ADAPTATION

Public Sector Buildings

Assessing Climate Vulnerability and Cross Dependences using XDI

Managing infrastructure in a changing climate requires understanding how extreme weather events may impact a facility as well as the critical infrastructure that supports its operations. The Climate Action Secretariat led a series of pilot projects testing the Cross Dependency Initiative (XDI) Platform, a software that analyzes climate risk and vulnerability of a wide range of infrastructure, to help aid in planning and decision making for a changing future.

Project Summary

Across B.C., people are experiencing more frequent heatwaves, cold snaps, extreme storms, wildfires, drought, and flooding as a result of climate change. These extreme weather events can cause critical system failures in facilities such as hospitals, leading to service disruptions, temporary evacuations and even closures at times when the facilities may be needed most.

Island Health was the focus of the first pilot project using the XDI Platform. Island Health previously completed a risk assessment for the Nanaimo Regional General Hospital in 2015 using the Public Infrastructure Engineering Vulnerability Committee (PIEVC) Engineering Protocol. This qualitative assessment identified potential high-risk interactions between infrastructure failure due to a variety of climate events, and interference with hospital operations.

Building on the success of the PIEVC assessment, the B.C. Climate Action Secretariat (CAS) leveraged federal funding from Natural Resources Canada to commission XDI Pty Ltd to undertake a quantitative climate vulnerability and cross-dependency assessment focussed on the Nanaimo Regional General Hospital and surrounding infrastructure. This assessment aimed to extend and enhance the original study by taking a quantitative approach to climate risk and vulnerability for the hospital combined with a wider analysis of risks and vulnerabilities to support infrastructure within the Nanaimo region including water, wastewater, power, telecommunications, and road networks. The foundational work of the PIEVC assessment meant that Island Health had the required data for the XDI assessment readily available.

Building on the success of the first pilot project, CAS extended the project to other public sector buildings in other regions, including Metro Vancouver and later, select health facilities at a provincial scale. CAS followed a similar process for all XDI pilot projects.

What is XDI?

The XDI platform is a software-based tool that combines a facility's asset level data with climate models to provide a quantitative analysis of climate-related risks to infrastructure.

The hazards the tool assesses include flood, coastal inundation, wildfire, wind, heat, soil movement and freeze-thaw.

XDI analyzes the probability of damage to assets from extreme weather events in two ways: 1) the probability that in any given year, a weather event will cause damage to a facility, and 2) the average annual cost of an asset failing to function or losses due to damage if weather events should occur.

The cross-dependency analysis identifies the risk of failure to upstream infrastructure, such as power, water, wastewater, telecommunications, and transportation, that supplies services to a facility. The cumulative risk of failure of the upstream infrastructure is then added to the risk profile of the facility's assets in the assessment for a more fulsome understanding of risks.

BRITISH COLUMBIA
Ministry of Environment and Climate Change Strategy

Project Summary

Step 1: Project Initiation

Launching a project involved inviting multiple interest holders to take part including health authorities, provincial ministries, local governments, and utility providers.

Step 2: Hazard Data Collection and Integration

The project team gathered data on mapped and modelled hazard areas for the region along with historical weather and climate change data. They obtained data from various sources including the Pacific Climate Impacts Consortium, Environment and Climate Change Canada, local governments, provincial ministries, and the Integrated Cadastral Information Society.

Step 3: Asset Data Collection and Integration

Each participating organization was responsible for collecting and sharing detailed asset information. Asset information included location, elevation, heat threshold, construction materials, and replacement cost. CAS and XDI worked with participants to ensure a safe transfer of their data to the XDI platform.

Step 4: Vulnerability Analysis and Assessment of Preliminary Results

After receiving all required data, XDI completes an initial vulnerability analysis to test each asset for risk from each hazard. The preliminary results were verified with participants at workshops. Participants also explored adaptation actions that could be applied to facilities to improve resilience.

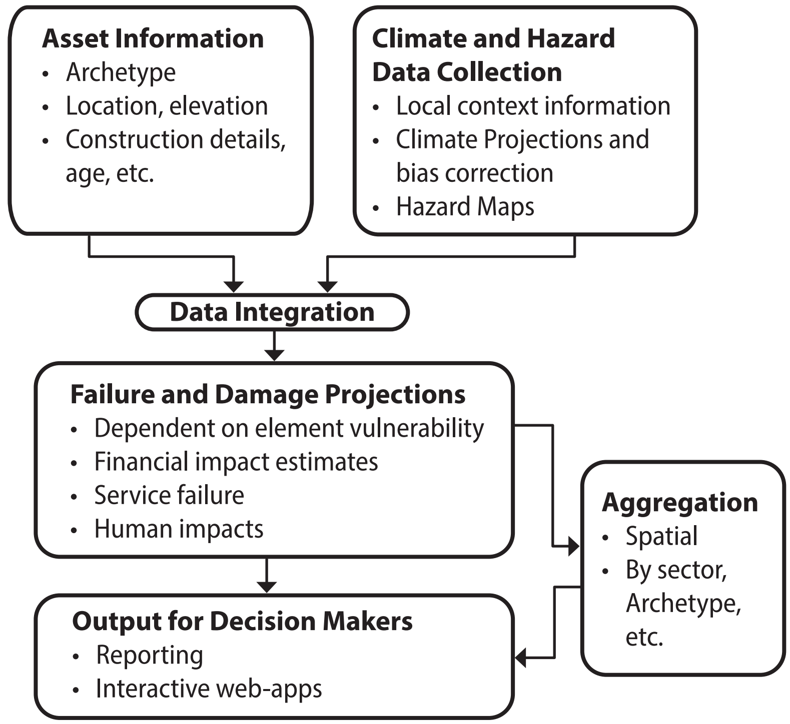
XDI communicates results for climate risks to each asset in terms of failure probabilities and damage costs. 'Failure' represents an asset's temporary loss of function, while 'damage' implies a need to replace an asset or one of its components. For example, extreme heat is a 'failure only' hazard, so no asset damage costs are calculated for it.

Step 5: Adaptation Action Assessment

XDI implemented corrections to the asset data and assessed each of the adaptation actions. The results were presented to participants at later workshops and adaptation actions were refined and retested.

Step 6: Final Reporting and Wrap Up

XDI provided a final report to public sector participants. Results of the analysis were made available to the project participants in the XDI Globe interface for twelve months after the completion of each pilot project.



XDI and PIVEC Protocol: Complementary Approaches

The XDI platform and PIEVC protocol are two complementary methodologies for assessing climate vulnerability and risk. The main difference between them is a qualitative vs quantitative approach.

The PIEVC protocol produces a qualitative risk assessment of how climate change will impact a facility, combined with an engineering analysis of how the facility may respond. The qualitative nature means that issues and options are identified through discussion and expert analysis.

The XDI assessment uses a quantitative analysis to provide direct numbers of likelihood and consequences. The quantitative approach allows adaptation actions to be costed, their effectiveness tested, and a cost benefit analysis to be completed.

Results

In total, the XDI pilot projects assessed 561 public sector buildings from across B.C. for risks from extreme weather events including extreme heat, coastal inundation, riverine flooding, extreme wind, wildfire, freeze-thaw, and soil movement due to drought. Climate risks not currently represented in climate models, i.e., wildfire smoke or joint climate events (e.g., wind-driven rain, freezing rain, etc.,) were not assessed in the pilot projects.

Climate risks vary across regions and time; however, extreme heat was identified as a risk to most buildings under current climate conditions and this risk will increase over time as average annual and day-time high temperatures are projected to continue to increase over the next century. Extreme heat has the potential to not only affect occupant safety but could also result in failure of electrical and other building components. Loss of life resulting from extreme heat was not included in the assessment.

After extreme heat, the highest risk hazards to the buildings assessed are coastal inundation, followed by extreme wind. An asset's extreme wind and extreme heat risks are highly sensitive to its assumed wind and heat thresholds, respectively. It is possible that with some assets, XDI's wind and heat threshold defaults are unrealistically high or low, in which case extreme wind and extreme heat risk results would likely be understated or overstated, respectively.

A wider hazard analysis was also completed for each pilot project, identifying potential cross-dependent risks for the buildings assessed. The cross-dependency analysis looked at the nearest points of infrastructure that are key supply points for the building. The vulnerability for each of these connected assets was calculated. The results of the cross-dependency analysis are useful for site planning as they help the users to understand the regional resilience context. For instance, a specific building may have moderate flood risk; however, the critical infrastructure supplying that site might have a high flood risk. These results can help inform conversations about the level of resilience for back-up supplies or redundant services.

While the XDI analysis provided quantified results to aid understanding and decision making, the greatest benefit may lie in the overarching results and the general trends, demonstrating areas of exposure, vulnerability, and the trends over time. This work will help inform government's climate adaptation work through the Climate Preparedness and Adaptation Strategy.

> "Better understanding how critical infrastructure is interdependent has never been more important and urgent than in this year of "extreme extremes" in BC including heat, wildfires, drought and storms. XDI Globe is a tool that enables our health organizations in the lower mainland to communicate cross-dependencies to our key stakeholders clearly and expediently, and start conversations about how to reduce climate risks and build resilience together, at the most effective junctures in the facility delivery life-cycle."
>
> - Angie Woo, Manager of Climate Risk & Resilience, Lower Mainland Health Facilities

Lessons Learned

1. Collaboration is key. The cross-dependency analysis demonstrated the importance of having multiple actors at the table when attempting to adapt and/or increase the resilience of an asset or region to climate change.

2. Climate models are a valuable tool to understand potential future climate conditions, but they must be used with an understanding of their limitations and ranges of uncertainty. Anecdotal information and expert judgement can fill the gaps.

3. Iteration is important. Climate models, hazard maps, and local weather data will change and improve over time. As new information becomes available, climate vulnerability assessments should be repeated regularly to ensure the best information is used to inform decision making.

4. Use open-source data. Some participants may be unable to access and share the required data within the required timeframe. Open-source and third-party infrastructure data providers can sometimes deliver the necessary information significantly faster, which reduces projects costs and waiting periods.

5. Hazard-specific data may not be readily available or in the required format for the XDI platform. Project timelines should account for the need to address issues with availability of mapping, permission to apply mapping, and differences in the science of climate projections.

Resources

Related Resources & Links:

- XDI: Cross-dependency Initiative:
  https://xdi.systems/
- Case Study- Nanaimo Regional General Hospital: Assessing Climate Risks & Opportunities:
  https://www2.gov.bc.ca/assets/gov/environment/climate-change/cng/resources/case-studies/casestudy_nanaimo-gen-hospital.pdf
- Public Infrastructure Engineering Vulnerability Committee (PIEVC)
  https://pievc.ca/
- Climate Change Adaptation in B.C. – Government of B.C. Resources
  http://www2.gov.bc.ca/gov/content/environment/climate-change/adaptation/resources
- Plan2Adapt – Pacific Climate Impacts Consortium
  https://www.pacificclimate.org/analysis-tools/plan2adapt
- Pacific Institute for Climate Solutions (PICS)
  http://www.pics.uvic.ca/
- Climate Data Canada
  https://climatedata.ca/

Regional Climate Change Projections:

- Moving Towards Climate Resilient Health Facilities for Vancouver Coastal Health:
  https://bcgreencare.ca/system/files/resource-files/VCH_ClimateReport%2BAppendices_Final_181025.pdf
- Climate Projections for the Capital Region
  https://www.crd.bc.ca/docs/default-source/climate-action-pdf/reports/2017-07-17_climateprojectionsforthecapitalregion_final.pdf
- Climate Projections for the Cowichan Valley Regional District
  https://www.cvrd.bc.ca/DocumentCenter/View/81884
- Climate Projections for Metro Vancouver
  http://www.metrovancouver.org/services/air-quality/AirQualityPublications/ClimateProjectionsForMetroVancouver.pdf
- Climate Projections for BC Northeast Climate Change Projections:
  https://www.fraserbasin.bc.ca/_Library/CCAQ/fbc_ne_climatereport_web.pdf

Contact

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