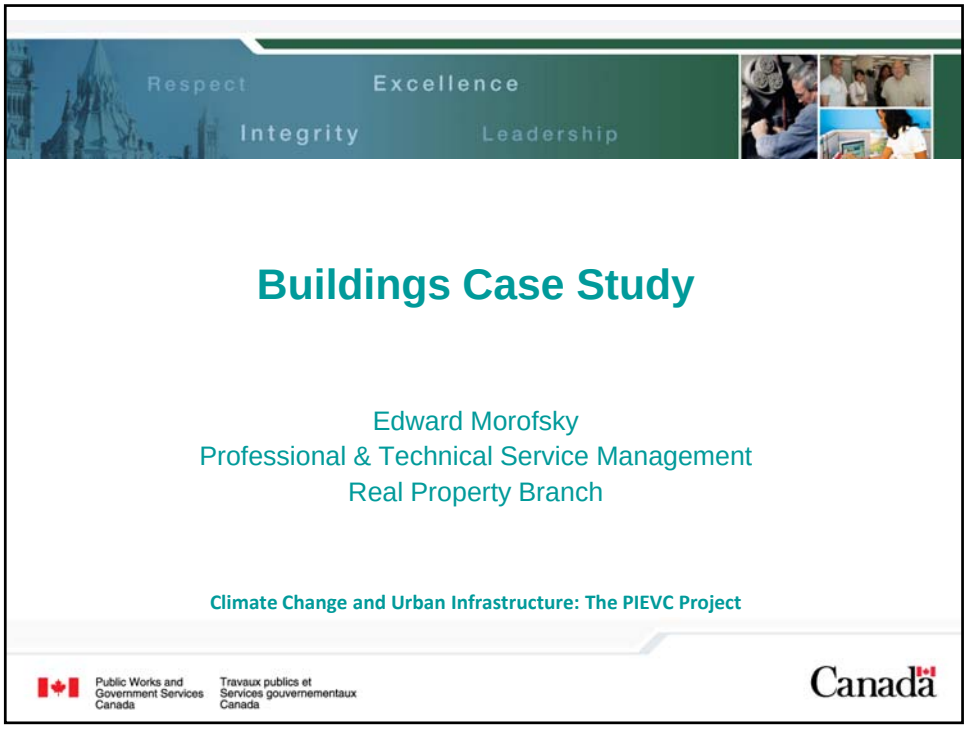
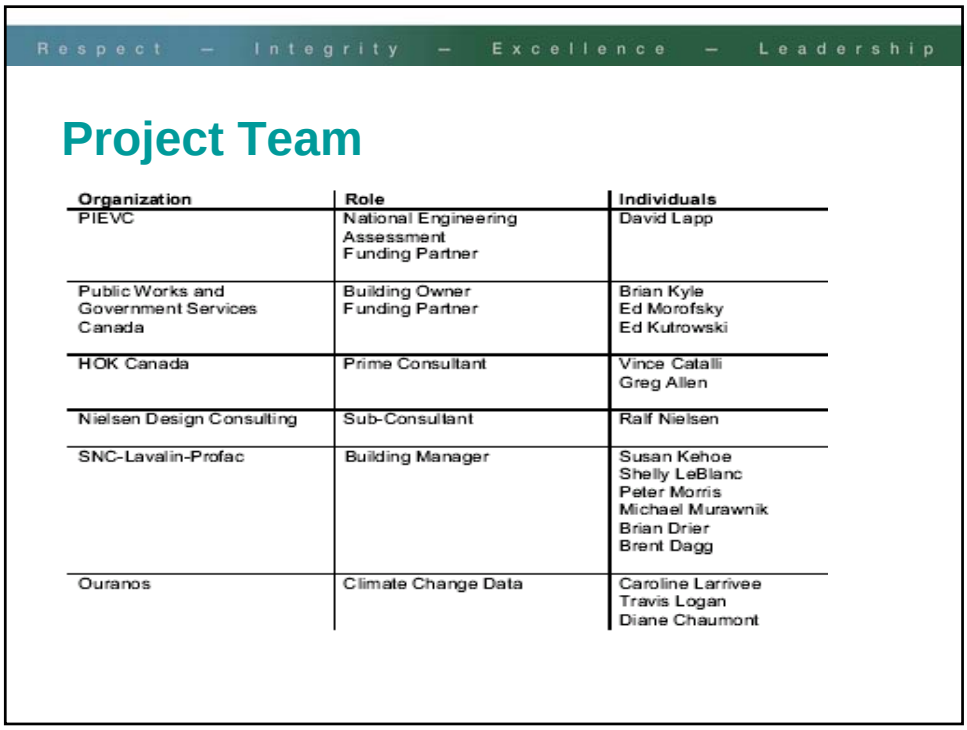
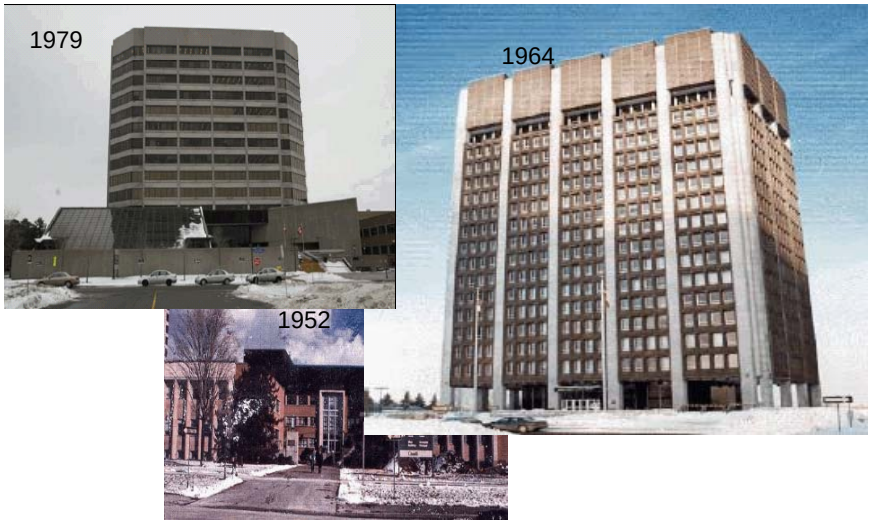

Respect
Excellence
Integrity
Leadership
Buildings Case Study
Edward Morofsky
Professional & Technical Service Management
Real Property Branch
Climate Change and Urban Infrastructure: The PIEVC Project
Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada
Canada


Respect – Integrity – Excellence – Leadership
Project Team
Organization | Role | Individuals
PIEVC | National Engineering Assessment Funding Partner | David Lapp
Public Works and Government Services Canada | Building Owner Funding Partner | Brian Kyle Ed Morofsky Ed Kutrowski
HOK Canada | Prime Consultant | Vince Catalli Greg Allen
Nielsen Design Consulting | Sub-Consultant | Ralf Nielsen
SNC-Lavalin-Profac | Building Manager | Susan Kehoe Shelly LeBlanc Peter Morris Michael Murawnik Brian Drier Brent Dagg
Ouranos | Climate Change Data | Caroline Larrivee Travis Logan Diane Chaumont

Three buildings



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Information provided

As-built drawings – mechanical, electrical, architectural
Specifications
Building Condition Reports
Energy Usage
Site Utilities
River water levels
Historical weather
Climate predictions for 2030, 2050, 2080
Meetings with building staff and tours
Complaints data base

Tunney's Pasture, Ottawa

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Summary of Climate Change Assumptions

Main regional effects in Ottawa likely to be:

- Increase in temperatures throughout the year.
- More rain and snow in spring, winter and fall.
- Less rain in June, July and August.
- Increase in rain on snow events.
- Increase in freeze-thaw events.
- Significantly shorter frost season.
- Significantly less Heating Degree Days.
- Significantly more Cooling Degree Days.

Project Objective

- **To test the PIEVC protocol on buildings**
  PIEVC Engineering Protocol for Climate Change Infrastructure Vulnerability Assessment
- Recommend modifications if necessary
- Provide case study examples for future building applications

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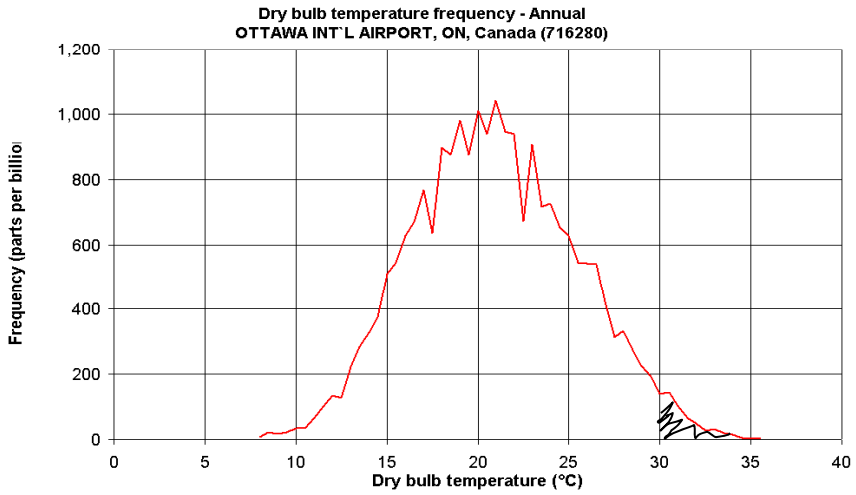
Engineering Vulnerability

The shortfall in the ability of public infrastructure to absorb the negative effects, and benefit from the positive effects, of changes in the climate conditions used to design and operate infrastructure.

Temperature frequency



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Ottawa extremes

Return period extreme dry bulb temperatures for OTTAWA INT`L AIRPORT, ON, Canada

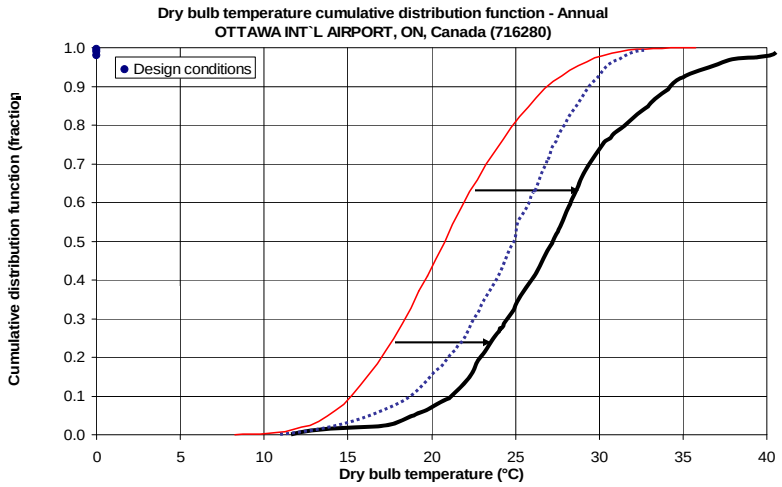
Extreme annual dry bulb temperature data

Mean	Max	°C	33.0
	Min	°C	-28.1
Standard Deviation	Max	°C	1.6
	Min	°C	2.7
Return period considered		Years	50

50-year return period extreme dry-bulb temperatures

	Max	°C	**37.1**
	Min	°C	**-35.1**

Does cooling design temp change?



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Key climatic factors considered

- Temperatures – average monthly and annual maximums and minimums are expected to increase;
- Rain average total – forecast to increase;
- Rain frequency measured in six-hour and one-day rain event – slight increase expected;
- Snow average totals – decreasing;
- Snow-on rain events – increasing;
- Frost season – decreasing;
- Heating degree days – decreasing;
- Wind;
- Humidity – historical data

Protocol Steps

Protocol Steps (continued)

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Climate factors vs Exterior systems

Main Stats Building	Climate Factors																															
	Temperature				Rain				Snow and Wind								Frost Season Length				Heating Degree Days				Humidity							
Future Change/Infrastructure Component/System	Increases in monthly tmax and tmin and annual avg. max and min				Avg. total rain increases DJF, MAM, SON. Decreases JJA. Avg. Max rain increases for 1, 2 and 5 day periods.6h frequency increases. 1				Average total snow increases. 1 day frequency increases. Rain on Snow events increases				Monthly avg windSh - windier winters, calmer summers. Avg. annual max windSh - decreases.				Frost season length decreases, and frequency of freeze/thaw events decreases				Less HDDays NOTE: Take into account the inverse				Humidity (monthly average) increases							
	Y/N	S-	S+	P+	Y/N	S-	S+	P+	Y/N	S-	S+	P+	Y/N	S-	S+	P+	Y/N	S-	S+	P+	Y/N	S-	S+	P+	Y/N	S-	S+	P+				
EXTERIOR SYSTEMS																																
Site Drainage – related to slopes away from the building and includes soil permeability and hard surfaces like stairs / ramps	yes			0	yes			0	yes			0	0			0	yes			0	no			0	no			0				
Site Drains – storm/rain water	no			0	yes			0	yes			0	0			0	yes			0	no			0	no			0				
Walls																																
Freestanding																																
concrete	no			0	yes			0	yes			0	0			0	no			0	no			0	yes			0				
masonry	no			0	yes			0	yes			0	0			0	no			0	no			0	yes			0				
Retaining																																
concrete	no			0	yes			0	yes			0	0			0	no			0	no			0	yes			0				
masonry (not applicable)	n/a			0	n/a			0	n/a			0	0			0	no			0	no			0	yes			0				
Walkways																																
Asphalt	yes			0	no			0	yes			0	0			0	no			0	no			0	no			0				
Concrete	no			0	yes			0	yes			0	0			0	no			0	no			0	no			0				
Unit pavers	no			0	yes			0	yes			0	0			0	no			0	no			0	no			0				
Stairs																																0
Concrete	no			0	yes			0	yes			0	0			0	no			0	no			0	no			0				
Metal	yes			0	yes			0	yes			0	0			0	no			0	no			0	no			0				
Ramps (concrete)	no			0	yes			0	yes			0	0			0	no			0	no			0	no			0				
Loading dock (concrete and enclosed area)	no			0	yes			0	no			0	0			0	no			0	no			0	no			0				
Window / Stair wells																																
Concrete	no			0	yes			0	Yes			0	0			0	no			0	no			0	no			0				
Masonry (not applicable)	n/a			0	n/a			0	n/a			0	0			0	no			0	no			0	no			0				
Gutters - metal	yes			0	yes			0	yes			0	0			0	no			0	no			0	no			0				
Parking, vehicle areas																																0
Asphalt	yes			0	no			0	yes			0	0			0	no			0	no			0	no			0				
Concrete	no			0	yes			0	yes			0	0			0	no			0	no			0	no			0				
Unit pavers	no			0	yes			0	yes			0	0			0	no			0	no			0	no			0				
Manholes/access doors	no			0	yes			0	yes			0	0			0	no			0	no			0	no			0				

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Climate Factors vs Building systems

Main Stats Building	Climate Factors																															
	Temperature				Rain				Snow and Wind								Frost Season Length				Heating Degree Days				Humidity							
Future Change/Infrastructure Component/System	Increases in monthly tmax and tmin and annual avg. max and min				Avg. total rain increases DJF, MAM, SON. Decreases JJA. Avg. Max rain increases for 1, 2 and 5 day periods.6h frequency increases. 1				Average total snow increases. 1 day frequency increases. Rain on Snow events increases.				Monthly avg windSh - windier winters, calmer summers. Avg. annual max windSh - decreases.				Frost season length decreases, and frequency of freeze/thaw events decreases				Less HDDays NOTE: Take into account the inverse				Humidity (monthly average) increases							
	Y/N	S-	S+	P+	Y/N	S-	S+	P+	Y/N	S-	S+	P+	Y/N	S-	S+	P+	Y/N	S-	S+	P+	Y/N	S-	S+	P+	Y/N	S-	S+	P+				
BUILDING SYSTEMS																																
Foundations, Floors and Roofs																																0
Footings – concrete	no			0	yes			0	no			0	0			0	no			0	no			0	no			0				
Walls - concrete	no			0	yes			0	no			0	0			0	no			0	no			0	no			0				
Slab on grade - concrete	no			0	yes			0	no			0	0			0	no			0	no			0	no			0				
Precast Light Weight Concrete Panel Roof	no			0	no			0	yes			0	0			0	no			0	no			0	no			0				
Envelop Systems																																
Precast Concrete	no			0	yes			0	yes			0	0			0	yes			0	yes			0	yes			0				
Glazed Curtain wall	yes			0	no			0	yes			0	0			0	no			0	no			0	no			0				
Masonry wall	no			0	yes			0	yes			0	0			0	yes			0	yes			0	yes			0				
Stone Panels (including header and sills)	no			0	yes			0	yes			0	0			0	yes			0	yes			0	yes			0				
Metal Cladding	yes			0	yes			0	no			0	0			0	yes			0	no			0	yes			0				
Windows / Doors																																
Aluminum Windows	yes			0	no			0	no			0	0			0	no			0	no			0	yes			0				
Doors (Steel / Aluminum)	yes			0	no			0	no			0	0			0	no			0	no			0	yes			0				
Flat Roof Systems (including roof drains)	yes			0	yes			0	yes			0	0			0	no			0	no			0	no			0				
MECHANICAL SYSTEMS																																
Heating System and Adequacy	no			0	no			0	no			0	0			0	no			0	yes			0	no			0				
Cooling System and Adequacy	yes			0	no			0	no			0	0			0	no			0	yes			0	yes			0				
ELECTRICAL SYSTEMS																																
Emergency power systems / generators (including fuel supply)	no			0	no			0	no			0	0			0	no			0	no			0	no			0				
Power Supply and Reliability	yes			0	no			0	no			0	0			0	no			0	yes			0	yes			0				

Obstacles

- Design assumptions? e.g., number occupants
- Existing loads?
- Changing climate predictions into future loads

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Summary of Findings

The findings of the Vulnerability Assessment are similar in the three test buildings in that the exterior systems (e.g. walkways, ramps, parking areas and stairs), building envelope, cooling systems and reliability of power are the key vulnerabilities.

There are differences regarding roofs, building envelope, tunnels and retaining walls specific to each building.

Conclusions

Building data may be a problem for some

Buildings with current problems will have more adaptation problems

Time and cost may be obstacles for assessment

Probably best integrated into existing Building Condition Studies (every five years)

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Further Information

PIEVC Web Site
www.pievc.ca

PIEVC Standard Presentation
http://pievc.ca/e/doc_detail.cfm?doid=%22%220%20%20%0A

First National Engineering Assessment Report
http://pievc.ca/e/Adapting_to_climate_Change_Report_Final.pdf

Buildings Study
http://pievc.ca/e/Appendix_B.7_Government_of_Canada_Buildings_in_Ottawa_Ontario.pdf