Are We Planning a Disaster Resilient Region?

An Evaluation of Official Community Plans in Metro Vancouver

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ARE WE PLANNING A DISASTER RESILIENT REGION? AN EVALUATION OF OFFICIAL COMMUNITY PLANS IN METRO VANCOUVER

by

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EXECUTIVE SUMMARY

Metro Vancouver, the area under study, is striving to set global precedence as a sustainable region. A sustainable region is necessarily a disaster-resilient one. A disaster-resilient region is composed of communities that proactively, and cooperatively, manage the interface of hazard risk and strategic planning for growth and development.

The study employs a content analysis method to determine the degree to which member municipalities of Metro Vancouver are planning for natural hazard risk management. Findings suggest, that overall, official community plans are not incorporating this critical topic in very much depth. The fact base and implementation components of the plans fall particularly short, whereas policy and goal components are found to be stronger. Congruency and subsidiarity are employed as guiding principles in postulating changes in governance required to improve the quality of strategic planning for natural hazard mitigation.

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LIST OF ABBREVIATIONS

APEG BC– Association of Professional Engineers and Geoscientists of British Columbia
DPAs- Development Permit Areas
EBM- Ecosystem-based management
FCLs- Flood Construction Levels
FCM- Federation of Canadian Municipalities
HRVAs- Hazard Risk and Vulnerability Assessments
GIS– Geographic Information Systems
NDMS- National Disaster Mitigation Strategy (Canada)
OCPs– Official Community Plans
IPCC- International Panel on Climate Change
IPREM- Integrated Partnership for Regional Emergecy Management
UBCM- Union of British Columbia Municipalities
QPs- Qualified Professionals

‘A changing, uncertain world in transformation demands action to build the resilience of the social-ecological systems which embrace all of humanity. A fundamental challenge is to change perceptions and mind-sets, among actors and across all sectors of society, from the over-riding goal of increasing productive capacity to one of increasing adaptive capacity, from the view of humanity as independent of nature to one of humanity and nature as co-evolving in a dynamic fashion within the biosphere’.

-Folke et al., The Resilience Alliance

1. Introduction

The focus of this study is the governance of natural hazard risk: the way in which the study and science of natural hazards informs laws, policies, and decision-making for community growth and development. It assesses the degree to which strategic community planning incorporates natural hazard risk management principles and approaches in a case study region within British Columbia. It aims to contribute to a shifting paradigm of risk management by exploring the nascent opportunity represented by natural hazard mitigation for synergistically linking social, economic, and ecological objectives in Canadian communities (Figure 1). The aim is to redefine the 'problem' of natural hazard exposure as an opportunity for building resilient communities, those whose trajectories are aimed at dynamic co-evolution with nature.

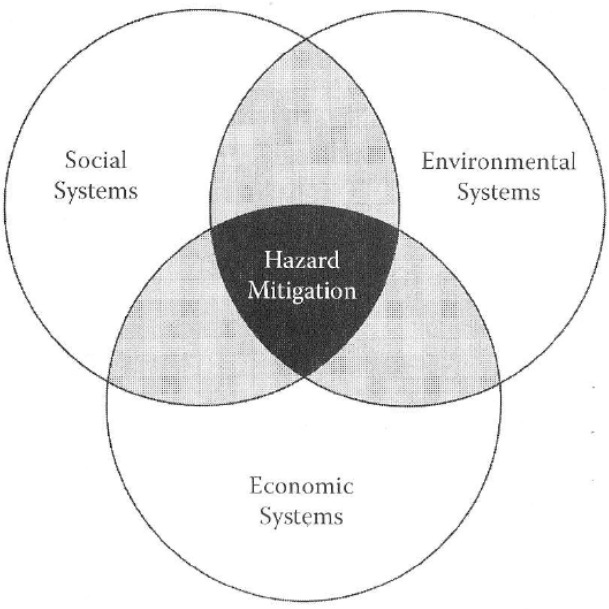

Figure 1: Nascent Opportunity Represented by Linking Management of Natural Hazard Risk with Strategic Community Planning (Pine, 2009)

Key assertions from the literature informing this conceptualization:

- The science of identifying natural hazards and designing to reduce their adverse impacts has far outrun the ability of local governments to put new knowledge into practice.
- Land use planning represents the single most promising approach for sustainable hazard mitigation.

(Mileti, 1999, Burby et al., 2000).

- Better hazard mitigation *planning* tends to reduce hazard risk (Nelson & French, 2002, Dalton & Burby, 1994)[1].

This paper begins by defining the research rationale and associated terminology. It then discusses the challenge posed by natural hazard risk, and the role that strategic planning can play in managing it. It then outlines the current governance system for hazard risk management and community planning in the study region. The paper then explains the methodology employed and discusses findings. It concludes with analyses, recommendations and suggestions for future research.

2. The Governance of Natural Hazard Risk

2.1 Research Rationale

There is currently no available assessment of what policies are employed in British Columbian communities to manage natural hazard risk. The main purpose of this study is thus to understand the current status of planning for hazard mitigation at the municipal and regional level and to highlight both areas for improvement and best practices. This will be accomplished by assessing the degree to which hazard mitigation planning is incorporated into the Official Community Plan (OCP). Analysis aims to provide insight for actors involved (e.g. physical scientists, engineers, planners and other policy and decision-makers) as to how to enhance connections between hazard risk information, risk management policy and strategic community planning to ultimately build resilient communities.

The ideal of planning practice is to begin from a solid understanding of the current state of affairs (e.g. a baseline), before defining objectives and formulating actions to reach desired futures. This same rationale was the impetus for this study; in British Columbia, there is no baseline in terms of understanding how communities are managing natural hazard risk. There is no inventory of 'where we are' such that we can define 'where we

[1] The first study examined the connection between hazard mitigation planning and the economic losses in the Northridge earthquake. Findings highlight that better quality hazard mitigation planning led to reduction in losses. The latter showed that land use plans play a significant role in limiting development in hazardous areas and found that local governments are not likely to adopt such plans without higher level government mandates that are actively monitored and enforced.

want to go'. This research aims to address that gap and provide a platform for action moving forward.

The central question explored through this research is**:**
To what degree are member municipalities of Metro Vancouver planning for natural hazard mitigation?

Sub questions:
Are there certain plan components in Metro Vancouver's Official Community Plans (e.g. fact base, goals and policies, implementation) that are stronger or weaker than others with regards to hazard mitigation?

If so, what might this suggest about the current governance structure for managing hazard risk?

2.2 A Common Lexicon

In the field of natural hazard risk management, literature is often beset by confused terminology. Thus, in discussing this topic, it is paramount to begin with explanation of terms and concepts employed.[2]

***Adaptation** (IPCC, 2011)**:** In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate.*

A key adaptation strategy of humans will be to learn to co-evolve with nature in a changing climate. This study aims to support the ability of communities to adapt to increasing uncertainty in natural systems by highlighting safe, smart land use management strategies.

***Disaster**: a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources*

***Disaster risk**: a function of the characteristics and the frequency of hazards experienced in a specific location, the nature of the elements at risk and their inherent degree of vulnerability or resilience*

***Disaster risk management** (IPCC, 2011): Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness,*

[2] Terminology is from the UNISDR, unless noted otherwise.

response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, resilience, and sustainable development.

***Emergency management**: the organization and management of resources and responsibilities for addressing all aspects of emergencies, in particular preparedness, response and initial recovery steps*

***Land use management** (Godschalk, Kaiser & Berke, 1998): broad ranging initiatives such as building standards, development regulations, critical and public facilities infrastructure siting, land and property acquisition, taxation and fiscal policy and information dissemination*

***Mitigation**: any structural (physical) or non-structural (e.g. land use planning, public education) measure undertaken to minimize the adverse impact of potential natural hazard events*[3]

This study is focused on evaluating strategic planning measures for disaster risk management at the local and regional level to highlight areas of synthesis between hazard risk management and quality of life, or how taking action to address disaster risk can increase quality of life for current and future members of a community.

***Natural hazard**: a natural process or phenomenon (e.g. earthquake, landslide, tsunami, windstorm, wave or surge, flood or drought) that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage*

This study is confined to an assessment of ***natural*** hazard risk management.[4] Hazards can be further conceptualized as rapid-onset events (e.g. earthquake) and slow-onset events (e.g. drought), which could have risk management approaches best suited to this temporal dimension.

***Risk**: the combination of the probability of an event and its negative consequences (risk =hazard x vulnerability)*

***Vulnerability**: the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of hazard*

This is employed in this study as having two components; one that is inherently social (e.g. socio-demographics), and the other, physical, arising from the siting and design of

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[3] From Canada's National Disaster Mitigation Strategy (NDMS): 'Mitigation strategies can reduce or prevent disasters, losses and emergency response and recovery costs that would otherwise be incurred. Mitigation is a key element of emergency management which to date has received relatively little emphasis in spite of increasing disaster costs'.

[4] The NDMS, developed in collaboration with provincial and territorial, governments notes: 'Responding directly to national consultation findings, the NDMS supports all-hazards emergency management, with an initial focus on reducing risk posed by *natural hazards*, an area that stakeholders agree requires urgent attention'.

built environments.

Resilience: *the ability of a system, community or society exposed to hazards to resist, absorb, accommodate and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions*

As resilience is a characteristic of systems, a key term and concept employed in this study is ***socio-ecological system*** (SES), which is used to emphasize social (human) systems as embedded in, and in constant interaction with ecological systems (natural).

2.3 The Challenge of Natural Hazards

The province of British Columbia is a relatively undeveloped, and hazardous place. Existing development tends to be in river valleys, on coastlines or in mountainous terrain. Population growth continues and competition over scarce availability of land is expected to intensify, as only five percent of landmass in the province is available for human settlement. Pressure to develop in hazardous areas is accordingly a serious concern. Further, one of the most significant impacts of climate change is increased frequency of extreme weather events and related natural hazards (e.g. storm surge, forest fire, drought, and landslide) (Walker & Sydneysmith, 2008).

Rising costs associated with responding and recovering from natural hazard events have already been assessed and will continue to increase, yet adaptation measures remain reactive (ibid). Low lying and coastal areas, as well as certain infrastructure including transportation, port facilities, and electricity and communication distribution networks are considered to be particularly vulnerable. In Metro Vancouver, specifically, hazards of concern are: earthquake, flooding, erosion, subsidence, mudslide, and interface fire (Metro Vancouver, 2011). All of these hazards, with the potential exception of earthquakes, will be exacerbated in a changing climate. Furthermore, in the coastal zone, significant impacts of sea level rise must also be taken into account.

As a growing urban region,[5] Metro Vancouver is becoming increasingly complex and interconnected. Accordant potential for significant damage and disruption from natural

[5] Metro Vancouver is the most populous regional district in British Columbia, with a population density of 735.6 people per square kilometre in 2006 (Statistics Canada, 2006).

hazards is increasing. To date, risk management strategies employed tend to be rooted in engineering and emergency management (e.g. structural protection, early warning and evacuation, response planning). While these strategies help alleviate concerns from a preparedness/response perspective, they do not address the root causes that drive increasing risk at the scale of the community and region. Further, they tend to address concern for risk to life but not societal disruption, economic loss and environmental degradation. A more proactive and comprehensive approach is required to address increasing hazard risk.

2.4 The Promise of Planning

Awareness of *un*sustainable land use and urban growth patterns has increased, leading to planning and design movements such as *Smart Growth* and *New Urbanism*, but proponents of such movements have often failed to concede that *sustainable* development must necessarily be *safe* development. However, there is a body of literature, spanning over a decade, that has increasingly called for a more proactive and adaptive approach to address natural hazard risk that is rooted in strategic community planning (Mileti, 1999, Burby et al, 1999, Schwab & Topping, 2010).

In shifting emphasis from traditional emergency management approaches to *proactive* risk management, hazard mitigation and land use management can be seen as natural compliments as they are future-oriented. They gear immediate action to longer-term objectives and suggest strategies such as: keep people and assets out of hazardous areas, maintain the inherently mitigative qualities of natural systems, ensure new development is disaster-resilient, and ensure safe evacuation potential (Figure 2) (Godschalk, Kaiser & Berke, 1998).

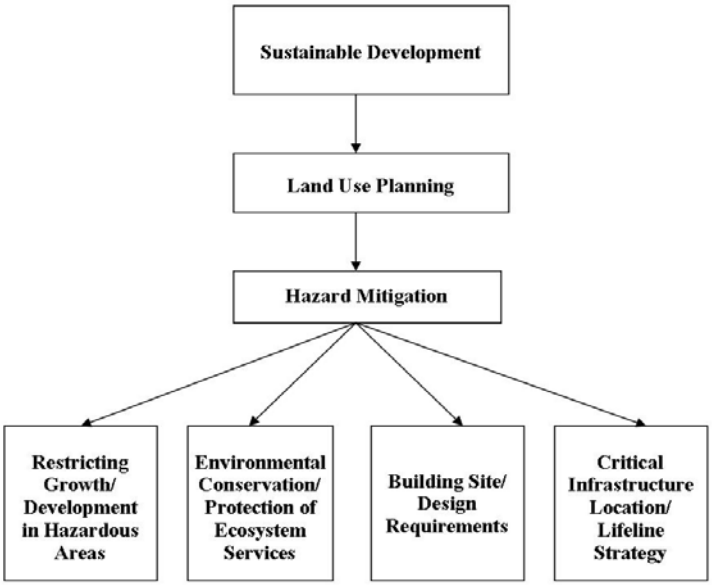

Figure 2: Integrating Concepts of Sustainable Development, Land Use Planning & Hazard Mitigation

Strategic planning, in particular, has its merits in fostering systems thinking over long-term time horizons. Thus, it provides a medium for public consideration and discussion of the long-term equity involved in land use management. Equity is a concern as: the land base is finite, and development decisions, in many cases maintained through public spending, have impacts lasting upwards of seventy years.

Incorporating principles and approaches for natural hazard mitigation in land use management is an effective way of building resilience into communities as they grow and develop. The extent to which planning programs can be used to reduce risks is summarized concisely by Burby et al. (1999):

> *Planning programs reduce losses by affecting both the location and the design of urban development (see Godschalk, Kaiser, & Berke, 1998) and by helping create a knowledgeable constituency of citizens who support hazard mitigation programs (Burby & May, 1998). By guiding urban expansion and redevelopment to locations that are free of hazards, planning programs eliminate the possibility of significant damage. Where hazardous areas have advantages for development that cannot be foregone, planning programs reduce potential losses by steering development to the least hazardous parts of building sites and by modifying building and site design practices so that risk is reduced. For past development located in hazardous areas, planning programs help property owners relocate their homes and commercial buildings to hazard-free sites, or to modify them to reduce the risk of loss. To further limit the risk of loss after development has taken place, planning controls set standards to reduce the magnitude of the hazard. For example, if the amount of imperviousness in watersheds is reduced, peak runoff can be kept at or near predevelopment levels. Finally, by involving citizens in all phases of the planning process, planning programs help build citizen awareness of the risks posed by*

natural hazards and create a base of citizen support for efforts to reduce risk by planning for and managing urban development and redevelopment.

At present, we know very little about the quality of strategic plans in Canada which could imply that they are failing to meet a desirable standard of quality and achieving their full potential as mechanisms for promoting sustainable, safe growth (Berke & Godschalk, 2009).

2.5 Governance Context

If disaster is understood as the product of a cumulative set of decisions taken over long periods, then the processes by which these choices are made become a focal point for potential change. These decision processes operate on different organizational levels and in different societal arenas simultaneously, affecting one another reciprocally and adding to the complexity of the operating system.
-Comfort et al., Reframing Disaster Policy

Over the past decade in Canada, there has been a general pattern of downloading decision-making responsibility from more senior levels of government to less senior levels of government, without accordant funding or knowledge transfer (David Suzuki Foundation, 2011). In British Columbia, local governments have inherited the responsibility to manage natural hazard risk through various federal and provincial mandates[6] without accompanying resources or expertise. Further, none of these senior-level policy documents set standards or best management practices that draw a clear distinction as to what constitutes tolerable thresholds of risk or safety (Journeay, under review)[7].

This lack of guidance and capacity at the local level is troubling, especially with regards to the downloading of tasks that involve safeguarding human life. There is also a conflict of interest inherent in local government implementing restrictions on the use of land from which they derive funds allowing them to carry out their duties and obligations. Finally, short political cycles foster local decision-making for land use management that tend to discount considerations of long-term, intergenerational equity in the use of the land base.

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[6] At the Federal level; the National Disaster Mitigation Strategy and Emergency Management Act (2007), at the provincial level, the BC Emergency Program Act (1996).

[7] APEG BC Guidelines for Professional Practice note that 'BC legislation that underlies flood management and flood assessments tends to be fragmentary, sometimes inconsistent between jurisdictions and may not always be in the public interest'

Strategic planning tools available in BC include (but are not limited to) the Official Community Plan (OCP) and at the regional level, the Regional Growth Strategy (RGS). The RGS coordinates inter-jurisdictional growth management and infrastructure planning at the local scale. The most recent RGS was adopted by Metro Vancouver in July 2011. The plan includes population and dwelling unit projections for member municipalities, sets an urban containment boundary and establishes substantive priorities for land use management, including: *manage land use and transportation infrastructure that improve ability to withstand natural hazard risk (Strategy 3.4)* (Metro Vancouver, 2011).

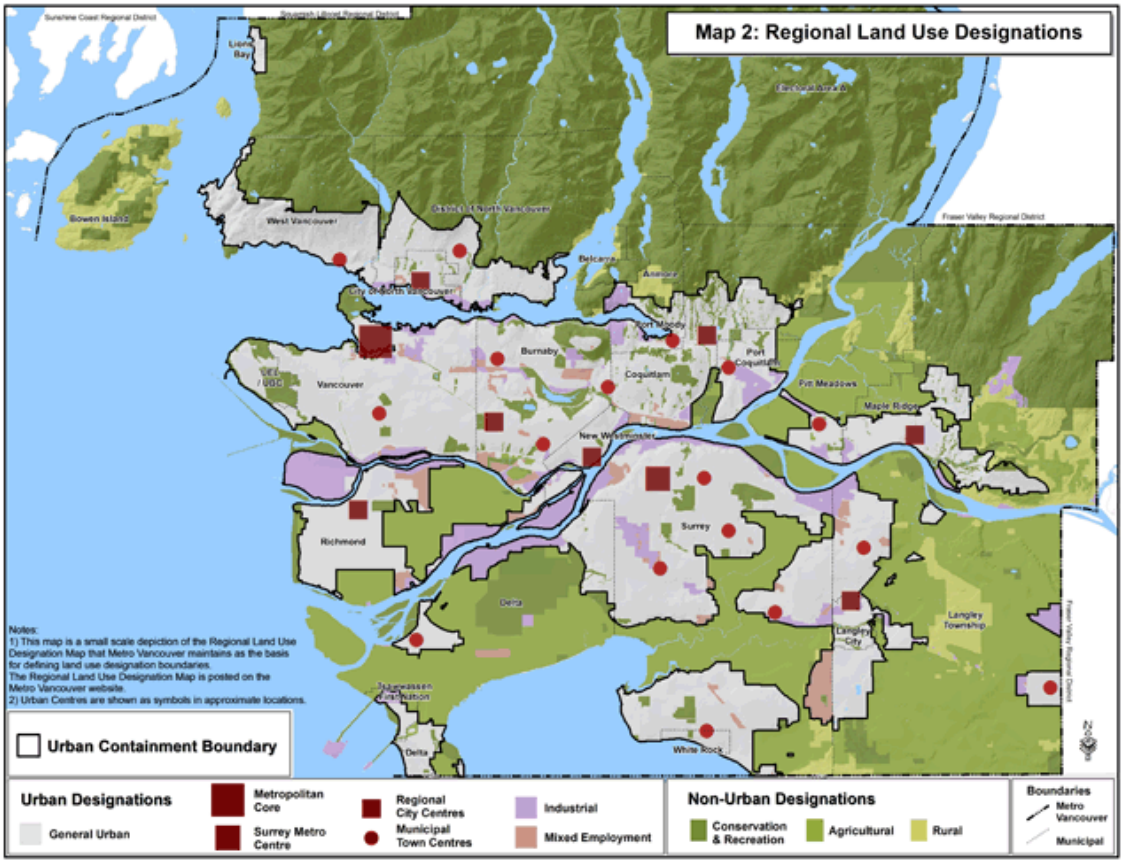

Figure 3: Regional Growth Strategy (Metro 2040)

Metro Vancouver is also responsible for regional emergency management, through the Integrated Partnership for Regional Emergency Management (IPREM). The work of IPREM is not informed by a comprehensive, regional multi-hazard risk assessment and it is unclear how the knowledge base regarding hazard risk in the region could inform

regional land use management as *Strategy 3.4* suggests it should.

At the local level, OCPs are the foremost policy tool for guiding growth and development. These plans are authoritatively positioned from a legal perspective and have potential as a rallying point for setting and correcting development paths. They set long-term priorities for economic, ecological and social dimensions of community development. As Figure 4 shows, the OCP works in tandem with many other policy tools and plans. The extent to which OCP policies are implemented is dependent to an extent on strength of policy language (e.g. mandatory or suggestive) and its integration with other bylaws.

Plan Type	Purpose	Scale/Scope	Method of Adoption	Timeframe
Sustainability Framework	Very long term vision and goals for a sustainable community that provides a umbrella framework for City plans and corporate activities.	Citywide	Resolution	100 years
Official Community Plan	Policy framework to move towards a sustainable community through planning and land use management.	Citywide	Bylaw	30 years
Corporate Strategic Plan	Vision and goals of Council and City business operations.	Corporate	Resolution	3 years
Master Plans	Comprehensive plans for citywide topics or service delivery areas such as transportation.	Citywide	Resolution	Variable
Local Area Plans	Implements OCP direction at the local scale while responding to local context	Local area/ neighbourhood	Resolution	Aligned with the term of the OCP
Strategies and Action Plans	Action oriented plans for defined policy areas such as homelessness and climate change.	Citywide	Resolution	Variable
Policies	Guidance that addresses gaps in existing plans, pilots new initiatives, or responds to emerging situations.	Various	Resolution	Variable
Financial Plan	Detailed plan that guides the implementation of the capital budget and the operating budget.	Corporate	Bylaw	5 years
Capital Budget	Funding and spending on capital investment in physical assets that support City operations.	Corporate	Resolution	20 years
Operating Budget	Funding and spending to operate City departments.	Corporate	Resolution	5 years
Regulatory Bylaws	Regulations that govern public and private activities within areas of municipal jurisdiction, including such things as land use, building, subdivision and development, nuisance, business licensing, and animal control.	Various	Bylaw	Continuous

Figure 3: Policy Framework for Managing Growth and Development at the Local Level in BC (Victoria OCP, p. 17)

Within this policy framework, emergency management plans would likely be classified as ‘strategies’ or ‘action plans’, which the BC government mandates local authorities to prepare. Emergency plans are to reflect ‘their assessment of the *relative risk* of occurrence and the *potential impact* on people and property of the emergencies or disasters that could affect all or any part of the jurisdictional area from which the local authority has responsibility’ (*Section 2:1* BC Emergency Program Act, 1996). In effect, this is asking local authorities to conduct hazard risk assessments. It is not clear how they

are fulfilling this is practice, except to hire consultants to conduct the *Hazard Risk and Vulnerability Assessments* (HRVAs) that is outlined as best practice by the province.[8]

In aligning a mandate for risk assessment with *emergency* planning, a reactive approach is perpetuated. In this outdated paradigm, risk assessments are viewed as having potential to identify risks for which there are no existing reduction strategies as opposed to a tool for building resiliency (e.g. long-term prosperity). As presently construed, the provincial risk assessment tool (HRVA) symbolizes a lack of integration of hazard risk assessment with strategic planning, as analyses are not informing policy formulation and decision-making for land use management.[9]

3. Research Methodology

3.1 Overview

Guided by the question of **what is the current quality of strategic planning policy for natural hazard mitigation in Metro Vancouver,** plan quality evaluation was selected as an appropriate methodology to inform data collection and analysis. This is a relatively new methodology that combines qualitative and quantitative approaches. It has been employed mainly in the United States, and also in New Zealand and Holland, over the past ~15 years to investigate a multitude of issues (e.g. housing affordability, smart growth, coastal development), and substantially to assess natural hazard mitigation (Berke & Godschalk, 2009). The method involves developing a research protocol, based on theoretical frameworks and social science standards, which is then used to assess and 'code' policy documents. In this particular design, the documents under consideration are the Official Community Plans (OCPs) of communities comprising the most substantially developed and densely populated region in British Columbia, the Greater Vancouver Regional District (a.k.a. Metro Vancouver).

3.2 Choice of Approach

This research began as an attempt to decipher whether communities possess the factual

[8] Web-based research results in only a handful of actual HRVAs, which are completed by emergency management consulting firms.

[9] This assertion is garnered from personal communications with municipal emergency managers in Vancouver's Lower Mainland who express frustration with the lack of collaboration sought from planning to address natural hazard risks.

basis to assess hazard risk, and capacity to translate hazard risk information into tractable policy for ensuring safe development. The plan quality evaluation method was selected, as there existed no baseline in trying to understand and evaluate what communities in British Columbia are doing to address natural hazard risk. It was hypothesized that there was substantial variation in the quality and quantity of hazard risk information and policies that communities brought to bear in their strategic planning approaches. Therefore, as a cursory contribution to research in this field in Canada, it was seen as valuable to provide a baseline assessment of natural hazard mitigation policy for the most populated region in the province, which is also predicted to absorb a substantial share of new growth in the next 30 years (Metro Vancouver, 2011).[10]

Evaluating plan quality for Metro Vancouver will outline the current state of policy and practice for hazard mitigation that is captured in the OCPs of member municipalities. The importance of incorporating hazard mitigation policies into the OCP, as opposed to developing stand-alone hazard mitigation plans, has been well developed in the literature (Schwab & Topping, 2010). The most serious deficiency with creating stand-alone hazard mitigation plans is that they lack legal status to guide local decision making regarding capital expenditures or land use (whereas an OCP, zoning bylaw and capital plan are to be made consistent). Further, lack of linkage between various plans impedes systems thinking and can create policy conflicts (Schwab and Topping, 2010).

In British Columbia, communities face an ever-evolving roster of planning requirements and incentives. If this leads to the production of a series of disconnected plans, this can be burdensome and self-defeating. Linkage and synthesis between plans is essential in creating effective and clear policy frameworks. Incorporating key considerations for safer development into the existing framework for OCPs is therefore the best-practice approach. The goal of this research is thus to contribute to an understanding of how the principles of natural hazard mitigation have been integrated into OCPs in BC. A critical further consideration is the linking of these approaches at the local level with plans,

[10] Metro Vancouver's population was 2.1 million people in 2006 (Statistics Canada, 2006). Based on the RGS, the area is expected to increase to 3.4 million people by 2041 (RGS, Appendix A). To accommodate this growth, over 570,000 dwelling units are projected for development over the next 35 years (Metro Vancouver, 2011a).

policies and funding at the regional, provincial and federal level. This integration is collectively perceived as the issue of vertical connection in the plan quality literature.

In sum, the ultimate goal in selecting this methodology is to provide an informed platform for action at a time when natural hazard mitigation is beginning to enter the lexicon and policy framework of professionals in the planning field in British Columbia. This study can ultimately help bring awareness to the importance of planning for disaster resilient communities, and also provide a best practice synopsis as grounds for shared learning and further policy development and implementation. In part, this approach is based on the common business and management maxim of 'what gets measured- gets improved'. We have only to look at the example of the Gross Domestic Product (GDP), and its failure to account for human wellbeing, for admonition in this regard (Chambers, Simmons, Wackernagel, 2000, Canadian Index of Wellbeing, 2011). The study is not meant to denigrate communities for failure to address natural hazard risk. It is meant to assist in advancing collaborative governance approaches so that communities will be better positioned to co-evolve with nature in a changing climate.

3.3 Data Collection and Coding Procedure

Unit of Analysis

Although communities are not officially mandated to prepare OCPs, in practice, it is rare that a BC municipality does not have one. Out of the 159 municipalities, in BC, 149 have plans (Stevens, & Senbel, under review). The legislative authority to prepare an OCP plans stem from the *Local Government Act (1996).* It specifies elements that must be included in the plan if the community elects to prepare one and also describes suggested elements that might be considered for inclusion. The particular items of interest in this study are:

Sec 877 (d):

*(1) An official community plan **must** include statement and map designations for the area covered by the plan respecting the following:*

> *(d) restrictions on the use of land that is subject to hazardous conditions or that is environmentally sensitive to development*

Authority to establish Development Permit Areas (DPAs) is set out in sec 919.1 and 920:

919.1 An official community plan may designate development permit areas for one or more of the following purposes:
(a) protection of the natural environment, its ecosystems, and biological diversity;
(b) protection of development from hazardous conditions;

For land designated under section 919.1 (1) (b), a development permit may do one or more of the following:

*(a) specify areas of land that may be subject to flooding, mud flows, torrents of debris, erosion, land slip, rock falls, subsidence, tsunami, avalanche or wildfire, or to another hazard if this other hazard is specified under section 919.1 (1) (b), as areas that must remain free of development**, except in accordance with any conditions contained in the permit;***
(b) require, in an area that the permit designates as containing unstable soil or water which is subject to degradation, that no septic tank, drainage and deposit fields or irrigation or water systems be constructed;
(c) in relation to wildfire hazard, include requirements respecting the character of the development, including landscaping, and the siting, form, exterior design and finish of buildings and other structures;
(d) in relation to wildfire hazard, establish restrictions on the type and placement of trees and other vegetation in proximity to the development.

After adoption of the plan, all bylaws (e.g. zoning bylaw) and works undertaken (e.g. capital plans) must be consistent with the plan (LGA, sec 884). Accordingly, the OCP is the authoritative document that *guides* development and the zoning by-law is the primary tool to *regulate* development. The OCP is intended to provide a degree of certainty as to the location and nature of change for municipal councils, residents, and private sector developers. For these reasons, as well as those mentioned previously, the OCP was chosen as the document to assess policy for natural hazard mitigation. The only items included for analysis were the OCP itself and associated Development Permit Areas (DPAs). Although at times included as appendices or attachments to the OCP, neighbourhood or area plans and design guidelines, were not included.

Sample Selection

Due to limited time and resources, the study could only incorporate one region for analysis. Metro Vancouver was selected due to existing density of people and assets that warrant protection and the projected growth that is expected to occur over the next ~30

years. The balance between the hazardous terrain that make this study region such a spectacularly beautiful place and the growth and development targeted here for the near-future, make it an ideal area to examine the nexus of community planning and hazard risk management.

The OCPs of twenty-one of the twenty-four local authorities were collected and the software *Atlas-ti* was employed to code them. The City of Abbotsford was excluded, as it is only a member of Metro Vancouver with respect to GVRD park services. Further potential exclusions included three local authorities: *Area A*, the Tsawwassen First Nations and the City of Vancouver, which are all exempt from the provisions of the *Local Government Act*. Area A and Tsawwassen First Nations' were excluded as they are substantially different entities than the other local authorities. Vancouver was included in the analysis as they have a strategic community plan (e.g. *City Plan*) and are organized and operate in the same fashion as the other local authorities (e.g. as a municipal entity).

Protocol Development and Plan Evaluation

An evaluation protocol was developed, based on a review of existing protocols pertaining to natural hazards and community planning and other literature highlighting best practices (Brody 2003, Godschalk, 2009, Schwabb & Topping, 2010). Plan quality was conceptualized and measured using components commonly identified in a literature review of plan quality studies (e.g. Burby & Dalton, 1994, Highfield and Carasco, 2003, Brody 2003, Norton, 2008): Fact Base, Goals/Objectives, Policies/Actions, and Implementation/Coordination. Fifty-seven indicators were developed according to these four components. Table 1 provides a listing of these indicators by component.

Table 1: Coding Protocol (abridged)

1. Fact Base		
	1.1 Location of Hazard(s)	1.9 Population Exposed- Social Vulnerability
	1.2 Magnitude of Hazard(s)	1.10 Public Infrastructure/Critical Facilities Exposed
	1.3 Ranking	1.11 Private Structures Exposed
	1.4 Location of Protective Systems	1.12 Subjective Indicators
	1.5 Historical Events	1.13 Emergency Shelter Demand/Capacity
	1.6 Local Knowledge Incorporation	1.14 Land Use and Future Growth
	1.7 Climate Change	1.15 Other Plans
	1.8 Population Exposed- Physical Vulnerability	
2. Goals		
	2.1 Overarching Goal- Hazard Risk Management	2.6 Preservation of Open Space/Recreation Areas
	2.2 Reduce Property Loss	2.7 Maintenance of Good Water Quality
	2.3 Minimizing Fiscal Impacts	2.8 Safety of Population
	2.4 Equitable Distribution of Costs	2.9 Hazard Awareness
	2.5 Public property	2.10 Measurable Objectives
3. Policies		
	3.1 Prohibition of development in hazardous areas	3.13 Land/Property Acquisition
	3.2 Educational Awareness	3.14 Impact Fees
	3.3 Real Estate Hazard Disclosure	3.15 Retrofitting/Relocation of Private Structures
	3.4 Hazard Warning/Response Program	3.17 Financial Incentives for DR Management
	3.5 Signage for Hazardous Areas	3.18 Storm/Watershed Management
	3.6 Technical Assistance- Developers/P. Owner's	3.19 Maintenance of Structures (e.g. dykes)
	3.7 Permitted Land Uses	3.20 Other- specify
	3.8 Transfer of Development Rights	3.21 Capital Improvements
	3.9 Cluster Development	3.22 Retrofitting of Public Structure
	3.10 Setbacks	3.23 Critical Facilities
	3.11 Special Study/Impact Assessment	3.24 Transportation
	3.12 Building Standards	3.25 Measurable Indicators
4. ***Implementation***		
	4.1 Intergovt. Coordination- Regional/Provincial	4.8 Timelines for implementation
	4.2 Intergovt. Coordination- Federal	4.9 Monitoring and Evaluation
	4.3 Intergovt. Coordination- Other Municipalities	4.10 Financial Commitment
	4.4 Coordination with Private Sector	4.11 Community-Based Risk Tolerance Threshold
	4.5 Risk Transfer	4.12 Method for Integrating New information
	4.6 Plan Update	4.13 Method for Repetitive Loss Accounting
	4.7 Implementation	

The Fact Base is the factual and descriptive basis upon which policy decisions are made and can include written statements as well as visual material. In this protocol, it encompasses maps and statements regarding such things as location, extent and magnitude of hazards, exposed populations, and structural and social vulnerabilities. This component is seen as the foundation of planning, and also as difficult to improve due to high costs of additional analysis and data gathering (Brody, 2003).

The second component, Goals or objectives encompasses the community goals that guide

policy development. Ideally goals are directional and tied to measurable objectives so that a community could gauge in review whether it was moving closer to or further away from its goals. Goals included in this protocol pertain to things such as; maintenance of good water quality, reducing property loss, increasing the safety of the population, and increasing hazard awareness among community members.

The third component, Policies or actions, is conceived of as 'the heart of the plan' as it actualizes the goals and objectives through policy tools such as regulations and financial incentives (e.g. transfer of density, clustering or land acquisition programs) (Brody, Highfield, and Carasco 2003). In this study, policies assessed included; the prohibition of development in hazardous areas, the transfer of density to safer areas, and the use of cluster development and setbacks to reduce risk.

The final component, Implementation and coordination involves examining commitment to implementing and reviewing the plan, for example, designating responsibility and timelines for actions, enforcing standards and sanctioning non-compliers (Brody, Highfield, Carsasco 2003). In this protocol, items in this component included; whether there were examples of coordination with various other levels of governments, whether the plan had been updated within the last five years, and whether there were specified timelines for implementation.

Once developed, two professionals with expertise in the field of hazard mitigation and community planning reviewed the draft protocol before it was finalized and tested. Two coders, working independently, then assessed test plans from locations external to the Metro Vancouver region until percent agreement scores reached above 80%. Percent agreement scores are intended to provide insight into inter-coder reliability. Literature suggests that an inter-coder reliability score in the range of 80% is considered acceptable (Miles and Huberman, 1994). The protocol was then used to code the most recently adopted OCPs of 21 member municipalities of Metro Vancouver using a scheme in which items from the protocol were scored a 0 for not present, and 1 for present. Two trained coders assessed each plan independently, then met to discuss agreements and

disagreements and reach consensus on the score for each item.

3.4 Role of Researcher

One of the main concerns with this methodology stems from a single coder working alone, creating subjective results. This concern was particularly valid in this study as the principal investigator was substantially more experienced and knowledgeable in the field of natural hazard mitigation and had direct experience working with one of the community's whose plan was assessed. Accordingly, best practice from previous research was followed and plans were 'double coded' by two coders working independently to reduce bias.

3.5 Limitations of this Approach

A limitation of this approach is that it is focused on OCPs to the exclusion of other planning documents that (ideally) work in tandem as a coherent policy framework (see figure 4 showing the interrelation of policies). Although OCPs represent the highest level of community policy which other policies must be consistent with, there are other important tools that must be utilized to address natural hazard risk, including, but not limited to: budgets, infrastructure plans, subdivision regulations, neighborhood/area plans, zoning bylaws, and design guidelines. This study thus represents an analysis of *strategic* planning for natural hazard risk reduction, with the knowledge that finer-grained plans and policies, also critical to fostering safer development, should be made consistent with these plans.

3.6 Anticipated Outcomes

It is expected that the coding process will provide a broad illustration of the planning policy context for natural hazard risk management in Metro Vancouver. Overall low scores are anticipated, due to the trend noted in the literature that 'the science of identifying natural hazards and designing to reduce their adverse impacts has far outrun the ability of local governments to put new knowledge into practice' (Mileti, 1999). It is likely that communities generally do not incorporate hazard risk information (e.g. probabilities of various hazard occurring as well as potential impacts and consequences)

into their OCPs, as a substantial component of their fact base, in part due to lack of capacity for conducting risk assessments and also due to perception that doing so could create barriers to growth and development. Implementation scores are expected to be low as monitoring and evaluation has been the least developed area of strategic planning.

4. Findings and Discussion

4.1 Overview

As summarized below in Table 2, the mean score for plans is 14.8 out of 57 indicators (26%). The lowest plan score is Vancouver's *City Plan*, achieving 0 out of 57 indicators. The highest scoring plan, overall, is Delta, achieving 24 out of 57 of the indicators (42%). This demonstrates that communities, in this region, are not generally addressing the issue of natural hazard mitigation in their most authoritative strategic planning document, the OCP, in a comprehensive way (e.g. the highest scoring plan includes less than half of the indicators). It also shows that there is significant variation in the degree to which the plans address natural hazard mitigation (e.g. a range of 24 indicators between highest and lowest scoring plans).

Table 2: Summary of Plan Scores

Plan Component	Number of Indicators	Lowest Score	Highest Score	Mean
Fact Base	15	0	6	18.0%
Goals	9	0	5	23.0%
Policies	21	0	13	30.0%
Implementation	12	0	6	22.3%
Overall Score	**57**	**0**	**24**	**24.3%**

Although it is appealing to focus on overall scores, analysis is more constructive if it addresses scores of individual plan components: fact base, goals, policies and implementation. The following is a discussion of these component scores and indicators within them that scored highest (e.g. maximum frequency). Also discussed are items that scored lowest or were absent across the sample (e.g. minimum frequency). Illustrative examples are provided from the OCPs assessed to contextualize discussion and highlight variations that can exist within indicators.

4.2 Fact Base: What do we know about natural hazard risk in our community?

The first category, fact base, is the lowest scoring component with plans scoring an average of 2.7 out of 15 indicators (18%). This creates cause for concern as the fact basis forms the foundation for all other components. It serves as a common platform from which all parties involved in community growth and development can act. It has also been noted, that this is viewed as the hardest component upon which to improve due to high costs of additional analysis and data gathering (Brody, 2003). In examining variations in the quality of fact bases in this study, it is important to keep in mind the operational definition of risk (risk = hazard x vulnerability). This means that a strong fact base for hazard mitigation requires an understanding of both hazard threats and physical and social vulnerabilities, in other words, a community risk assessment.

The plans scoring highest in the fact base component are Port Moody and Delta, both achieving 6 out of the 15 indicators (40%). The lowest scoring plans were Vancouver and Burnaby, achieving 0 out of 15 indicators. The Port Moody plan acknowledges; the link between climate change and increasing hazard risk, the physical vulnerability of a population segment, historical hazard events, the location of hazards and protective systems, and other plans related to hazard mitigation. Delta's plan contained four of the same indicators: location of hazards, location of protective systems, physical vulnerability of population, and climate change. The differing indicators were for private structures exposed and infrastructure or critical facility exposure.

Port Moody and Delta, assessed as having the strongest fact base, both included statements acknowledging hazardous conditions, the role of protective systems, features of physical vulnerability, and a connection between a changing climate and increasingly hazardous conditions.

Port Moody:

Location of Hazards

The Geological Survey of Canada identifies a rim of land around the head of Burrard Inlet composed of unconsolidated sediments that may be susceptible to liquefaction in an earthquake of sufficient severity (p.34)

Location of Protective Systems

Two inland wetland areas on the North Shore are tributaries of Hett Creek and Mossom Creek. During storms, wetlands reduce flooding and erosion by absorbing water and controlling downstream creek flows. In dry periods, a wetland is a valuable source of water. (p. 33)

Climate change

Extreme fluctuations in weather patterns and severe weather events are also attributable to this increase in global warming (p.8)

Physical Vulnerability

The Chines hillside are subject to ravine erosion and debris flow (designated on Map 13 (p.34)

Delta:

Location of Hazards

DPA LV2- As shown on map IIA: Justification: The waterfront area is subject to flooding, debris flow and erosion. The slough bank is subject to erosion and requires protection of existing vegetation and tree cover or hard surface engineered protection. (p. E-9 of DPA Guidelines)

Location of Protective Systems

Designate Burns Bog as environmentally sensitive, which preserves the environmental and ecological roles of the Bog (p. 1-16, Schedule A)

Climate Change

Global warming and climate change have the potential to impact our infrastructure system as rising sea levels may result in future flooding (p. 2-53)

Physical Vulnerability of Population

The area (also designated by map) of Ladner East-Urban is located within the floodplain and subject to flooding in the event of a failure of the dyke system.

The fact base components achieving highest frequency were the location of hazards (16 out of 21 plans) and location of protective systems (15 out of 21 plans). This is likely due to wording in *Local Government Act* requirement, that an:

> *official community plan **must** include statement and map designations for the area covered by the plan respecting the following:*
> *(d) restrictions on the use of land that is subject to hazardous conditions or that is environmentally sensitive to development.*

The fact that this item is present in the majority of plans demonstrates the effectiveness of a mandate in having communities acknowledge where there are restrictions on the use of land. However, this legislative language fails to provide a requirement that communities seek out an understanding of the hazardous conditions that may affect them.

Many of the plans that are assessed as identifying hazardous conditions establish a Development Permit Area (DPA) for a given area. These DPAs often require a site-specific analysis from a qualified professional (QP). The municipality is perhaps aware that there are hazardous conditions, enough to establish one or more DPAs, but does not want to make a decision to allow or not to allow development (e.g. to decide whether a specific site will be 'safe for the use intended'). Accordingly, this responsibility is delegated to QPs. This is likely a result of both insufficient information (e.g. lack of understandings of hazard risk in the community) and an unwillingness to disallow development using a precautionary approach.

Fact base indicators absent across the sample include: social vulnerability, shelter demand and capacity, subjective indicators, magnitude of hazards, and ranking. The first three generally require some type of informational overlay to understand various dimensions of vulnerability. Hazard information is combined with geographically based statistical census data or built environment data so that a basic loss-estimation can be conducted. While many communities have hazard maps and maps that indicate critical facilities and infrastructure they have not combined these to explore interactions and accordant vulnerability. Further, communities employ census socio-demographic census data to varying degrees within their OCPs, but not in relation to hazards.

The other absent indicators from this component, magnitude of hazards and the inclusion of a ranking of hazard threats, would generally follow from a comprehensive understanding of all hazards affecting the community. An understanding of probable

magnitude of these events could trigger exploration of potential consequences, and consequently, a ranking of community concern. Absent an understanding of potential magnitude, ranking threats of concern to the community is virtually impossible. This is likely why these indicators are concomitantly absent.

The low score for fact base could suggest a number of interrelated causes:

- The information does not exist, that is why communities are not asking for it.
  There is a lack of reliable local level hazard data (ARMONIA Project, 2006). In Canada, there lacks a federal level mandate to provide it, for example, Natural Resources Canada generates natural hazard information but is not mandated to provide local level assessment.

- Communities do not have the information
  It exists, but someone else has it

- Communities do not know where to go or who to ask for assistance with such information
  Communities have been delegated a responsibility to manage hazard risks without concordant capacity

- Communities do not want the hazard information
  They lack incentive to seek it out

- Communities have the information, but in formats they do not know how to utilize for decision-making.
  Natural hazard science is often not produced in decision-driven ways (Wein, Journeay & Bernknopf, 2007).

- Communities do not have the resources to get the information, or think they cannot afford the information
  Community resources tend to be population dependent and there is a presumption that reliable data tends to be expensive (e.g. LIDAR data)

- Communities have the information, but it is included in a separate document other than the OCP
  Another type of plan may contain the information

As noted, communities tend to have very basic understanding of some of the hazards that could affect them (e.g. floodplain maps of varying quality) but do not tend to interface this with any of the other maps or data they have. Simple overlay, which can be provided using GIS-based tools, would aid understanding of inherent vulnerabilities (structural and

social) that hazards are likely to exacerbate. Another potentially useful overlay is to combine maps of various hazards to help examine interactions between them (e.g. multi-hazard mapping). Communities are not putting limited factual information they do have to use in their plans in order to manage risks, which at a primary level of risk assessment, requires interfacing hazard threat information with built environment and socio-demographic data (e.g. basic ability to generate loss estimations and understand multi-hazard risk).

4.3 Goals & Policies: What are our community goals for addressing hazard risk, and what policies will we apply to support those goals?

The second category, goals, is the second highest scoring component at 2.3 out of 9 or 25% (policies being the highest scoring component at 6.9 out of 23 or 30%). The fact that these two categories scored highest can be partially linked to the synthesis between hazard mitigation and other more familiar goals and policies that communities have in place (e.g. goals for maintenance of good water quality, and policies for stream setbacks). Further, it is generally easier and less resource intensive to state goals and policies than to develop a stronger factual basis or implementation strategy. In essence, goals and policies represent the 'low-hanging fruit' on the OCP landscape for addressing natural hazard risk. This should not be construed so as to demean these components. Setting objectives in an OCP tends to direct resources, energy and attention in a community over the long-term. Having strongly worded policies closely linked to those goals is the next, critical step.

The highest scoring plan on the goal component is Bowen Island, scoring a point for 5 out of 9 indicators (56%). The minimum frequency (e.g. a score of 0) was assessed in three plans, Anmore, Surrey and Vancouver. Bowen Island's plan set goals to; increase hazard awareness, reduce hazard impacts in a way that also achieves maintenance of good water quality, reduce damage to public property from natural hazards, reduce private property loss, and enhance safety of the population from natural hazards.

Bowen Island's plan was assessed as the strongest on the goal component, demonstrating a range of hazard risk reduction objectives.

Hazard Awareness

To encourage community groups and educational institutions to develop programs to increase community awareness of Bowen's environmentally sensitive and hazardous areas (p.57)

Good Water Quality

To recognize the importance of permanent and seasonal creeks and other wetlands and their buffer areas for surface and groundwater supply, pollution and sediment control, flood control and erosion control (p. 60)

Safety of Population & Reduce Damage to Public Property

To protect people, property and the natural environment from the consequences of natural hazards and development on unsafe, unstable and potentially hazardous areas of the island (p. 65)

Private Property Loss

Objectives respecting storm water management in the plan area are:
1. To ensure that property is not flooded or damaged (p.53)

The goal indicator with the maximum frequency is for good water quality, with 12 out of 21 (57%). This is indicative of the strong overlap between goals that contribute to higher environmental quality and also increase a community's resilience to potential hazards. Goal indicators that were absent across the study include: measurable objectives and equitable distribution of costs.

Goals are more likely to be achieved if they are phrased as measurable objectives (describing a goal in a way that one could measure progress towards it). This is an area where immediate improvement can be made. Measurable objectives can be derived from looking at best practices internationally if there are no relevant, local examples. Further, dynamics of Canadian geography and climate suggest that sometimes a foreign example of a measurable objective for reducing hazard risk will be better suited than one from another region or province. Phrasing objectives in this manner will set the stage for more effective monitoring and evaluation.

The second indicator absent from all plans is equitable distribution of costs. This is cause

for concern as it demonstrates the lack of public discussion regarding who pays for disaster losses. It is often the case that public funds are used to compensate private property owners inhabiting places where repetitive losses are incurred. Further, the level of government responsible for mitigating hazards (e.g. municipal) is generally not the level that pays for assistance when events occur (e.g. provincial or federal).

The policy component, as mentioned, is the highest scoring category across the study sample. Plans scored, on average, 6.9 of the 21 indicators (33%). All plans, except Vancouver's, scored several points in this category. The highest scoring plan in this category was West Vancouver with 13 of the 21 (62%) indicators. Delta was the second strongest plan on the policy component.

West Vancouver's plan was assessed as having the strongest policy component, with Delta's being the second strongest. Both plans addressed a spectrum of actions for hazard mitigation including those focused on the built environment (e.g. building standards and capital improvements), as well as use and alteration of land (e.g. setbacks, cluster development, prohibition of development in hazard area).

West Vancouver

Capital Improvements

Design stormwater management and long-term flood control measures to carry out best environmental practices: Design drainage facilities and flood control works based on the 100 year storm event.

Cluster Development

Development should be clustered to minimize the impact of development on the steep slope (p. 164)

Prohibition of Development in Hazardous Areas

Prohibit new development and restrict redevelopment within creek corridors or significant environmental areas (p. 88)

Delta

Capital Improvements

Storm sewers and Drainage: Support pilot projects for innovative and sustainable infrastructure design and explore the use of alternative development standards to reduce storm water runoff (p. 2-54 Schedule A)

Cluster Development

DPA for protection from hazardous conditions: Clustering of development may be permitted without altering the permitted density (p. E-9 DPA guidelines)

Prohibition of Development

Carefully assess, and where appropriate, prohibit development in areas prone to hazardous conditions and/or flooding

The highest scoring item in the policy component is for watershed management/storm water management, with a marked 19 out of the 21 (90%) plans indicating this item. This can be largely attributed to a Metro Vancouver regional mandate to prepare Integrated Stormwater Management Plans (ISMPs). The second highest scoring item in this category (81%) is policy related to building standards. This is in part attributed to a long tradition of employing structural mitigation approaches to reduce hazard risk (Mileti, 1999).

Policies for building standards (note the spectrum of language used, 'encourage', 'should', 'must'):

District of North Vancouver

Encourage low impact development and stormwater management best practices to protect local watersheds and stream hydrology (p. 78)

Pitt Meadows

New development should use fire-resistant materials and design that increase house's longevity. Roofs should be steep in order not to collect leaves of tree needles (p. 94)

White Rock

New buildings within the areas shown in Schedule G: Environmentally sensitive and Hazardous Areas must be adequately floodproofed to a standard established by the city and the provincial government (p. 23)

4.4 Implementation: How do we ensure our policies are acted upon so that we move toward our stated goals for addressing hazard risk?

The final category, implementation, is the second lowest scoring component after fact base, with plans scoring, on average, only 2.9 out of 12 items (24%). White Rock and Port Moody tied as the highest scoring plans in this component, both scoring 6 out of the 12 indicators (46%), while both Vancouver and Langley Township's plans achieved the minimum frequency (e.g. 0). White Rock's plan identifies: actors for implementation, areas for coordination with federal, provincial or regional and other local governments, timelines for implementation and was updated within the last five years. Port Moody's plan contains four of the same indicators but does not specify actors for implementation or discuss timelines for implementation. Alternatively, it describes coordination with the

private sector and discusses risk transfer. It was the only plan across the study indicating the latter, and it was with regard to inter-municipal risk transfer.

Port Moody and White Rock were assessed as the strongest plans on the implementation component, including statements for intergovernmental coordination at all three levels (e.g. federal, provincial/regional, other municipalities) and having a recently updated plan (e.g. within the past five years).

Port Moody

Intergovernmental Regional-Provincial, Federal, and Other Municipalities

> *The city will work in cooperation with neighboring municipalities, Metro Vancouver and senior government agencies to develop an integrated stormwater management approach to manage shared watersheds based on sound science related to hydrology and hydraulics (p. 76)*

White Rock

Intergovernmental Regional-Provincial

> *Continue working with Metro Vancouver to develop a regional integrated storm water management plan (p.48)*

Intergovernmental Federal & Other municipalities

> *The City will work with senior government agencies (DFO and MOE), other municipalities and Metro Vancouver to protect the environment (p.21)*

The highest scoring indicator in this category across the sample is intergovernmental coordination- regional or provincial (16 out of 21 plans scoring, or 76%) and the second highest scoring was intergovernmental coordination- federal (14 out of 21 plans scoring or 67%). This attests to the nature of hazard mitigation as a topic requiring regional, eco-system based management (EBM) and denotes that communities seek support and guidance in managing natural hazard risk from senior governments.

Indicators that were absent across the plans include: a community-based threshold for risk tolerance, method for incorporating new information, and repetitive loss accounting. These three items represent critical pieces for managing community disaster risk in an *ongoing* and *systemic* manner (e.g. through monitoring, evaluation, iteration). Continued absence of these three items implies that, regardless of how strong other plan components are, the rate and quality of feedback between realities in ecological systems and the social system of strategic planning will remain inadequate.

Table 2: Summary of Highest and Lowest Frequency Indicators

Component	Highest Frequency Indicator	Number of Plans Scoring	% of Plans Scoring	Absent Indicators
Fact Base	location of hazards	16/21	64%	[a]population exposed-social vulnerability [a]shelter demand [a]magnitude of hazards [a]ranking [a]subjective indicators
Goals	enhanced water quality	12/21	48%	[a]equitable distribution of costs [a]measurable objectives
Policies	stormwater/watershed management	19/21	76%	[a]retrofit/relocate private structures
Implementation	intergovernmental coordination-regional/provincial	16/21	64%	[a]community-based threshold for risk tolerance [a]method for integrating new information

In sum, the plans scoring highest in the individual components are generally not the same, although there is notable overlap. Port Moody, one of the most recently adopted plans, scores highest for fact base and ties for the highest score in the implementation component. This could represent a sign of future directions in strategic planning for natural hazard mitigation: that as plans are updated, these components will become stronger. The new RGS strategy 'to encourage land use and transportation infrastructure that improve the ability to withstand climate change impacts and natural hazard risks' (Metro Vancouver, 2011) will hopefully influence local plans in this direction. It is also notable that Delta, scoring highest (along with Port Moody) in the fact base component, also scores strongly on the goal and policy components and is the overall highest scoring plan. This could denote that starting from a strong fact base leads to higher quality strategic planning for hazard mitigation overall.

5. Analysis and Recommendations

While one single land use decision may not increase risk significantly, years of small decisions that incrementally increase risk can lead to unacceptable risk levels.
–Frew & Samant, Planning for the Unexpected

The study was motivated by an effort to understand the governance of natural hazard risk, or how the study and science of natural hazards informs laws, policies and decision-making for growth and development at the local and regional scale. In particular, it focused on policy to examine:

- **the degree to which member municipalities of Metro Vancouver plan for natural hazard mitigation**
- **whether there are certain plan components in Metro Vancouver's Official Community Plans (e.g. fact base, goals and policies, implementation) that are stronger or weaker than others**
- ***and* if so, what might this suggest about the current governance structure for managing hazard risk?**

Findings echo a historic, national pattern of managing environmental risks in an ad-hoc and reactive manner (Boyd, 2003). Communities in Metro Vancouver are not incorporating natural hazard risk management as a 'top of mind' topic in their comprehensive planning efforts (scoring on average 14.8 out of 57 potential points or 26%). Potential gaps in governance that contribute to these low scores are first discussed. Suggestions are then made for policy approaches that could curtail incremental increases in risk over time. Increased capacity and incentive at the local level could shift management of natural hazard risks beyond a site-by-site, reactive approach to one that addresses risks proactively and comprehensively. This would in turn lessen the burden borne by senior governments at the response and recovery stages.

5.1 Gaps in Governance

Findings demonstrate a disconnect between community development and natural hazard risk management. This is likely due to a confluence of high uncertainty and low consensus.[11] Uncertainties are inherent in: the science of hazard risk, an emerging body of climate change projections, and continually evolving dynamics of human populations

[11] Pine (2009) recounts the dilemma of managing natural hazard risk as 'problem solving in an ill-structured environment' (p. 46)

and their built environments. Consensus is generally low, as the values engaged in land use management tend to be highly contentious. Accordingly, integrating risk management and community planning presents a fascinating challenge: how to address varied epistemologies (e.g. ways of knowing) to move towards a collective version of the 'good life'.

Putting scientific, technical knowledge into practice can be seen as a two-stage process in examining the connections between the understanding of natural hazard threats and planning for community resilience. The first stage can be seen as a translation of scientific understanding of hazard exposure into community planning policy (e.g. knowledge of soil types and ground shaking motion from seismic activities informs DPAs in an OCP). The second stage involves the translation of policy into action for development and growth (e.g. a multi-unit residential development is made to comply with specific siting and design guidelines based on soil type mapping informing the DPA, with specifications monitored and enforced over time). These steps tend to be assessed independently in the literature, however, understanding the two simultaneously, as a continuous process, offers insight into potential improvements to be made in governance approaches.

The first gap is understood as a science-policy gap (see figure 4). This is the gap between the scientific understanding of hazards and the inclusion of such knowledge in the policy formulation process. At the societal scale, there are incredible amounts of data and knowledge produced that are not utilized by those who write policy and make decisions. This holds true in the field of natural hazard mitigation, where there exists a significant disconnect between the work that physical scientists and engineers produce on hazards and structural vulnerability and the work of those making decisions about growth and development at the community level; including, among many actors, planners and politicians. This is partially attributed to the fact that science should be, and is often not, produced in decision-driven ways (Wein, Journeay & Bernknopf, 2007). Further, it is recognized that there are fundamentally different approaches to dealing with uncertainty in the physical sciences as compared to the socio-political realm (Bradshaw & Borchers,

2000).

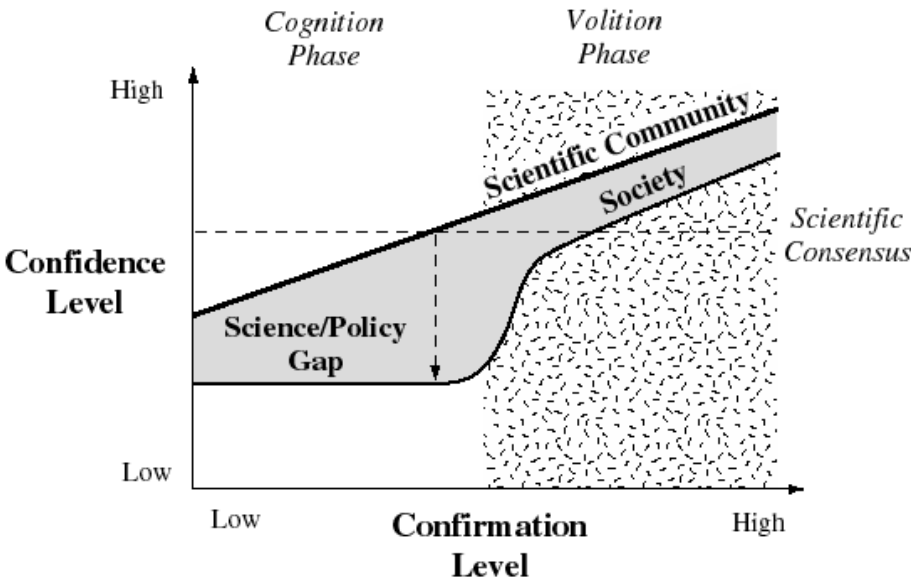

Figure 4: The Science-policy Gap (Bradshaw and Borchers, 2000)

There is some understanding of the factors (e.g. user-driven design, digital visualizations) contributing to informational uptake and this understanding could be furthered. However, the underlying fact remains that there lacks critical debate around this disconnect between the production of information and knowledge as valuable in itself versus being driven by societal need. There often exists not a need for more or better information, but rather, a need for assistance in interpreting existing information and determining what inputs can be utilized to make informed decisions (Bernknopf, Rabinovici, Wood, & Dinitz, 2006). The fact that local governments often have no in-house scientific expertise or a public science liaison to rely upon in the policy formulation process is a symptom of this first disconnect and a glaring issue.

The second stage is conceptualized as the 'implementation gap', which marks the gap between planning policy and actual decision-making for development on the ground. This is notoriously difficult to measure and in this study, is not explored in any depth due to limitations in data collection and analysis. It is in part a measure of the role orientation of planners, as implementation is dependent on even-handed application by planners of

strategic policy to individual developments (Stevens, 2010). It is suggested that in-depth community case studies, including personal interviews, are needed to further understand the extent of this gap and its underlying causes (Dalton and Burby, 1994, Brody, 2003, Tang & Brody, 2009). Ensuring integration of the OCP with binding policy tools, such as development permit areas (DPAs) and zoning by-laws, has potential to foster even-handedness.

5.2 Closing the Gaps

The low scores achieved, especially in the fact base and implementation components, suggests solutions are needed to close these gaps and thus enhance the connection between strategic planning and management of natural hazard risk in this study area. The following measures are suggested: a combined mandate and incentive approach to level the playing field between communities and address apathy, guidance in enhancing local fact bases and conducting risk assessments, risk tolerance criteria and ongoing analytic approaches.

These recommendations are discussed in more detail in the following section. They are informed by the interrelated concepts of subsidiarity and congruency. The former is defined as: an organizing principle that matters ought to be handled by the smallest, lowest or least centralized competent authority and any centralized authority should perform only those tasks which cannot be performed effectively at a more immediate or local level (Oxford English Dictionary, 2011). Congruency simply means that risks need to run with rewards and vice versa. The level of governance that assumes risk must be the one to address potential negative consequences of doing so. A governance system that fosters resilience within communities, regions, and in turn, the nation, will be one guided be these principles.

Mandates and Incentives

Findings highlight a high degree of variation in the extent to which communities are incorporating hazard risk management in their OCPs. As the OCP is the foremost plan for guiding land use management, the topic of natural hazard mitigation should be consistently integrated. There must be flexibility in OCP content for them to remain

relevant and inspiring within a local context, but a stronger framework for required elements with regards to hazard mitigation would be beneficial for public safety.

To reiterate, risk management should not be left to stand-alone hazard mitigation or emergency plans. It is critical to go beyond the existing requirement (for the OCP *to include statements and map designations that identify restrictions on the use of land that is subject to hazardous conditions)* to compel a strategy to acknowledge and address hazard risk at a community-wide scale. It is recommended that provincial government establish a minimum standard in terms of required risk-management actions in the OCP.[12]

This could be accomplished through monitoring, enforcing and/or incentivizing completion of hazard risk assessments and their integration with strategic planning. Detailed analysis could be contained in an appendix and hyperlinked for easy access on-line. Essential items to be interfaced in the OCP[13] could form the foundation of a mandate, and an incentive structure could award funding for going beyond it. The Union of British Columbia Municipalities (UBCM) and the province could facilitate this. Tax dollars are already being spent. They are simply being spent in recovery as opposed to mitigation. A reactive approach is ~ 4-7 times more costly (Journeay, under review) and accordingly grossly unjust from a standpoint of intergenerational equity (the very core of the Brundtland Report's definition of sustainability).

Enhanced Fact Base and Capacity for Risk Assessment

Quality technical information and data are the footing for effective land use planning for hazard mitigation and findings suggest there is a lack of capacity within communities for conducting natural hazard risk assessments. An ideal fact base is multi-hazard mapping

[12] Steinburg and Burby (2002) conclude from their study 'communities making the greatest improvements in safety are located in states that *require* hazard elements in local plans'

[13] The American Planning Association identifies several hazard mitigation topics as essential for inclusion within a strategic land-use plan: a future land use map so that increases in population can be directed away from high hazard areas, combined efforts of conservation of natural features with hazard risk reduction, awareness surrounding siting and design of public facilities and services (e.g. capital spending policy that steers development away from hazardous areas, and locating public facilities safely as example), transportation planning (e.g. evacuation routing and capacity with attention to the elderly and disabled), and capital improvements (e.g. linking budgetary spending with reduction of public risks) (APA, 2010). All of these items were included in this study's coding protocol.

and vulnerability assessment translated into an integrated risk map. Accordingly, communities require tools to help understand interactions between the data and information that characterizes hazard threats, socio-demographics, and elements of the built environment. Communities that lack such tools (namely GIS capacity) should have assistance from regional and provincial governments to enhance capacity for risk assessment. Senior governments could also assist communities by providing basic hazard information, especially in regions where significant growth is targeted. Furthermore, senior governments should foster enhanced data sharing and upkeep.

To bolster mapping efforts, QP reports that are retained by communities could be compiled in a database so that information could be referenced and utilized by municipal staff. This has potential to contribute to a stronger fact base of hazard risk information and would be managing information paid for with private dollars in the public interest.

Risk Tolerance Criteria

In the current approach, an outside expert (most often a consulting engineer), reports on whether hazard risks are tolerable. This is problematic due to (a) reliance on expert opinion in determining what is a tolerable level of risk to be accepted by the public, and (b) its site-by-site approach. The establishment of risk-tolerance criteria helps address the concern that risk will be transferred (either geographically or temporally) due to disconnects between everyday decision-making and the larger objective of building community resilience.

Such criteria are employed in other parts of the world (e.g. Hong Kong) and have been adapted for use in the District of North Vancouver. They are ideally multi-hazard but can be set at different thresholds for existing versus new development. The criteria form the foundation of a comprehensive hazard risk management approach, in conformity with the commonly accepted strategic planning principle: that a systems perspective is required to plan effectively for land use management.

These criteria are ideally developed through citizen-based processes so that what is determined to be an unacceptable level of risk is a decision that a community becomes

actively engaged with and then uses to guide its growth strategy and risk management activities. Citizen engagement in planning processes is a crucial element in disaster risk reduction as broad dissemination of risk information among affected citizens helps hold municipal officials accountable for making responsible decisions with regard to the use of land.

There remains the chance, that due to the competitiveness inherit in land development, communities will continue down increasingly risky paths of growth and development if there is no senior government enforcing an even standard (e.g. a higher-level government setting a threshold of risk tolerance), hence the recommendation is to provide a mandate for the establishment of community-based risk tolerance thresholds to a minimum standard and incentives to make them more progressive.

Analytic-Deliberative Approach to address Imperfect Information

Lack of proactive risk management is often attributed to lack of data. However, this ignores that the perfect knowledge that decision-makers seek is not attainable. Although fact bases should be improved, the definition of having a solid fact base as platform for policy formulation and action must be renewed. This requires addressing the differing acceptance thresholds for uncertainty in science and political decision-making. Analytic-deliberative processes should be employed to help bridge these thresholds. This requires integrated engagement of scientists, planning professionals and fellow community members.

Ongoing analytic-deliberation should fuel innovation with regards to the form of the OCP and public input into it. The OCP must become a living document. Public engagement that typically surrounds the updating of an OCP should be tackled in a more ongoing manner, through periodic public decision-making. Hazard risk information can be used as a frame for dialogue and to tap into existing concern that citizens have for their environment, natural surroundings and community.

This approach bolsters sense of agency by offering citizens an opportunity to be meaningfully engaged with contentious and uncertain issues affecting their lives and their

community (Stern & Finebeg, 1996, Hadden, 1989). Due to long-term time frames and considerable amounts of uncertainty, new modelling and visioning techniques will be required to engage citizens with future impacts of development decisions, ensure effective participatory process, and follow through on implementation.

5.4 Further research

This study does not provide explanation of the variables affecting plan quality. Further research could explore these causal links. Variables examined in previous studies include: local commitment (Norton, 2005), planning mandates (Berke and French, 1994), public participation (Brody, 2003), and intergovernmental collaboration (Burby and May, 1998) (Tang and Brody, 2008). A supplementary study could examine correlations between plan quality in this region and capacity factors (number of planning staff, per capita incomes of population, etc). This could be especially helpful in supporting or contradicting a common conception that smaller communities have lower capacity and thus quality of planning. If the deficit of capacity is demonstrated to affect plan quality and there is also new growth targeted in some of these areas as they represent land base available for development, then assistance from a regional or provincial government would be a critical intervention for reducing risks over the long-term.

Further research could also contribute to an understanding of how risk tolerance criteria can be established and enacted in communities with varying development trajectories (e.g. those with generally built out environments as opposed to communities with projected high growth-rates). It would be of interest to discover how the process and approach of establishing such criteria could and should differ in varying community contexts or at different scales. It is perhaps critical, on a temporal scale, for high growth communities to establish such criteria first. Alternatively, as growth management is directed regionally in this area, it would be of interest to explore how a regional threshold could form the basis of a system of transferring density amongst municipalities.

This leads to another area requiring further examination: innovations in intergovernmental arrangements to better manage social-ecological systems. Although the concepts of subsidiarity and congruency are used to frame recommendations in this

report, further research is needed to understand optimal arrangements for vertical linkage between levels of government in managing hazard risks (see Crawford, 2010 for treatment of this topic in the context of floodplain management in the Fraser Valley). In BC, this requires understanding which arrangements between municipal, First Nations', regional, provincial and federal governments contribute to effective management at the social-ecological interface.

Specifically, this study gives rise to questions regarding the regionally designated town centers and the frequent transit development areas (FTDAs), to be determined by communities in conjunction with Translink. Regional growth management has thus far been planned and undertaken with little attention to managing natural hazard risk in the context of a changing climate. Examining growth management in the context of intergovernmental collaboration between First Nations, local governments, and the region for hazard mitigation represents an area requiring further and immediate attention in a region projected to grow by almost 1.5 million citizens over the next three decades.

Finally, methods applied in this study do not assess implementation in any depth. Further research could employ comprehensive, mixed-methods case studies to flesh out the policy assessment conducted here. Community case studies, including personal interviews, could enhance understanding of the gap between strategic planning policy and actual development (e.g. examining building permitting records, infrastructure development, etc.). This remains an area requiring study as it is recognized that 'the best plans are only as good as the commitment of planners to ensure even-handed implementation' and that the adoption of a plan is insufficient to ensure that community goals are reached (Stevens, 2008). Although it is not clear from this research whether communities maintain ongoing and adequate records of each development and building permit that pass through their system, if they do, this could offer a rich mine of quantitative data for assessing what actually happens on the ground.

6. Conclusions

This evaluation of OCPs in BC's most populated region demonstrates that there is

considerable variation in the extent to which hazard mitigation is being addressed. In general, municipalities do fairly well at setting goals and policies to address hazard risk, but struggle to establish risk assessments as a legitimizing factual basis or strategies for implementation and evaluation. In effect, communities lack a comprehensive framework for managing natural hazard risk in an ongoing way.

Communities could use support and incentive with the following:

- *enhanced geospatial identification of various hazard threats (fact base)*
- *understanding magnitudes of potential hazards as associated with a changing climate to help prioritize mitigation strategies and understand linkages between hazard threats (e.g. multi-hazard risk) (fact base)*
- *understanding the amount and locations of land required for growth and development as compared to amount and location of hazardous lands so that a long-term approach may be taken to community development that is safe (e.g. a land demand and supply analysis that incorporates indicators of safety, or land suitability analysis) (fact base)*
- *vulnerability assessments: physical and social (fact base)*
- *establishment of community-based threshold of risk tolerance, and concordant land use designations to accompany the threshold (implementation)*
- *linking hazard assessment to mitigation strategies (implementation and monitoring)*

The low mean score of plans in this study area should not be viewed with dismay. The fact that communities incorporate hazard risk management in their strategic plans to the extent they do, without a comprehensive mandate to do so, is testament to the ethic of care for the ecological underpinnings of human well-being that seem to permeate the culture in this region. Many plans, in reporting on public input in the OCP process, describe how a concern for the natural environment resounded as a top priority for community members. Accordingly, effort should be made to match governance systems to reflect this strongly voiced priority. This requires making more effective tradeoffs for growth and development that do not undermine capacity to live safely, in cooperation with nature. Although development itself is generally unavoidable, it is the location, quality and format of development that is at issue.

Natural hazard threats cannot be eliminated, thus, emphasis must be on land use management for safer development. Urgent innovation is required in this domain.

Measures suggested here share similarities with those found to be successful in managing other common-pool resources[14] and include:

- *top-down approaches, such as binding regulation, to level the playing field at lower geographic scales, combined with cooperative, incentive-based approaches*
- *senior government support for provision of hazard information and GIS capacity to enable multi-hazard, integrated risk assessment*
- *community-based risk tolerance criteria*
- *ongoing analytic-deliberative processes for risk-based decision-making at the level of municipal and regional governments that fosters innovative OCP processes and formats*

Transformation to a proactive and comprehensive approach to managing hazard risk can be driven by demonstrating areas of synthesis and co-benefit; how addressing hazard risk can concomitantly save in infrastructure costs, build robustness in local economies, hone deeper democracy and address issues of intergenerational equity by fostering a sense of the long-term impacts of current development decision-making. The OCP is precisely the tool where such an approach can be fostered. Communities that address natural hazard risk in their OCP are making a bold statement that their desired trajectory is one of resilience. This is the path that communities who seek to thrive, economically, socially and ecologically, must pursue.

In this shifting paradigm, it is recognized that disasters are not 'acts of god' but rather, representative of failures in strategic planning and decision-making. To increase resilience, individual decisions must recognize and address cumulative impacts and potential extremes of nature. Commitment to being this mindful has been lacking in the past, but the necessity of adapting to climate change represents a temporally unique driver to implement risk management as a lens that guides decision-making in the short-term, for sake of long-term balance.

[14] Ostrom (2003). Best practices for management of common-pool resources included: encouraging dialogue among affected parties, a combination of coercive, enforced measures and incentive based ones and the facilitation of learning, experimentation and change.

WORKS CITED

Associating of Professional Engineers and Geoscientists, British Columbia (APEG BC) (under review) *Professional Practice Guidelines for Legislated Food Hazard and Risk Assessments in a Changing Climate in BC.*

ARMONIA Project (2006) *Harmonised Hazard, Vulnerability, and Risk Assessment Methods Informing Mitigation Strategies Addressing Land-use Planning and Management.* Accessed 21 July 2010 from http://eea.eionet.europa.eu/Public/irc/eionet-circle/airclimate/library?l=/public/2010_citiesproject/interchange/armonia_project/armonia_project_8/_EN_1.0_&a=d.

Bernknopf, R.L., Rabinovici, S.J.M., Wood, N. J. & Dinitz, L.B. (2006) The Influence of Hazard Models on GIS-based Regional Risk Assessments and Mitigation Polices, *International Journal of Risk Assessment and Management*, 6(4), 369-387.

Berke, P. R., & French, S. P. (1994). The Influence of State Planning Mandates on Local Plan Quality. *Journal of Planning Education and Research*, 13, 237-250.

Berke, P.R. & Godschalk, D. (2009) Searching for the Good Plan: A Meta-Analysis of Plan Quality Studies. *Journal of Planning Literature*, 23(3), 227-240.

Boyd, D. (2003) *Unnatural Law: Rethinking Canadian Environmental Law and Policy*. Vancouver, BC, UBC Press.

Bradshaw, G. A. & Borchers, J.G. (2000) Uncertainty as Information: Narrowing the Science-policy Gap. *Conservation Ecology*, 4(1): 7. Accessed 21 July 2009 from http://www.consecol.org/vol4/iss1/art7/.

Brody, S. D. (2003) Are we Learning to Make Better Plans? A Longitudinal Analysis of Plan Quality Associated with Natural Hazards. *Journal of Planning Education and Research*, 23, 191-201.

Brody, S.D. Highfileld, W. & Carasco, V. (2003) Measuring the Collective Planning Capabilities of Local Jurisdictions to Manage Ecological Systems in Southern Florida. *Landscape and Urban Planning*. 69, 33-50.

British Columbia (1996) *Emergency Program Act*. Accessed 8 August 2010 from: http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/00_96111_01

British Columbia (2004) *Hazard, Risk and Vulnerability Toolkit*. Accessed 7 August 2011 from: http://www.pep.bc.ca/hrva/toolkit.html

British Columbia (1996). *Local Government Act: Chapter 323*. Retrieved September 7, 2011 from:

http://www.bclaws.ca/EPLibraries/bclaws_new/document/ID/freeside/96323_00

Burby, R. J., & Dalton, L. C. (1994) Plans Can Matter! The Role of Land Use Plans and State Planning Mandates in Limiting the Development of Hazardous Areas. *Public Administration Review*, 54(3), 229-238.

Burby, R. J. (1998) Natural Hazards and Land Use: An introduction, in *Cooperating with Nature: Confronting Natural Hazards with Land-use Planning for Sustainable Communities*, Burby, R. J. (ed.) Washington, D.C., Joseph Henry Press.

Burby, R. J., & May, P. J. (1998). Intergovernmental environmental planning: Addressing the commitment conundrum. *Journal of Environmental Planning & Management*, 41(1), 95-110.

Burby, R. J., with Beatley, T., Berke, P. R., Deyle, R. E., French, S. P., Godschalk, D. R., Kaiser, E. J., Kartez, J. D., May, P. J., Olshansky, R., Paterson, R. G., & Platt, R. H. (1999). Unleashing the Power of Planning to Create Disaster-resilient Communities. *Journal of the American Planning Association*, 65(3), 247-258.

Burby, R.J. Deyle, R.E. Godschalk, D.R. & Olshanksy, R.B. (2000) Creating Hazard Resilient Communities through Land-use Planning. *Natural Hazards Review*, 1(2), 99-107.

Canadian Index of Wellbeing. (2011). *How are Canadians Really Doing? Highlights: Canadian Index of Wellbeing 1.0*. Waterloo, ON: Canadian Index of Wellbeing and University of Waterloo.

Chambers, N., Simmons, C., & Wackernagel, M. (2000) *Sharing Nature's Interest: Ecological Footprints as an Indicator of Sustainability*. Sterling, VA, Earthscan.

Comfort, L., B.Wisner, Cutter, S., Pulwarty, R., Hewitt, K., Oliver-Smith, A., Weiner, J., Fordham, M., Peacock, W. & Krimgold, F. (1999) Reframing Disaster Policy: The Global Evolution of Vulnerable Communities. *Environmental Hazards*, 1, 39-44.

Crawford, E. (2010) Institutions Contributing to System Adaptability: An Assessment of Flood Management in the Fraser Valley. Unpublished Masters Thesis, University of British Columbia, Vancouver, BC.

Dalton, L. C., & Burby, R. J. (1994). Mandates, Plans, and Planners: Building Local Commitment to Development Management. *Journal of the American Planning Association*, 60(4), 444-461.

Molnar, M. (2011) *Natural Capital Policy Review: A Review of Policy Options to Protect, Enhance and Restore Natural Capital in B.C.'s Urban Areas*. David Suzuki Foundation. Accessed 7 January, 2012 from: http://www.davidsuzuki.org/publications/downloads/2011/REPORT--

BC_natcap_policy_review_web.pdf.

Frew, S., Johnson, L., & Samant, L. (2005). *Planning for the Unexpected: Land Use Development and Risk*. Planning Advisory Service (PAS) Report 531. Chicago: American Planning Association.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., & Walker, B. (2002). Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations. E.A. Council (ed.) Stockholm, Royal Swedish Academy of Sciences. Accessed 9 September 2010 from http://www.ncbi.nlm.nih.gov/pubmed/12374053.

Godschalk,D., Kaiser, E., Berke, P. (1998) Integrating Hazard Mitigation and Local Land Use Planning, in *Cooperating With Nature: Confronting Natural Hazards with Land Use Planning for Sustainable Communities.* Burby, R. J. (ed.) Washington, D.C., Joseph Henry Press.

Godschalk, D.R. (2009) Safe Growth Audits. APA Zoning Practice, Issue 10. Accessed 5 August 2010 from: http://www.planning.org/zoningpractice/open/pdf/oct09.pdf.

Hadden, S. G. (1989) *A Citizen's Right to Know: Risk Communication and Public Policy*. Boulder, CO, Westview Press.

IPCC (2011) Summary for Policymakers, in: Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Field, C. B., Barros, V., Stocker, T.F., Qin, D., Dokken, D., Ebi, K.L., Mastrandrea, M. D., Mach, K. J., Plattner, G.-K., Allen, S. K., Tignor, M. and P. M. Midgley (eds.) New York, NY, Cambridge University Press. Accessed 20 November, 2011 from http://ipcc-wg2.gov/SREX/.

Journeay, Murray (under review). *Disaster Resilience by Design: A Framework for Integrated Assessment and Risk-Based Planning in Canada*. Vancouver, BC, Geological Survey of Canada**.**

Metro Vancouver (2011). "Metro Vancouver 2040: Shaping Our Future (Regional Growth Strategy)." Accessed 7 September 2011, from: http://www.metrovancouver.org/planning/development/strategy/Pages/default.aspx

Miles, M. B. & Huberman, A. M. (1994). *Qualitative data analysis (*2nd ed.). Thousand Oaks, CA, Sage.

Mileti, D. (1999) *Disaster by Design: A Reassessment of Natural Hazards in the United States*. Washington, DC, Joseph Henry Press.

Nelson, A. C., & French, S. P. (2002). Plan Quality and Mitigating Damage from Natural Disasters: A Case Study of the Northridge Earthquake with Planning Policy Considerations. *Journal of the American Planning Association*, 68(2), 194-207.

Norton, R.K. (2005) Local Commitment to State-mandated Planning in Coastal North Carolina. *Journal of Planning Education and Research*, 25, 149-171.

Norton, R.K. (2008). Using Content Analysis to Evaluate Local Master Plans and Zoning Codes. *Land Use Policy*, 25(3), 432-454.

Official Community Plan (2011) Municipality of Victoria. Accessed January 2012, from: http://www.shapeyourfuturevictoria.ca/

Oxford English Dictionary. Accessed 5 December 2011, from: http://oxforddictionaries.com/definition/subsidiarity

Stern, P.C. Dietz, T. Dolsak, N. Stern, Ostrom, E. Stonich, S. (2003). Knowledge and Questions After 15 Years of Research, in *The Drama of the Commons*, Ostrom, E. Dietz, T. Dolsak, N. Stern, P.C., Stonich, S. Weber, E.U. (eds.) Washington, DC, National Academy Press.

Pine, J.C. (2009) *Natural Hazards Analysis: Reducing the Impact of Disasters*. New York, NY, Taylor & Francis Group.

Public Safety Canada. (2008) *Canada's National Disaster Mitigation Strategy*. Accessed November 8, 2011, from: http://www.publicsafety.gc.ca/prg/em/ndms/_fl/NDMS_Web_E.pdf

Schwab, J. C. & Topping, K. C. (2010) Integrating Hazard Mitigation Throughout the Comprehensive Plan, in *Hazard Mitigation: Integration Best-Practices into Planning*. Schwab, J.C. ed, American Planning Association. Planning Advisory Service (PAS) Report 560. Chicago, American Planning Association.

Statistics Canada. (2006). "2006 Census of Canada Community Profiles – Greater Vancouver." Statistics Canada. Accessed 7 August, 2011 from http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/details/Page.cfm?Lang=E&Geo1=CD&Code1=5915&Geo2=PR&Code2=59&Data=Count&SearchText=Greater%20Vancouver&SearchType=Begins&SearchPR=01&B1=All&Custo=.

Steinburg, M. & Burby, R.J. (2002) Growing Safe. *Planning* 68(4), 22–23.

Stern, P.C & Fineberg, H.V. (1996) *Risk: Informing Decisions in a Democratic Society*. Washington, DC, National Academy Press.

Stevens, M. (2008) Can Individual Planners Make Communities Safer? A Study of the Use of Discretion in Managing Urban Development. Unpublished Dissertation. University of North Carolina at Chapel Hill, Chapel Hill, NC.

Stevens, M. (2010) Implementing Natural Hazard Mitigation Provisions: Exploring the

Role that Individual Land Use Planners Can Play. *Journal of Planning Literature* 24(4): 362-371.

Stevens, M. & Senbel, M. (under review). Examining Municipal Response to a Provincial Climate Action Planning Mandate in British Columbia, Canada. *Local Environment: International Journal of Justice and Sustainability.*

Tang, Z. & Brody, S. D. (2009) Linking Planning theories with Factors Influencing Local Environmental-plan Quality. *Environment and Planning B: Planning and Design.* 36 (3), 522-537.

UNISDR (2009). *Terminology on Disaster Risk Reduction*. Accessed December 2011, from:
http://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf

Walker, I.J. & Sydneysmith, R. (2008): British Columbia, in *From Impacts to Adaptation: Canada in a Changing Climate*, Lemmen, D.S. Warren, F.J. Lacroix J and Bush, E. (eds.) Ottawa, Government of Canada.

Wein, A.M., Journeay, M. and Bernknopf, R.L. (2007) Scenario-based Risk Analysis Within an Analytic-deliberative Framework for Regional Risk Reduction Planning in *MODSIM 2007: International Congress on Modeling and Simulation.* Oxley, L., and Kulasiri, D., (eds.) Perth, Modeling and Simulation Society of Australia and New Zealand.