Reducing Disaster Vulnerability of Coastal Communities on the Salish Sea

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Reducing Disaster Vulnerability of Coastal Communities on the Salish Sea

Stephanie Chang
University of British Columbia

With: J. Yip, R. Chaster, S. van Zijll de Jong, A. Lowcock, C. Carter
Coastal Hazards in Metro Vancouver

- Earthquake
- Tsunami (incl. undersea landslide)
- Storm surge, coastal flooding
- Freshet flooding
- Sea level rise-related
- Oil spills
- …
Coastal Disasters

*earthquake... tsunami...*

- >30% probability of damaging earthquake in 50 years
- **M9.0 Cascadia event** *(IBC 2013)*
  - C$62 b. direct loss, C$75 b. with indirect, C$20 b. insured
- **M7.3 Georgia Strait** *(Chang et al. 2012; Chang and Lotze 2014)*
  - 51,000 pop. in significantly damaged buildings
  - Up to 88% business disruption in DNV

[tornado](Photo: AFP)  [ground failure](Photo: NISEE e-Library)  [structural damage](photo: EERI)  [liquefaction](photo: Japan Times)
Coastal Disasters

flood… oil spill…

- **Sea-level flooding events**
  (Forseth/ACT 2012)
  - 7 events, 1960-2011
  - C$11 m. damage in 1982 & 2006 events

- **SLR C$2.1~7.6 b. damage in BC by 2050** (NRTEE 2012)

- **Oil spills**
  - No experience in region
  - Kinder Morgan proposal increase 650 tankers/year
  - Clean-up costs & economic impacts (Allo and Loureiro 2012)
    - Valdez 2010$US 4.3 b
  - Health & social impacts

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(dyke breach)

(Photos: K. Stallknecht, PNG)

(kwl.ca)
## Vulnerability Factors

### Exposure

<table>
<thead>
<tr>
<th>Earthquake</th>
<th>Flood</th>
<th>Oil Spill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pop. in shake zone &amp; liquefaction areas</td>
<td>Pop. in flood zone</td>
<td>Pop. in local airshed &amp; oiled shores</td>
</tr>
</tbody>
</table>

Population growth, economic growth, development patterns, land-use planning, transportation planning,…

- Dykes, seawalls, Green infrastructure

**Cautions:**
1. “Levee effect”
2. Solutions need to be viable in multi-hazard environment
## Vulnerability Factors

### Susceptibility, Capacity

<table>
<thead>
<tr>
<th>Earthquake</th>
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<th>Oil Spill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low income, low education,…</td>
<td>Low income, low education,…</td>
<td>Low income, low education,…</td>
</tr>
<tr>
<td>Small businesses, neighborhood effect,…</td>
<td>Small businesses, neighborhood effect,…</td>
<td>Small businesses, neighborhood effect,…</td>
</tr>
<tr>
<td>Response capacity, assistance programs</td>
<td>Response capacity, assistance programs</td>
<td>Response capacity, assistance programs</td>
</tr>
<tr>
<td>Risk perception, preparedness,</td>
<td>Risk perception, preparedness,</td>
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</tr>
<tr>
<td>community cohesion, social capital</td>
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</table>

G.I.
Green Infrastructure for Disaster Risk Reduction

- **Flood protection mechanisms of coastal ecosystems:**
  - Tidal wetlands – reduce size and erosive power of waves
  - Floodplains – divert, hold, and slow flood water
  - Stabilizing sand dunes – sustain wave energy reduction mechanism
  - Oyster reefs and eelgrass beds – reduce wave energy, increase sedimentation
  - Mangrove forests – reduce tsunami velocities, wave heights; attenuate storm surge amplitude and winds

(TNC 2013) (Mangrove Restoration Project, Thailand)
**Effectiveness**

- Storm surge attenuated at -1m per 14.5km marsh (Resio 2008)
  - Range 7~20km
  - So. Louisiana

**FAO 2006 Coastal Protection Workshop:**

1. Forests and trees *can act as bioshields* that protect people and other assets against tsunamis and other coastal hazards, but whether they are effective and the degree of their effectiveness depend on many variables;

2. Care must be taken to avoid making generalizations and creating a *false sense of security* that bioshields will protect against all hazards;

3. The use of bioshields should be considered within the framework of *disaster management strategies*, which also include effective early warning systems and evacuation plans.

Cost-Effectiveness

- In many cases, same level of risk reduction as gray infrastructure, at lower cost (TNC 2013)
- 1 ha wetland loss => $33,000 storm damage in specific storms (Costanza et al. 2008)
- Coastal ecosystem restoration in 3 cases: BCR >15 (Conathan et al. 2014)
- Netherlands CBA: higher, stronger dikes most cost-effective in dense area
  - land-use change and floodplain restoration justified over 100 yrs and w/other benefits (Brouwer et al. 2004)
- GI costs higher in urban areas (Jonkmann et al. 2013, Linham and Nicholls 2010)
Multiple Benefits

- Habitat, carbon sequestration, water quality, recharge aquifers, recreation, property values, jobs,… (TNC 2013)

- Community livability: aesthetics, recreation, sense of place and well-being, community cohesion (CNT 2010)

- Greenspace access as social equity, social well-being and participation, sense of place attachment, stress reduction and health (Barnhill and Smardon 2012)

- What types of G.I. could effectively reduce risk in the Salish Sea region?
- How cost-effective?
- Other benefits?