A primer on climate change and the durability of the building envelope

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Institute for Research in Construction

A Primer on Climate Change and the Durability of the Building Envelope

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NRC-IRC

BECOR Christmas Lunch and Learn

December 10th, 2008 Ottawa

Is it really happening ?

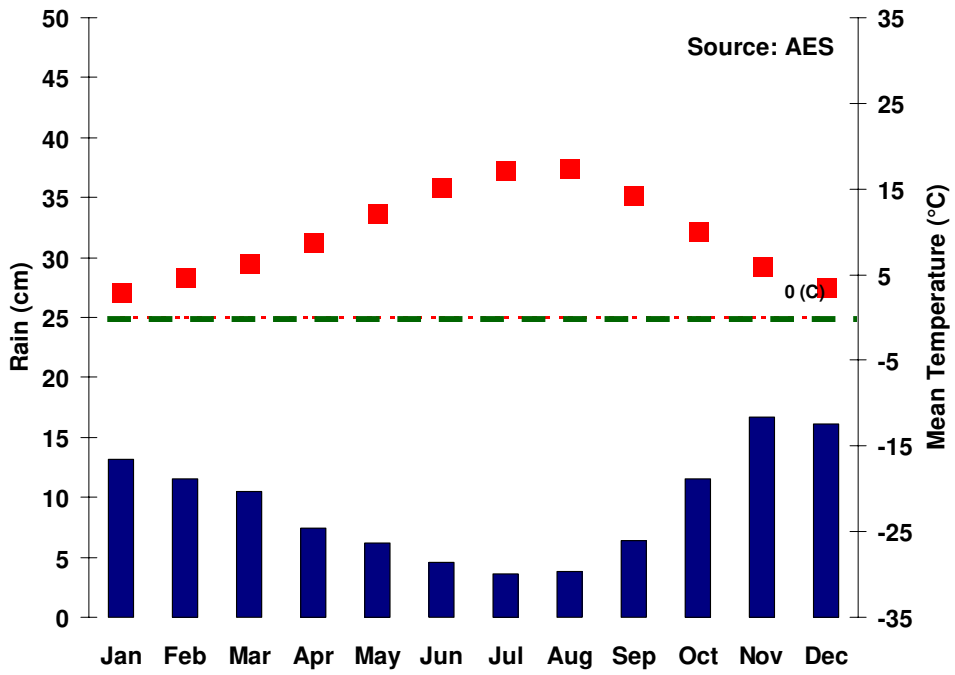
“It is widely accepted that the emissions generated by human activity are rapidly increasing the concentration of Greenhouse gases in the atmosphere. There is scientific consensus that these rising concentrations will increase the average temperature of the earth resulting in rising sea levels, shifts in climatic zones and increased frequency and severity of weather extremes”.

Source: Executive summary “Engineering Vulnerability Assessment of the Main Statistics Canada Building to the Impacts of Climate Change” by the Public Infrastructure Engineering Vulnerability Committee (PIEVC)

Observed/Predicted Phenomenum:
Increase in Temperature

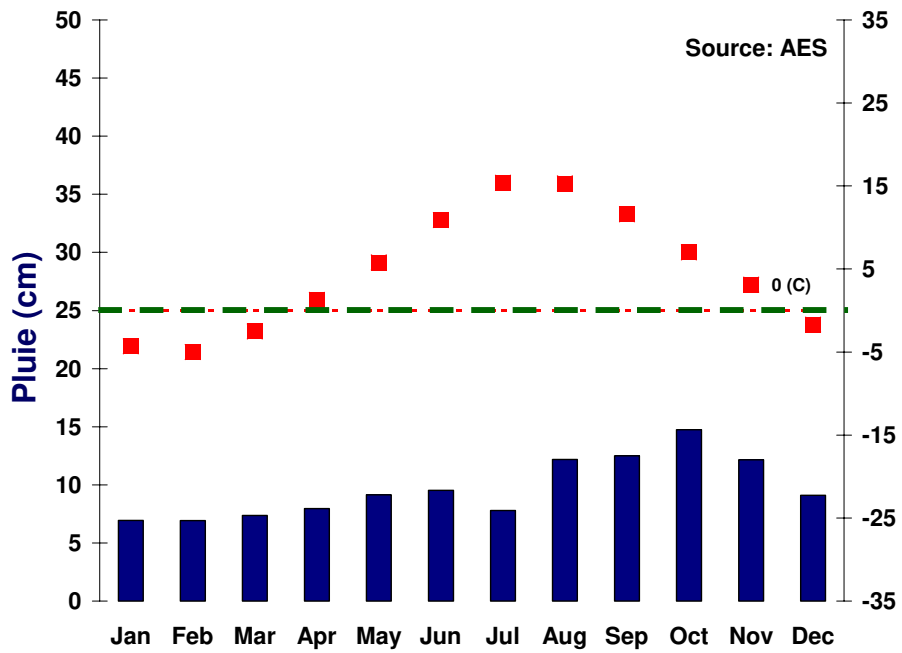
Climate Effect	Effect on Buildings
Melting of permafrost in Arctic	Building stability; Design of foundations
Reduction of heating degree-days and increase in cooling degree-days	Design of building envelope and mechanical systems to accommodate the loads) Space overheating and comfort of occupants
Increase in freeze-thaw cycles in cold regions	Durability of masonry and concrete bldgs (spalling, cracks) Ice dams on sloped roofs Ice loads & drainage on low sloped roofs
Higher frequency of rain and wet snow events in wintertime	Durability of masonry and concrete bldgs Structural strength and drainage capability of low sloped roofs
Increase in rates of deterioration	Potential of mould growth Corrosion of metals Accelerated aging of building materials
Reduction of temperature differential across the envelope in winter	Reduction of moisture accumulation within enclosure (duration and quantity)

Annual Rainfall and Temperature Distribution



Vancouver

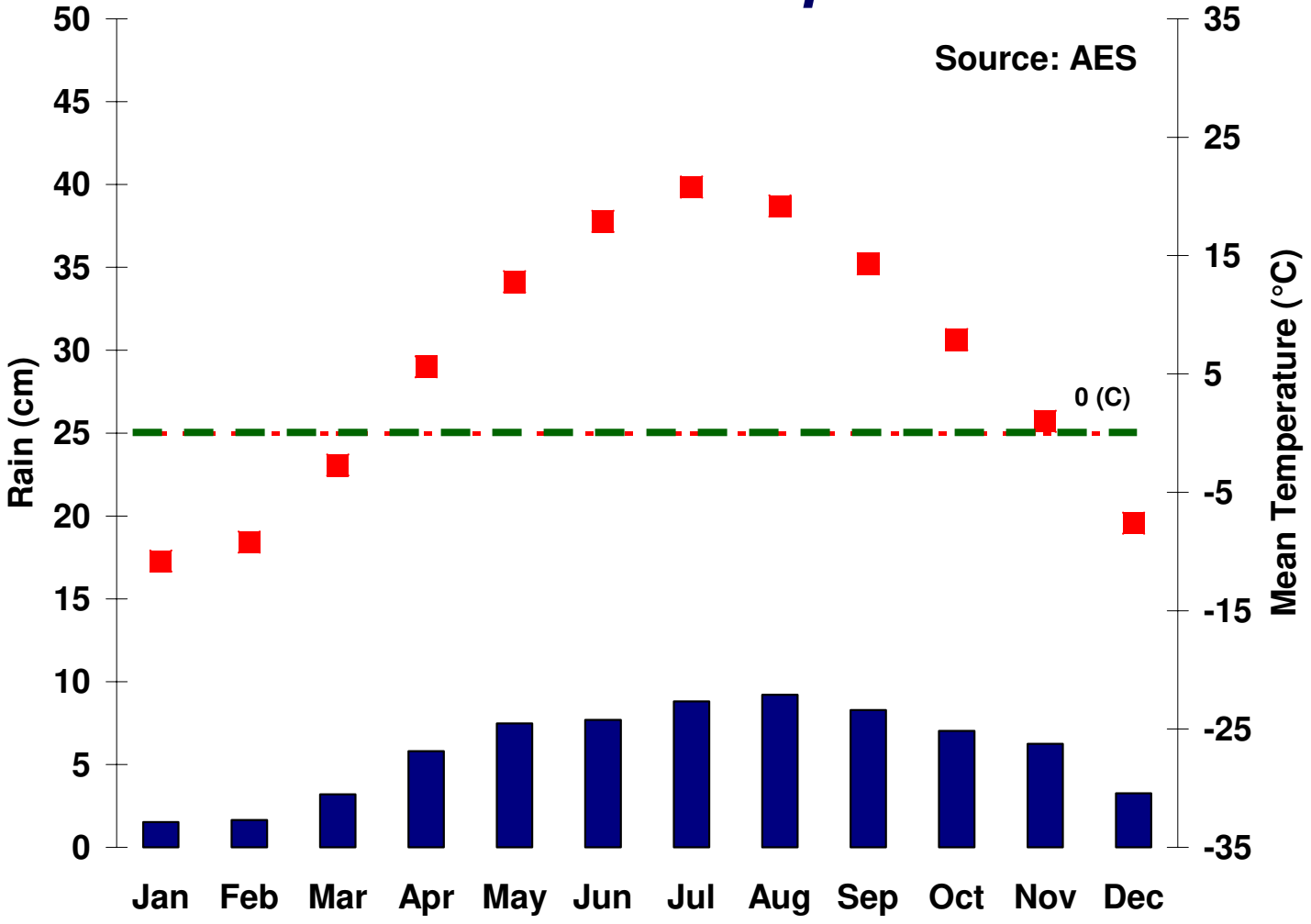
Annual rain: 1117 mm



St John's

Annual rain: 1163 mm

Annual Rainfall and Temperature Distribution

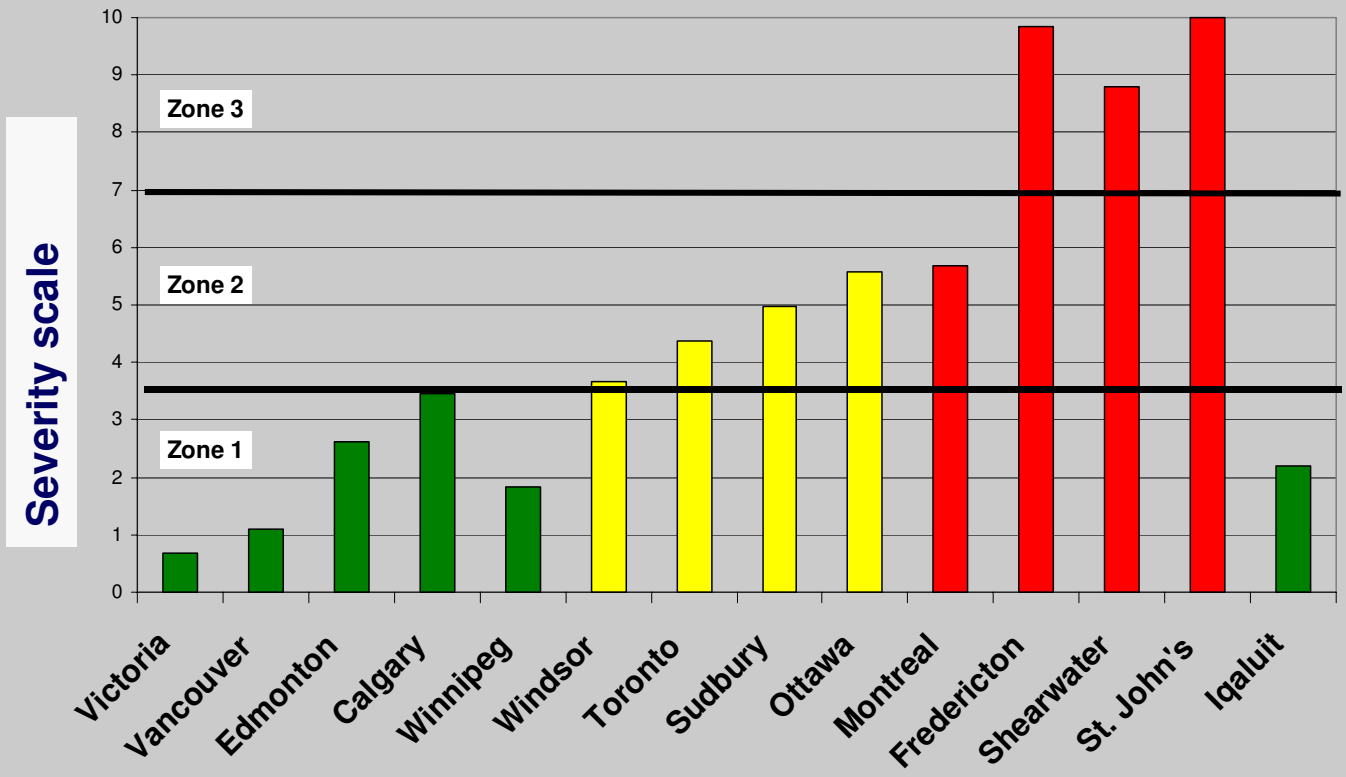


Ottawa

Annual rainfall: 700 mm

Freeze-thaw severity index

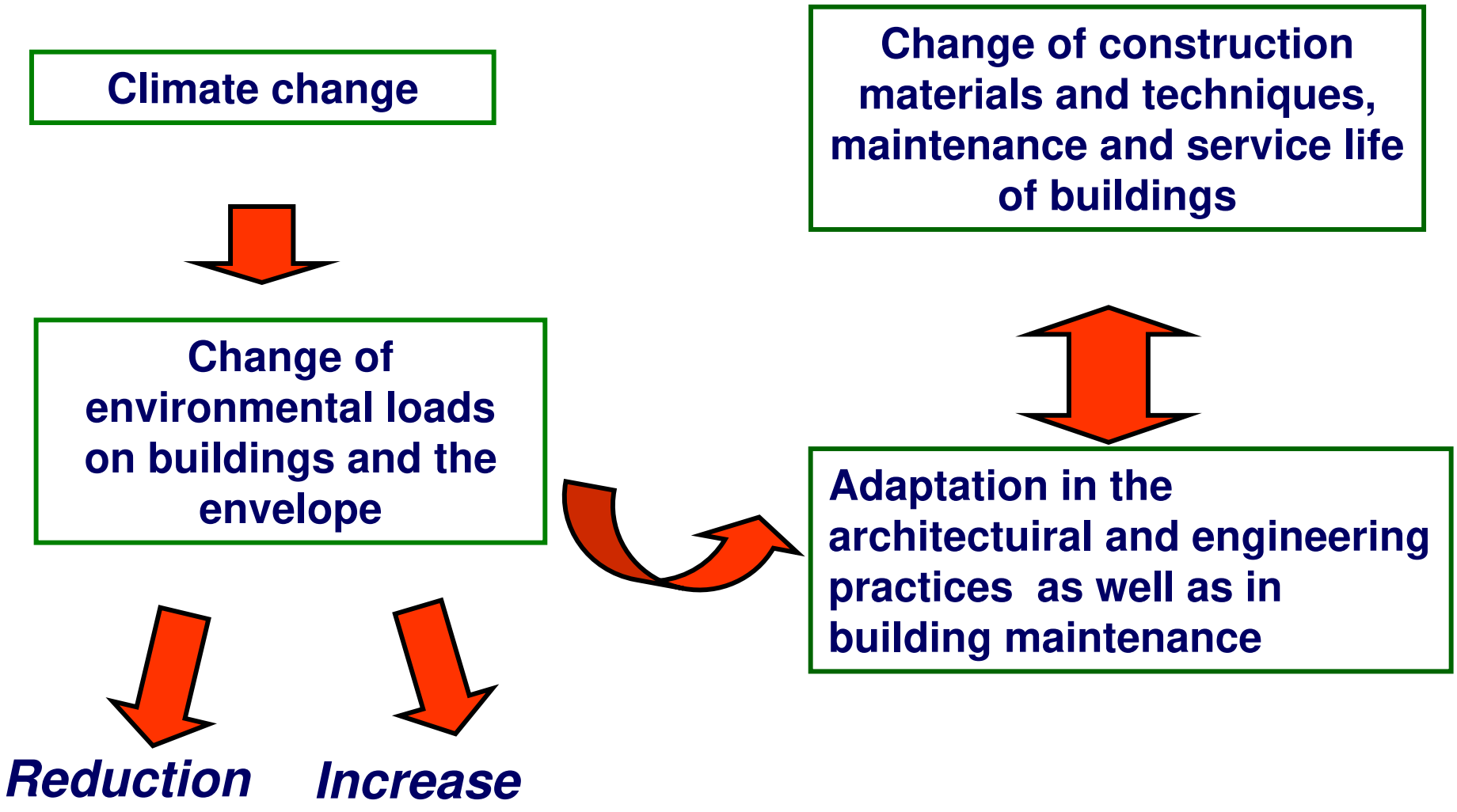
(F/T cycles about –5°C in month x (precipitation in month + previous month)/10. Mean over 30 years)



Observed/Predicted Phenomenum:
Increase in Frequency of Extreme Climate Events

Climate Effets	*Effects on Buildings*
Wind-driven rain	**Rain penetration** **Prematured deterioration (mould growth, wood decay, metal corrosion)** **Design of basements, facades and roofs**
Strong winds	**Wind uplift of parapets, mechanically attached roofing membranes** **Air infiltration** **Glazing design**
Snow falls	**Structural loads on roofs**
Heat waves	**Design of envelope and mechanical systems** **Thermal comfort of occupants**

Domino Effects



Two-prong Approach

Mitigation

Reduce greenhouse gas (GHGs) emissions

- **Increase in energy efficiency in buildings (Equilibrium, LEED, ECOnergy)**
- **Opt for green and more efficient energy sources**
- **Conserve existing buildings**

Two-prong Approach

Mitigation

Reduce greenhouse gas emissions

- Increase in energy efficiency in buildings (Equilibrium, LEED, ECOnergy)
- Opt for green and more efficient energy sources
- Conserve existing buildings

Adaptation

Reduce the risks and damage from current and future harmful impacts or exploit potential benefits

- Evaluate and manage the risks and vulnerabilities
- Estimate new environmental loads
- Promote timely maintenance and extended service life of buildings

Adaptation- Building Envelope

- **What we can do now:**
  - **Integrate climate change into existing planning processes**
  - **Estimate risks of vulnerability of project and develop elements of solutions**
  - **Develop a holistic approach for our interventions**
    - Ex: impact of adding insulation on temperatures of components , to consider along rainwater ingress on such components
    - Impact of mechanical systems with the building envelope
    - Interaction between airtightness and ventilation needs
  - **Selection of solutions offering redundancies and resilience**
    - Rain screen design, steep slopes for drainage, effective flashings
    - Opt for specifications above minimum codes and standards
    - Facilitate maintenance of buildings
  - **Develop new knowledge through post-occupancy evaluation; Share this new knowledge with others**

NRC-IRC Current Research Related to Climate Change

- **Mitigation**
  - Supplementary cementing materials (SCM) to replace Portland cement in concrete and mortar
  - High-performance thermal insulation (R36/in. – evacuated panels)
  - Wall systems for the Arctic
  - Heating and ventilation systems
  - Model National Energy Code for Buildings (planned for 2011)

- **Adaptation**
  - Glazing properties for heating vs air-conditioning loads in Canada
  - Effect of solar shading devices on cooling loads and glazing durability
  - Design of roofing systems to resist dynamic wind loads
  - Design of basements (for housing) adapted to planned use
  - Window installation for effective rainwater management
  - Durable low-strength mortars for conservation of older masonry buildings
  - GIS-supported management systems for prioritization of bldg façade maintenance