


CLIMATE CHANGE AND RESOURCE ROADS: ARE YOU AT RISK?

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FPInnovations

CLIMATE CHANGE AND RESOURCE ROADS: ARE YOU AT RISK?

OBJECTIVES

- Bring awareness to the relationship between roads and climate change
- Define resource road resiliency and adaptation
- Understand the process to identify risks and vulnerabilities to resource roads
- Identify methods to mitigate climate change risks to resource roads

CLIMATE CHANGE AND RESOURCE ROADS: ARE YOU AT RISK?

Resource roads support critical access for multiple industries, public recreation, and remote communities.

600 000
kms
of resource roads estimated in BC

400
kms
average annual primary road construction in Ontario

450
kms
average annual secondary road construction in Ontario

10-15
%
average road costs as percentage of delivered wood costs

CLIMATE CHANGE AND RESOURCE ROADS: ARE YOU AT RISK?

CHANGES IN CLIMATE ARE IMPACTING RESOURCE ROAD MANAGEMENT

- In general, regions are currently experiencing, or are expected to experience:
  - Warmer winters and more frequent mid-winter thaws
  - Average annual precipitation remains similar but is concentrated in more frequent high-intensity, short duration rainfall events
  - Increase in precipitation in the form of rain on snow or heavy snowfall
- The impacts to resource roads are being felt immediately on aspects such as:
  - Reduced ability to construct and utilize winter roads
  - Restrictions on seasonal transportation schedules
  - Increased demands on water crossing infrastructure
  - Increased road surface maintenance
  - Plus many more !

WHAT IS NEEDED ?

AWARENESS THAT ROAD MANAGEMENT NEEDS TO ADAPT

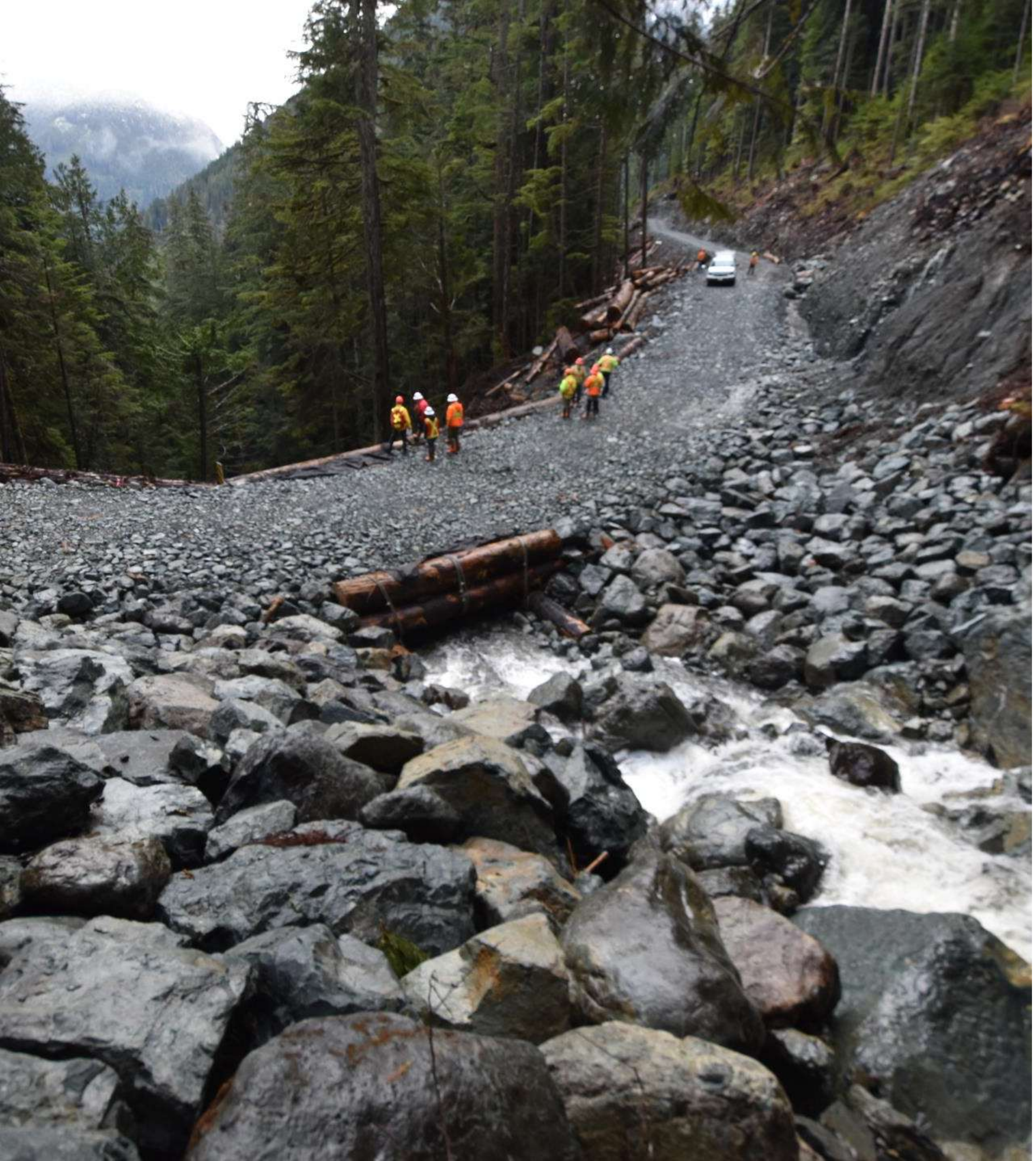
Photo courtesy: FLNRORD

KNOWLEDGE OF THE CLIMATE EVENTS THAT WILL HAVE THE GREATEST IMPACT

UNDERSTANDING OF PRACTICES THAT CREATE RESILIENT ROAD NETWORKS

WHY DO WE NEED TO ADAPT ?

- Year round access to fibre supply is increasingly required
- Roads less likely to be “shutdown” for extended periods
- Multiple-users needs must be considered
- Road user safety of high importance
- Compliance to EMS and government standards



UNDERSTANDING ADAPTATION

- Refers to **any action** that reduces the negative impact and reduces the vulnerability of the infrastructure to climate change
- Actions are often focused on **structural adaptations** (direct changes to infrastructure) which can be quickly implemented
- **Operational adaptations** (policies and procedures) are an important component but typically take longer to implement

Photo credit: FLNRORD

UNDERSTANDING ADAPTATION

- Implementation does not necessarily require significant change or costs
- Implementing **“soft strategies”** such as robust erosion control practices, or performing ongoing maintenance are examples of easy wins
- Higher impact changes or **“hard strategies”** will require higher capital and long term investments to deal with events such as milder winters

ADAPTATION BUILDS RESILIENCY

- Resiliency is the capacity to withstand disruption and disturbance and to adapt to changing conditions
- The intent :
  - **is not to** create infrastructure that is resistant to all hazards,
  - **is to** create infrastructure with the capacity to respond and adapt to climate change while reducing the severity of damage

IDENTIFYING RISKS AND VULNERABILITIES

- Risk
  - *Is the product of the probability (P) of a negative event and the severity (S) of the consequences of that event*
  - *RISK = P x S*

- When assessing risk, consider three questions:
  - What can happen ?
  - How likely is it to happen ?
  - Given that it has happened, what are the consequences ?

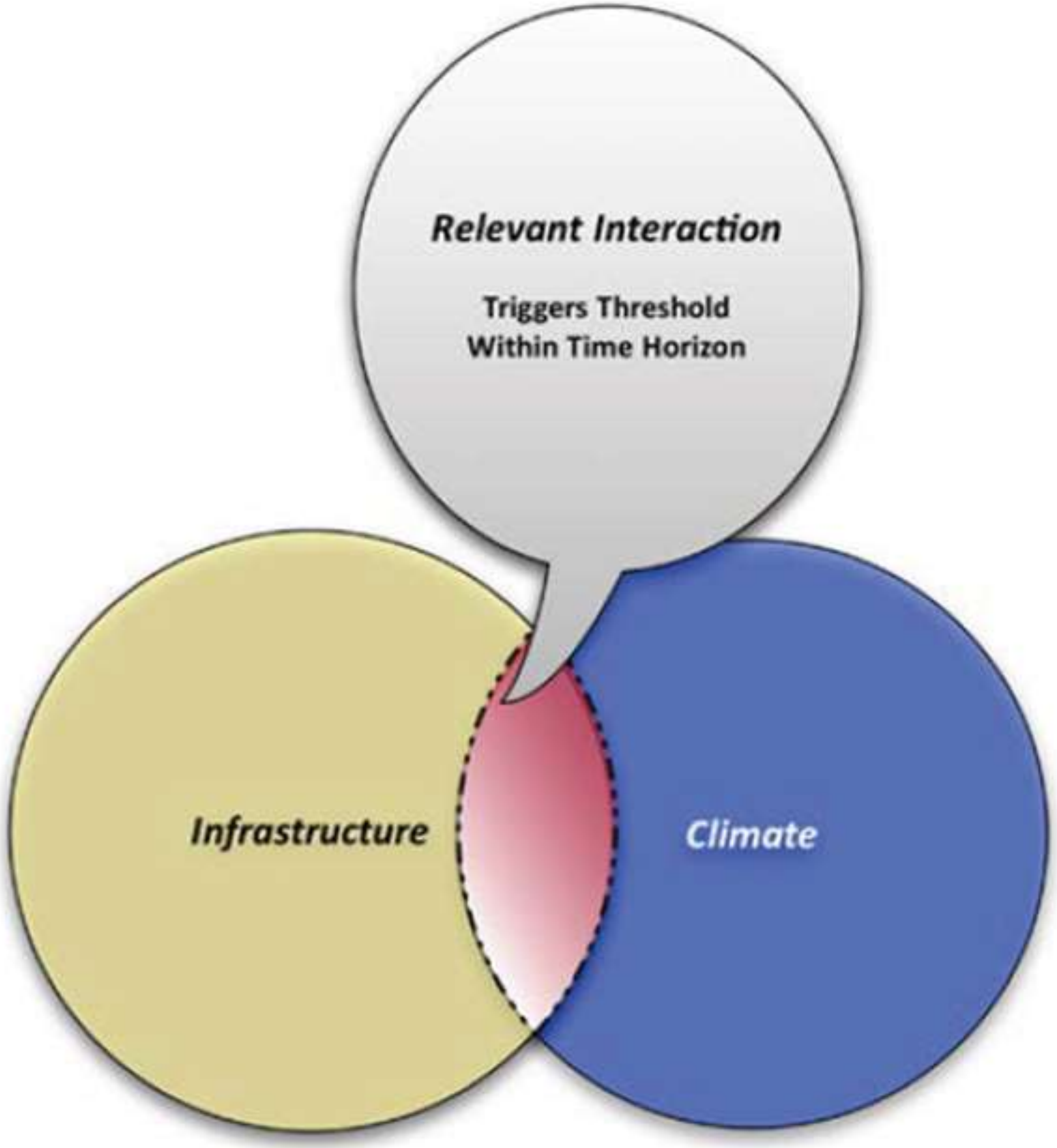
IDENTIFYING RISKS AND VULNERABILITIES

- Vulnerability
  - *The shortfall in the ability of infrastructure to absorb negative effects, and benefit from positive effects, of changes in the climate conditions used to design and operate infrastructure* (PIEVC)

- Vulnerability is a function of three factors:
  - Exposure
  - Sensitivity
  - Adaptive capacity

IDENTIFYING RISKS AND VULNERABILITIES

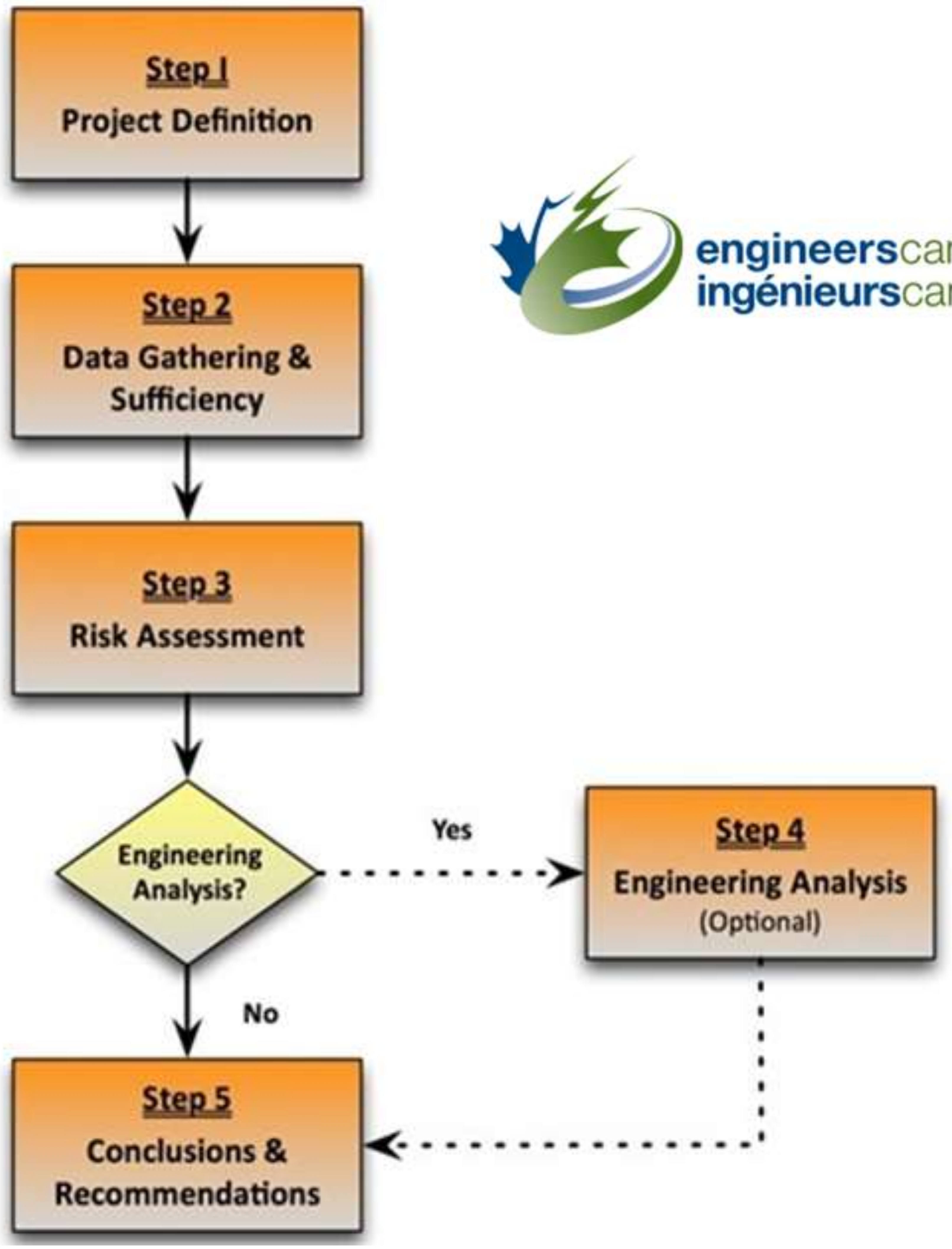
- The potential for risk is created where the infrastructure and climate interact
- If there is no interaction, there is no risk
- The tolerance to risk is determined by many factors and can be different for each user, jurisdiction or manager



Reproduced from Engineers Canada 2016

HOW TO ASSESS RISK ?

- The Public Infrastructure Engineering Vulnerability Committee (PIEVC) protocol was developed by Engineers Canada
- Describes a step-by-step methodology of risk assessment for evaluating the impact of a changing climate on infrastructure
- Provides a framework to support effective decision making for infrastructure operation, maintenance, planning and development



Reproduced from Engineers Canada 2016

HOW TO ASSESS RISK ?

- The PIEVC protocol is designed to assess engineering vulnerability
  - Focus on infrastructure structural and operational features
- The process relies on a team approach and professional judgement
- Emphasis on practical approaches to reducing vulnerability within established schedules and budgetary constraints

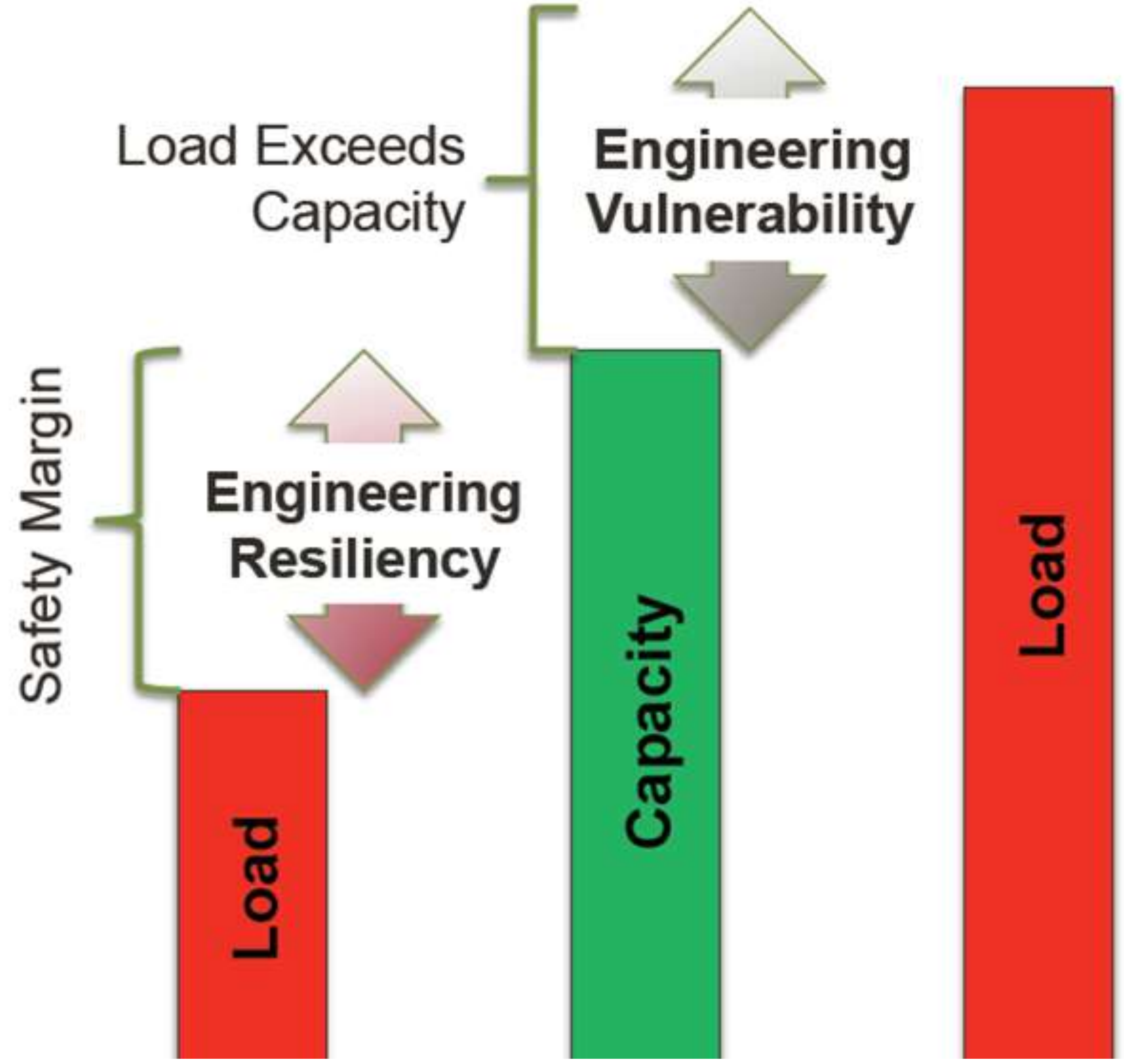


Image: David Lapp Engineers Canada

HOW TO ASSESS RISK ?

- Provides an outcome of risk scores
- These scores can provide an indication of the overall risk of certain infrastructure components to particular climate events
- This information can then be used to identify adaptation needs, budget forecasting and short-and long term management interests

Infrastructure Components and Operational Considerations	Extreme High Rainfall in 24 hour period				
	1-day rainfall > 65 mm @ high elevation				High runoff. Culvert and bridge damage or destruction, road surface damage or deterioration, safety
	Y/N	P	S	R	
Road Prism Features					
Road surface	Y	5	3	15	
Cut and fill slope	Y	5	3	15	
Ditches & cross ditches	Y	5	3	15	
Catch basins	Y	5	2	10	
Cross drains	Y	5	5	25	
Stream Crossings					
Major culverts > 1.8 m	Y	5	4	20	
Other culverts < 1.8 m	Y	5	5	25	
Bridges	Y	5	6	30	
Upslope/Downslope beyond road prism					
Managed (Upper Adams Park)	Y	5	3	15	
Unmanaged	Y	5	2	10	
Operational Considerations					
Commercial and recreational access	Y	5	5	25	
Emergency response	Y	5	5	25	
Winter maintenance	N				
Summer maintenance	Y	5	3	15	
Personnel	Y	5	3	15	

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HOW DO WE MITIGATE RISK ?

- Identify and implement adaptation practices
- Evaluate performance of adaptation practices
- Implement change and continuos improvement
- Adaptation needs to occur throughout the entire resource road cycle, including:
  - Planning and construction
  - Water management
  - Water crossings
  - Maintenance
  - Transportation / road usage

PLANNING AND CONSTRUCTION

- Develop an accurate inventory, condition and performance assessment of existing infrastructure
- Create and implement inspection plans, protocols and schedules
- Consider implementing a **"safe-to-fail"** design approach
- Optimize road density to consider risk management and usage needs
- Establish the use of satellite log yards to manage wood flow and transportation
- Utilize foundation reinforcement designs, such as geosynthetics to ensure access in low soil bearing conditions

Photo credit: FLNRORD

PLANNING AND CONSTRUCTION

SATELLITE LOG YARDS

- Material is stockpiled until it is required by the processing facility
- Optimize transportation (higher payloads) during periods of high road strength
- During periods of poor resource road conditions transportation may continue on public roads

PLANNING AND CONSTRUCTION

GEOSYNTHETICS

- Woven geotextiles and geogrids can offer road reinforcement
- Suitable for application in areas with low soil bearing capacity
- Can provide access to areas that were previously dependent on frozen or very dry conditions

WATER MANAGEMENT

- Review cross-drain culvert design requirements (placement, spacing and design) to manage roadside water
- Ensure effective road surface drainage at the time of construction and with regular maintenance
- Incorporate water management structures into winter roads to manage water during thaw periods
- Make sure that grading practices preserve and/or create proper road surface crowning

WATER MANAGEMENT

CROSS DRAIN CULVERT USAGE

- Roadside ditch performance and ability of existing cross-drains to pass water through the road can be strained by increased precipitation
- Utilize water control structures, such as ditch blocks to direct flows
- Increase culvert densities
- Increase minimum pipe diameter to at least 450 mm

Photo credit: Kruger Corner Brook

WATER MANAGEMENT

WINTER WATER MANAGEMENT

- Rain on snow events and mid-winter thaws can create challenges in dealing with melt waters
- Water management on winter roads has traditionally been overlooked
- Implement larger, higher density cross drain culverts
- Pre-plan water management needs to avoid construction in frozen periods

WATER MANAGEMENT

ROAD SURFACE MANAGEMENT

- Ensure that a crown of 3-5% is created and maintained on the road
- Road surface should be a well-graded granular material containing low plasticity clays
- Utilize broad-based dips, open-topped surface drains and other practices to evacuate water off of the road surface

WATER CROSSINGS

- Avoid reducing the stream width when sizing structures
- Implement streambed simulation designs
- Consider the use of fords where these structures are deemed appropriate
- Consider removing water crossings if a road is expected to remain inactive and access is not required

WATER CROSSINGS

FORDS

- Armoured fords can be suitable risk reduction strategies where deemed appropriate
- Low streamflows and low-traffic levels are required
- Reduced maintenance requirements as compared to buried structures or bridges

WATER CROSSINGS

VENTED FORDS

- Vented fords are designed to pass low water flows and to provide debris and stream flows during peak events
- Specifically designed to accommodate overtopping
- Sumps, broad based dips and porous rock embankments can be critical additions

WATER CROSSINGS

MAINTAIN NATURAL STREAM WIDTH

- Relying solely on hydraulic capacity may not be sufficient to mitigate risk of structure failure
- Consider the practice of streambed simulation, where a closed bottom structure is embedded and partially infilled to mimic natural streambed conditions

WATER CROSSINGS

MAINTAIN NATURAL STREAM WIDTH

- Relying solely on hydraulic capacity may not be sufficient to mitigate risk of structure failure
- Consider the practice of streambed simulation, where a closed bottom structure is embedded and partially infilled to mimic natural streambed conditions
- Alternatively, fully span the watercrossing with abutments outside of the streambanks

MAINTENANCE

- Review dust abatement strategies
- Ensure that a well-graded surface material is used on high traffic roads
- Develop and implement maintenance protocols, schedules and procedures
- Remove bedload and debris accumulations to ensure that structures perform to their designed performance

MAINTENANCE

DUST ABATEMENT

- Road dust can create significant safety issues due to reduction of visibility
- Haul times may be increased if truck vehicle speeds are reduced
- Evaluate the road surface material to determine the most cost-effective dust abatement product

TRANSPORTATION

- Consider management of hauling schedules and payload optimization opportunities
- Periods of restricted haul may appear earlier with the onset of spring thaws
- The implementation of tire pressure control systems (TPCS) and high flotation tires may provide improved access

KEY ELEMENTS FOR INFRASTRUCTURE ADAPTATION

- Understand what adaptation is
- Know the climate changes in which to adapt
- Identify adaptation tools and practices
- Recognize that adaptation occurs locally
- Be aware that strategies are evolving

CHALLENGES TO ADAPTING TO CLIMATE CHANGE

- Poor inventory and maintenance programs
- Lack of resource road infrastructure asset management
- Multi-layer ownership and responsibilities
- Performance and design standards often lacking
- Low-barrier to entry

RESILIENT ROADS

- Whether or not the anticipated climate events or changes occur, adaptation practices will improve road infrastructure performance
  - "no-regrets approach"
  - A risk-reward or cost-benefit analysis is required
- Short-term **incremental and/or reactive strategies** need to be implemented
- Long-term **proactive strategies** need to be identified
- Implementing an infrastructure asset management plan and integrating climate impacts, can create **reliable, cost –effective** resource road networks

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CLIMATE CHANGE AND RESOURCE ROADS

Present a summary of three PIEVC risk and vulnerability case studies on resource roads in British Columbia.

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WEB CONFERENCE

FOREST OPERATIONS PROGRAM 2018-2019

Thursday : 1-2 PM, EASTERN Time
10-11 AM, WESTERN Time

Climate Change and Resource Roads: Summary of three risk and vulnerability case studies

Date: March 7th 2019

With: **Mark Partington**, Senior Researcher, Transportation and Infrastructure

The forecasted changes in precipitation and temperature associated with climate change are expected to create impacts to resource roads that will affect the performance of infrastructure. In order for managers and owners to recognize how these forecasted changes may impact infrastructure, there is a need for the application and understanding of an approach to identify the risks and vulnerabilities that may be presented. Through the application of this approach, trends may be identified that will provide important information for anyone interested in resource road management in Canada.

This webinar will present the approach and general outcomes of the application of the PIEVC protocol for risk and vulnerability assessments for three resource roads in British Columbia.

Registration before March 6th

Contact the following individuals, based on your region:

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FURTHER READING

FPINNOVATIONS

Bradley, A., & Forrester, A. (2018). *Analysis of a British Columbia Resource Road's Vulnerability to Climate Change: in-SHUCK-ch Forest Service Roads PIEVC case study* (Technical Report 30). Pointe-Claire, Quebec: FPInnovations.

Partington, M., Durand-Jézéquel, M., & Bradley, A. (2018). *Analysis of a British Columbia Resource Road`s Vulnerability to Climate Change: Tum Tum Forest Service Road PIEVC case study* (Technical report 35). Pointe-Claire, Quebec: FPInnovations.

Partington, M. Bradley, A.H., Durand-Jezequel, M., Forrester, A. (2017). *Adapting Resource Road Infrastructure to Climate Change* (Technical Report 61). Pointe-Claire, Quebec: FPInnovations.

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Keller, G., & Ketcheson, G. (2011). *Storm Damage Risk Reduction Guide for Low-Volume Roads*. United States Department of Agriculture, Forest Service.

Williams, K. & Carrol, P. (2018). *Sustainable buried structures.* Forestry Adaptation Community of Practice webinar. Retrieved from: http://mirarco.adobeconnect.com/pvzz9x9tqnes/.

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