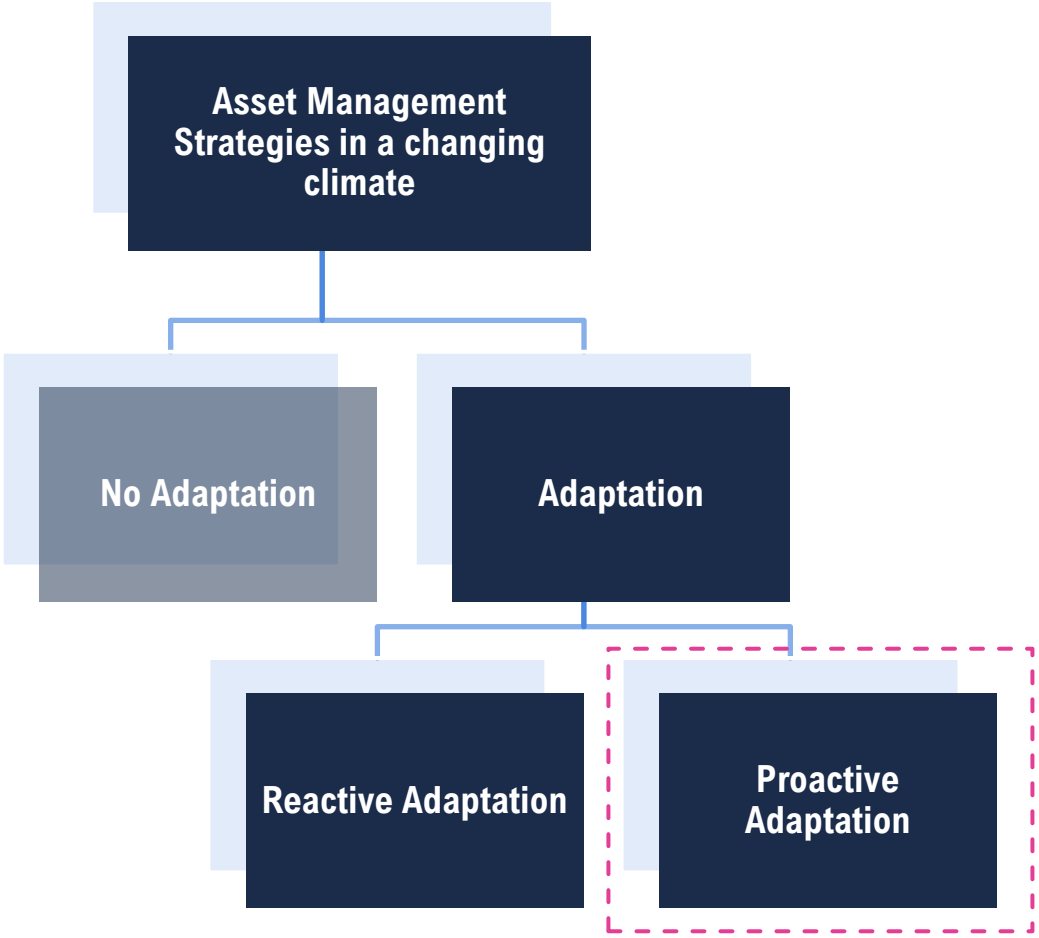
Note: The solid line is the median (or 50th percentile) climate projection using "most likely" engineering outcomes. The coloured bands represent the range of possible outcomes in each emissions scenario given climate and engineering uncertainty.
Source: WSP and FAO.

The FAO costed two adaptation strategies



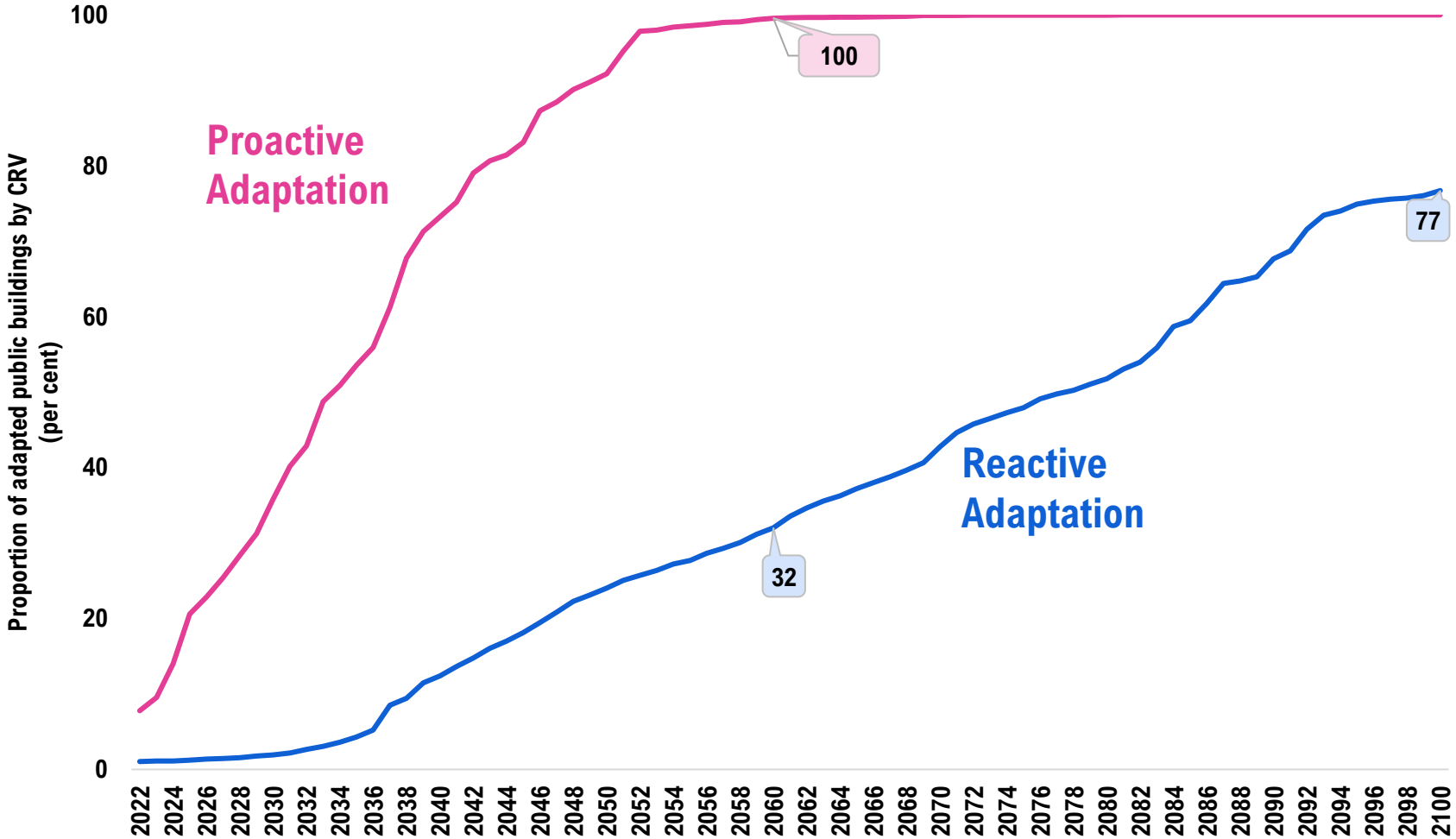
Assets adapted at the end of service life

The FAO costed two adaptation strategies



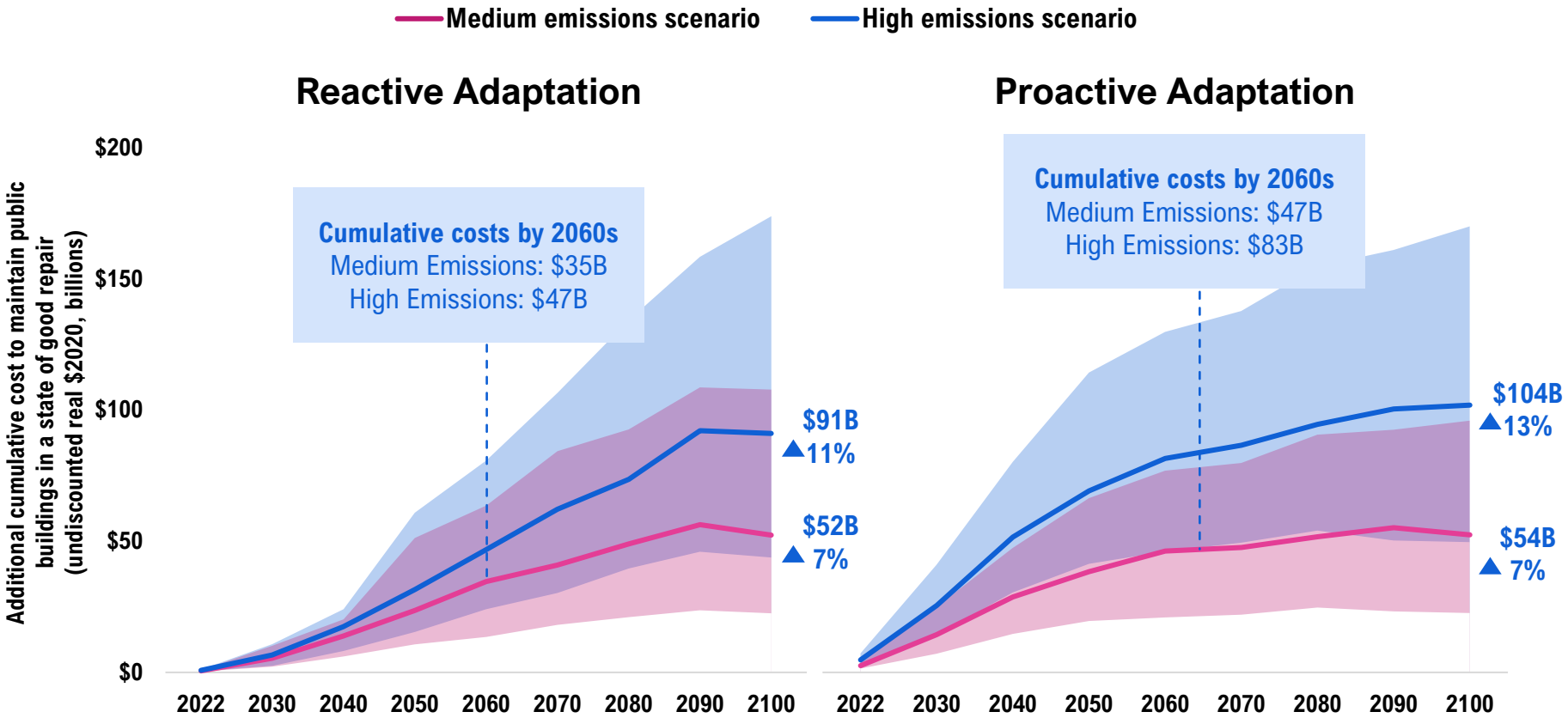
Assets mostly adapted during their service life through retrofits

Reactive adaptation strategy results in slower adaptation



Source: FAO.

Adaptation of public buildings will require significant investments



Notes: The solid line is the median (or 50th percentile) projection. The coloured bands represent the range of possible outcomes in each emissions scenario. The costs presented in this chart are in addition to the projected baseline costs over the same period.
Source: FAO.

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Baseline
$799 Billion

2 | How climate change impacts that cost in absence of adaptation

Medium emissions scenario
$66 Billion
▲ 8%

High emissions scenario
$116 Billion
▲ 15%

3 | How climate change impacts that cost if adaptation actions are undertaken

Medium emissions scenario
Reactive: $52 Billion
▲ 7%
Proactive: $54 Billion
▲ 7%

High emissions scenario
Reactive: $91 Billion
▲ 11%
Proactive: $104 Billion
▲ 13%

The CIPI buildings report examines the following questions in the context of this portfolio over the 2022-2100 period

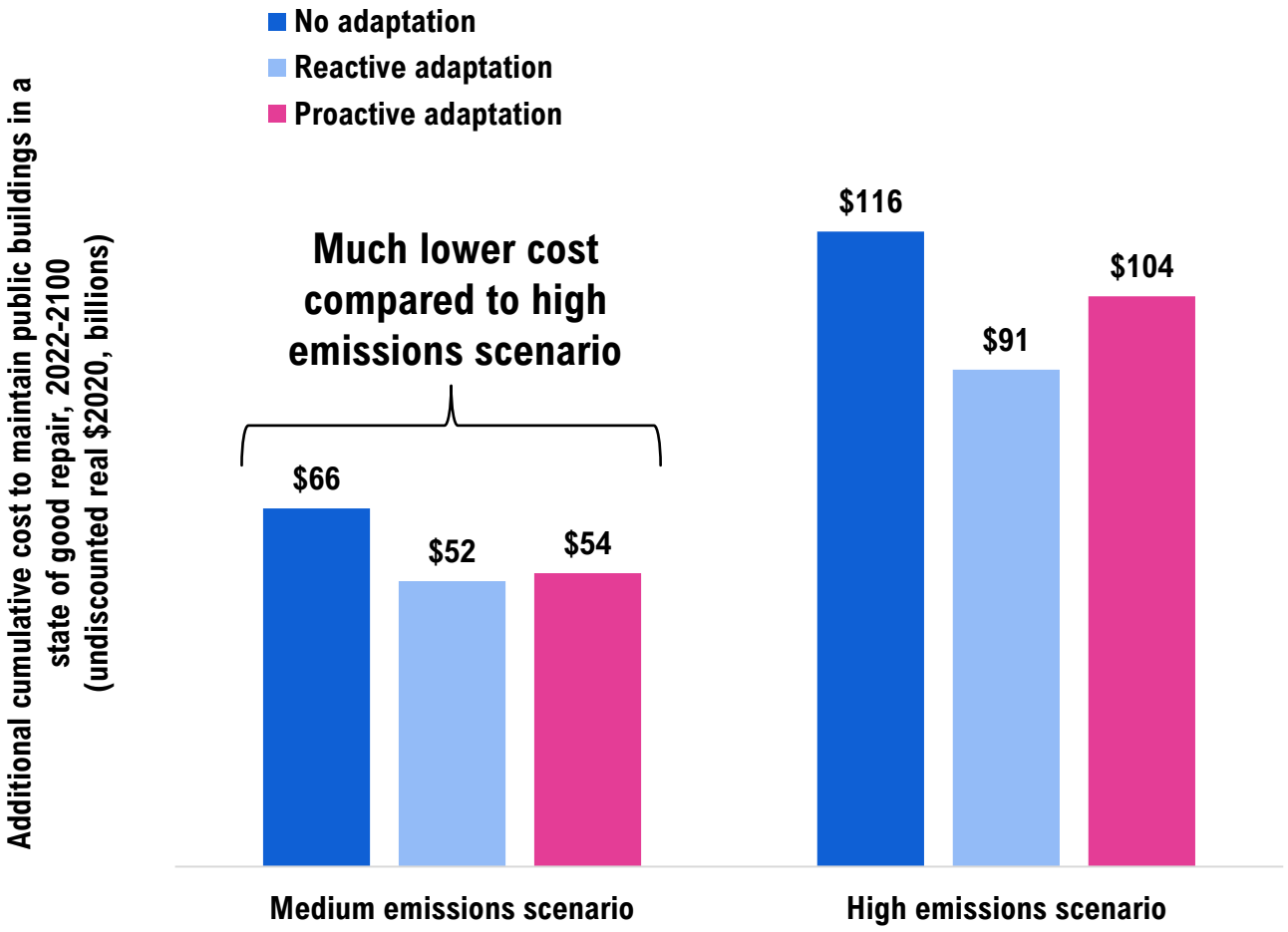
Medium emissions scenario
No Adaptation:$66 Billion
▲ 8%

High emissions scenario
No Adaptation:$116 Billion
▲15%

Medium emissions scenario
Reactive: $52 Billion
▲ 7%
Proactive: $54 Billion
▲ 7%

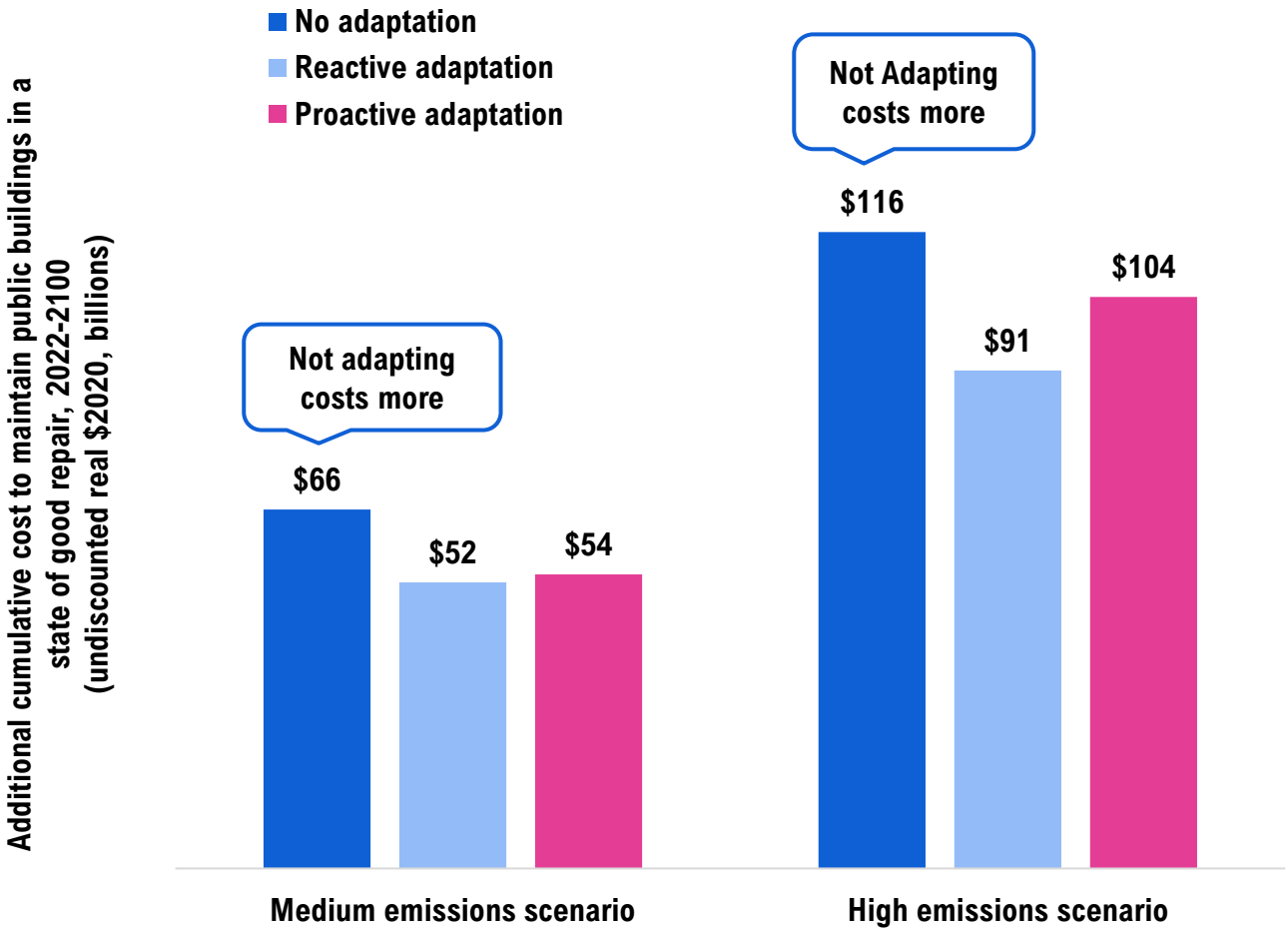
High emissions scenario
Reactive: $91 Billion
▲ 11%
Proactive: $104 Billion
▲ 13%

Comparing the cost of different asset management strategies



Note: The costs presented in this chart are in addition to the baseline costs over the same period.
Determining the most cost-effective strategy for an individual asset would require comparing the costs of different adaptation strategies over its service life, for a broader range of climate hazards and societal costs, and in consideration of its specific circumstances.
Source: FAO.

Comparing the cost of different asset management strategies



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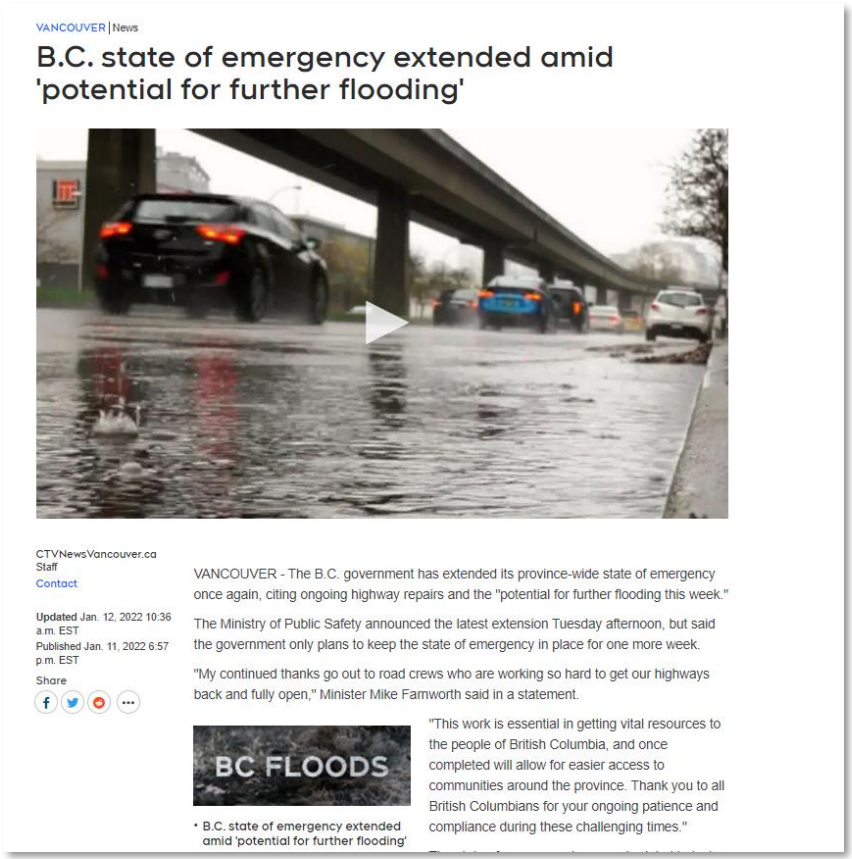
Examples of indirect damage cost



VANCOUVER | News

B.C. state of emergency extended amid 'potential for further flooding'

CTVNewsVancouver.ca Staff
Contact

Updated Jan. 12, 2022 10:36 a.m. EST
Published Jan. 11, 2022 6:57 p.m. EST

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VANCOUVER - The B.C. government has extended its province-wide state of emergency once again, citing ongoing highway repairs and the "potential for further flooding this week."

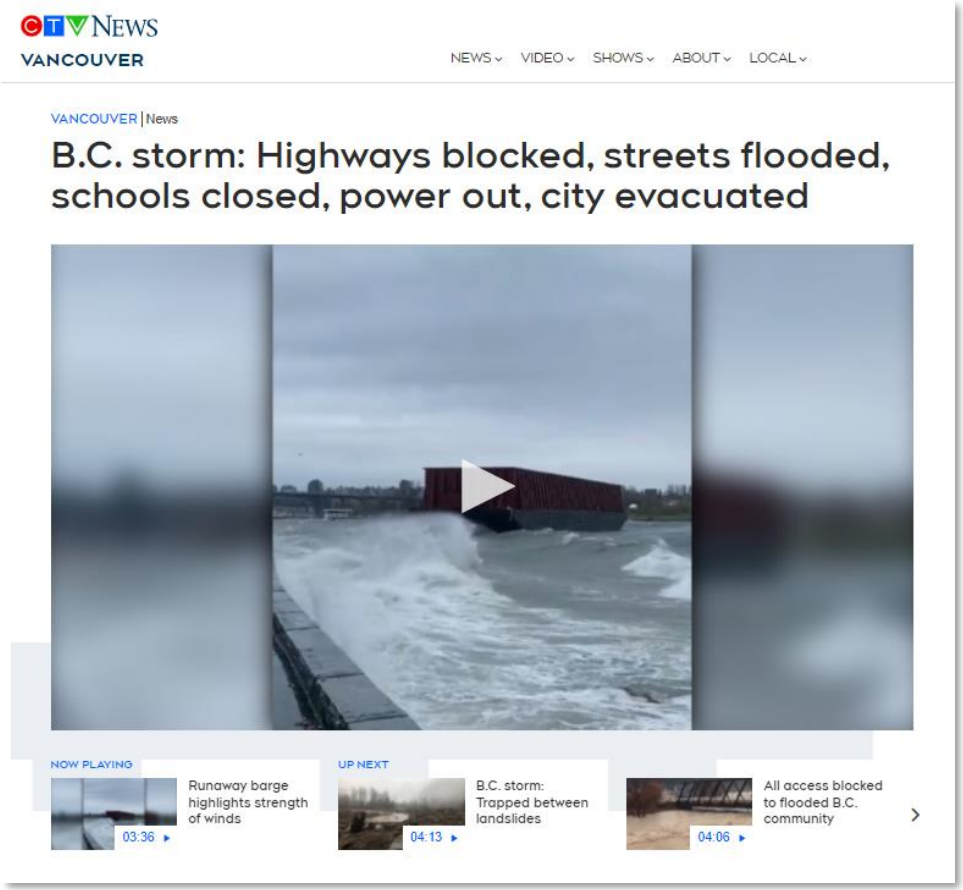
The Ministry of Public Safety announced the latest extension Tuesday afternoon, but said the government only plans to keep the state of emergency in place for one more week.

"My continued thanks go out to road crews who are working so hard to get our highways back and fully open," Minister Mike Farnworth said in a statement.

BC FLOODS

• B.C. state of emergency extended amid 'potential for further flooding'

"This work is essential in getting vital resources to the people of British Columbia, and once completed will allow for easier access to communities around the province. Thank you to all British Columbians for your ongoing patience and compliance during these challenging times."



CTV NEWS VANCOUVER

NEWS VIDEO SHOWS ABOUT LOCAL

VANCOUVER | News

B.C. storm: Highways blocked, streets flooded, schools closed, power out, city evacuated

NOW PLAYING

Runaway barge highlights strength of winds 03:36

UP NEXT

B.C. storm: Trapped between landslides 04:13

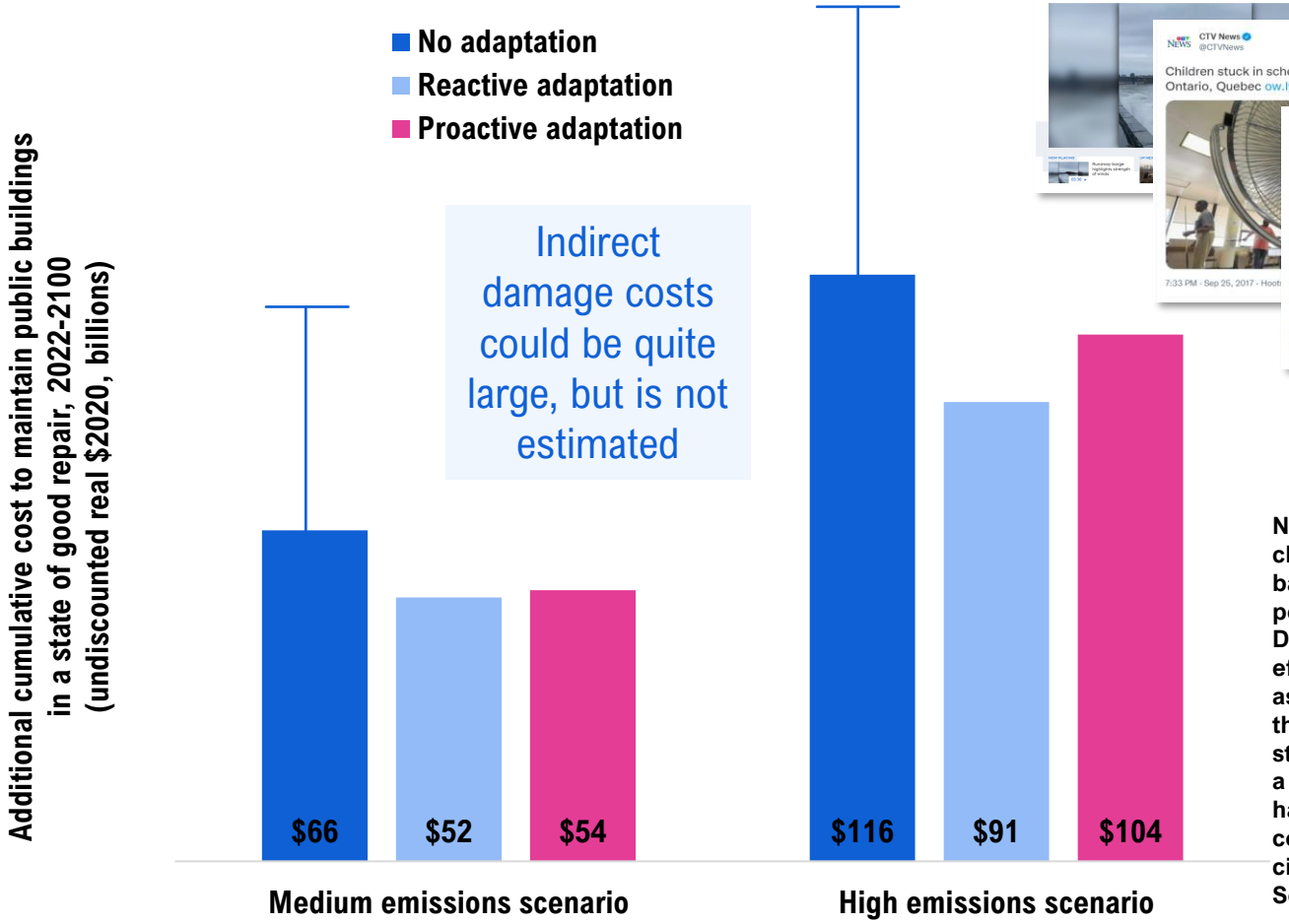
All access blocked to flooded B.C. community 04:06

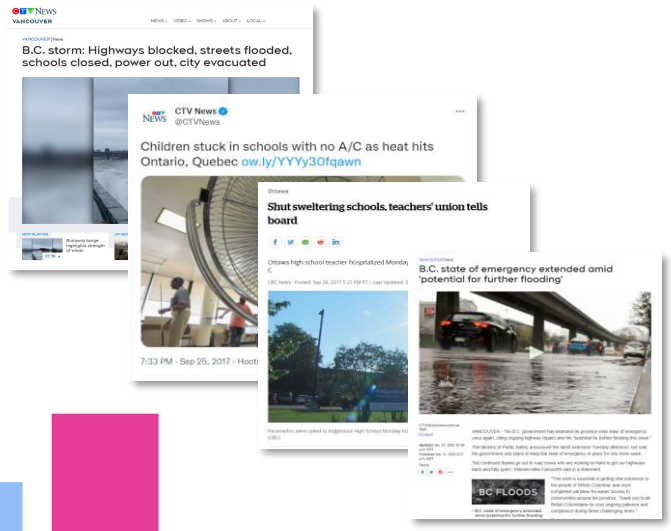
Source: https://bc.ctvnews.ca/b-c-storm-highways-blocked-streets-flooded-schools-closed-power-out-city-evacuated-1.5666709, https://bc.ctvnews.ca/b-c-state-of-emergency-extended-amid-potential-for-further-flooding-1.5736283

Examples of indirect damage cost

Source: https://twitter.com/ctvnews/status/912460177621872641, https://www.cbc.ca/news/canada/ottawa/ridgemont-high-school-heat-staff-member-hospitalized-1.4307559

Comparing the cost of different asset management strategies





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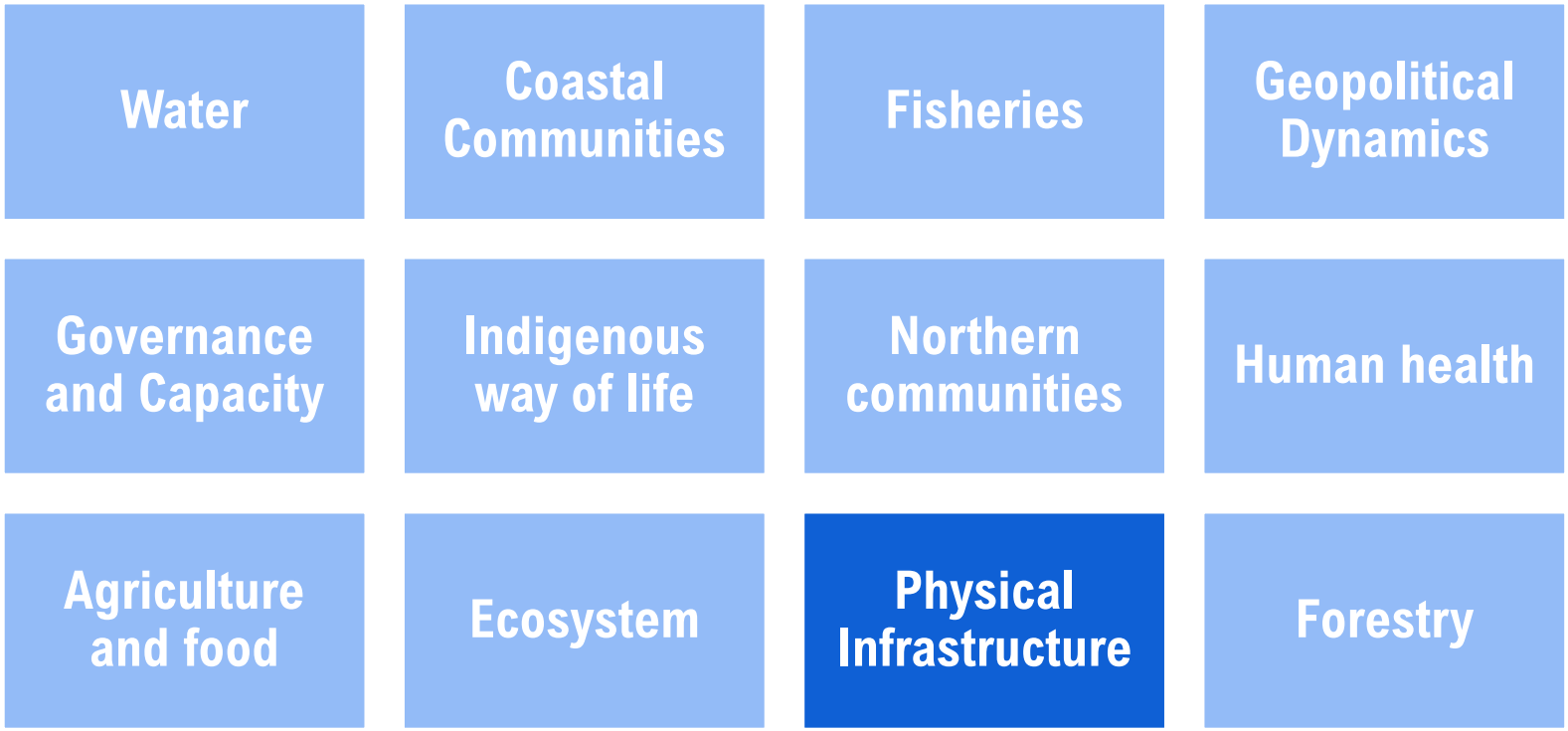
Source: FAO.

The FAO costed a small part of all climate change impacts

Scope of Climate Impacts



Source: Council of Canadian Academies and FAO.

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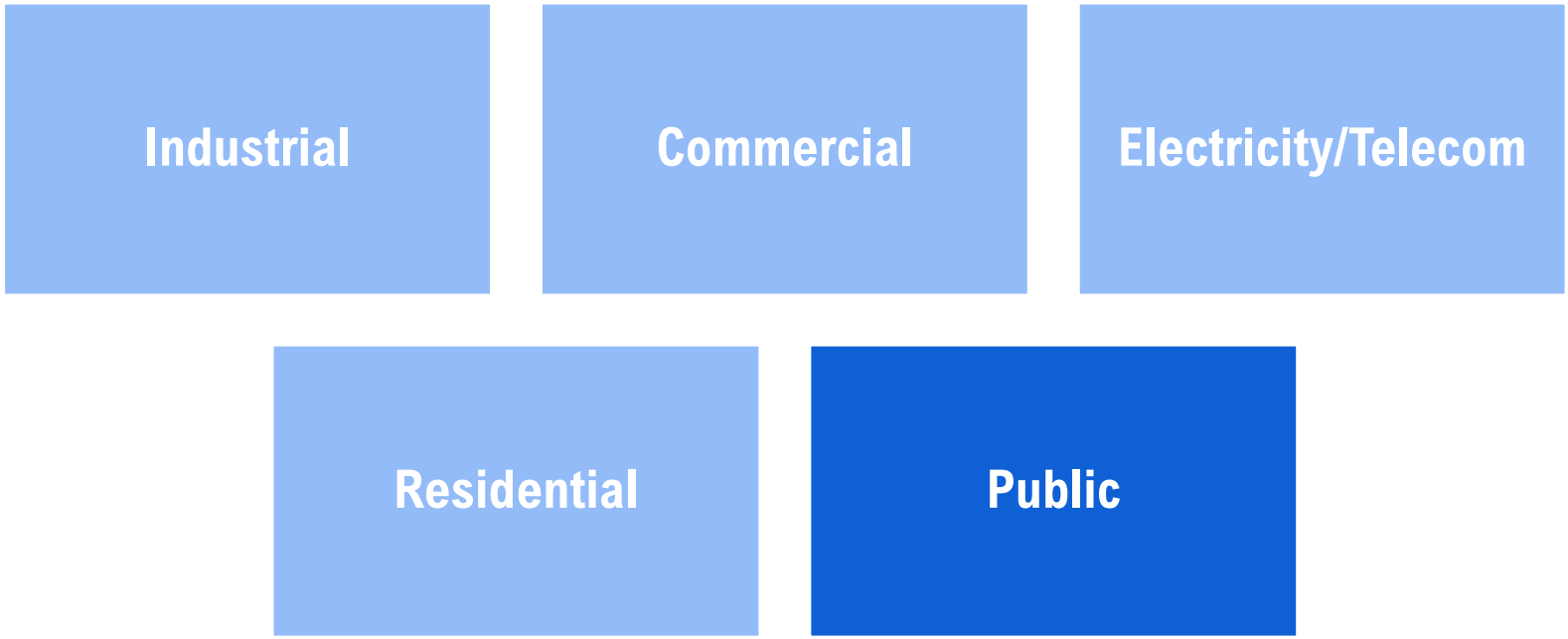
Scope of Physical Infrastructure



Source: Council of Canadian Academies and FAO.

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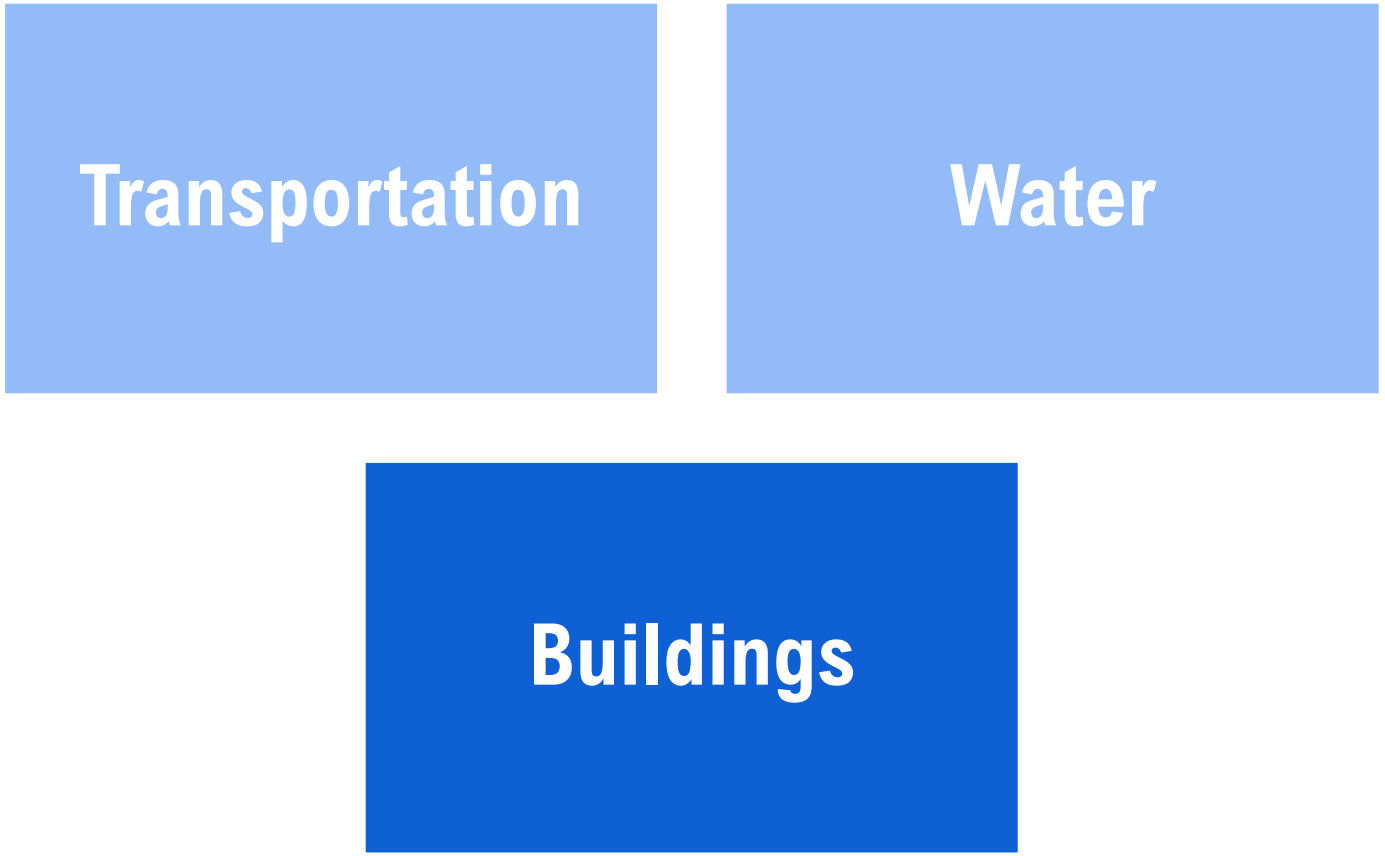
Scope of Public Infrastructure



Source: Council of Canadian Academies and FAO.

The FAO costed a small part of all climate change impacts

Scope of Climate Hazards

Extreme Heat	**Extreme Rainfall**	**Freeze thaw cycles**	Permafrost melt
Windstorms	Sea level rise	Ice storms	Drought
	Wildfires		

Source: Council of Canadian Academies and FAO.

The FAO costed a small part of all climate change impacts

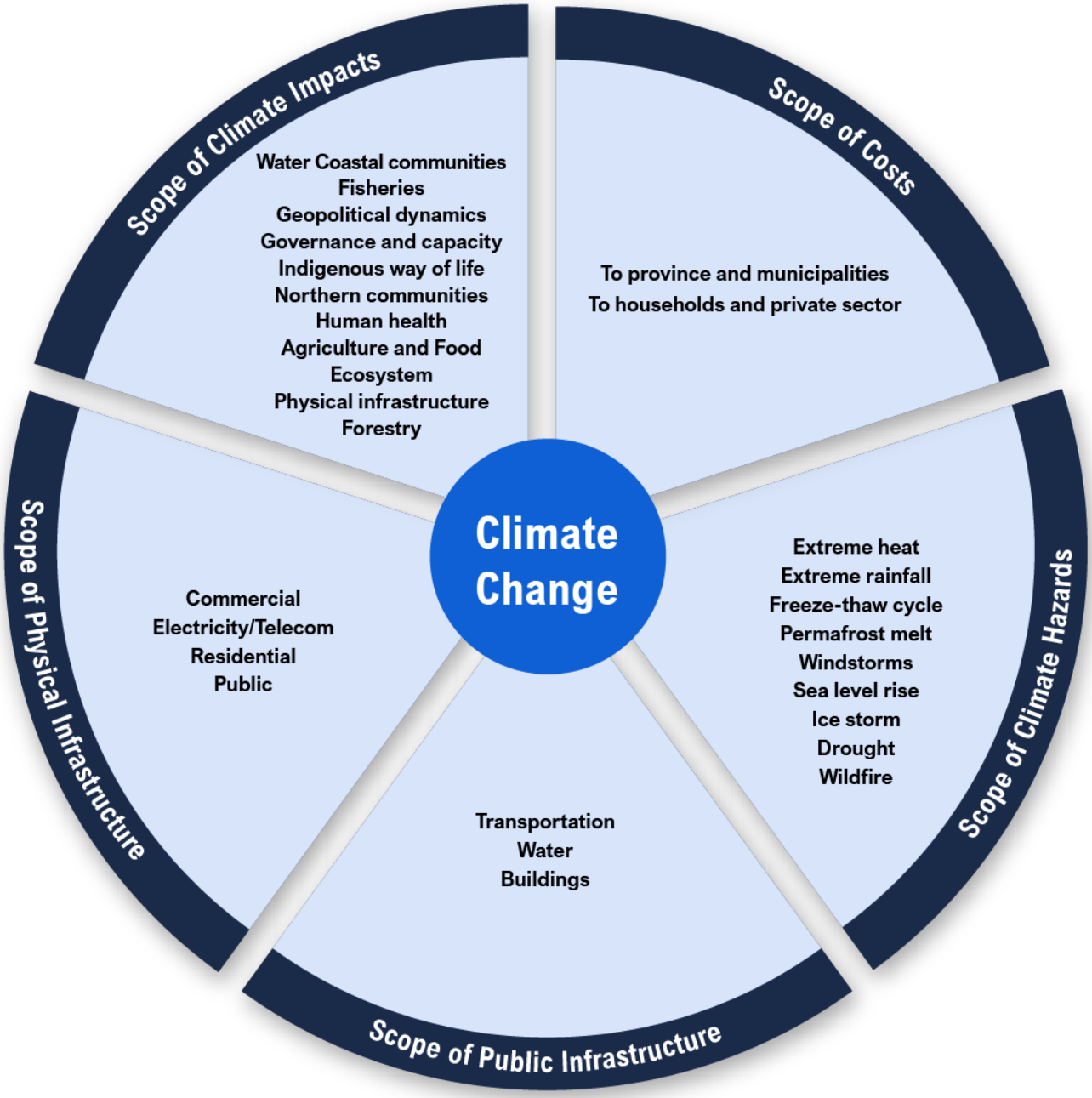
Scope of costs considered

Costs to province and municipalities

Costs to households and private sector

Source: Council of Canadian Academies and FAO.

The FAO costed a small part of all climate change impacts



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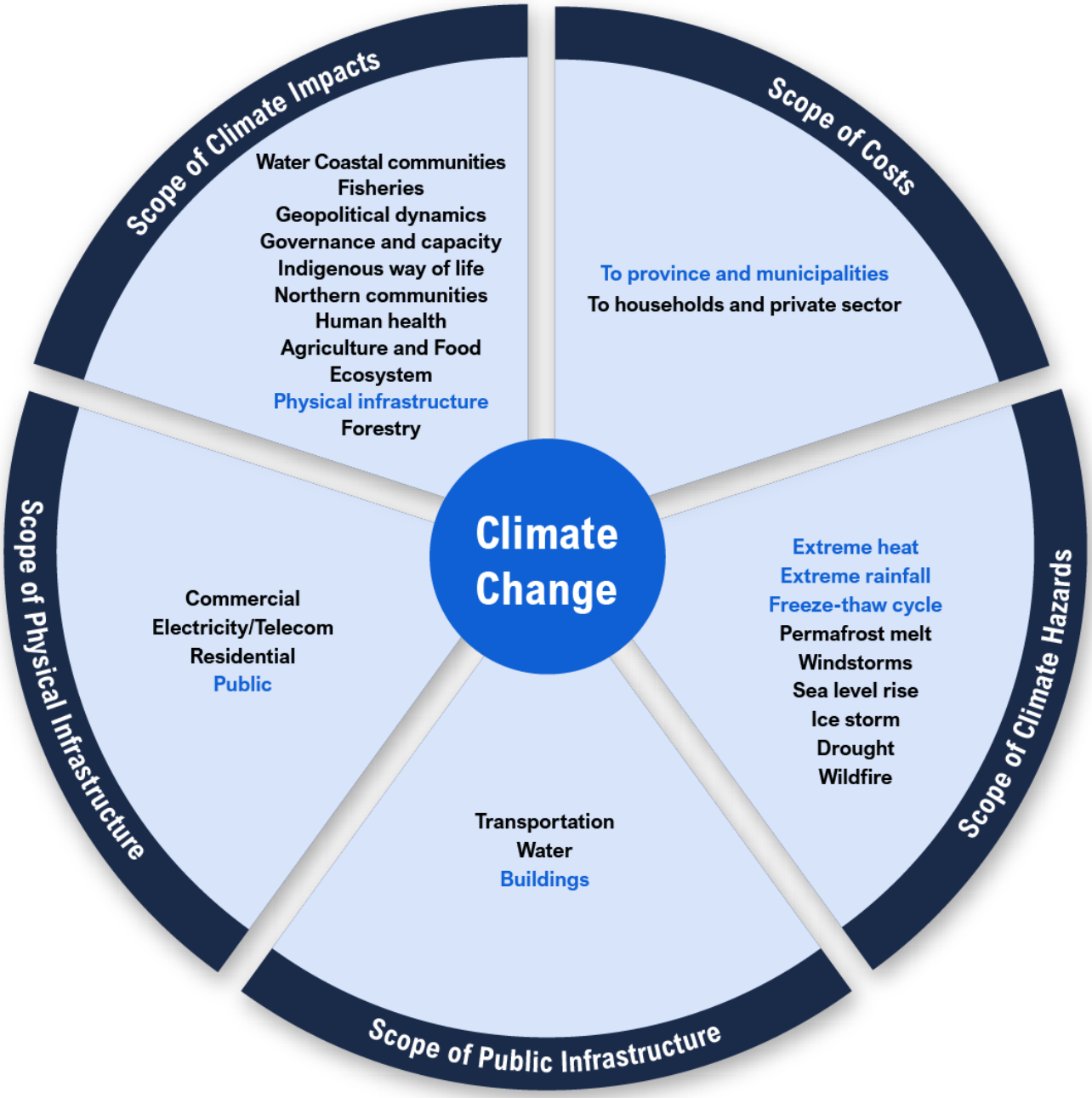

Source: Council of Canadian Academies and FAO.

Climate change will have material impacts on provincial and municipal infrastructure budgets

Source: Photo by Patrick Hendry on Unsplash

- The FAO's portfolio-level results show that climate change will materially increase the cost of maintaining public buildings in Ontario.
- The extent of these additional costs on the province's budget over the long term will depend on how severe global climate change becomes.

Thank you!

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