WFEO Model Code of Practice: Principles of Climate Adaptation and (in future) Resilience for Engineers

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Outline

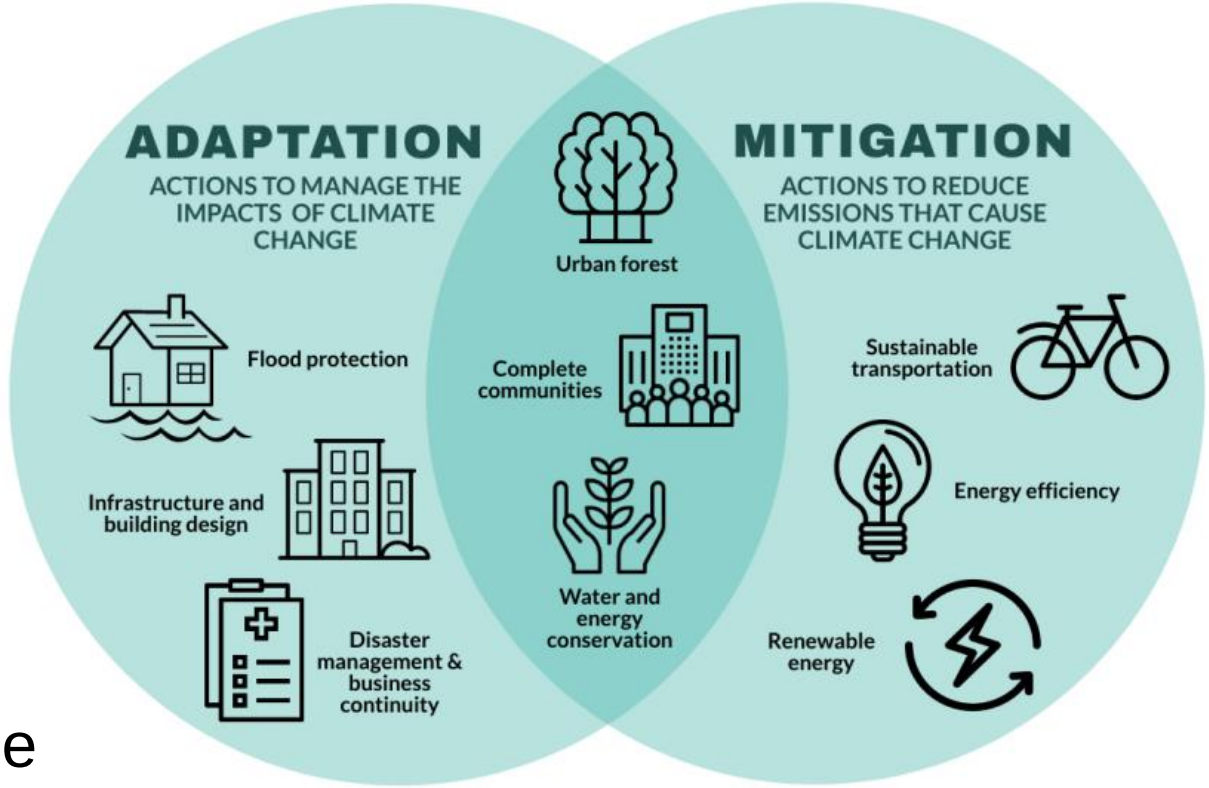
1. Introductory Remarks
2. Status, Authority and Application of the Code
3. Existing Principles Explained
4. New Principles and Concepts
5. Closing Remarks
6. Questions and Discussion

Changing climates, changing loadings…

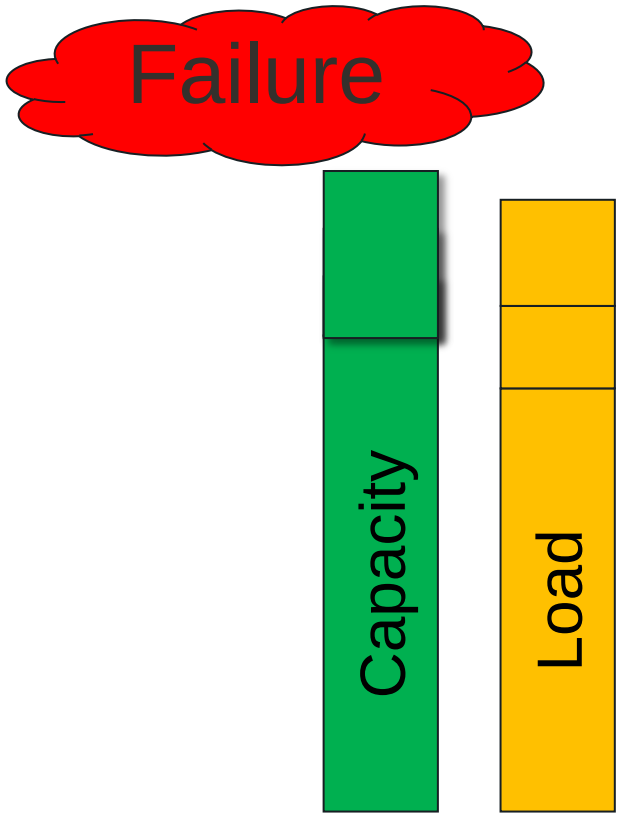
- Changing temperature
- Changes in seasonality and type of precipitation
- Changes in extreme wind loadings
- Frequency and Intensity of precipitation
- Earlier freshet
- Sea level rise and storm surge
- More freeze-thaw cycles
- Melting permafrost
- **Climate is non-stationary……**

Climate Adaptation and Climate Mitigation

- **Adaptation** is managing the unavoidable
- **Mitigation** is avoiding the unmanageable
- It is not a choice

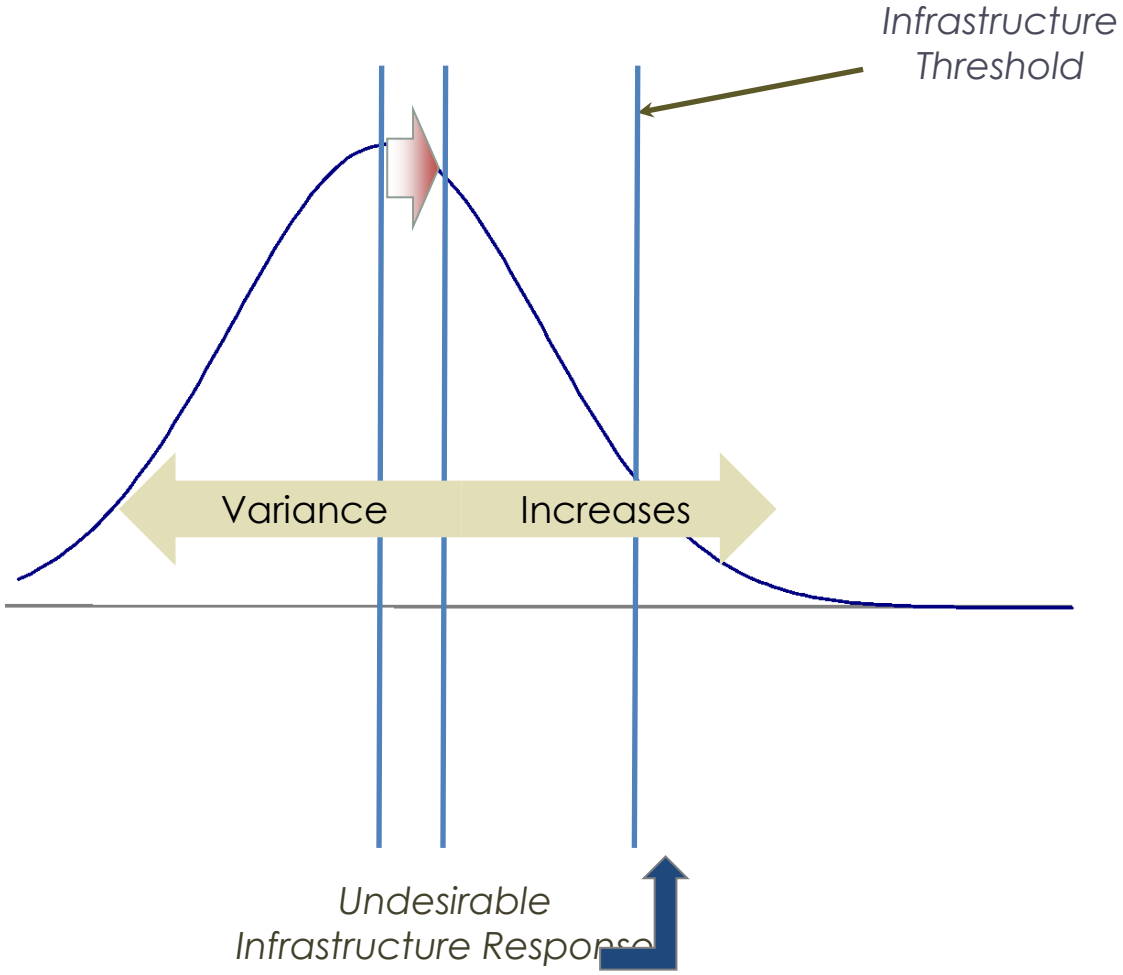


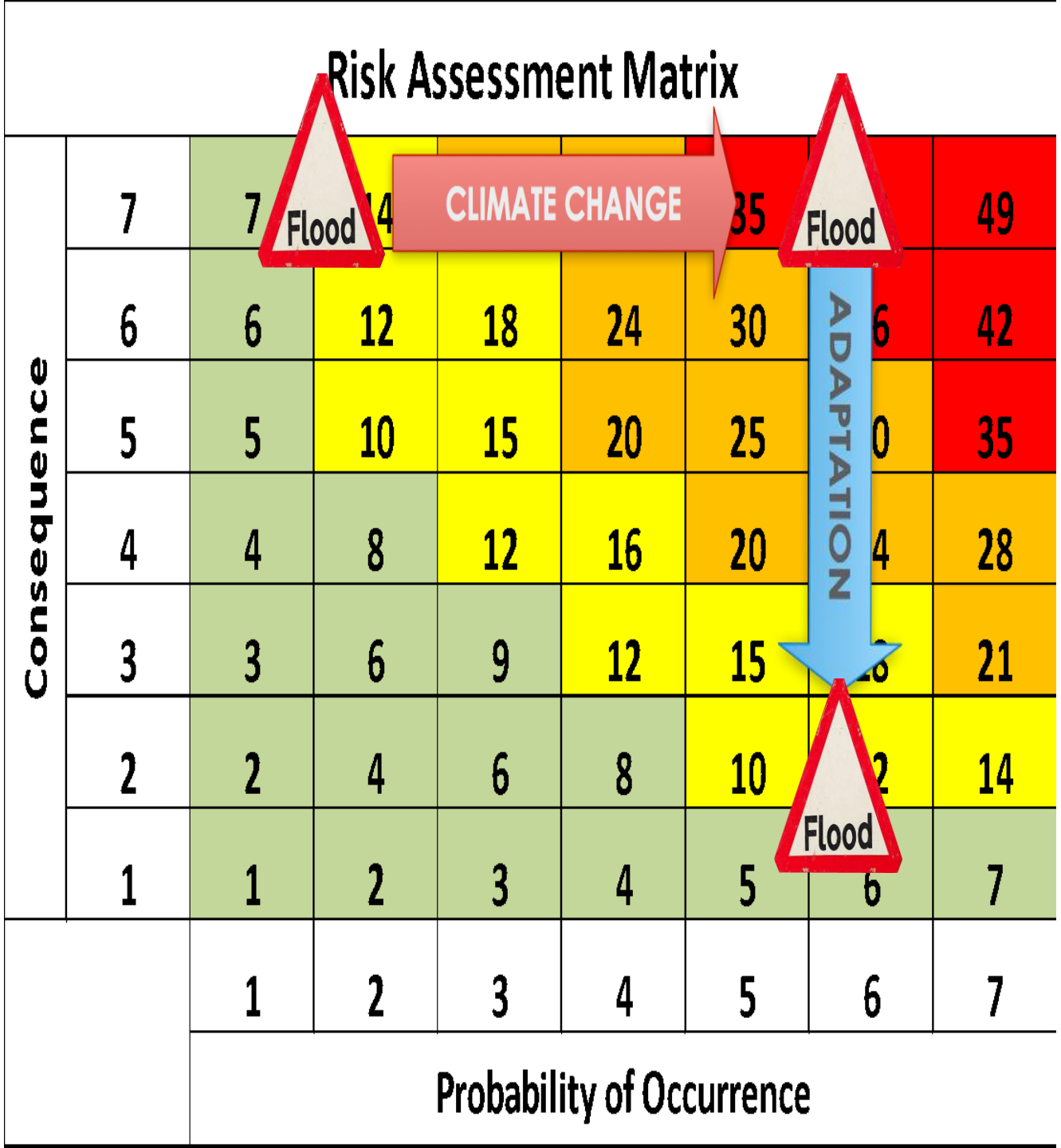
How do Small Changes in Climate Lead to Failure of Infrastructure Assets?



- Design Capacity
  - Safety Factor
  - Impact of age on structure
  - Impact of unforeseen weathering
- Design Load
  - Change of use over time
    - e.g. population growth
  - Severe climate event or climate creep

Changing Climate - Impact on Mean & Variance




Risk Assessment Matrix
Consequence
7
6
5
4
3
2
1
Flood
CLIMATE CHANGE
Flood
ADAPTATION
Flood
49
42
35
28
21
14
7
1
2
3
4
5
6
7
Probability of Occurrence

Creation and Current Status of the CoP

1. **Approved at the WFEO General Assembly - December 2015**
2. **Resident (buried) on WFEO website** http://www.wfeo.org/code-of-practice-on-principles-of-climate-change-adaptation-for-engineers/
3. ***Model* Code of Practice - Voluntary**
4. **Public Guideline on Principles of Climate Adaptation (and Mitigation) for Engineers - Engineers Canada - Mirror to WFEO CoP**
5. **Updating and Revisions underway through WFEO Working Group on Climate Change**

Authority of the CoP(1)

To inform, provide guidance, define a scope of professional practice to deal with this infrastructure issue

Strictly advisory in nature - guides engineering judgment

Guidance in the absence of legislation and regulation

Balancing competing interests related to climate adaptation (and resilience)

Decisions around adaptation and reliance normally rest with the client, owner or employer

Authority of the CoP (2)

Principles concerning the use and application of engineering judgment:

Should - A strongly preferred recommendation (but non binding)

Shall or Must - Is required to (legal requirement, compliance, mandated, potential for sanction)

May - One of several options, voluntary, discretionary, situation dependant, optional (yes or no), guidance only

Adoption of the WFEO CoP

WFEO is not a legal authority in any jurisdiction

Model CoPs are issued to provide guidance on specific areas or elements of professional practice

National members may adopt the CoP in whole or in part, binding or non-binding, modify or edit to reflect local circumstances, regulatory environment, status and authority

Can become binding through reference or requirement in legal agreements, contracts etc

How the Principles are Presented and Explained

1. Description of the principle;

2. Amplification of the principle; and,

3. Suggested implementing actions that address the principle.
    a. Examples of actions for engineers
    b. Engineers may identify additional actions or may decide that only a subset of the suggested actions is necessary or appropriate.

WFEO Model Code of Practice
The Original Nine Principles of Climate Change Adaptation for Engineers

1. Integrate Climate Adaptation into Practice
2. Review Adequacy of Current Standards
3. Exercise Professional Judgment
4. Interpret Climate Information
5. Work with Specialists and Stakeholders
6. Use Effective Language
7. Plan for service life and resilience
8. Apply Risk Management Principles for Uncertainty
9. Monitor legal liabilities

Goal

Ensure that engineers consider the implications of climate change in their professional practice and that they create a clear record of their considerations

Principle #1 - Integrate Climate Adaptation into Practice

Ensure changing climate is considered in all elements of the engineering process through climate understanding

Incorporate into normal day-to-day design, construction, operation, maintenance, planning and procurement activities

Principle #1 - Implementing Actions

1. Listing the climate change predictions and potential impacts

2. Discuss aspects of the project the engineer believes could be impacted

3. What has been done in the design to mitigate those impacts

4. What additional/revised O&M and inspection procedures are recommended within the design-life

5. Maintain a record of these actions

6. Use engineering judgment in applying these actions

Principle #2 - Assess adequacy of current codes and standards

Review local design standards - do they represent current and anticipated climate

Review professional tools used in practice eg procedures, codes, standards, guidance, rules of thumb, local knowledge etc

Use credible international codes, standards and data where local ones do not exist or are deemed inadequate

Eg. ISO 14090 Series of Standards

Principle #2- Implementing Actions

1. Seek and apply most up to date versions of codes and standards that include climate parameters

2. Use these as a baseline and adjust as needed to accommodate project objectives and outcomes

Codes and standards are the minimum baseline that assure safety but not necessarily performance - maintain a record of adjustments

Principle #3 - Exercise Professional Judgment

1. **Evaluate and document the impact of current and future climate on the engineering works (infrastructure)**

2. **<u>Document</u> your engineering judgment and decisions around adjustments to climate paramaters beyond their minimums**

3. **Provide rationale and documentation for not making adjustments, making adjustments andresults of consultation with outside experts**

Principle #3 - Implementing Actions

1. Develop a checklist of climate parameters with potential to impact performance of design

2. Confirm applicability of climate information that may be embedded in codes, standards and assumptions.

3. In engineering working papers, spreadsheets and other documents note that the review has been completed and prepare an accompanying memo to file that the review was completed and the review itself.

4. The engineer responsible for engineering activity should date and sign the accompanying memo.

Principle #4 - Interpret Climate Information

1. Work with climate scientists and specialists

2. Determine current and future climate parameters for the intended life cycle of the infrastructure

3. Assess uncertainties and sensitivites of estimating climate data and projections

More detailed information is not always necessary to inform better decisions

Decisions should be based on a range of plausible climate scenarios, not just one

Principle #4 - Implementing Actions

Develop the current climate profile based on analysis of historical weather data

Estimate the changes in frequency and value of extreme values of relevant climate parameters based on scientifically defensible methods of future climate projections over the service life of the engineered system

Engage climate scientists and climate experts as appropriate to derive current and future extreme values and frequencies of relevant climate parameters

Principle #5 - Work with Specialists and Stakeholders

Work with others, including other practitioners to have a full understanding of the impacts of changing climate and weather

Composition of multi-disciplinary and multi-stakeholder teams should include a broader spectrum of stakeholders and expertise

Principle #5 - Work with Specialists and Stakeholders

Skills of the Project Team (Multi-Disciplinary)

Fundamental understanding of risk and risk assessment processes;

Directly relevant engineering knowledge of the system;

Climatic and meteorological expertise/knowledge relevant to the region;

Expertise in natural sciences such as hydrology, geology, forestry, biology and other specialized sciences;

Principle #5 - Work with Specialists and Stakeholders

Hands-on operation and maintenance experience with the system or similar systems;

Hands-on management knowledge with the system or similar systems;

Local knowledge and history, especially regarding the nature of previous climatic events;

High awareness of levels of process or design "minimum acceptable performance" for the community and stakeholders reliant on the design.

Principle #6 - Communicate Effectively

Communicate about climate change adaptation issues and recommendations using simple, unambiguous, language.

Communicate effectively with the decision-maker about climate change adaptation issues and the associated risks - costs and benefits of adaptation and risk reduction measures

Communicate effectively with the general public about the climate risks and how they will be addressed

Principle #7 - Plan for Service Life

Consider the impact of changing climate over the entire service life of the infrastructure.

Make decisions in the context of current scientific, economic and social constraints.

Capitalize on refurbishment opportunities to review, revise and adapt during the service life of the Infrastructure

Principle #8 - Apply Risk Management Principles

Establish owner risk tolerance considering the cost and complexity to mitigate or reduce climate risks

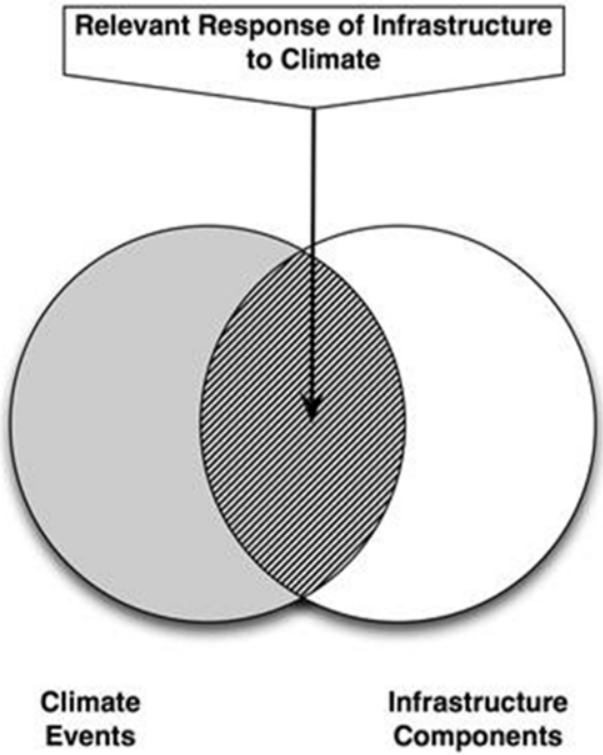
Maintain a competence in risk assessment and management to assess the impact of changing climate on the infrastructure

Consult with the broad range of stakeholders/users

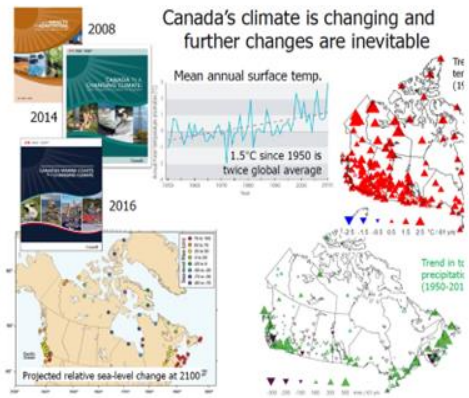
PIEVC (Engineering) Protocol

- Qualitative risk screening tool derived from standard risk management methodologies
- Developed to assist engineers in factoring climate change impacts into plans for design, operation, maintenance and adaptation of public infrastructure
- Applied by professional teams (Engineers, Climate Scientists, Natural Scientists, Planners, Risk Managers, Owners, Operators, Political Decision-Makers, as well as Civil Society stakeholders)

- Intended for use by qualified engineering professionals and infrastructure practitioners (clients and consultants)
- Requires contributions from those with pertinent local knowledge and operations/maintenance experience
- Focused on the principles of vulnerability and resiliency



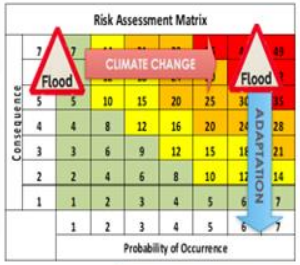
PIEVC Process – *Brief* Overview



Step I
Project Definition

Step 2
Data Gathering & Sufficiency

Step 3
Risk Assessment



Engineering Analysis?

Yes

Step 4
Engineering Analysis

No

Step 5
Conclusions & Recommendations

TBL Analysis?

No

Reporting

Yes

Step 6
Adaptation Scenarios

Step 7
Multi-Factor Analysis

Step 8
Recommendations & Follow-Up

Reporting

Principle #9 - Monitor legal liabilities

Be aware of any legal liability associated with reliance on historic climatic and weather information

Remain apprised of decisions and case law in their country of work governing societal expectations of reasonable professional care and practice.

Actions that consider and/or adjust the engineering work to accommodate current and future climate should (must) be documented.

Principle #10 (Proposed) - Incorporate Resiliency into Adaptation

What is Climate Resilient Infrastructure

Infrastructure planned, designed, constructed and operated to withstand climate impacts with ability to recover and provide service quickly after disruptions

Principle #11 (Proposed) -
Consider Nature-based Solutions in Adaptation Planning

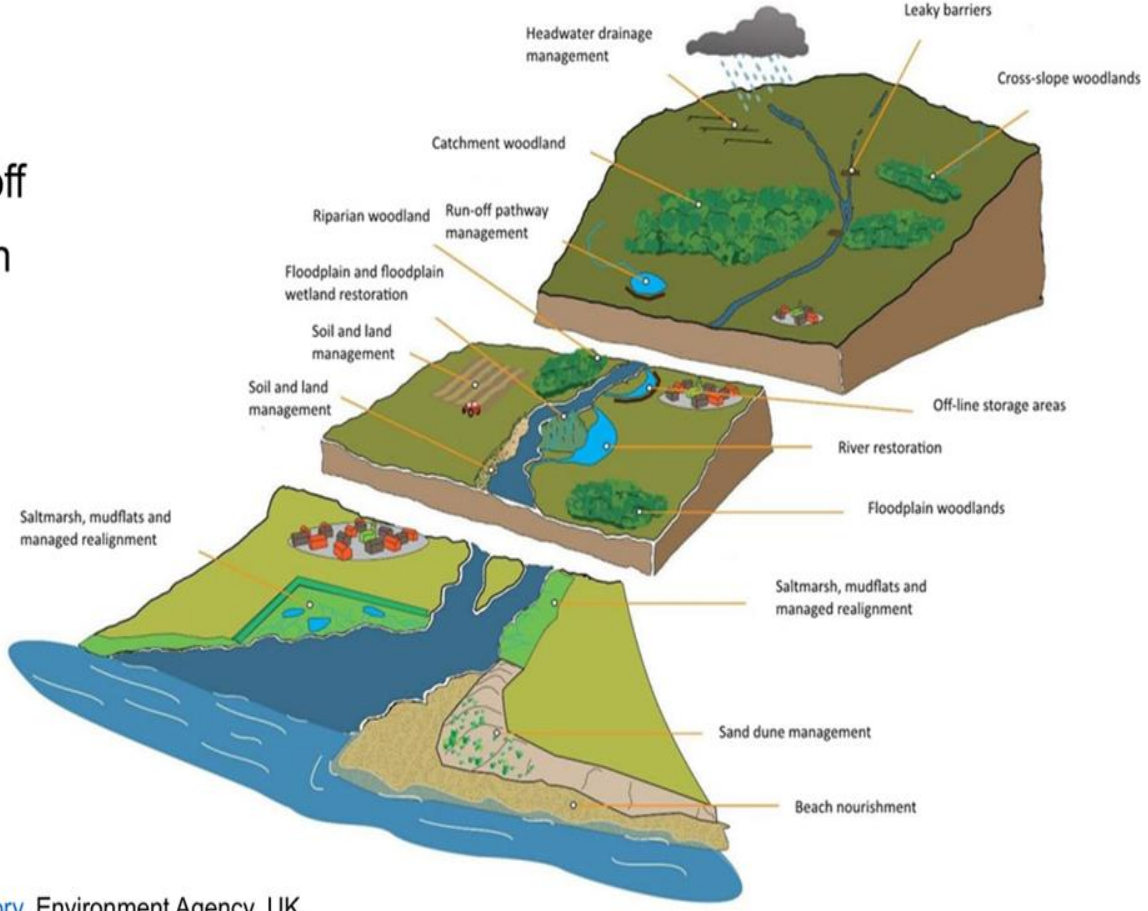
NbS is a growing field of application to address climate impacts and effects

Particularly relevant for coastal infrastructures and mitigating effects of sea level rise and storm surges

Natural Infrastructure Reduces Flooding, Erosion and Drought

INTACT CENTRE
ON CLIMATE ADAPTATION

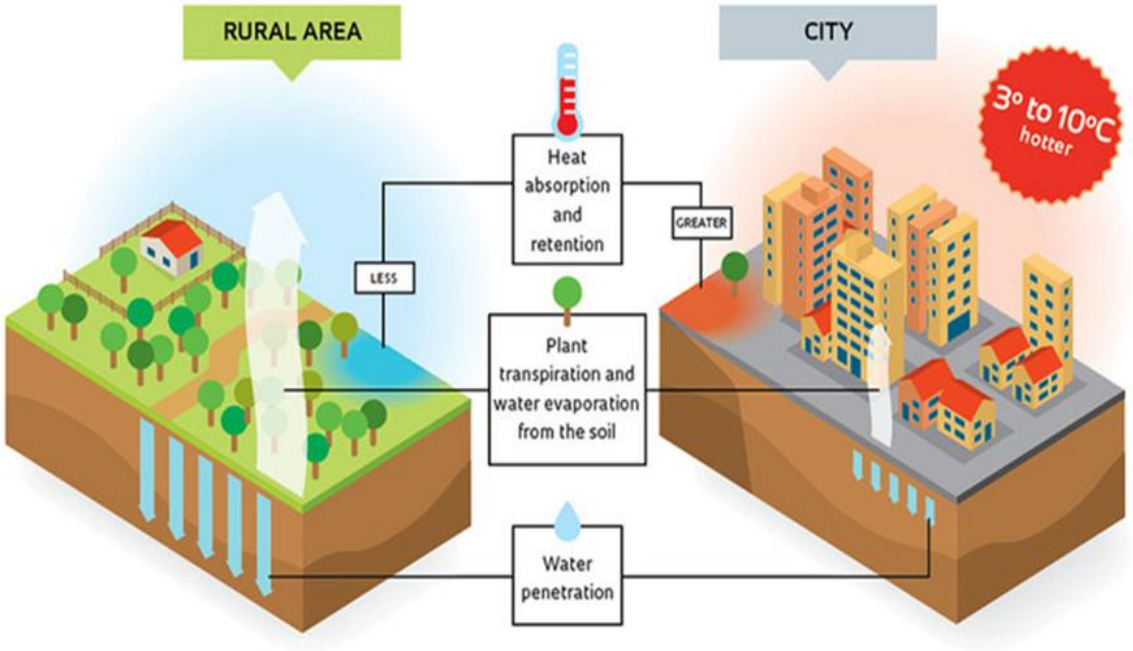
- Store water
- Slow down water
- Reduce volume of peak runoff
- Reduce soil and river erosion



Source: Burgess-Gamble et al. (2018)
Working with Natural Processes – Evidence Directory. Environment Agency, UK.

Natural Infrastructure Reduces Extreme Heat

INTACT CENTRE
ON CLIMATE ADAPTATION



Source: ecoRi (2019) Cool Ideas for Reducing Urban Heat-Island Effect
https://www.ecori.org/green-tip/2019/8/9/cool-ideas-for-reducing-urban-heat-island-effect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NRC·CNRC
Nature-Based Infrastructure for Coastal Flood and Erosion Risk Management
A Canadian Design Guide
National Research Council Canada
Conseil national de recherches Canada
Canada
Suggested citation: Murphy, E., Cornett, A., van Proosdij, D., & Mulligan, R. P. (Eds.) (2024). Nature-Based Infrastructure for Coastal Flood and Erosion Risk Management – A Canadian Design Guide. ISBN 978-0-660-71886-6.
2021 2030 United Nations Decade of Ocean Science for Sustainable Development
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Closing Remarks

1. Climate consideration has become an essential component of engineering practice across most disciplines especially as it relates to infrastructure
2. Integration of climate change into engineering practice is achieved through climate risk and vulnerability assessment
3. Demand for climate consideration by infrastructure owners and clients is increasing
4. Climate services, climate data, climate projections, practice guidance, tools and climate design standards (international and national and local) are increasingly available and improving

Intact Centre: Tools Freely Available to Reduce Risk

INTACT CENTRE
ON CLIMATE ADAPTATION

FLOOD

1) Home, 2) Existing Communities, 3) New Community Design, 4) Commercial Real Estate, 5) Coastal Communities, 6) Integrated Solutions, 7) Cities, Provinces, Territories, 8) Home Protection Infographic

WILDFIRE

EXTREME HEAT

NATURAL INFRASTRUCTURE

HEALTH

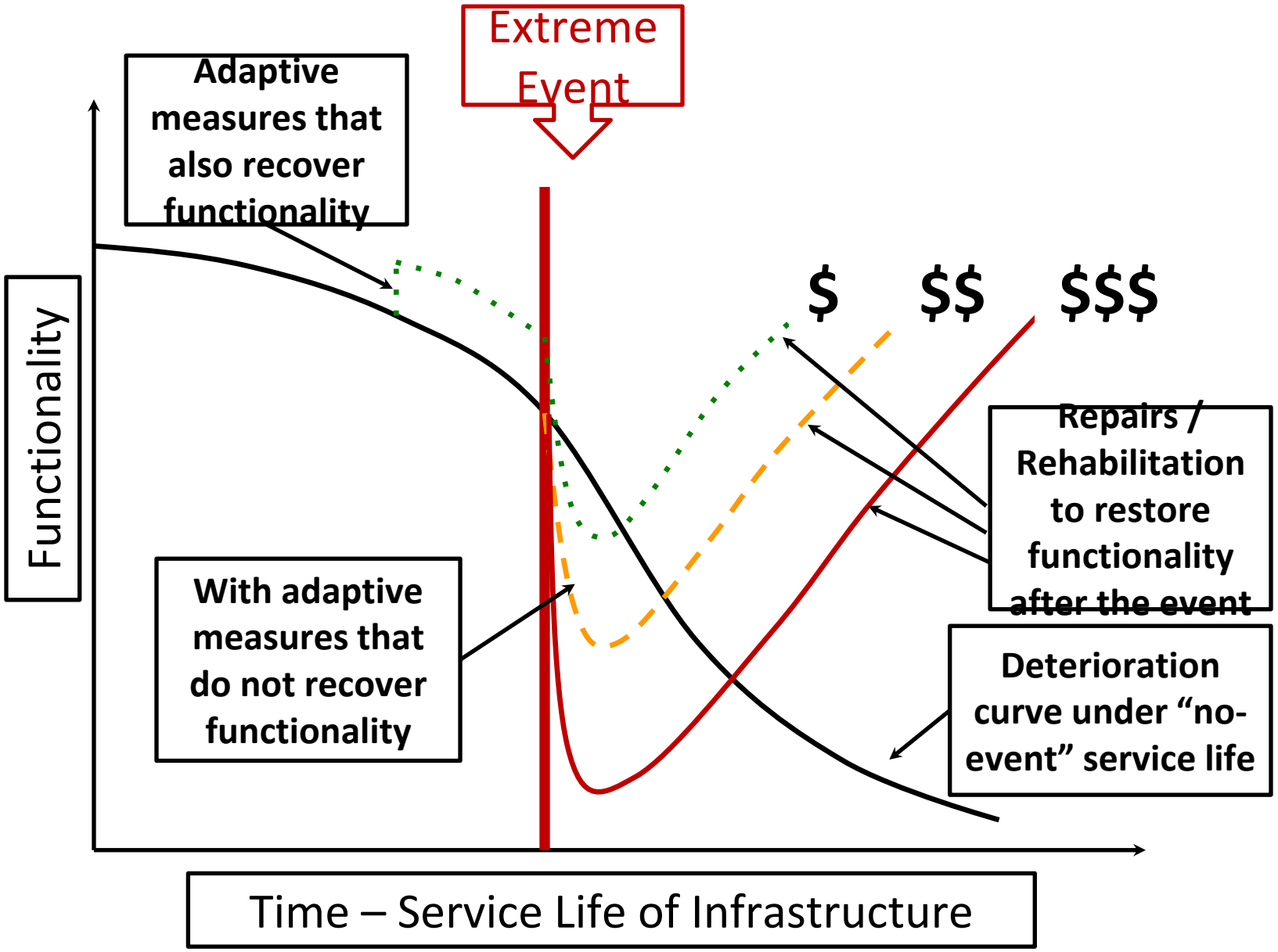
CAPITAL MARKETS

Steps towards Climate Resilient Infrastructure

- **Climate Risk and Vulnerability Assessment**
  - Identify nature and severity of risks to components
  - Adjustments to design, operations and maintenance
  - Application to new designs, retrofitting, rehabilitation and operations and maintenance
  - Reviews and adjustments of codes, standards and engineering, planning practices and processes
- **Capacity Development**
  - Practitioner – Include opportunities for women and younger professionals
  - Institutional – engage infrastructure owners and management, educational institutions
  - Governmental – National Adaptation Planning for Infrastructure

Steps towards Climate Resilient Infrastructure (2)

- **Design, construction, operation and maintenance**
  - Cost benefit analysis
  - Asset management
  - Engagement of operations and maintenance staff
  - Reviews and adjustments of codes, standards and engineering planning practices and processes
- **Government Commitment**
  - Policies and legislation
  - Financial resources – internal and external e.g. IFIs, Green funds etc



Adapted from McAllister, T.P. (2013) *Developing Guidelines and Standards for Disaster Resilience of the Built Environment: A Research Needs Assessment*, NIST TN 1795, National Institute of Standards and Technology, Gaithersburg, MD, 20899.

"it is critical the profession (engineering) create conditions where climate change adaptation is not only an accepted part of daily practice, but also a guiding principle of professional practice.

Individual engineers should make reasonable efforts to incorporate adaptation into their personal professional practice through continuing professional development and experience

This, in turn, calls on engineers to communicate more effectively with decision makers about climate change adaptation issues and the associated risks."

The WFEO Code of Practice

Principles of Climate Adaptation and Resilience

provides a consistent framework with

guidance for

structured and fulsome consideration of

climate in engineering practice

Thank You!

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Questions and Discussion

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