Addressing Climate Risks for Coastal Transportation Infrastructure

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Climate Change

There has been a substantial increase in the intensity of heavy-precipitation* events over large parts of the Northern Hemisphere due to greenhouse gases

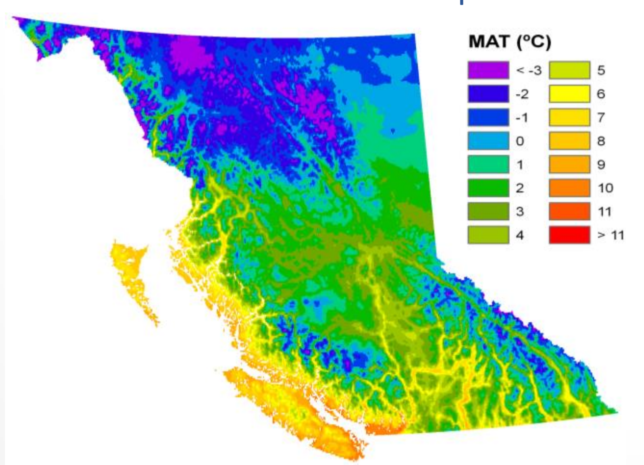
(*Storms with over 100 millimetres of precipitation in 24 hours)

Source: Zwiers, Nature, 2011

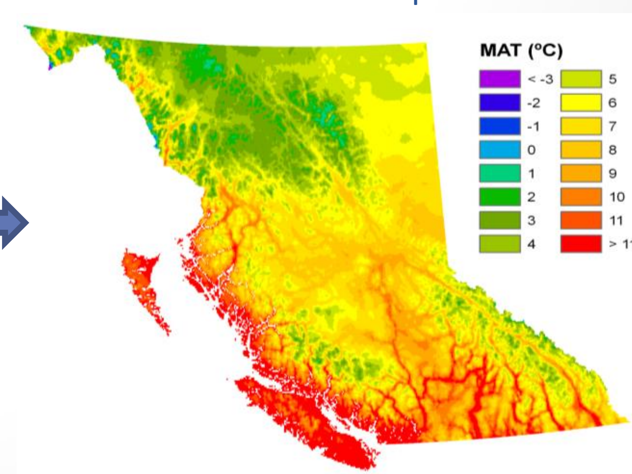
Climate Adaptation

- Significant impacts even with GHG reductions
- Future climate change and extreme event considerations required
- Adaptation for resiliency and reliability of transportation system
- Adaptation involves preparing for economic, social and environmental impacts of climate change

1961-1990 Mean Annual Temperature BC

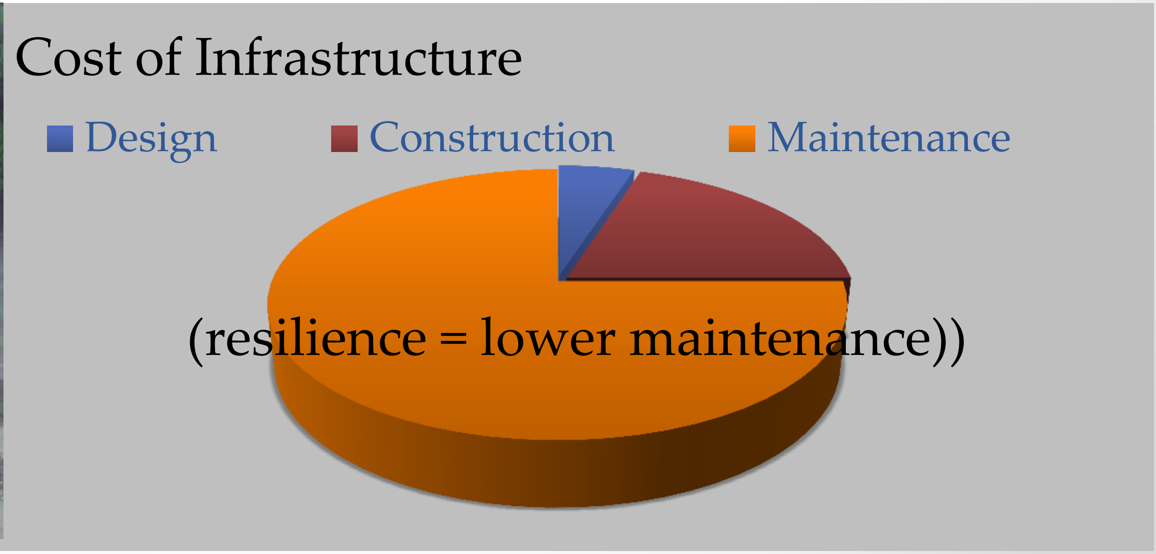


2080s Mean Annual Temperature BC

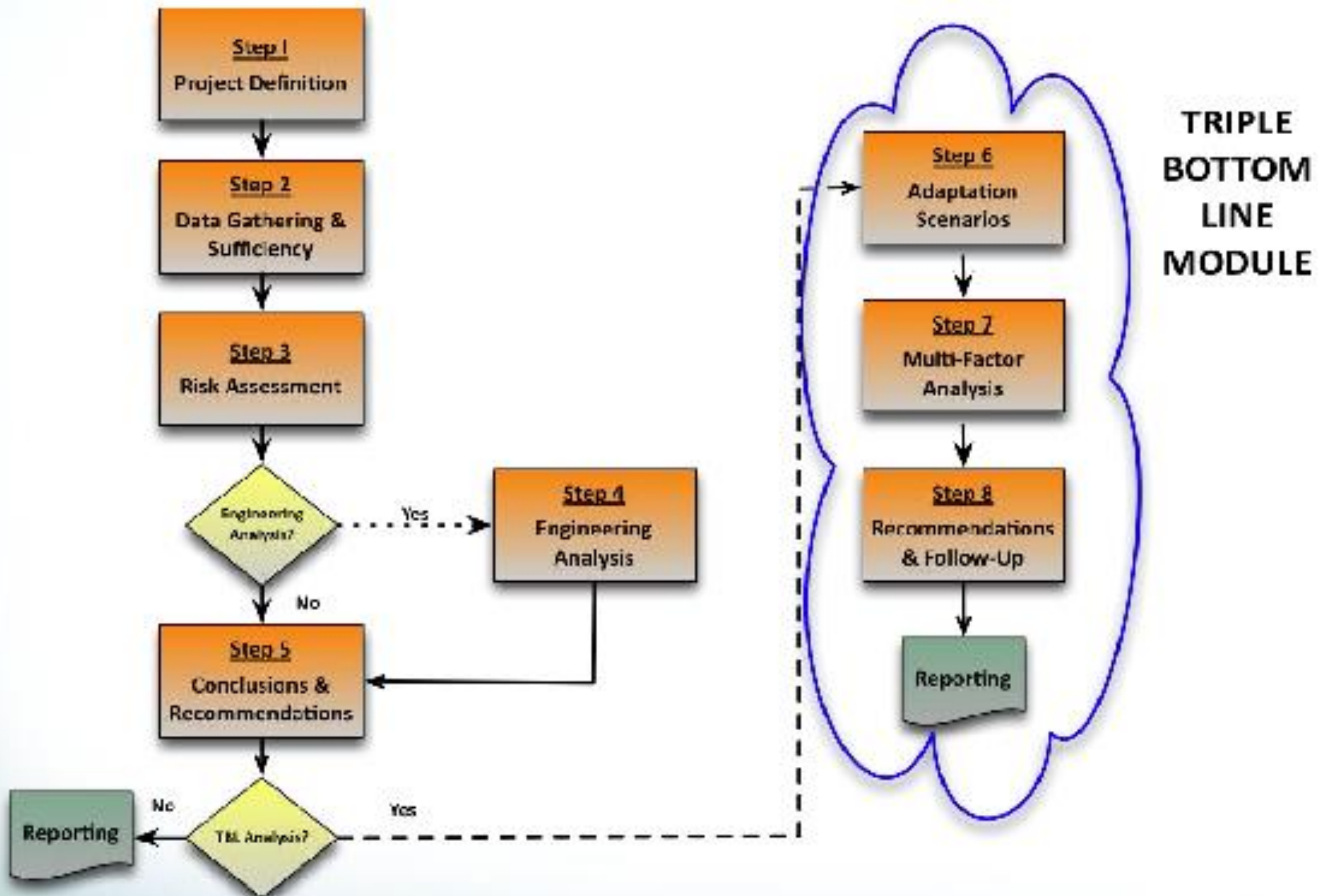


Motivation to Adapt

- Considering character, magnitude and rate of change of climate and extreme weather events
- Impact potential on design, operation & maintenance
- Adapt engineering design practices for resilient, reliable, efficient and effective transportation infrastructure



PIEVC - Process



Vulnerability Assessment Conclusions

- Based on risk assessments, the study segments of BC Highways are generally resilient to climate change
- Extreme precipitation events could overload drainage infrastructure
- Gaps include effects on highway components from climate extremes, rain on snow, fog & wind, avalanche, landslides, sea level rise, etc.

Bella
(Sept

Yellowhead Hwy

Bitter Creek Bridge Stewart (Sept 2011)

Design Implications

Depends on structural components design life & site

- Pavement 15-20 years, culverts 75 years, bridges 50-100 years
- Design for potentially higher temperatures and precipitation in many parts of the province
  - Review temperature and precipitation sensitive components
  - Climate and product specification changes

Best Practices


Lantzville (Jan 2018)

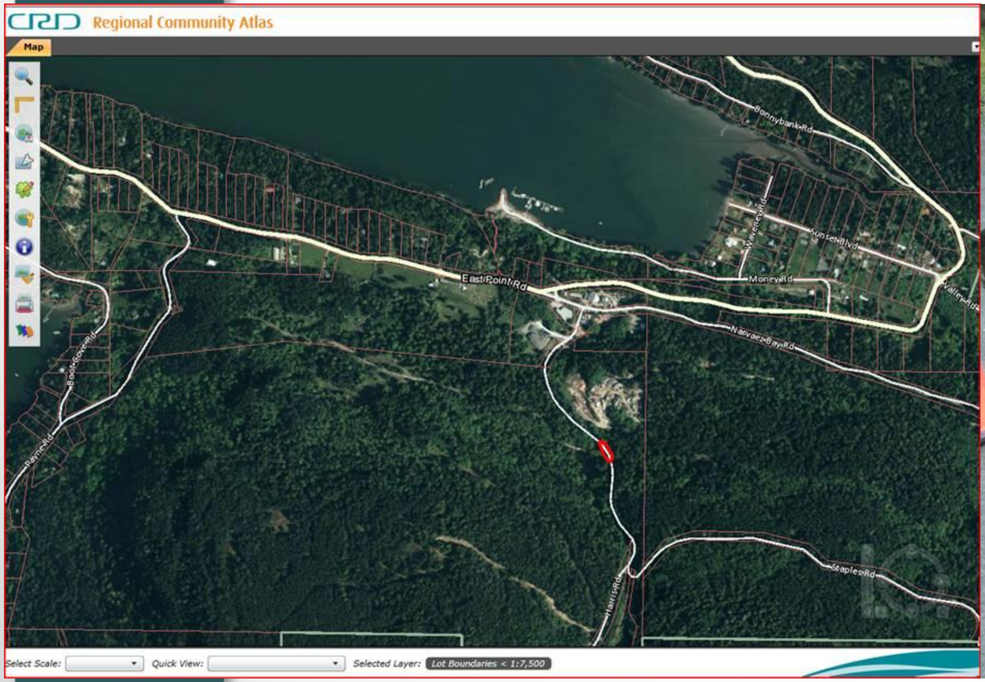
- Monitor **data** used in codes and standards
- Use quantitative data and/or professional judgement
- Apply sensitivity analysis
- Understand risks and uncertainties
- Review association guidance


Errington (Jan 2018)

- Use information from ensemble of climate models
- Determine best models & data to use

Saturna Island Mudslide (Harris Rd) 2013

- No alternative road for six residents affected (many islands have circular road systems)
- Some material for repair on island otherwise from mainland



Design Value Matrix

Discipline	Climate Design Parameter	Design Value	Adaptation Value
Geotech	slope stability	safety factor 1.5	compare recent conditions & future climate projections
	pavement ac mix	PG values based on historic temperature & use	modify PG rating based on future temperature & use
Structures	scour design flow return period	past record Q200 flow magnitude	Anticipated Q200 flow magnitude from climate models
	thermal movement	max, min daily temp	future max, min daily temp

Rock and Mud Slide on Galiano Island
(Porlier Pass Rd) 2016

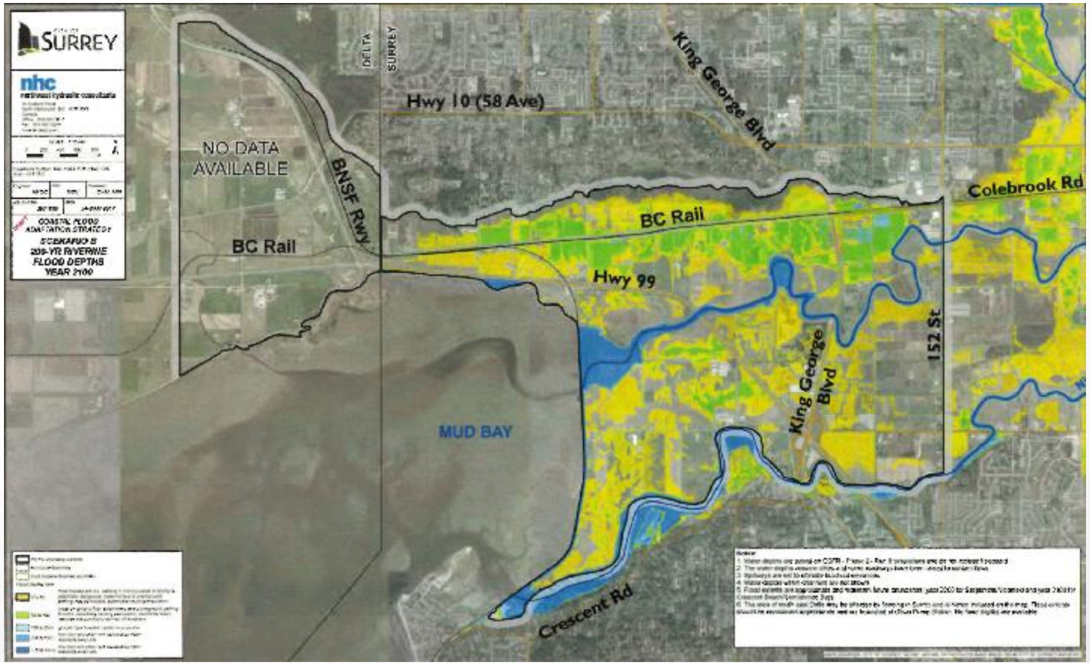
Debris Torrents

Current Standards	• consider impact of debris torrents (surge of water, mud, and rocks) in steep creek
Triggers	Climate: • rainfall amounts, rainfall intensity, increased runoff amounts, snow accumulations • storm and/or snowmelt runoff, water release from subglacial or lake storage, log jam bursts, rockfall, debris or snow avalanches from upslope or seismic shaking Other: • vegetation provides protection against erosion of slopes - changes can cause landslide events - debris torrents
Risk Issues	debris torrents can result in structure damage or washouts due to scour and erosion from high flows
Adaptation	designs may need to include further measures to protect structures from debris torrent events

Surrey Coastal Flood Adaptation Strategy
(SLR and river flooding issues)

Options at Mud Bay near border crossing with USA:

- Coastal realignments (Hwy 99 or 152nd St)
- Managed retreat
- Barrier at Mud Bay
- Current conventions (diking)




Thank you
Questions
Salt Spring Island (Jan 2018)