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Multiple Dimensions of Vulnerability: Influence on Adaptation

Linda Mortsch
Adaptation and Impacts Research Section
Climate Research Division

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Growing recognition of importance of adaptation:

- Adaptation necessary because:
  - some degree of climate change inevitable
  - documenting impacts of changing climate
  - moderates current climate risks
- **Adaptation** • *an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities; there are various types of adaptation, including anticipatory, autonomous and planned adaptation* (IPCC)
- To initiate adaptation need to understand nature of "vulnerability" to climate change & adaptive capacity
  - who, what, stresses

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IPCC definition of vulnerability and adaptive capacity:

- **Vulnerability** • *degree to which a system (geophysical, biological and socio-economic) is susceptible to, & unable to cope with, adverse effects of climate change, including climate variability and extremes; function of the character, magnitude, & rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity*
- V = Exposure + Sensitivity + Adaptive Capacity
- **Adaptive capacity** • *ability or potential of a system to respond successfully to climate variability & change & includes adjustments in both behavior, resources & technologies*

IPCC AR4 Assessment: Chapter 19 key vulnerabilities…

- Identified key vulnerabilities in market, social, geophysical, ecological systems
  - Criteria: magnitude, rates of change, irreversibility, thresholds, likelihood, distribution, adaptation potential, importance
  - Regions: North, Africa, small island states, coastal deltas
  - People: poor, elderly, young, infirm
  - Sector: water stress, extreme heat, air pollution, food security
  - Uneven distribution across socio-economic groups – equity
  - Scope for adaptation:
    - None – preserve endemic species
    - Little – sea level rise, low-lying deltas
    - Some – agriculture systems

IPCC AR4 Chapter 14: North America is "vulnerable" to climate variability and weather extremes …

- North America's considerable adaptive capacity not always protected people & property
- Current adaptation deficit



IPCC AR4 Chapter 14: Comparing vulnerability of coastal communities …

- Sea level projected to rise along most coasts
  - progressive inundation, storm-surge flooding & shoreline erosion
- Attributes of vulnerability regarding projected sea level rise along most coasts in North America
- Coastal development & population growth increase vulnerability
- Current adaptation uneven & readiness for increased exposure is poor

IPCC AR4 Chapter 14: Water resources management more challenging …

- Warming in western mountains - decreases in snowpack, more winter flooding, reduced summer flows – exacerbating competition for over-allocated water resources (e.g., Columbia River)
- Reduction in groundwater recharge in American Southwest
- More difficult to meet water quality goals (e.g., Great Lakes)

Other dimensions of vulnerability…

- Vulnerability multi-dimensional & conceptualization evolved over time
- Perspectives depends on discipline
  - Engineering – performance, reliability
  - Natural hazards & disasters – biophysical effects
  - Climate change…adaptation
    - Need to move from only biophysical aspects of hazard to social construction (social, economic, political factors)
    - Two approaches to vulnerability assessment:
      - Impacts-driven, residual approach, top-down, outcome
      - Contextual, bottom-up, state/condition (pre-existing)

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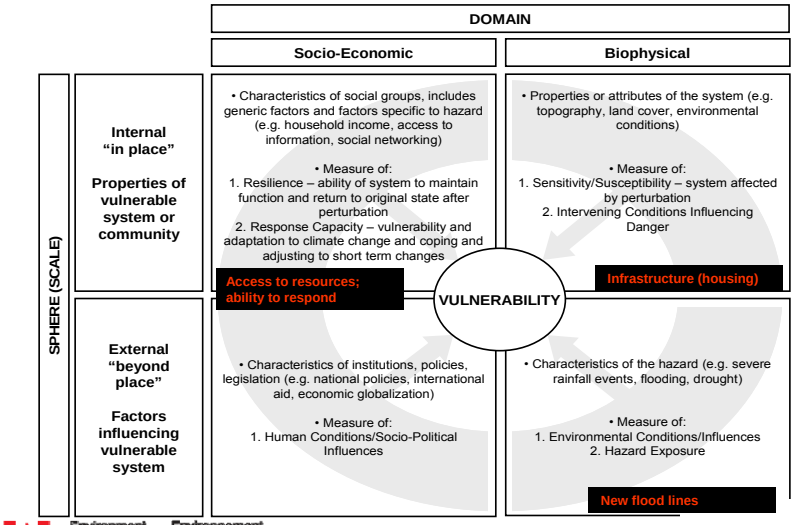
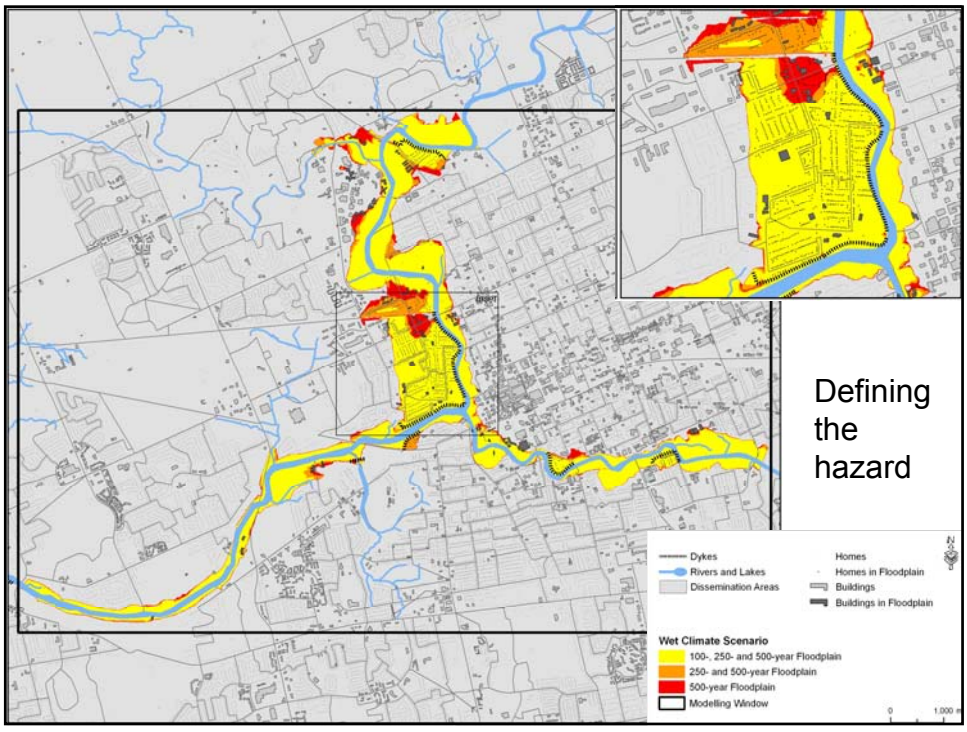
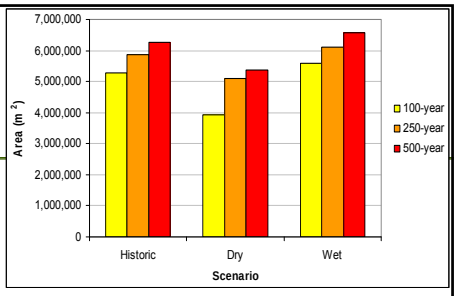
Case study: Climate change and flooding Upper Thames River, London, Ontario



(modified from Füssel, 2007, 158)



Area, People and Structures Affected



* Population and dwelling counts estimated based on the proportion of the Dissemination Area (DA) flooded

Floodline	Climate Scenario	Area (m^2)	Change in		No. Homes Flooded	No. Buildings Flooded	Proportion Affected (Census Data)*	
			Area (m^2)	%			Pop.	Dwellings
100-year	Historic	5,291,440			1,141	34	7,701	3,969
	Dry	3,930,436	-1,361,004	-25.7	68	18	4,881	2,521
	Wet	5,595,988	+304,548	+5.8	1,249	42	7,949	4,109
250-year	Historic	5,858,976			1,376	58	8,474	4,381
	Dry	5,101,848	-757,128	-12.9	1,059	33	7,351	3,802
	Wet	6,116,988	+258,012	+4.4	1,486	59	8,745	4,543
500-year	Historic	6,268,729			1,560	71	9,119	4,740
	Dry	5,362,852	-905,877	-14.5	1,155	36	7,717	3,988
	Wet	6,567,292	+298,563	+4.8	1,690	83	9,388	4,886

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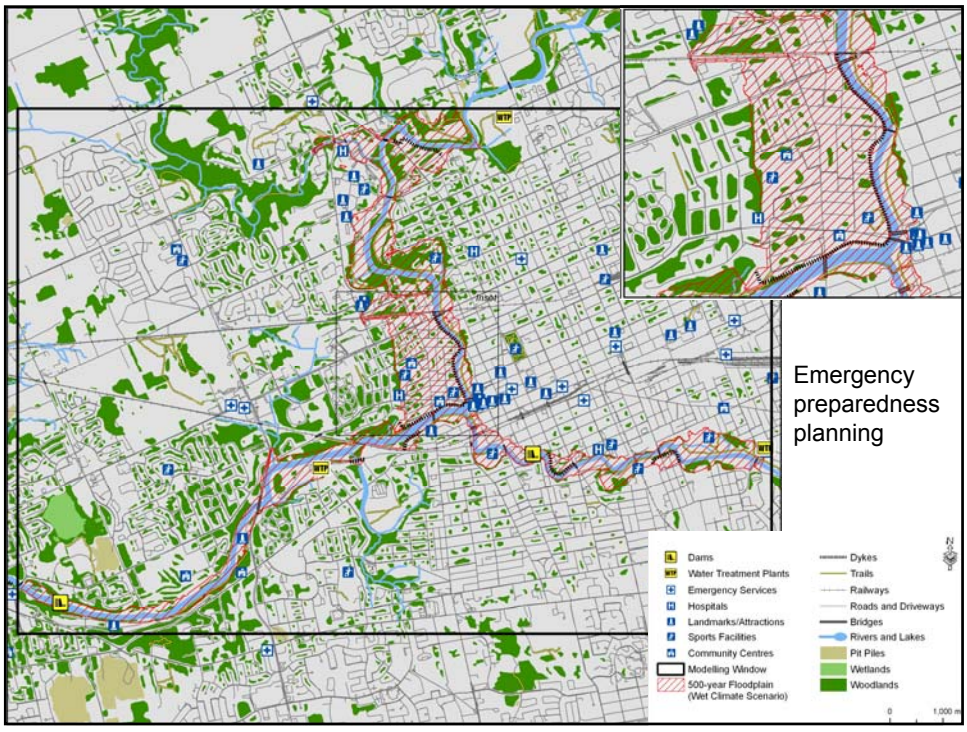

Emergency preparedness planning

Indicators of vulnerability to flooding:

- Theme 1 – Ability to Cope and Respond
  - Over 65 years of age
  - Under 19 years of age
  - No Knowledge of Official Languages
  - Female
- Theme 2 – Differential Access to Resources
  - Low Income Households
  - Single Parent Families
  - Rely on Public Transit
  - Renters
- Theme 3 – Level of Situational Exposure
  - Housing Type (single, semi-detached, mobile, apartment etc.)
  - Period of Construction (built before 1970)

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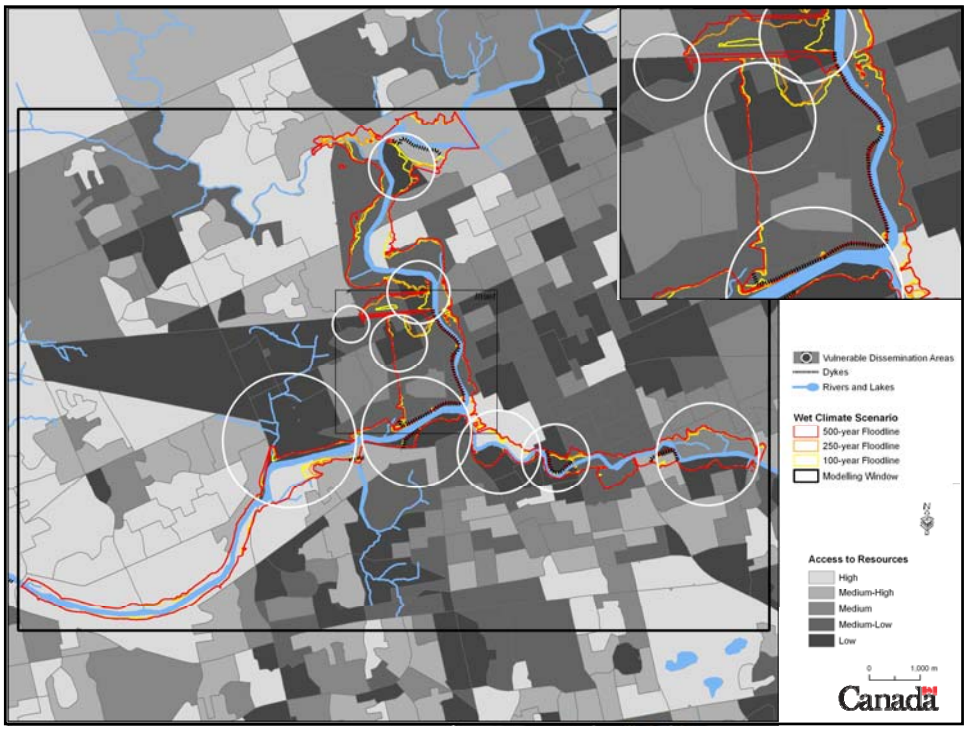

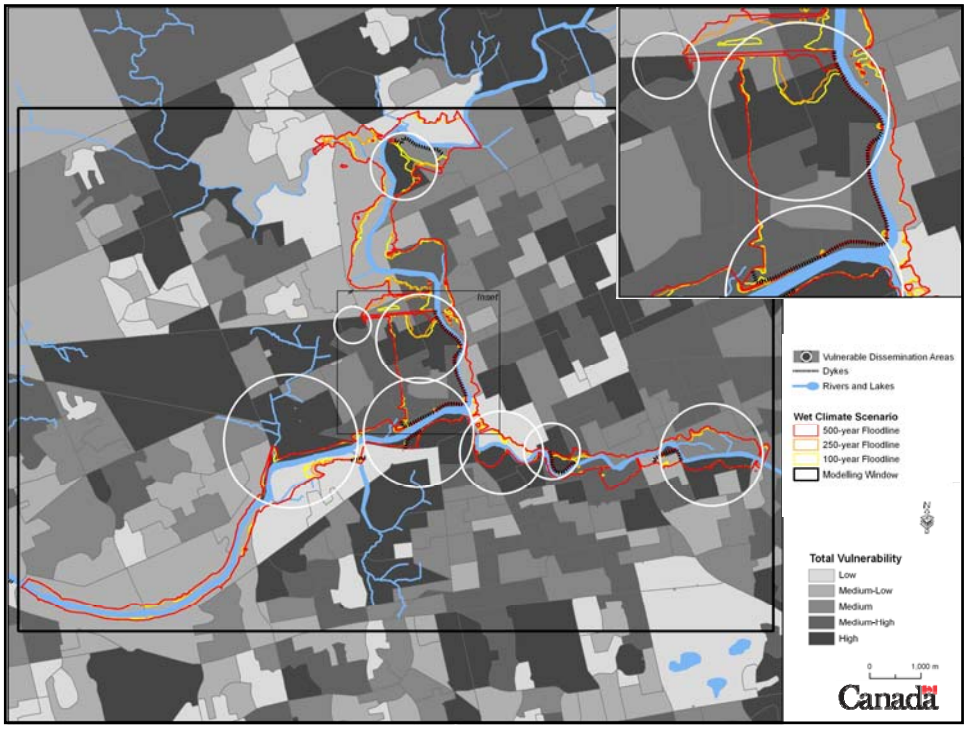

Final Points:

- How vulnerability is framed & assessed affects the perspective of adaptation & influences adaptation responses developed & implemented
  - Need to consider multiple dimensions including human (social, economic, policy) as well as biophysical
- Developed countries have vulnerabilities & adaptation challenges (not just developing countries)
  - Determinants of vulnerability & barriers to adaptation may be different
    - Developing – education, governance, capital
    - Developed - infrastructure, highly managed (optimized) systems, institutions & policy process, technology

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