

CIPI

Costing Climate Change Impacts to Public Infrastructure

BUILDINGS

Assessing the financial impacts of extreme rainfall, extreme heat, and freeze-thaw cycles on public buildings in Ontario



2021/22



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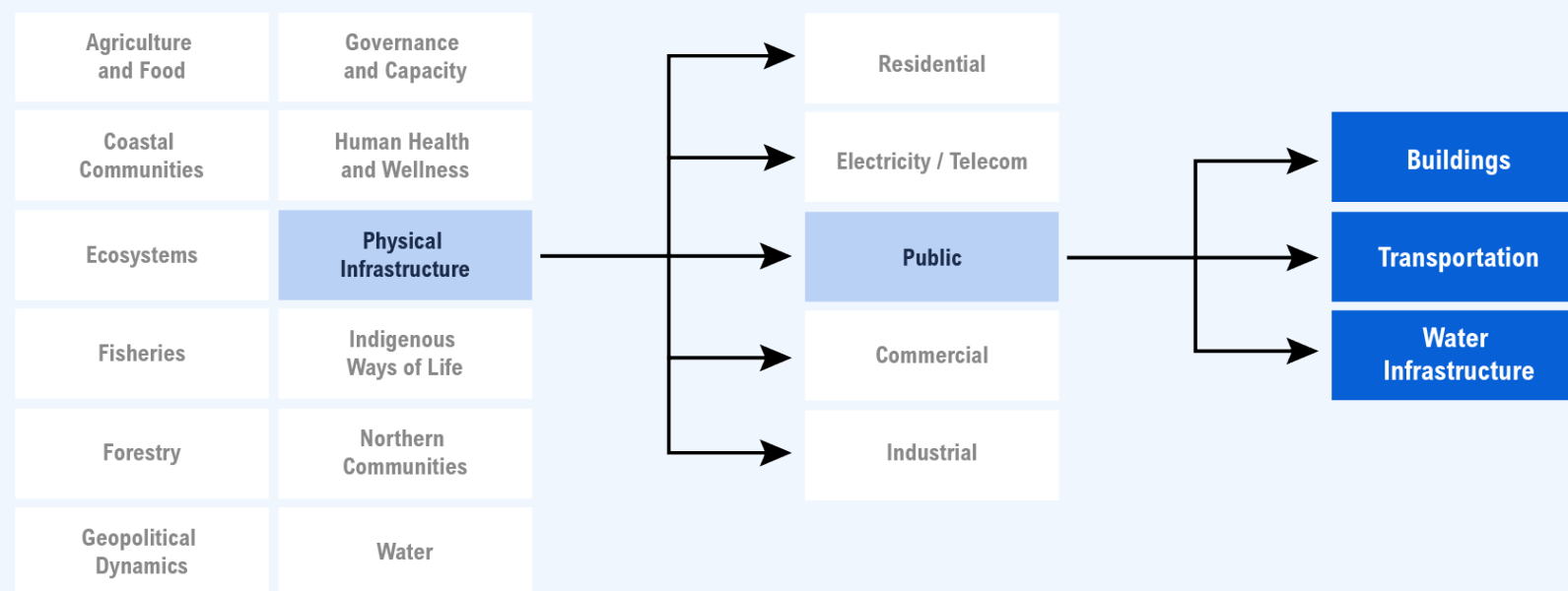


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Climate change is causing costly and disruptive impacts

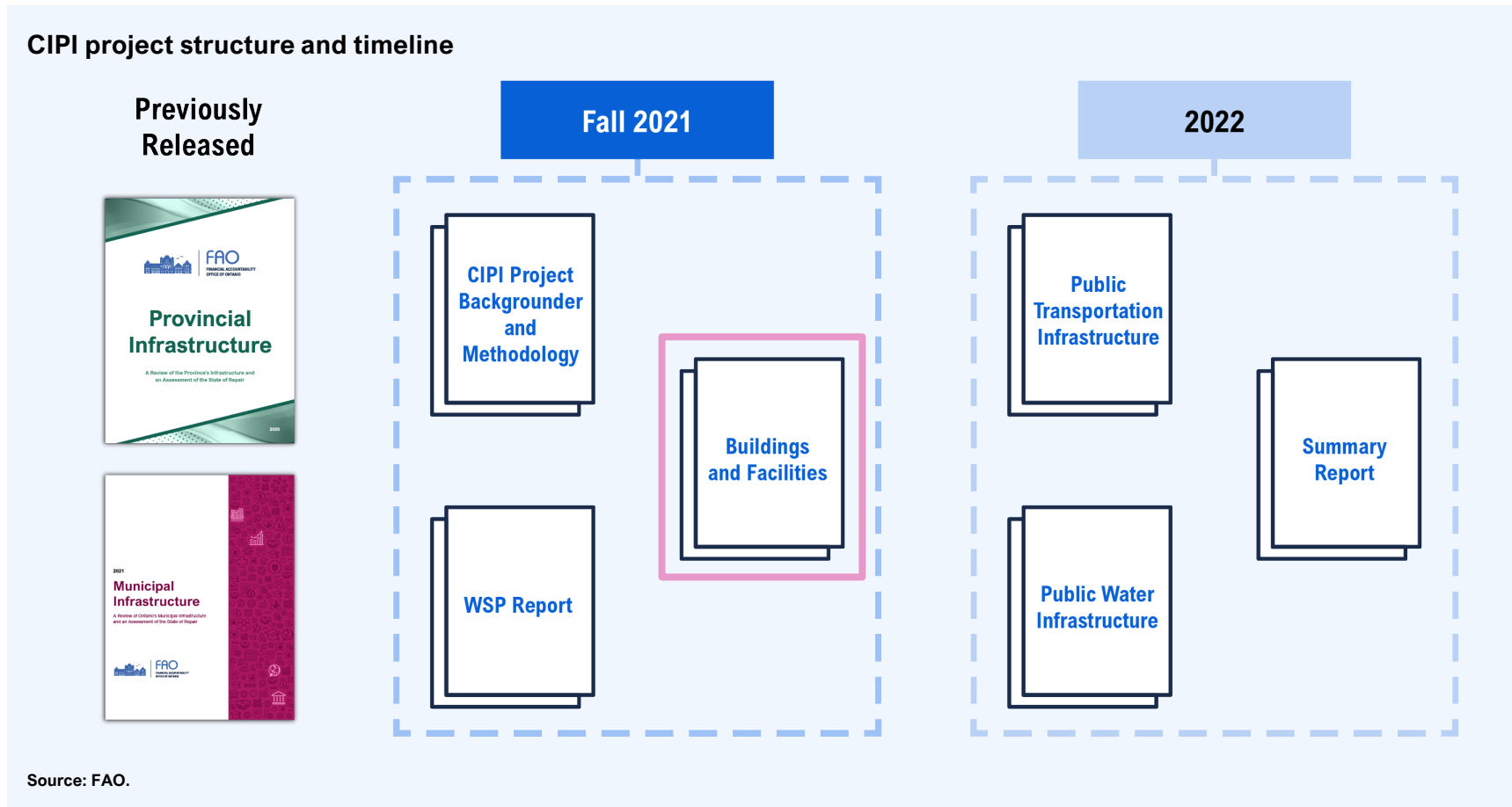
- In June 2019, a Member of Provincial Parliament asked the FAO to analyze the costs that climate change impacts could impose on Ontario's provincial and municipal infrastructure, and on the long-term budget outlook of the province.

Impacts to physical infrastructure is one of the many ways climate change is affecting Ontario



Source: Council of Canadian Academies and FAO.

The buildings report is part of the larger CIPI project



The FAO's "Costing Climate Change Impacts to Public Infrastructure (CIPI) project estimates the budget impacts of select climate hazards on provincial and municipal infrastructure.

Scope of climate hazards

- Of all the climate hazards, the FAO and WSP determined which could have the most material financial impacts on provincial and municipal infrastructure, and which could be projected with reasonable scientific confidence.

Climate Hazards

Included

Based on potential impact on infrastructure and higher scientific confidence in climate projections.

Extreme heat

Average and extreme temperature variables

Extreme rainfall

Total and extreme short-duration precipitation variables

Freeze-thaw cycles

Daily maximum and minimum temperature and precipitation variables

Excluded

Based on limited expected impact on infrastructure and/or lower scientific confidence in climate projections.

Drought

Ice storms

Wildfires

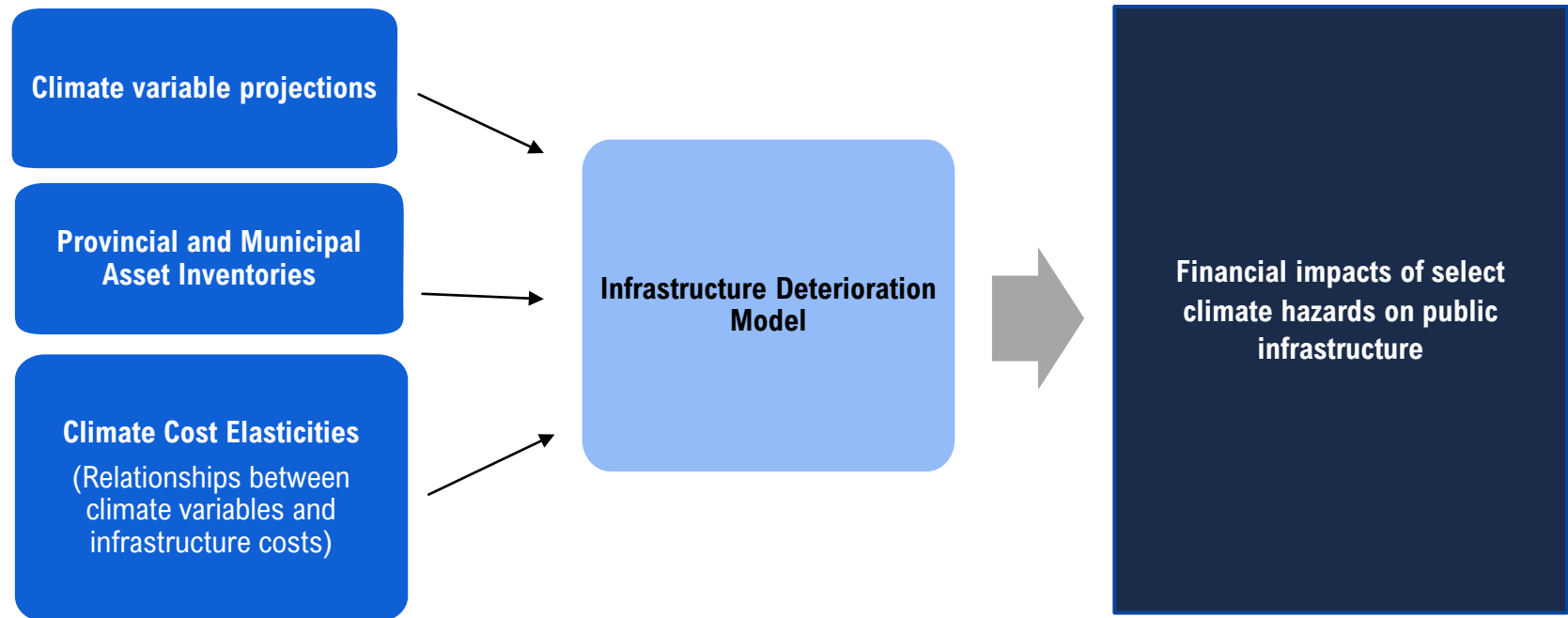
Sea level rise

Permafrost melt

Windstorms

FAO's CIPI backgrounder details the methodology

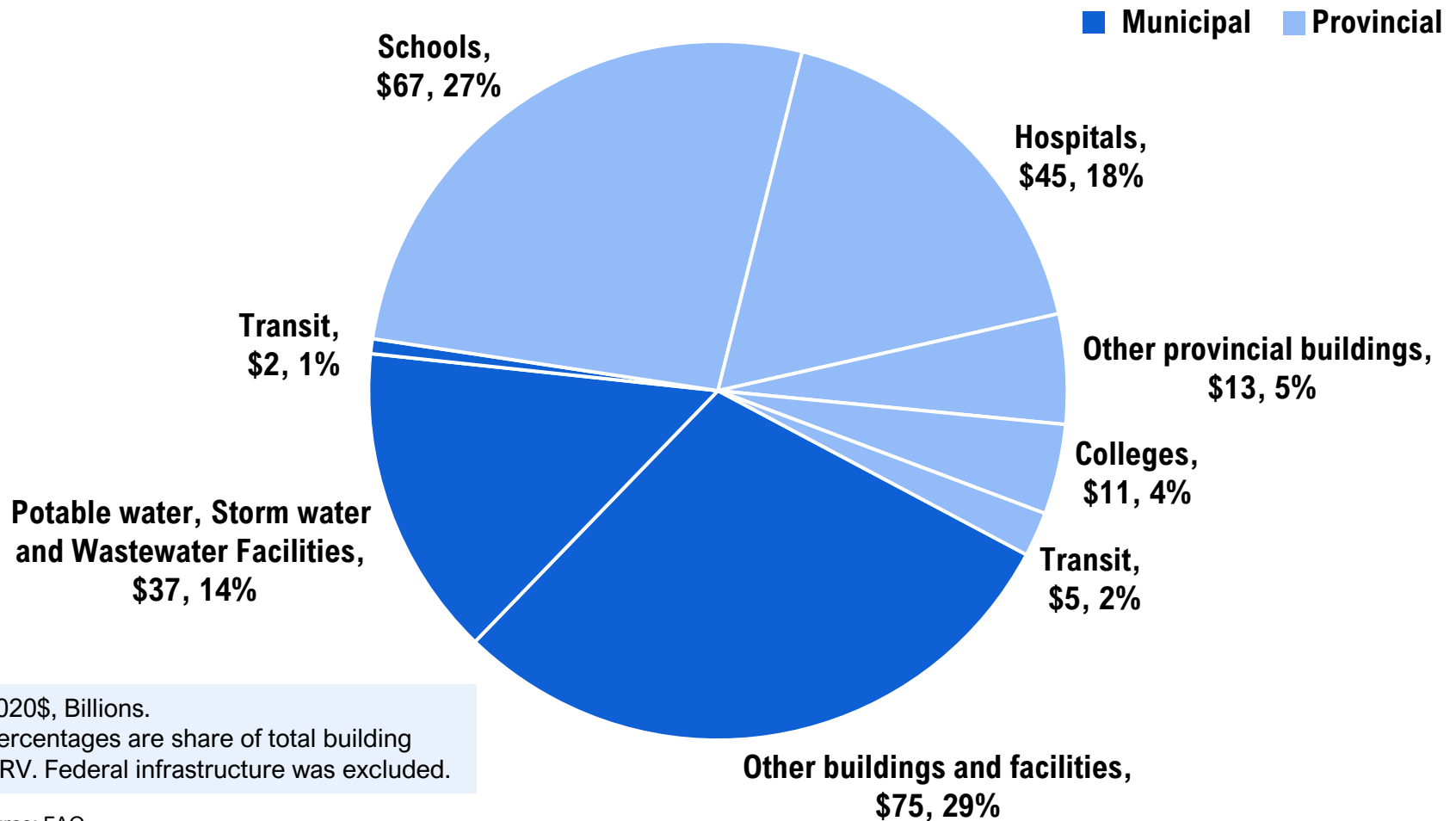
- The CIPI project is an interdisciplinary analysis that combines asset management, engineering, climate science and economics.
- The backgrounder details how these disciplines come together to estimate the budget impacts of select climate hazards on public infrastructure.



Results



Ontario has a very large portfolio of public buildings and facilities, worth \$254 billion



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

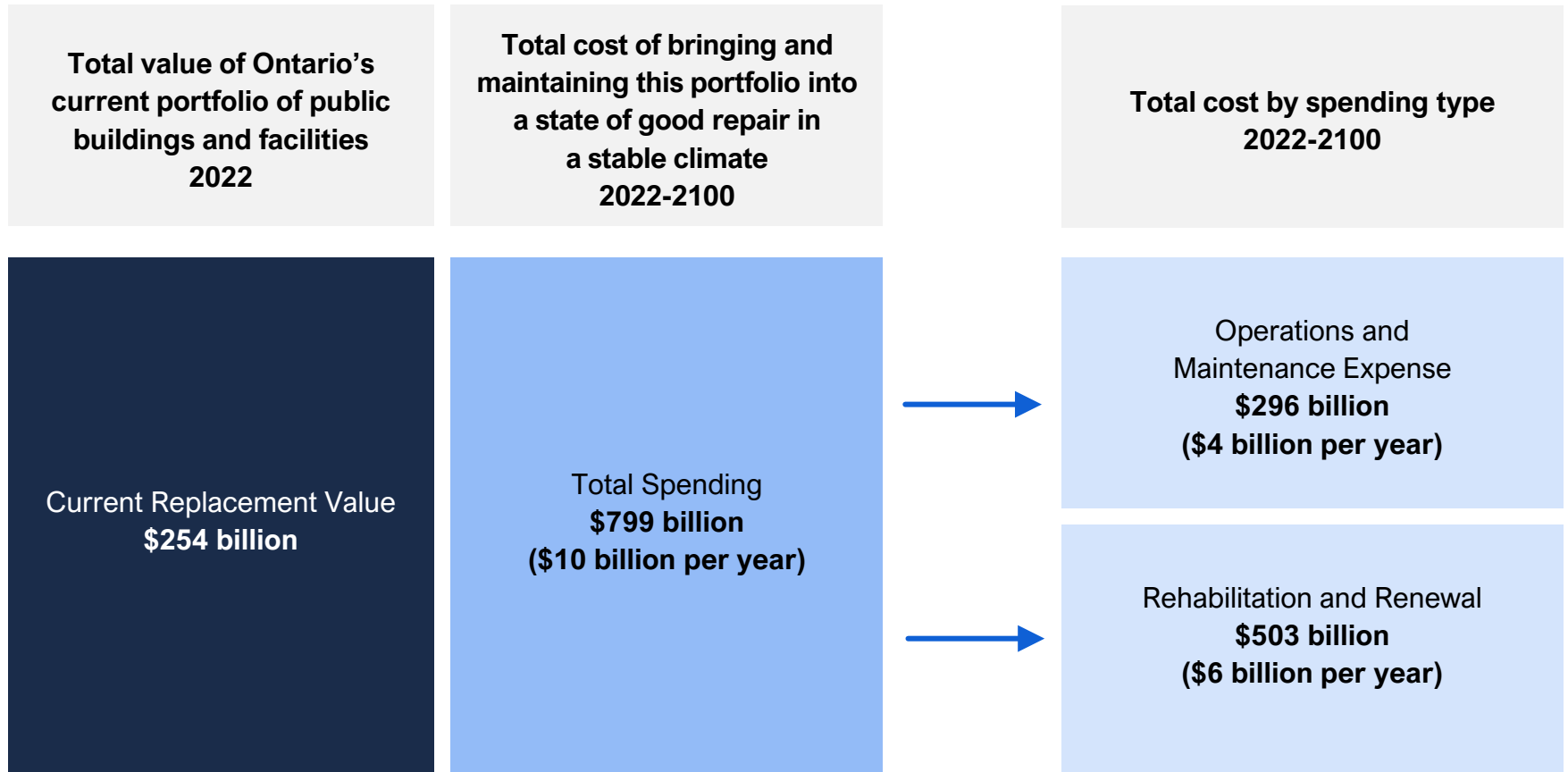
Source: FAO.

If the climate was stable, maintaining these assets in a state of good repair would require **\$799 billion over the rest of the century**

- Keeping assets in a state of good repair helps to maximize the benefits of public infrastructure in the most cost-effective manner over time.
- This requires annual operations and maintenance (O&M) spending, as well as intermittent capital spending either to rehabilitate part(s) of an asset or to fully renew it at the end of its service life.
- The FAO estimates that to maintain assets in a state of good repair would require **\$10.1 billion per year on average, totaling \$799 billion (real 2020 dollars) over the century**. These projected “**baseline costs**” are what would have occurred in a stable climate.*

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

This \$799 billion includes both O&M expenses and spending on rehabilitation and renewal



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

The FAO costed climate impacts to public buildings for three global emissions scenarios:

Low Emissions Scenario

- Assumes a major and immediate turnaround in global climate policies.
- Global mean temperature is projected to increase **1.6°C** (0.8 to 2.4°C)* by 2100 relative to 1850-1900 average.

Medium Emissions Scenario

- Global emissions peak in the 2040s, then decline rapidly over the following four decades before stabilising at the end of the century.
- Global mean temperature is projected to increase **2.3°C** (1.7 to 3.2°C) by 2100 relative to 1850-1900 average.

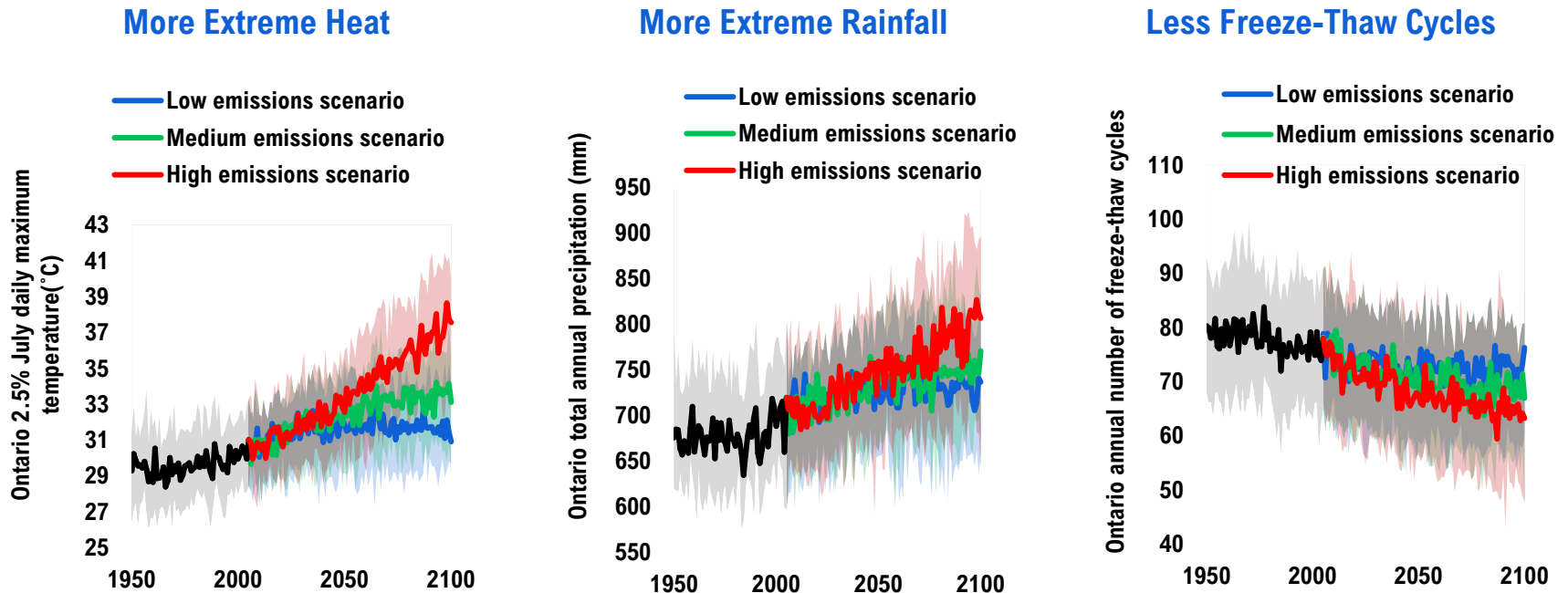
High Emissions Scenario

- Global emissions continue to grow for most of the century.
- Global mean temperature is projected to increase **4.2°C** (3.2 to 5.4°C) by 2100 relative to 1850-1900 average.

* 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 All.7.5.)

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

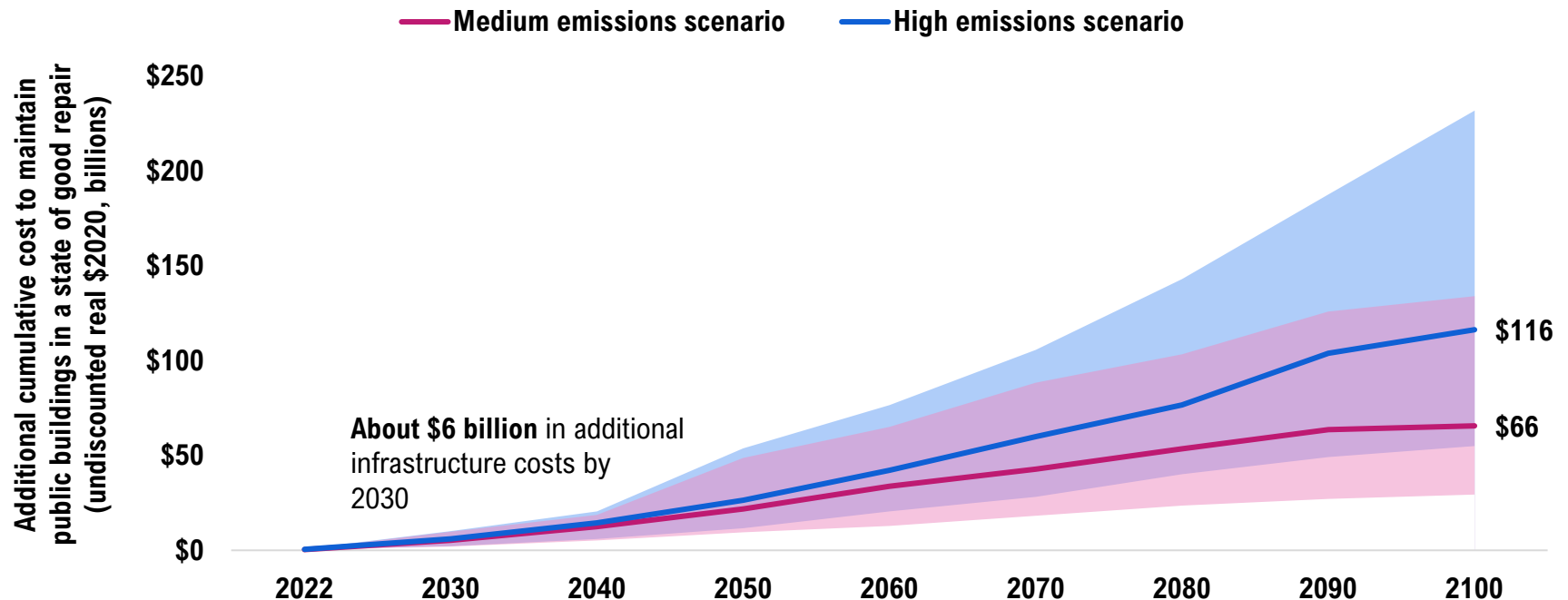
- To ensure safety and reliability, public infrastructure is designed, built and maintained to withstand a specific range of climate conditions typically based on historic climate data. But these variables are changing.



Source: Environment Canada, Canadian Centre for Climate Services.

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

- These three climate hazards will result in more rapid building deterioration and increased operations and maintenance (O&M) activities, adding about \$6 billion in infrastructure costs by 2030 and significantly more over the rest of the century.

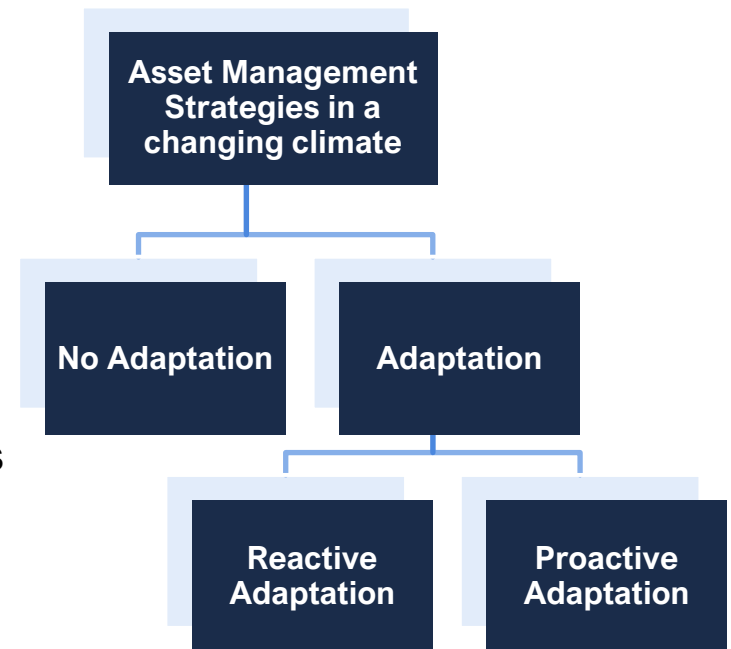


Notes: The solid line is the median (or 50th percentile) projection. The coloured bands represent the range of possible outcomes in each emissions scenario. The costs presented in this chart are in addition to the projected baseline costs over the same period.

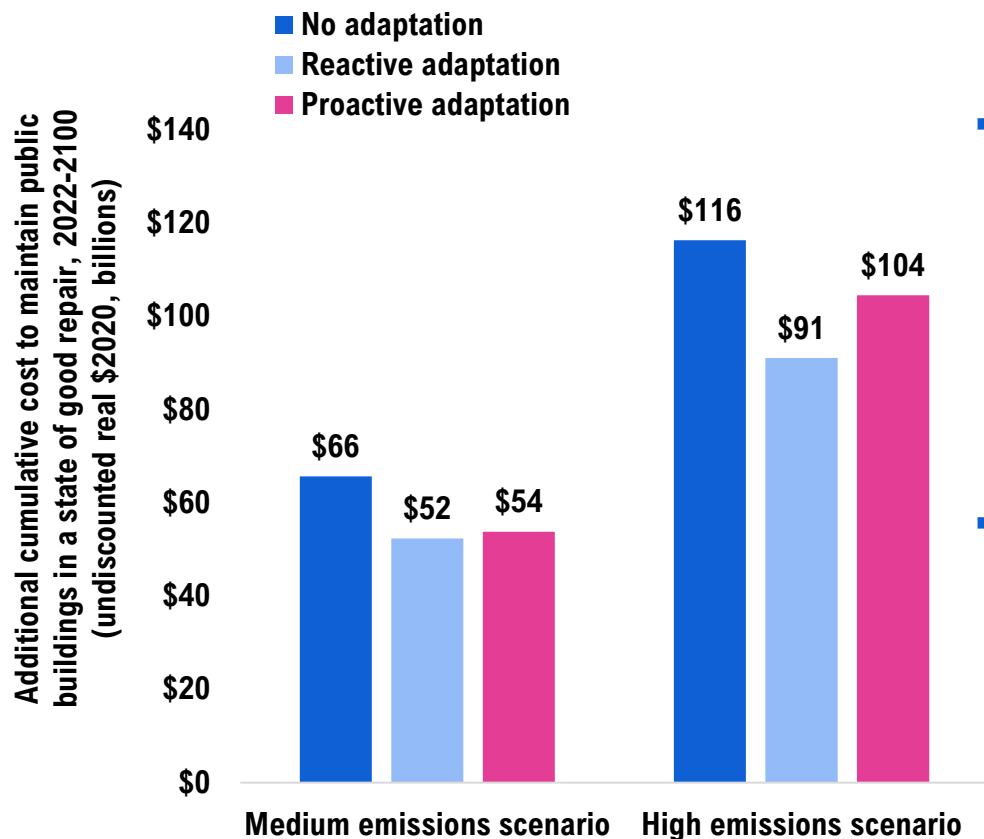
Source: FAO.

Public buildings can be adapted to withstand climate hazards

- To explore the financial implications of adapting Ontario's public buildings to withstand extreme rainfall and extreme heat, the FAO costed two adaptation approaches:
 - The reactive strategy assumes public buildings are rebuilt at the end of their service life to withstand late-century projections of extreme rainfall and extreme heat. This results in a gradual adaptation of assets, with 77 per cent of buildings adapted by 2100.
 - The proactive strategy assumes most public buildings are retrofitted during their service lives to withstand late-century projections of extreme rainfall and extreme heat. This strategy sees nearly all buildings adapted by 2060.



Adapting public buildings will require significant investment

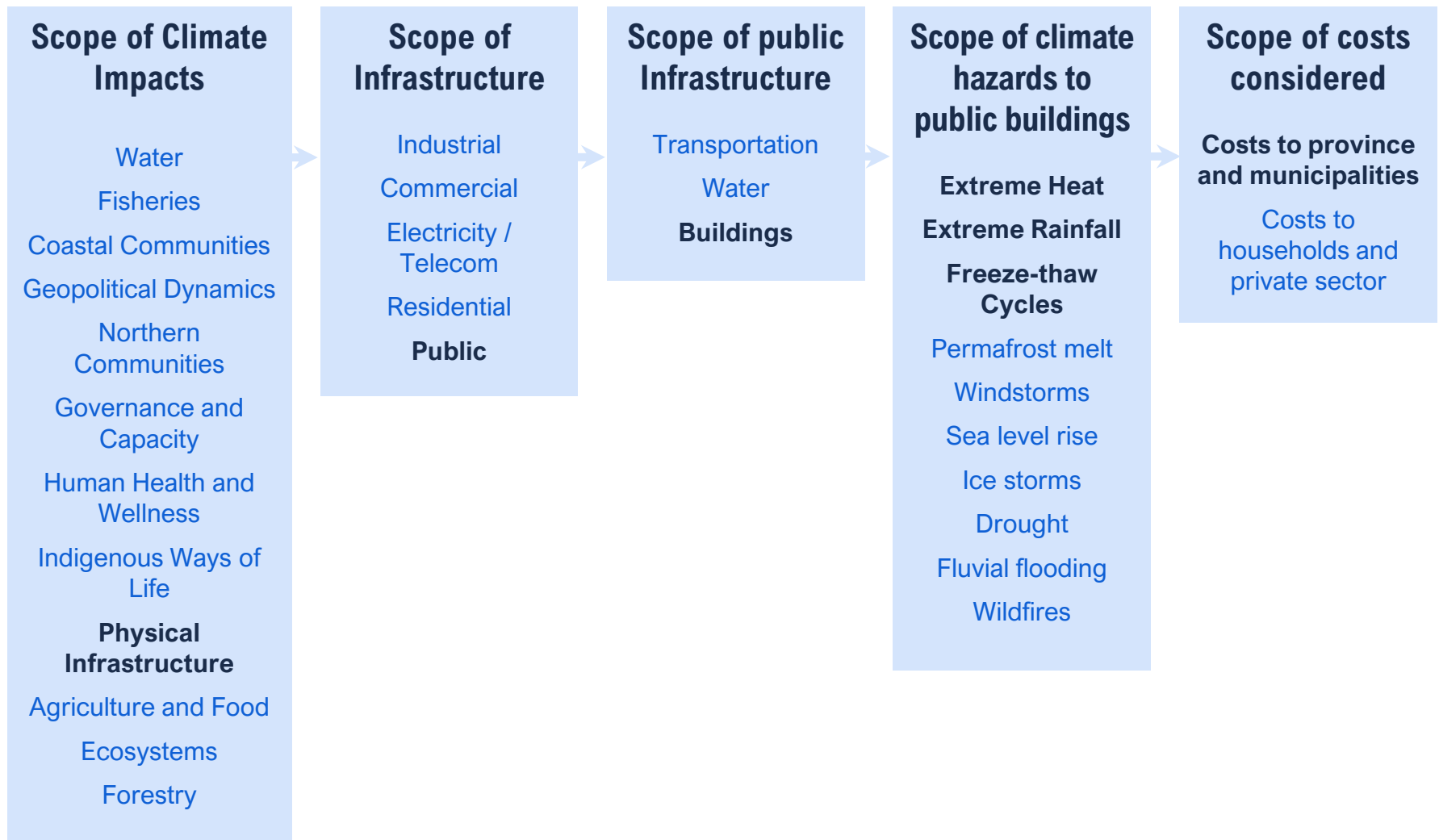


- While adaptation will be expensive, it is modestly less costly for provincial and municipal governments than not-adapting over the long term.
- However, adaptation carries significant, but un-costed benefits, such as minimizing the disruption of public services.

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.

The FAO costed a small part of all climate change impacts



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

- The FAO's portfolio-level results show that projected changes in extreme rainfall, extreme heat and freeze-thaw cycles caused by 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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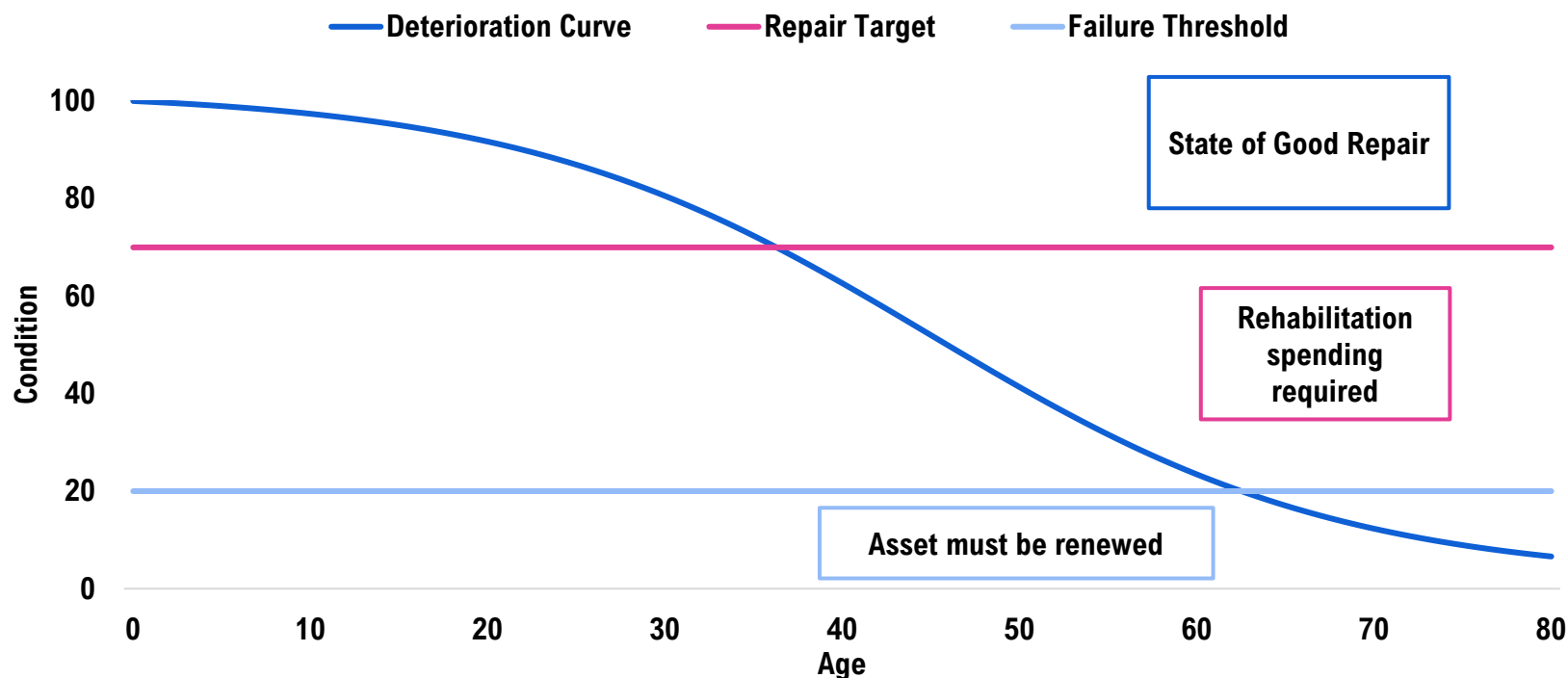


Appendix: Methodology



FAO's deterioration model projects infrastructure costs

- The FAO's deterioration model, combined with a detailed asset inventory of provincial and municipal assets, provides the projection the long-term infrastructure costs necessary to maintain assets in a state of good repair.



Source: FAO.

WSP engineers estimated the impact climate hazards would have on infrastructure costs

- Once the relevant hazards were determined, WSP estimated how changes in these hazards would impact the costs of maintaining public infrastructure.
- The impacts of climate hazards were broken into two types of costs.
 - **Damage costs:** If public buildings are not adapted to changing climate hazards, maintaining them in a state of good repair will require higher O&M expenses as well as additional capital expenses to address accelerated deterioration.
 - **Adaptation costs:** adaptation is modelled as an alteration of a building's physical components to prevent damage costs, including accelerated deterioration and higher O&M expenses, and enable buildings to perform at the same standard for which they were initially designed.

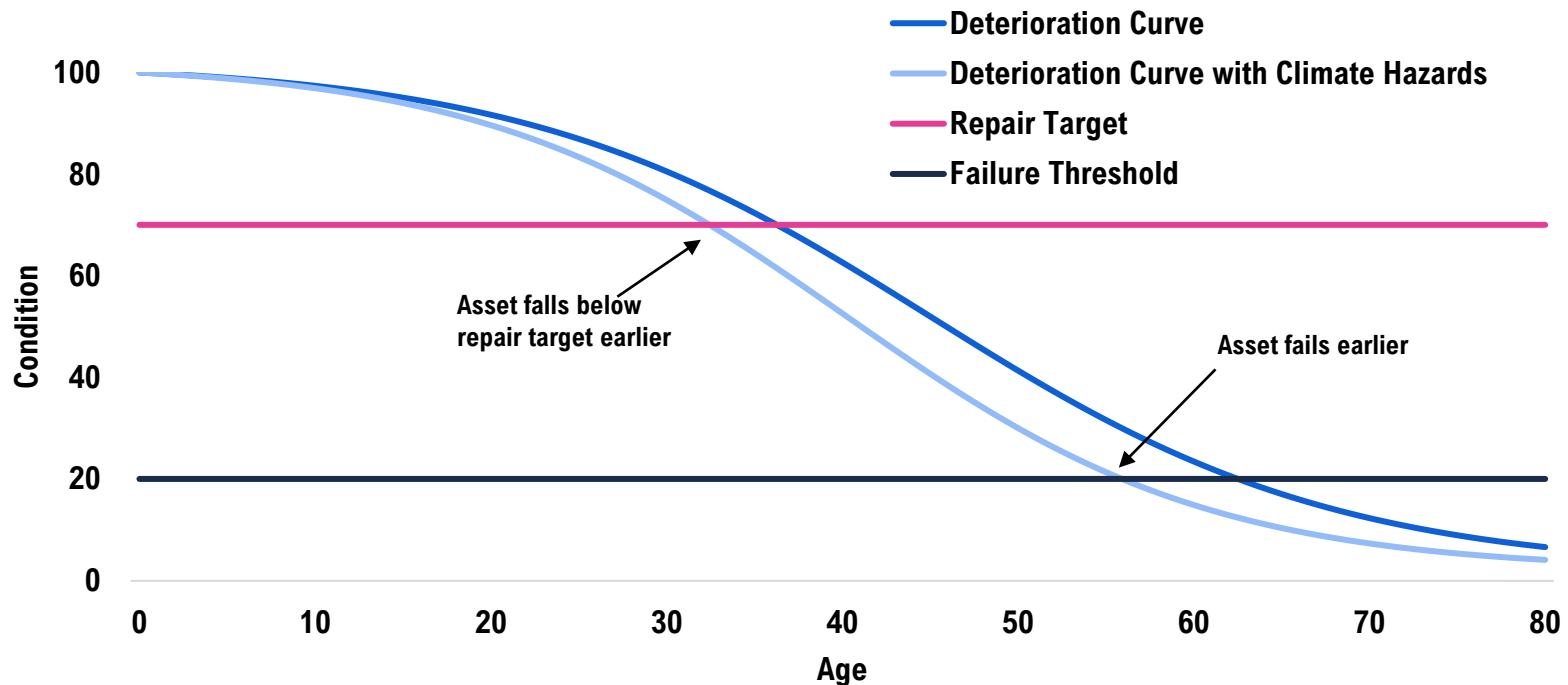
Regional climate change projections were obtained from Environment and Climate Change Canada

- Climate change will impact each region of the province differently.
- To account for this, the FAO worked with Environment and Climate Change Canada to obtain regional projections of the climate indicators deemed important by WSP engineers.



WSP's climate-cost relationships enable the FAO to project how climate hazards will impact infrastructure costs

- The enhanced deterioration model projects the financial impact of these climate hazards on public infrastructure costs, as well as the cost impacts of different adaptation strategies.



Source: FAO.