Risk-based Land-use Guide: Reducing Risk from Hazards

Building a guide to considering land-use options to reduce disasters

Joseph & Rosalie Segal Room
Simon Fraser University
Harbour Centre Campus
Vancouver, British Columbia

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Purpose
Contribute to the content of a Land-Use Guide to building resilient communities. Discuss improvements to existing guidelines for land zoning and development that would reduce injuries, damage and disruption from disasters.

At the September 17, 2010 Land-use Decision Support Workshop, participants created the scope and outline for a risk-based land-use guide. This one-day workshop builds on that work and gathers ideas on which practices to include in the guide and how best to portray the practices within existing practices to make land-use recommendations. (www.sfu.ca/cnhr/workshops.html).

Participants
Land-use planners, city managers, engineers, permitting officers, critical-infrastructure owners and managers, insurers, researchers and practitioners of land-use policy, and emergency managers.

Outcomes and outputs
The workshop intends to increase disaster resilience with a hazards risk reduction-focused guide for land-use decision-makers. It is hoped the promotion and implementation of this guide and its further development will promote risk mitigation and disaster resilience.

Workshop findings will be promoted with agencies and institutions that reduce risk from hazards through research, policy and application.

Canadian risk mitigation network
These workshops, and the communications surrounding them, are a contribution to building a multidisciplinary risk mitigation network in Canada.

Workshop process
Introductions to the workshop set the stage and guide the day’s process. Following the keynote address, the day consists of a primary breakout where groups discuss a particular aspect of the land-use guide and how to augment its content and make it accessible. The following breakout gives participants a chance to move quickly through all of the guide topics.

Results of the breakout working tables, plenary reports, the keynote address and other discussions will be recorded graphically throughout the workshop.

Background and acknowledgements
This workshop was conceived through the workshop committee as supported by the Centre for Natural Hazards Research at Simon Fraser University. It is funded by the Centre, and Natural Resources Canada, and through in-kind contributions of the Justice Institute of British Columbia, Pearces2 Consulting, Public Safety Canada, District of North Vancouver, and the Integrated Partnership for Emergency Management.
We are grateful for the generous contributions of time and materials made by each of the agencies supporting the organizing committee members, by various volunteers from the supporting agencies, and particularly the participants at the workshop and the agencies who supported their participation.

**Organizational Committee**
John Clague, *Simon Fraser University*
Bert Struik, *Natural Resources Canada*
Larry Pearce, *Pearces 2 Consulting*
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Cindy Jeromin, *Public Safety Canada*
Jessica Shoubridge, *School of Community and Regional Planning, University of British Columbia*
Maggie Wojtarowicz, *Natural Resources Canada*
Program

Bert Struik, Natural Resources Canada, Workshop Facilitator

07:45  Reception and Continental Breakfast

  **John Clague, Director, Centre for Natural Hazards Research, SFU**

08:30  **Richard Walton, Mayor, District of North Vancouver**

  Welcoming remarks

  **Bert Struik, NRCan, SFU**

09:05  Introduction

  **Mark Holland, New Monaco Enterprise Corporation**

09:15  Natural and Social Engineering: Creating Community Resiliency through Land-use Decisions

10:15  Refreshment break

  **Laurie Pearce, Pearces 2 Consulting,**

10:30  Breakout 1: Evaluate and build draft land-use guide concepts

12:30  Lunch

13:00  **Laurie Pearce**

  Breakout 2: Carousel contributions to each of 10 key guide concepts.

15:15  Refreshment break and review of graphic records for workshop breakouts

15:30  **Facilitators and table mates create reports**

15:45  **Facilitators and Laurie Pearce**

  Reports of priorities identified for the guide

  **Review and next steps**

16:45  **John Clague**

  Closing Remarks
**Breakout structure**

Ideas and discussion are conducted at two breakouts. At breakout 1 you can discuss, for an hour and a half, one of ten guide components. During breakout 2 you have the opportunity to contribute for 15 minutes to each component.

Each table has a recorder and facilitator. The record is made primarily on a single poster that will contain key concepts from the table discussion. They will summarize the outputs of the table in the plenary following the breakouts.

**Guide components for discussion**

The guide components for discussion are key parts of the land-use guide manuscript. We are looking for your contribution on the critical elements that should be included in the guide for each of these components. A page of background and guidance for discussion is provided for each topic, and should be referenced.

**Components:**

1. **Community Engagement**
2. **Hazard identification**
3. **Community inventory**
4. **Risk Assessment**
5. **Risk Tolerance**
6. **Mitigation Options**
7. **Development Permit Area concept**
8. **Cost-benefit Analysis**
9. **Zoning / Recommendations**
10. **Monitoring**
Table Discussion Topic #1 – Community Engagement

Community engagement should be included in a Land-use Guide because:

- It is important for the community to understand the existing hazards and likelihood of damaging events
- The community should be open and transparent
- The community may have potential solutions to existing situations or threats
- It is up to the community to decide what they are willing to lose and the community should decide what needs to be protected
- Regulations require the community to be engaged in the development of the Official Community Plan and thus the community must also be aware of hazards and threats that would affect the ability of the community to carry out its Official Community Plan

Actual Case Example:
Following a damaging landslide the politicians dictated that in the future environmental, geo-hazard, soil studies and any other study conducted regarding hazards and risks must be fully available to community residents. A volunteer Natural Hazards Task Force comprised of local residents was formed, educated by the community and consulted in hazard and Land-use planning decisions. Decisions before council were approved more quickly and with less public dissent.

Objectives for Working Group:
Identify for inclusion in the Land-use Guide:

- What best practices in regards to community engagement should be included in the Land-use Guide?
- What best practices for community engagement do you use?
- What best practices for community engagement analyses are you aware of?

Possible Scenarios Community Engagement Regarding Risk from Disasters:

- Landslides: Options to reduce building footprints in order to minimize the risk of soil lateral spreading results in higher density in residential areas
- Urban/Wildland Fires: Having at least two routes to exit all developments decreases the privacy of homeowners and increases access of unwanted visitors

These guide components will be included in: Chapter 2 (tool chest), Chapter 3 (proposal evaluation), Chapter 4 (proposal approval) and Chapter 5 (decision monitoring).
Table Discussion Topic # 2 – Hazard Identification

Hazard identification should be included in a Land-use Guide because:

- Well identified hazards are essential to set priorities for managing hazard risk.
- Risk calculation requires appropriately measured hazard parameters.
- Development Permit Areas for Hazards require a well identified hazard zone, recurrence and magnitude.

Actual Case Example:
Natural and man-made processes have altered the river bed and banks of the lower Fraser River. Hydrologists recognized that flood potential has increased because the bed has filled higher with gravel, leaving less room for river water. The flood plains and river bed were remeasured with modern methods to assess the potential for flooding. That mapping will be used for decisions about dyke heights, development in the flood plains and managing the extraction of gravels from the river.

Objectives for Working Group:
Identify for inclusion in the Land-use Guide:

- What best practices in regards to identifying hazards should be included in the Land-use Guide?
- What best practices for identifying hazards do you use?
- What best practices for identifying hazards are you aware of?

Possible Scenarios of Land Uses at Risk:

- Riverside land: Can be at the base of slope, can be flat land created by over topping banks, saturated soils, weak soils, require lifeline crossings, industrial uses along water and at water's edge, attractive, lowest air masses (fog, particulates, chemical...).
- Mountain stream-side land: Steep slopes, can be loose soil on banks and up stream, rapid water volume changes, attractive, forested, require lifeline crossings...

These guide components will be included in: Chapter 2 (tool chest) and Chapter 5 (decision monitoring).
Table Discussion Topic #3 – Community Inventory

A community inventory includes identifying social demographics (including marginalized populations); location of key buildings and facilities; critical resources such as police stations and hospitals; ecological zones; recreational and green belt areas; economic zones (e.g., agricultural zones, commercial sectors); areas of cultural importance (e.g., museums, areas of spiritual significance); key infrastructure (e.g., substations, main water pipes); hazardous material sites; important structures (e.g., cell phone towers); response capacity and capability. Completing a community inventory should be included in a Land-use Guide because it:

- Is required in order to comply with regulations requiring a Hazards, Risk and Vulnerability assessment to be completed – without understanding what is in place, it is impossible to identify what may be lost
- Creates opportunities to set priorities for sustainable hazard mitigation
- Sets the groundwork for developing mutual aid agreements and developing system redundancy.

Actual Case Example:
Completing a demographic analysis the community was able to plan for a local reception centre near a neighbourhood with a high degree of aging buildings and social housing likely to be seriously impacted by a damaging earthquake.

Objectives for Working Group:
Identify for inclusion in the Land-use Guide:

- What best practices in regards to completing community inventories should be included in the Land-use Guide?
- What best practices for completing community inventories do you use?
- What best practices for completing community inventories are you aware of?

Possible Scenarios of Land Uses at Risk from Disasters:

- Earthquakes: An inventory of key infrastructure revealed that an electrical substation providing electricity to 25,000 people was on liquefiable soil
- Ice-Jam Flooding: A community inventory of hazardous material sites identified that should a flood occur, water and soil would be seriously contaminated in the industrially zoned area

These guide components will be included in: Chapter 2 (tool chest), Chapter 4 (proposal approval) and Chapter 5 (decision monitoring).
Table Discussion Topic #4 – Risk Assessment

A community, neighbourhood, or parcel risk assessment requires an assessment of the hazard potential for that area, a community inventory of the assessment area and a method to calculate the risk. Risk assessment methods should be included in the Land-use Guide because they:

- Are necessary to determine the level of potential losses in the community from a hazard event.
- Provide outputs that demonstrate the most likely useful mitigation scenarios
- Can be used in the calculation of the effectiveness of mitigation options.
- Make possible reasoned conversations about the necessity for risk mitigation.

Actual Case Example:
Government researchers testing hazard measurement technologies created detailed seismic acceleration potential maps of the nation's capital. Academic researchers used that information and a detailed community inventory to analyze the risk the people, buildings and infrastructure faced from an earthquake. The results were shared with city officials. Strategic plans and emergency plans for the city were re-examined based on the results, and an interest expressed for a more complete analysis.

Objectives for Working Group:
Identify for inclusion in the Land-use Guide:

- What best practices in regards to risk assessment methods and application should be included in the Land-use Guide?
- What best practices for using the outputs of risk assessment should be included in the Land-use Guide?
- What best practices for completing risk assessments do you use?
- What best practices for completing risk assessments are you aware of?

Possible Scenarios of Land Uses at Risk from Disasters:

- Wildfire: Assessing the risk to the community inventory in the wildfire DPA revealed the potential losses from fire to be 65% of the inventory and 30 lives.
- Tsunami: Zoning changes are being considered to support building 6 to 12 story condominium towers along an inlet exposed to potential tsunamis.

These guide components will be included in: Chapter 2 (tool chest), Chapter 4 (proposal approval) and Chapter 5 (decision monitoring).
Communities are challenged to make risk mitigation decisions unless they know the level of risk they are willing to tolerate. Each person accepts a different level of risk. Some people live to skydive, while others will not travel on commercial airlines. A person’s tolerance for risk changes as they age.

The land-use guide will include methods to develop commonly acceptable risk levels through a community collaborative planning effort. It will include benefits of establishing risk tolerance based on criteria such as life lost, impact on property values and disruption of service.

**Risk Levels:**

**Unacceptable Risk**
- Extreme risk, cannot support continued action/development

**Tolerable Risks**
- Can be tolerated in order to realize some benefit
- Not negligible
- Should be kept under review and reduced further if possible

**Acceptable Risks**
- Broadly acceptable to the public
- Further efforts to reduce risks are not warranted.

**Actual Case Example:**

The city task force adapted risk criteria for loss of life as used in the UK, Hong Kong and Australia. Acceptable risk from natural hazards for existing developments is 1 death per 10,000 population, and for new developments is 1 death per 100,000 population. A comparative mortality rate: motor vehicle accidents (1997): 1 death per 10,000.

**Objectives for Working Group:**

Identify for inclusion in the Land Use Guide:

- What guidance for risk tolerance criteria/factors should be included?
- How should risk tolerance be communicated to the public?
- What is an acceptable level of risk?

**Possible Scenarios of Land Uses at Risk:**

- Debris flow: Future development along a mountain stream is at danger of impact from severe debris flows. The risk to life has been calculated at 1 in 9,000 within the life span of any structure. The economic, social and environmental risk has not been calculated

These guide components will be included in: Chapter 2 (tool chest), Chapter 4 (proposal approval) and Chapter 5 (decision monitoring)
Mitigation strategies should be included in a Land-use Guide because they can:

- Lessen the social (loss of life, social disruption, cultural displacement), economic and environmental impact of a disaster
- Allow for buildings, infrastructure networks and temporary uses to be established in what may otherwise be unsafe locations

**Actual Case Examples:**
Following the second damaging flood the community passed an ordinance that required all existing and new residential homes in the identified flood plain to be raised above the expected level of a 200 year flood using stilts or other mechanisms.

The municipal government allows homes to be built in forested areas but the Fire Chief wants to require all new homes to have sprinklers, metal or asphalt roofs and to ensure trees are cleared around the home to FireSmart standards. The Planning Director favours publishing guidelines suggesting the above requirements but not forcing anyone to comply as it increases the cost of home ownership and discourages new home buyers from moving into the community. The arborist is pushing for regulations prohibiting unnecessary cutting of trees.

**Objectives for Working Group:**
Identify for inclusion in the Land-use Guide:
- What best practices in regards to adoption of mitigation strategies should be included in the Land-use Guide?
- What best practices for adoption of mitigation strategies do you use?
- What best practices for adoption of mitigation strategies are you aware of?

**Possible Scenarios of Land Uses at Risk from Disasters:**
- Landslides: Building on escarpments to enjoy a beautiful view versus the risk to landowners below the escarpment
- Chemical spill: All news homes being built within a certain radius from a chemical plants must include a designated room for sheltering-in-place that has no direct access to outside air

These guide components will be included in: Chapter 2 (tool chest), Chapter 4 (proposal evaluation) and Chapter 5 (decision monitoring).
Table Discussion Topic #7 – Development Permit Areas

Natural hazard Development Permit Areas (DPAs) are a regulatory tool to identify areas where hazard mitigation is required and guides the development applicant to build/develop the property resilient to natural hazards. Similar regulations are included in the building permit process.

The guiding principles are:

- New development could be located outside of potential hazard areas.
- Where not possible to locate outside the hazards, special construction limitations/conditions may apply.
- Proposed development should not transfer risk to others.
- Minimize alteration of land on or near steep slopes.
- A qualified professional will assess the property and proposed development prior to any work. The recommendations of the qualified professional form the basis of the development permit or exemption issued.
- Existing permanent structures and land uses are exempt.

Actual Case Example:
Slope Hazards: DPA-Slope applied to properties near the crest and base of slopes that have a slope angle greater than 20 degrees (36%) and are more than 10 m in height. DPA guidelines reduce risk through professional design and management of construction practices, including major landscaping and drainage.

Objectives for Working Group:
Identify for inclusion in the Land-use Guide:

- What natural hazards should have Development Permit Areas? Which should not?
- What best practices regarding DPAs should be included in the Land-use Guide?
- Who should participate in the DPA development process?

Possible Scenarios of Land Uses at Risk from Disasters:

- Wildfire Urban Interface: Neighbourhoods built on steep slopes with limited water supply, narrow road access and limited firefighting resources
- Creek Hazards: properties adjacent to creeks prone to debris flows, debris floods and flooding
- Earthquakes: Liquefiable soils with future commercial development potential

These guide components will be included in: Chapter 2 (tools), Chapter 3 (proposal evaluation) and Chapter 4 (proposal approval)
Table Discussion Topic #8 – Cost-Benefit Analysis

Cost/benefit analyzes should be included in a Land-use Guide because they can:

- Assist in completing the disaster risk assessment process regarding overall land-use decision-making processes
- Help to support community engagement in land-use decision-making processes
- Provide options for mitigation (*Note: identify best practices without getting into evaluating which option is better*)
  - e.g., Land-use Portfolio Model (LUPM) – an application developed by the US Geological Survey to assist local and regional agencies in analyzing the financial risks and benefits of alternate mitigation strategies (return on investment) (Bernkopf – [http://geography.wr.usgs.gov/science/lupm.html](http://geography.wr.usgs.gov/science/lupm.html)).

Actual Case Example:

Following a damaging tsunami the community decided to remove single-family homes along the ocean waterfront, and put in a park and camping ground (costs for the campground included expropriation and reparation of the area). Recently, in the summer, there was a tsunami warning. Campers ran to their large motor homes and campers to evacuate the area. The one road in and out of the campground was in grid lock. Fortunately, there was no tsunami. If the tsunami had occurred, casualties and losses of vehicles and facilities would have been great.

Objectives for Working Group:

Identify for inclusion in the Land-use Guide:

- What best practices in regards to cost/benefit analysis should be included in the Land-use Guide?
- What best practices for cost/benefit analyses do you use?
- What best practices for cost/benefit analyses are you aware of?

Possible Scenarios of Land-uses at Risk from Disasters:

- Flat land flood: Trailer park community on flood plain along a river vs. use the land for another purpose.
- Chemical spill: Major transportation route accident (includes port)? or factory accident?. Designation of transportation route through community (i.e., zoning and possible loss of lives and/or services).

These components will be included in Chapter 2 (tool chest) and Chapter 4 (proposal approval)
Table Discussion Topic #9 – Zoning / Recommendations

Zoning recommendations should be included in a Land-use Guide because:

• they provide best practices in mitigation
• they provide practical solutions to safely develop hazardous lands

Actual Case Example:
A rural, outlying area was originally slated for a housing subdivision. The area was recognized previously by geologists to consist of a large landslide debris field, caused by a landslide some 100 years ago. Chances were determined to be certain that another such landslide would occur within a hundred to two hundred years. After court action, initiated by the developer, the judge decided the land should be zoned for recreational use only.

Objectives for Working Group:
Identify for inclusion in the Land-use Guide:

• What best practices in regards to zoning should be included in the Land-use Guide?
• What best practices for zoning to reduce risk do you use?
• What best practices for risk reduction zoning are you aware of?

Possible Scenarios of Land Uses at Risk from Disasters:

• Industrial development: Development pressure has proposals for housing and community services to be built close to industrial areas where hazardous practices are undertaken.
• Flat land floods: Flat lands along rivers are inexpensive to develop for housing and are attractive to potential buyers. They are also prime land for agriculture, recreation and flood management.

These guide components will be included in Chapter 2 (tool chest), and Chapter 4 (proposal approval).
Table Discussion Topic #10 – Monitoring

Monitoring activities should be included in a Land-use Guide because:

• New information can arise (e.g., the impacts of climate change were not recognized and appreciated 10 years ago)

• Communities change – e.g., family neighbourhoods are now comprised mostly of seniors with no children who have remained in the family home; densification strategies may have resulted in insufficient services to meet current needs

• Building practices and codes are regularly upgraded – i.e., what may have been acceptable 20 years ago is longer best practice today

• Decisions will have been made in the past without the knowledge that is in place today – e.g., technology has resulted in better quality soil sampling techniques

Actual Case Example:
A rural, outlying area was originally established as a summer vacation home location. Over the years as the urban community grew and real estate prices soared, nearly all residents were now living permanently in these enhanced dwellings. The area was not well serviced, susceptible to numerous hazards including rising ocean levels and wildland fires. Existing emergency services are unable to meet the needs of residents and owners of undeveloped lots push for development variance permits.

Objectives for Working Group:
Identify for inclusion in the Land-use Guide:

• What best practices in regards to monitoring should be included in the Land-use Guide?

• What best practices for monitoring do you use?

• What best practices for monitoring are you aware of?

Possible Scenarios of Land Uses at Risk from Disasters:

• Climate Change: Homes have been traditionally built close to the high tide level and/or waterfront bike and walking paths are being designed even as oceans levels are predicted to rise.

• Wildland Fires: Residential homes have only one egress/access route and a wildland fire could trap hundreds of residents without an escape route or evacuation plan.

These guide components will be included in Chapter 5 (decision monitoring).
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