



CEC Methodology Review

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CEC Methodology

- Develop a **standardized methodology** for assessing the cost of extreme flood
 - Collaborative process across government agencies, community members, private sector partners, and Indigenous experts
 - Create a database using this methodology and populate with data from three countries
- Discuss the extension of this methodology to a multi-hazard assessment
 - E.g., hurricanes, tornadoes, forest fires, landslides
 - Conduct in-depth case studies



Methodology Development and Project Stages

1. Methodology development

- Identification of existing methodologies
- Multi-stakeholder analysis of methodologies (First Expert Workshop)
- Formulation of a proposed methodology

2. Methodology validation and testing

- Data compilation for the 2013-2017 period – *database development*
- Data analysis – robustness of methodology and geographical/temporal trends
- Dialogue on Indigenous perspectives (Indigenous Perspectives Workshop)
- Methodology revision and finalization (Second Expert Workshop)

3. Identification of approaches for multi-, cascading hazards

- Developing a trajectory for costing the impact of cascading hazards
- Case studies for demonstration purposes & to assess challenges and opportunities
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Identification of Existing Methodologies

- Systematic review of methods in Canada, Mexico, and the United States
 - Peer-reviewed articles, grey literature, books
- Inclusion Criteria (must meet one or more of the following):
 - Focused on the economic damages and indirect losses caused by floods in Canada, Mexico, and the United States
 - Studies that did not include economic impacts were not considered further
 - Evaluated governmental approaches for assessing economic impacts of floods
 - Evaluated the approaches for economic assessment and risk analysis used by the insurance sector



Key: Effectiveness Level

 High effectiveness

 Moderate

 Low

Method	Key Data Holders	Data Collection	Data Analysis & Presentation	Data Availability & Accessibility	Overall Effectiveness & Acceptability
<i>Canadian Methods</i>					
Parliamentary Budgetary Office Method	Federal & provincial agencies; Insurance companies				
Hazus	Default inventory data User-derived data				
Computable General Equilibrium Models	Federal and provincial agencies				
<i>Mexican Method</i>					
ECLAC Method	Local government agencies				
<i>United States Methods</i>					
Human Assessor	Federal government; Insurance companies				
Model-Based Methods	FEMA, US Army Corps of Engineers				
Federal Budget Outlays	Government agencies				
State/Local Budget Outlays	All 50 states, territories & tribal governments				



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CEC Methodology Timeline

- Modification of the United Nations' Economic Commission for Latin America and the Caribbean (ECLAC) methodology
- Discussed and amended further during
 - Review Conducted (Summer 2019)
 - First Expert Workshop (September 2019, Vancouver, Canada)
 - Indigenous Perspectives Workshop (July 2020, Virtual)
 - Second Expert Workshop (October 2020, Virtual)
 - Academic Peer Review Process (Paper accepted September 2020, IJDRR)



CEC Methodology

- The CEC flood-costing **method** defined impacts from three categories
 - Direct Damages
 - Impact of floods during the event on the assets of each sector
 - E.g., losses to physical assets or stocks of final goods
 - Indirect Effects
 - Second-order effects due to flooding on, e.g., product, labor, and housing markets
 - E.g., Impacts to neighboring communities not directly inundated by floodwaters
 - Losses & Additional Costs
 - Losses: Goods and services that go unproduced or unprovided relative to the baseline levels
 - E.g., Lost output from temporary factory closure
 - Additional costs: outlays required to produce goods and services as a result of the disaster
 - E.g., Costs of temporary accommodation



CEC Methodology

- The CEC flood-costing **method** defined the damages from
 - 4 sectors
 - social sector, infrastructure, economic sector, and emergency assistance
 - 18 damage categories
 - Losses to Indigenous peoples a qualitative category

- In particular, the method includes:
 - 55 direct damage indicators
 - 15 indirect damage indicators
 - 35 losses & additional cost indicators



Social Sector

Category	Direct Damages	Indirect Effects	Losses & Additional Costs
Housing	Household Items	House Rental	Temporary Accommodation
	Dwelling		Relocation
	Cleaning		
Education	Building	Missed Workdays	Temporary Classrooms
	Classroom		Reset Service
	Cleaning		
Health	Death toll	Patients	Hospital-related Costs
	Physical damage	Missed Workdays	Structure-related Costs
	Medical equipment		
Water and Sanitation	Storage tank		
	Distribution network		Temporary Water Needs
	Treatment plant		
Cultural Resources	Places of Worship		Revenue
	Recreation Area		Recreation
	Sacred Burial Places		
	Cultural Artifacts		
	Museum Collections		
	Culturally-relevant Historic Structures		
Local Government/Community	Damaged Zones		
	Local Infrastructure and Services	Missed Workdays	Revenue
			Loans and Bonds



Infrastructure

Category	Direct Damages	Indirect Effects	Losses & Additional Costs
Transportation	Railroad	Revenue	Cost for Transporting Freight
	Airport		Loss of Tolls
	Road		Passanger Costs
	Protection Wall/Dyke		Crew Costs
	Infrastructure Restoration		
	Service Restoration		
Energy and Utilities	Power Generation Plant	Spills Damage	Revenue
	Substations		Reconstruction
	Distribution Grid		
	Dispatch Center		
Technology and Communications	Service Tower	Manufacturing Revenue	
	Communication Infrastructure	Commerce Revenue	
Public Infrastructure		Public Space Value	Cleaning
			Rescheduling Costs



Economic Sectors

Category	Direct Damages	Indirect Effects	Losses & Additional Costs
Agriculture	Road or Bridges		Value of Lost Crops
	Storage Space		Income
	Farming Infrastructure		Livestock Value
	Livestock Infrastructure		Poultry Value
	Poultry Infrastructure		Private Forest Value
	Private Forestry Infrastructure		
Fisheries	Storage Space		Market Value of Fish
			Market Value of Crustaceans
			Income
Manufacturing	Building and Facilities	R&D Impacts	
	Machinery and Equipment	Loss of Wages	
	Inventory of Goods		
Commerce	Building and Facilities	Credit	
	Machinery and Equipment		
	Inventory of Goods		
Tourism	Tourism Areas	Loss of Wages	Service Flows
	Property		
Public Forests	Employees	Workdays Lost	Market Value
	Road or Bridges		
	Park Infrastructure		
Environment	Erosion and Sedimentation		
	Wildlife Health		
	Nutrient and Pollution Dispersion		
	Local Landscapes and Habitat		



Emergency Response

Category	Direct Damages	Indirect Effects	Losses & Additional Costs
Emergency Response			Transportation for Injured
			Emergency Evacuations
			Equipment
			Temporary Shelters
			Search and Rescue



Impacts to Indigenous Communities

- Highlights of recommendations from Indigenous Perspectives Workshop
 - Establish longstanding relationships with Indigenous Nations and Communities
 - Create beneficial, non-extractive relationships
 - Traditional knowledge must be honored and protected
 - Meaningful integration of Indigenous voices
 - Narrow focus on economic value may be insufficient to capture full impacts
- Qualitative section in CEC Methodology
 - This table will provide a narrative for non-monetary impacts or intangible impacts on Indigenous communities with different data types (e.g., videos, pictures of the event, and descriptive text)
 - However, data collection in this table needs to work in collaboration with Indigenous representatives to be sure of the specific data types, indicators, categories, and perspectives



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Data Collection

- Data collection in three countries
 - All major flood events in Canada, Mexico, and the United States from 2013 to 2017
 - Conducted by graduate students with direction by steering committee
 - Canada: Hirmand Saffari (Pacific Water Research Centre, Simon Fraser University)
 - Mexico: Ana Maria Alarcón Ferreira (PCT/Universidad Nacional Autónoma de México)
 - United States: Lynn M. Rae (School of Natural Resources and the Environment, University of Arizona)
 - Collected all available quantitative flood impacts data by event
 - Categorize based on indicator
 - Data synthesis, organization, and analysis conducted by project Postdoctoral Scholar Dr. Xin Wen (Pacific Water Research Centre, Simon Fraser University)



Data Cleaning

- *CPI-adjusted price conversion to real 2020 \$USD*
 1. Evaluate flood damages at local nominal prices
 2. Convert local nominal prices \$USD
 3. Adjust prices for inflation using 2020 \$USD as base year, using the Consumer Price Index (CPI; <https://www.bls.gov/cpi/>)
- *A population-based weighting method in **Canada** (provincial to municipal)*
 1. Sum the total population affected by flood events
 2. Calculate percentage of the total population of municipalities (census divisions) affected by flood events
 3. Weight flood damages based on the percentage of the population



E³ID Database

- Extreme Events Economic Impact Database (E³ID)
- Composed of eight tables
 - Location table: This table provides information about the locations that were affected by flooding (or other extreme events) from 2013 to 2017 in Canada, Mexico, and the United States
 - Flood event table: This table provides information about floods by year, including start and end dates, from 2013 to 2017 in the three countries
 - Flood-event location attributes: This table provides support information about the event location (e.g., population)
 - Direct damage table: This table has 55 indicators that document direct damages caused by floods from 2013 to 2017 in the three countries
 - Indirect effect table: This table has 15 indicators about the indirect effects caused by floods from 2013 to 2017 in the three countries
 - Losses and additional cost table: This table has 35 indicators that detail additional costs caused by floods from 2013 to 2017 in the three countries
 - Indigenous communities flood damage table: This table will provide a narrative for non-monetary impacts or intangible impacts on Indigenous communities
 - Data source table: This table provides information about the data sources and level of data aggregation that reflects a statistical view of the collected data points, e.g., average or minimum



Data Challenges

- Spatial and temporal scale mismatch
- Incomplete data
 - E.g., missing indicators
- Ensure no double counting
- Lack of attribution to particular flood event
- Difficulty in disentangling flood losses from other disaster losses
 - E.g., Loss from hurricane wind or rain?
- These will be covered in greater detail in the next presentation



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Case Studies

- Case study objectives

1. To undertake a comprehensive application of the CEC flood-costing methodology to a selected site and related events such that all insured and uninsured economic impacts are captured, define a narrative for non-monetary impacts, including intangible impacts on Indigenous communities, and document other inter-related (cascading) hazards
2. To provide insights into the complexities and challenges in data accumulation as they pertain to cascading hazards (including variable timescales for inter-related events and differing geographical/jurisdictional footprints)



Case Study Scope

- Desk-based investigation of a particular flooding event, including other inter-related hazards
 1. *Geographical scope:* The geographical footprint will be selected for each case study to fully contain elements of an event that led to economic impacts. Ideally, the geographic scope will be defined by the footprint of a sub-watershed (but could also comprise an entire watershed/river basin)
 2. *Temporal scope:* The time period for the case study could span several months and will be determined based on the inter-relatedness of various events; ideally, this time scale would not exceed a 12-month window



Case Study Selection Criteria

1. One case study for each of the three countries: Canada, Mexico, and the United States
 2. The economic impacts for the events are well recorded and accessible
 3. Prior reports and publications allow the CEC teams working on each case study to determine the inter-linkages between various events
 4. Each selected case study preferably includes Indigenous communities
 5. One of the three case studies preferably is an event that crossed state/province borders or, in the best case, crossed an international border to compare available data
 6. One or more case studies that include impacts in both urban and rural communities
- Case study feedback and suggestions solicited during the 2nd Expert Workshop



Case Studies

- Canada
 - May 2016 Fort McMurray Flood
 - Cascading event (wildfire triggering flooding)
- Mexico
 - September 2013 La Montaña region, State of Guerrero
 - Includes some Indigenous impacts
- United States
 - March 2016 Flooding in Louisiana
 - Includes qualitative Indigenous impacts
- International
 - June 2011 Souris River Flood in Saskatchewan, Canada and North Dakota, United States
- Case studies discussed in detail later this morning



Results and Products

1. A flood economic and cost database estimated across the three countries from 2013 to 2017
2. Maps for temporal and spatial distribution of flood economic damages from 2013 to 2017 across three countries created and analysed
3. Three case studies analysis to further test the CEC flood-costing methodology (plus one international case study)
4. Analysis of common features of flood economic and cost data
5. Presentation of results and policy recommendations during this 3rd Expert Workshop



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Developing a comprehensive methodology for evaluating economic impacts of floods in Canada, Mexico and the United States

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Project References

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<https://www.sciencedirect.com/science/article/pii/S2212420920313637>
- 1st Expert Workshop Report (September 2019)
- Indigenous Perspective Workshop Report (August 2020)
- 2nd Expert workshop report (October 2020)
- 3rd Workshop Background Paper (March 2021)
- Project website: <http://www.cec.org/costing-floods-and-other-extreme-events-1/>



Thank you



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