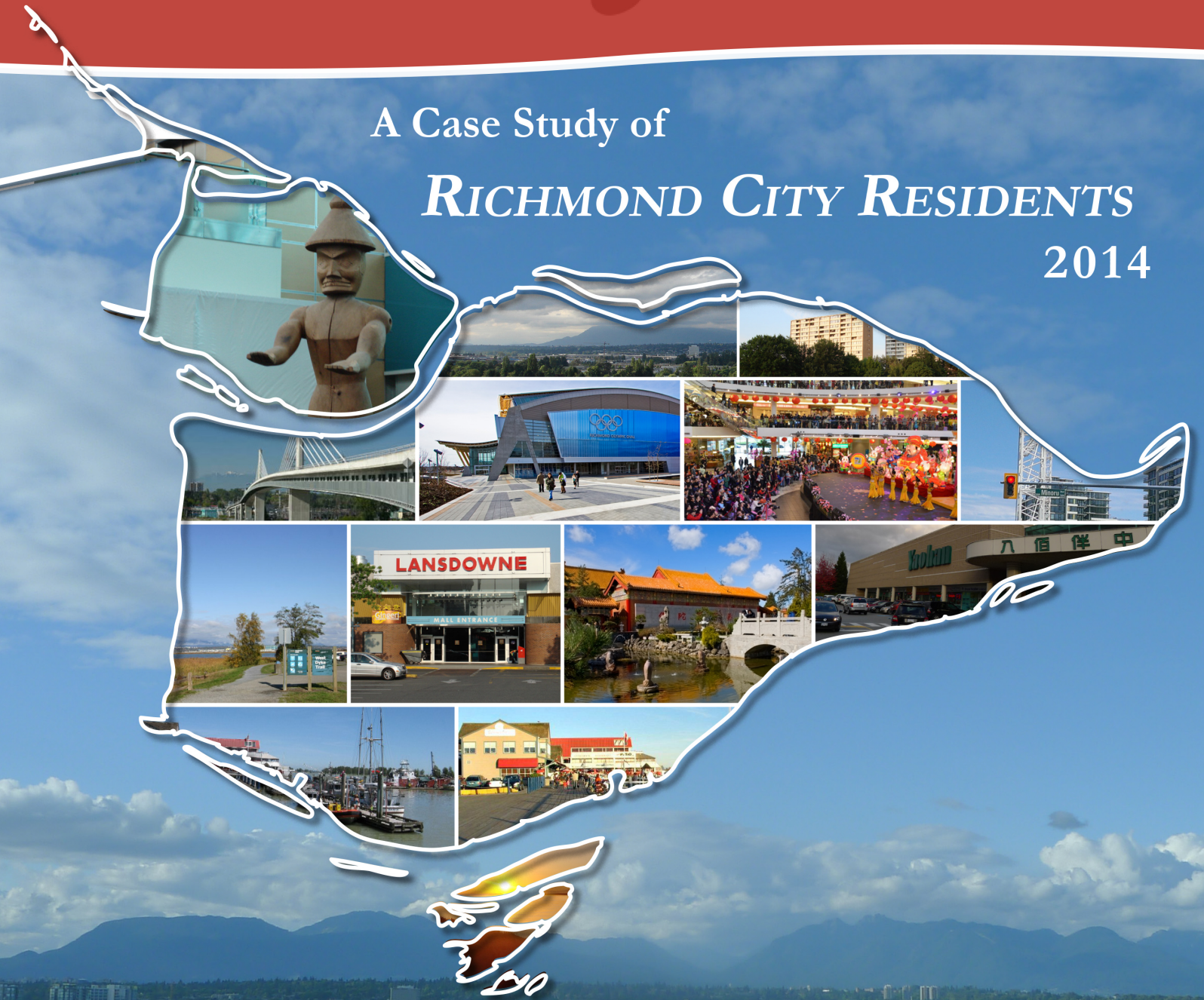


# Social Vulnerability and Risk Perception of Chinese-speaking Immigrants in Metro Vancouver

A Case Study of

*RICHMOND CITY RESIDENTS*

2014



a place of mind  
THE UNIVERSITY OF BRITISH COLUMBIA



Wei-Chung Chen  
M.Sc.

**SOCIAL VULNERABILITY AND RISK PERCEPTION OF CHINESE-SPEAKING  
IMMIGRANTS IN METRO VANCOUVER:  
A CASE STUDY OF RICHMOND CITY RESIDENTS**

by

WEI-CHUNG CHEN

B.A., National Taiwan Normal University, 2010

A PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE (PLANNING)

in

THE FACULTY OF GRADUATE STUDIES

School of Community and Regional Planning

We accept this project as conforming  
to the required standard

.....

.....

.....

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

November 2014

© Wei-Chung Chen, 2014



## Executive Summary

**R**isk and disaster management planning derives from both technocratic and social approaches to addressing physical and social vulnerabilities. This project assesses social vulnerability, using various research methods, with a case study focus on the City of Richmond, British Columbia.

The City of Richmond has a unique socioeconomic and demographic composition due to its high proportion of Chinese-speaking residents, and has played an important role as a cultural centre in the Chinese-speaking community of Metro Vancouver. With this in mind, this project has not only assessed general social vulnerability in Richmond but also has focused on its Chinese-speaking immigrants' perceptions and knowledge of risk and disaster, as well as their experiences with it, to further reveal their hidden social vulnerability.

Three methods were used in this project to conduct the social vulnerability assessment: literature and policy reviews, the Social Vulnerability Index (SoVI) Model (applied at the scale of 2011 Census Data of Dissemination Areas), and a household-level survey (with 101 responses in total). The findings of these methods are as follows:

1. The literature and policy reviews showed that even though emergency programs in Richmond have been developed throughout the emergency cycle, the current emergency programs do not fully address the unique and diverse social characteristics and culture in Richmond,

especially as concerns the provision of emergency materials, education and services in different languages (see Chapter 2).

2. The SoVI model indicated eight main social vulnerability factors that Richmond is facing (see Chapter 3):

- *Household, dwelling, and density of built environment*
- *Socioeconomic status*
- *Race and ethnicity*
- *Population age*
- *Occupation, education, and social dependence*
- *Population change and mobility*
- *Emergency services*
- *Single family and housing quality*

Areas of highest social vulnerability were mapped and include Richmond City Centre, East Cambie, Seafair, Blundell, Broadmoor, East Richmond, and Fraser Lands. In addition, Chinese-speaking immigrants are part of the social vulnerability landscape in Richmond.

3. The results of the survey (Chapter 4) reveal that:

- *Most of the Chinese-speaking respondents are aware of all potential hazards in Metro Vancouver. Respondents are most aware of the possibility of an earthquake, and least aware of the possibility of a heat wave.*

- *Around 50 percent of the respondents indicated that they and/or members of their families have experienced one or more the hazard types that might strike Metro Vancouver. Notably, 33 percent have experienced earthquakes.*
- *Government authorities play a paramount role in emergency full-cycle management for the respondents as a source of information, organizer of preparedness activities, and provider of emergency responses and recovery.*
- *Almost half of the respondents' families have not yet prepared for an emergency. A primary barrier to emergency preparedness is a lack of interest among respondents in prioritizing emergency preparedness in their daily lives.*
- *The respondents showed a high-level sense of community and public engagement in terms of willingness to support others in an emergency and to participate in emergency preparedness activities.*
- *The respondents, majority are first-generation immigrants, indicated moderate levels of social networks being available to their families.*
- *Respondents indicated high unfamiliarity and low confidence towards the City's emergency and risk management programs, suggesting a challenge in addressing social vulnerability in Richmond.*

respect to disaster and risk management in Richmond (Chapter 6), specifically, it is recommended that the City:

- 1. Promote local disaster and risk management programs with possible preventive hard and soft measures to address the unique cultural, socioeconomic, and demographic characteristics of Richmond residents.*
- 2. Strengthen awareness in the community about the need to implement actions that encourage local populations to prioritize risk and emergency preparedness in their households.*
- 3. Facilitate local community engagement and public participatory process throughout the emergency management cycle, both educationally and culturally.*
- 4. Improve communication strategies with technical and social information about emergency issues and topics.*
- 5. Support building trust in the public sectors and building a culture of safety and resilience in Richmond.*

A set of recommendations is presented to reduce current social vulnerability with



## **Preface**

This project research is an original and unpublished work by the author, W.C. Chen, under the collaboration with the School of Community and Regional Planning, UBC, the non-governmental organization, S.U.C.C.E.S.S, and the Emergency Program of the City of Richmond. The survey reported in Chapters 4-6 was covered by UBC Ethics Certificate number H14-01419.

The recruitment process of the survey questionnaires was supported by S.U.C.C.E.S.S Richmond Service Centre and by the Settlement Program Coordinator of S.U.C.C.E.S.S, Doris Lam. The design of the survey questionnaires was finalized through consultation with the project Principal Investigator, Stephanie E. Chang, the Settlement Program Coordinator, Doris Lam, and the Manager of Emergency Program, Deborah Procter. Other than the design of the survey questionnaire, the entire project was conducted primarily by the author, W.C. Chen, under the supervision of Professor Stephanie E. Chang and Professor Leonora C. Angeles, the project's second reader.

## **About the Author**

I am Wei-Chung (Lavino) Chen. I was born in Taiwan. I attended the Department of Earth Sciences at National Taiwan Normal University (NTNU) and the School of Community and Regional Planning (SCARP) at the University of British Columbia for my Bachelor and Master degrees. As it is one of the most important areas of sustainable development, I have dedicated much time to studying environmental and natural resources planning, and risk and disaster management. It is hoped that by this project I can make some contributions to make our society more sustainable and livable.

Sincerely,

A handwritten signature in dark ink, appearing to read 'Lavino', followed by a horizontal line and a comma.

Wei-Chung Chen

Master of Science in Planning, School of Community and Regional Planning, UBC

## Table of Contents

<b>Executive Summary .....</b>	<b>I</b>
<b>Preface.....</b>	<b>i</b>
<b>Table of Contents .....</b>	<b>ii</b>
<b>List of Tables .....</b>	<b>iv</b>
<b>List of Figures.....</b>	<b>v</b>
<b>Glossary (Terms and Definition) .....</b>	<b>vii</b>
<b>Acknowledgements .....</b>	<b>ix</b>
<b>Chapter 1: Introduction .....</b>	<b>1</b>
1.1 Why Social Vulnerability?.....	1
1.2 Why Social Vulnerability of Immigrants?.....	3
1.3 Why the Chinese-speaking Immigrants in the City of Richmond? .....	4
1.4 Project Objective & Research Questions.....	5
1.5 Project Design & Rationale .....	6
1.5.1 Overview: Social Vulnerability Assessment and Indicators.....	6
1.5.2 Project Methodology.....	7
1.6 Project Report Structure.....	8
<b>Chapter 2: City of Richmond Overview .....</b>	<b>9</b>
2.1 Demographic Review in the City of Richmond.....	9
2.2 Risk & Disaster Management Overview in Richmond.....	14
2.2.1 Risk & Disaster Governance Structure in the City of Richmond .....	14
2.2.2 Risk & Disaster Fact Basis and Risk Analysis .....	14
2.3 Emergency Program and Immigrants in Richmond.....	16
2.4 Potential Risk & Disaster Influence & Vulnerability in Richmond .....	18
<b>Chapter 3: Social Vulnerability Scores &amp; Mapping.....</b>	<b>19</b>
3.1 Social Vulnerability Index: Indicators & Proxy Variables .....	19
3.2 Process of Conducting the SoVI Model.....	20
3.3 Dominant components of Social Vulnerability.....	22
3.4 Spatial Distribution of Social Vulnerability in Richmond.....	23
3.5 Highly Vulnerable Areas: SoVI Mapping .....	25
3.6 Limitations .....	29
<b>Chapter 4: Household-level Survey Questionnaires.....</b>	<b>31</b>
4.1 Survey Questionnaires & Procedures .....	31
4.2 Characteristics of Survey Respondents.....	32
4.3 Questionnaires Regarding Risk, Emergency, and Disaster .....	36
Perception and Attitude of Risk and Emergency in Community.....	36
Risk and Disaster Experience .....	37



Information Source of Risk, Emergency, and Disaster.....	38
Emergency Preparedness and Risk Reduction.....	39
Community and Public engagement .....	41
Responding and Social Network Availability.....	43
Confidence in Public Institutions.....	43
4.4 Limitations .....	44
<b>Chapter 5: Synthesis and Discussion .....</b>	<b>45</b>
5.1 Project Limitations.....	45
5.2 Chinese-speaking Immigrants' Vulnerability in Richmond .....	45
<b>Chapter 6: Next Step: Planning Implications &amp; Recommendations.....</b>	<b>48</b>
6.1 Planning Implications .....	48
6.2 Recommendations and Moving Forward.....	49
<b>Chapter 7: Summary .....</b>	<b>53</b>
<b>Bibliography .....</b>	<b>56</b>
<b>Appendices.....</b>	<b>61</b>
Appendix A Disaster Impact Model .....	61
Appendix B Elevation Map of the City of Richmond .....	62
Appendix C Vancouver YVR Airport – Aircraft Flight Routes .....	63
Appendix D.....	64
D.1 Descriptive Statistics for Social Vulnerability Variables in Richmond.....	64
D.2 Total Variance Explained by Social Vulnerability Factors in Richmond.....	66
D.3 Rotated Component/Factor Matrix of Social Vulnerability Variables in Richmond .....	67
Appendix E Maps of Social Vulnerability Factors in Richmond .....	68
Appendix F Statistic Data of the Social Vulnerability Variables with the Highest SoVI Dissemination Areas in Richmond .....	72
Appendix G Survey Questionnaires (English version).....	75
Appendix H Map of Chinese-speaking Population Distribution with SoVI Scores in Richmond .....	79
Appendix I Summary of List of Disaster Risk Reduction Measures before, during and after Disasters.....	80

## List of Tables

Table 2-1. Facts about Chinese-speaking immigrants in Richmond .....	13
Table 3-1 Summary of Included Indicators and Proxy Variables (34 in total).....	19
Table 3-2. Dimensions of Social Vulnerability: factors, factor labels, loadings, sign adjustment, and variance explained by factor analysis .....	21
Table 3-3. Summary of highest SoVI dissemination areas and the dominant SoVI factors in Richmond. ....	27



## List of Figures

Figure 1-1. Social Vulnerability Assessment in Risk Management Framework. Adapted from Source: Dunning & Durden (2011) .....	2
Figure 2-1. The map of the City of Richmond's geographical location. Source: City Profile - Richmond, link: <a href="http://www.richmond.ca/discover/maps.htm">http://www.richmond.ca/discover/maps.htm</a> .....	9
Figure 2-2. Richmond historic proportion of population trend by ethic group from 1991 to 2011. Source: BC Stats, 2012, link: <a href="http://www.bcstats.gov.bc.ca/StatisticsBySubject/Census/MunicipalPopulations">http://www.bcstats.gov.bc.ca/StatisticsBySubject/Census/MunicipalPopulations</a> .....	10
Figure 2-3. Map of Net Dwelling Unit Densities in Richmond, 2011. Source: Census of Canada, 2011, link: <a href="http://hdl.handle.net/10573/42747">http://hdl.handle.net/10573/42747</a> .....	10
Figure 2-4. The age and sex distribution of Richmond in 2001 and 2011. Source: Statistics Canada, 2012, 2013 .....	11
Figure 2-5. Percentage of Canadian born (non-immigrants), foreign born (immigrants) and non-permanent residents in Richmond and Metro Vancouver in 2011. Source: Statistics Canada, 2012a. ....	12
Figure 2-6. Countries of origin for Richmond's immigrants, 2011. Source: Statistics Canada, 2012a .....	12
Figure 2-7. Chinese Languages Spoken in Richmond and Metro Vancouver. Source: Statistics Canada, 2012a .....	13
Figure 2-8. Estimated seismic risk map of Metro Vancouver. Source: Institute for Catastrophic Loss Reduction, 2003, link: <a href="http://www.bcbusiness.ca/files/EarthquakeMap_Aug.pdf">http://www.bcbusiness.ca/files/EarthquakeMap_Aug.pdf</a> .....	15
Figure 2-9. Floodplain in Richmond and lower mainland. Source: Fraser Basin Council, n.d., link: <a href="http://www.fraserbasin.bc.ca/water_flood_fraser.html">http://www.fraserbasin.bc.ca/water_flood_fraser.html</a> .....	15
Figure 3-1. . Spatial Distribution of Overall Social Vulnerability Scores (SoVI) in the City of Richmond by Dissemination Areas and community planning boundaries, based on 2011 Census of Canada Data.....	24
Figure 3-2. The standard deviation from the mean of factor scores by highly vulnerable planning community in Richmond. ....	26
Figure 4-1. Length of time survey respondents have lived in Metro Vancouver. ....	32
Figure 4-2. Ares survey respondents are living in Metro Vancouver.....	32
Figure 4-3. Current immigration of status survey respondents.....	33
Figure 4-4. Country survey respondents' family are originally from. ....	33
Figure 4-5. Survey respondents by age group. ....	33
Figure 4-6. Language spoken mostly at survey respondents' home. ....	34
Figure 4-7. Household size of survey respondents. ....	34
Figure 4-8. Income source status of survey respondents' household. ....	34
Figure 4-9. Insurance status of survey respondents' housing. ....	35
Figure 4-10. Survey respondents by housing type.....	35
Figure 4-11. Survey respondents' level of concern regarding disasters in Community. ....	36

Figure 4-12. Level of likelihood survey respondents conceive disasters to directly impact their family.....	36
Figure 4-13. Disasters experienced by survey respondents or their members.....	37
Figure 4-14. Survey respondents' preferred sources of information regarding emergency response. ....	38
Figure 4-15. Survey respondents' preferred sources of information regarding emergency preparedness. ....	39
Figure 4-16. Level of preparedness for an emergency by survey respondents' family. ....	40
Figure 4-17. Emergency preparedness approaches taken in respondents' family. ....	40
Figure 4-18. Survey respondents' barriers to emergency preparedness approaches. ....	41
Figure 4-19. Survey respondents' feeling of capability in supporting others in an emergency. ..	41
Figure 4-20. Survey respondents' willingness to support others in an emergency. ....	41
Figure 4-21. Survey respondents' willingness to participate in emergency preparedness activities. ....	42
Figure 4-22. Survey respondents' choices for support in an emergency. ....	42
Figure 4-23. Amount of support survey respondents felt their family might have in an emergency. ....	42
Figure 4-24. Survey respondents' assessments of City of Richmond's level of emergency preparedness. ....	43
Figure 5-1. The distribution of percentage population of Chinese-language mostly spoken at home overlapped with the overall SoVI level by dissemination areas.....	46



## Glossary (Terms and Definition)

Many of the terms presented in this project are terminologies commonly used in the field of risk and disaster management. To facilitate the readers in using this project, the terms and definitions referred to in this project are listed below, based on Cutter (1996) and UNISDR (2009).

**Building code:** a set of ordinances or regulations and associated standards intended to control aspects of the design, construction, materials, alteration and occupancy of structures that are necessary to ensure human safety and welfare, including resistance to collapse and damage.

**Capacity:** the combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals.

**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:** the potential disaster losses, in lives, health status, livelihoods, assets and services, which 10 could occur to a particular community or a society over some specified future time period.

**Disaster risk management:** the systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

**Disaster risk reduction:** the concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to 11 hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

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

**Emergency services:** the set of specialized agencies that have specific responsibilities and objectives in serving and protecting people and property in emergency situations.

**Environmental degradation:** the reduction of the capacity of the environment to meet social and ecological objectives and needs.

**Exposure:** people, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.

**Hazard:** a dangerous phenomenon, substance, human activity or condition 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.

**Mitigation:** the lessening or limitation of the adverse impacts of hazards and related disasters.

**Preparedness:** the knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions.

**Public awareness:** the extent of common knowledge about disaster risks, the factors that lead to disasters and the actions that can be taken individually and collectively to reduce exposure and vulnerability to hazards.

**Recovery:** the restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors.

**Resilience:** the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to 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.

**Risk:** the combination of the probability of an event and its negative consequences.

**Risk management:** the systematic approach and practice of managing uncertainty to minimize potential harm and loss.

**Sustainable development:** development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

**Social Vulnerability:** the capacity to anticipate, cope with, resist and recover from the impact of a natural hazard, which is influenced by characteristics of a person or group and their situation. When (social) vulnerability is conceived within a specific areal or geographic domain, it is called: “**Place-based (social) Vulnerability**”.

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

## Acknowledgements

Two years ago, I left my home country, Taiwan, with my gut and heart of full gratitude and anxiety, for the Master degree at the UBC, Canada. For me, it was not only the first time in my life to live so far away from home, but also my first to study in a full-English environment. I wasn't quite sure where I was and what I was going to be at the time; everything was so new and strange to me. In the SCARP orientation, a young person, one of the only few students of "Asian ancestry" in SCARP, could even barely proceed the ice-breaker game of introduction because I could barely understand what the people were talking about. "Could I really do this?", I asked myself. This scene is still clearly emerging in my mind, and has become my life-long memory.

It is really unbelievable that this day, completion of my Master degree from SCARP, UBC, has indeed come to my life. Although being small, this achievement is very meaningful to me that it demonstrates my growth and sets a landmark in my life. All of these are actually attributed to the supports of my families and friends. Without them, all of these would be impossible to happen. First of all, I would like to sincerely appreciate the supports from my families, my parents, grandmother, older brother, and my uncle and aunt. Your warmest and kindest encouragements and supports helped me overcome all the difficulties I had during the past two years. I especially would like to present this honor to my parents for your infinite love towards me.

Second, I would like to express my most genuine gratitude to all of my friends in Taiwan and Canada who are always with me with your patient, kindness, supports and sharing. You help me go through all the challenges and the lows during the past two years in my life. Thank you, my friends in Taiwan, for always being so patient about my complaints; MNCs, Xindian buddies, high school and NTNU friends, and friends from the army. Thank you, my friends in SJC, for being so willing to help me and practice English with me; Ian, Nathaniel, Zoe, Wendy, Matt, Woobin, Richard, Minoru, Chelsea, Blake, Sheng, Henry, Olivia, Alice and all the residents in SJC. Thank you, my friends in Vancouver, for your kindness when I was in need; Kevin, Libor, Chiann, Ling, Justin, Tzu-ting, Gary, all friends of TGSA, and especially Jen-Ai.

Last but not the least, I could definitely not make through these two years without the supports of SCARPies, the professors in SCARP, and the people coordinating my graduation project. It is very appreciative of your patient and understanding to make me overcome the barrier of my English. I especially would like to thank everyone who had worked with me on the course projects in SCARP; Gabi, Peer, Frankie, Eliana, Christa, Victor, Robert, Erin, Sarah, Christ, etc.. Thank you very much, Daniel, Melanie, and Sandy, for being so wonderful to me, for treating me as one of your families and for your consideration. Thank you, Nora, Jordi, Maged, and Lily, for your wonderful instruction and the opportunities that are offered to me for learning and career searching. Most importantly, thank you so much, Stephanie E. Chang, my graduate supervisor, for your guidance and advice for the past two years, particularly on this project.

These two years have definitely become one of the most precious and unforgettable periods in my life. Thank you all above for helping me consummate my Master degree and leaving me such a good memory at the UBC, Vancouver.

## Chapter 1: Introduction

Increasing disaster threats have become one of the most challenging planning issues in the 21st century. This phenomenon not only reflects the increasing onset of different types of disasters, and impacts of climate change and environmental degradations, but also the changing demographic and socioeconomic characteristics of the population (e.g. population densification, migration, urbanization, etc.) (Cutter & Finch, 2008; Donner & Rodríguez, 2008; Perrow, 2007; Wisner et al., 2003). The research most needed on assessing vulnerability at the moment is on understanding the magnitude and characteristic of changes imposed by the dynamics of *the system* related to the impacts of hazards, namely social vulnerability.

This project focuses on understanding the social vulnerability to disasters of Chinese-speaking immigrant populations in the Metro Vancouver, focusing on the City of Richmond as a case study. The following sections in this Chapter explain the rationale of this project in terms of why to study social vulnerability, why focus on social vulnerability of immigrants, and why choose social vulnerability of Chinese-speaking immigrants in the City of Richmond.

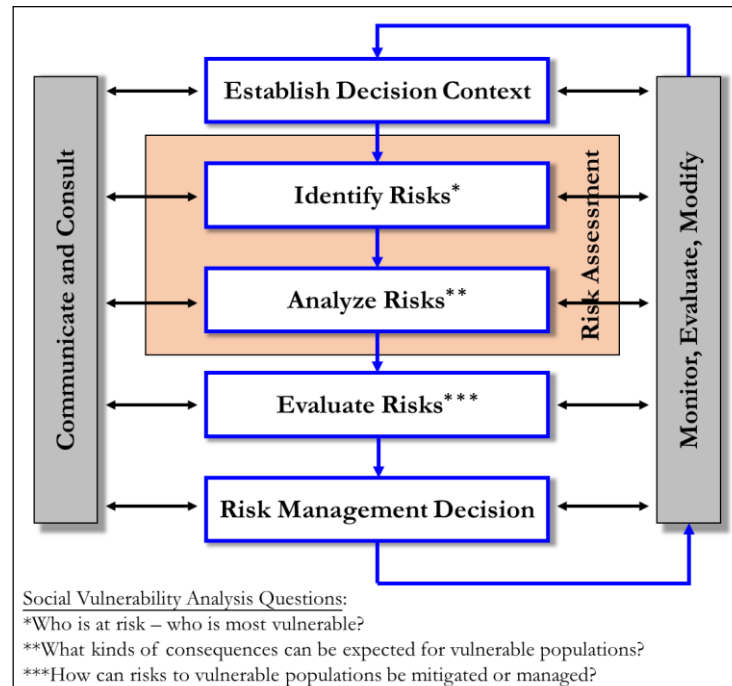
### 1.1 Why Social Vulnerability?

Vulnerability, broadly defined as the potential for loss and damage, is a key concept and core to the development of risk and disaster management (Adger, 2006; Cutter, 1996; Wisner et al., 2003). It varies geographically and temporally, and can be defined both structurally and non-structurally. In fact, vulnerability comprises three elements: exposure (physical factors; likelihood of occurrence of disaster impacts), susceptibility, and resilience (adaptive capacity) of the system experiencing hazards (Adger, 2006; Birkmann, 2006; Cutter & Finch, 2008; Cutter et al., 2003; Massmann & Wehrhahn, 2014; Phillips & Fordham, 2010; Turner et al., 2003). *Social vulnerability* to hazards is especially the indispensable component associated with the susceptibility and capacity of social individuals and groups within communities to prepare for, respond to, cope with, adapt to, and recover from disasters (Birkmann, 2006; Cutter, 1996, 2010; Cutter et al., 2006; Phillips & Fordham, 2010; Turner et al., 2003; Wisner et al., 2003). Hence, for the sake of building hazard resilience, the system, which is socially, economically, environmentally, and historically (culturally) embedded, needs to be full-fledged taken into consideration of risk and disaster management (see Appendix A for the disaster impacts model).

### Social Vulnerability and Risk Management

The efficacy of risk management is highly related to social vulnerability. It is important to integrate social vulnerability assessment into the Comprehensive Risk Management Framework (CRMF): (1) understanding natural systems, (2) assessment of interactions within and between social systems and the built environment, and (3) understanding geo-spatial processes. Dunning & Durden (2011) demonstrated the general Risk Management Framework that integrates social vulnerability assessment to improve risk management more effectively (Figure 1-1).





**Figure 1-1.** Social Vulnerability Assessment in Risk Management Framework. Adapted from Source: Dunning & Durden (2011)

Studies have shown that social vulnerability plays an amplification role in impacts of disasters. (Cutter et al., 2006; A. Fekete, 2009; Noriega & Ludwig, 2012; Yoon, 2012). It is critical to conduct social vulnerability assessment to understand why groups of individuals or communities are disproportionately affected by the same hazard event among and within nations and regions (Cutter, 2010; Cutter et al., 2006; Mileti & Gailus, 2005; Noriega & Ludwig, 2012; Phillips & Fordham, 2010). The outcomes of social vulnerability assessment (e.g. who, what, and where are vulnerable and why) can help local planners and emergency managers be more effective in decision-making processes of setting up priorities and needs for risk and disaster mitigation, preparedness, response, and recovery, in order to strengthen community's disaster resiliency (Adger, 2006; Holand et al., 2011; Massmann & Wehrhahn, 2014; Yoon, 2012).

### Social Vulnerability and Risk Perception

Social vulnerability is a representation of multidimensional phenomena, presenting pre-existing conditions in communities that make them susceptible to harm and affect their preparedness and recovery strategies from a disruptive event (Cutter, 2010). In this sense, risk perception of social groups or individuals can be regarded as one of the factors that affect the social vulnerability of any community (Novelo-casanova et al., 2012; Prelog & Miller, 2013; Messner & Meyer, 2006). Thus, comprehending the relationship between people's risk and disaster perception and their socioeconomic and demographic characteristics is beneficial in understanding their social vulnerability (Xu et al., 2014; Q. Zhou et al., 2003).

Risk perception is a product of the knowledge, experience, cognition, psychology, and socioeconomic and cultural context of people (Cutter, 1996; Dake, 1991; Slovic, 1987). People actually perceive risk differently and prefer different risk reduction measures even though they might be regarded as equally vulnerable in terms of living in similar socioeconomic conditions. For example, warnings for any kind of hazard are filtered through experiences and perceptions, influencing the interpretation of the messages (Takao et al., 2004). Therefore, understanding the state of people's perception of risk and disaster is an indispensable step in risk and disaster management to provide effective warnings, preparedness, and emergency plans.

## 1.2 Why Social Vulnerability of Immigrants?

With the unique demographic composition in Canada, it is important to understand the role of different cultures of social groups in producing disaster vulnerability. Race and ethnicity (i.e., immigrants) with different cultures influence how they may perceive, prepare, and respond to disasters or emergencies (Carter-Pokras et al., 2007; Dash, 2010; Gierlach et al., 2010; Jones et al., 2013). They may exacerbate social vulnerability through the lack of access to resources, cultural differences, and the social, economic, and political marginalization. The situation during and after Hurricane Andrew and Katrina, in particular, are examples of how people of color and different culture (i.e., minority) affected by negative effects of disasters disproportionately (Cutter & Finch, 2008; Cutter et al., 2006; Dash, 2010; Donner & Rodríguez, 2008; Noriega & Ludwig, 2012).

It should be always kept in mind that, according to Dash (2010; p.103):

***It is not race or ethnicity that inherently creates increased disaster vulnerability for groups of people, but rather, it is how race and ethnicity are interpreted by society, and the structures surrounding race and ethnicity that relate to vulnerability.***

Actually, foreign-born or immigrant population tend to be concentrated geographically for similar lifestyle and community functions. However, they also tend to be clustered in disaster-prone areas (Morrow, 1999 and 2010), based on the experiences from the Northridge earthquake in California, Hurricane Andrew in Florida and Katrina in Louisiana, where poverty and social inequalities coexist. Immigrants may thus be subject to compounded vulnerabilities due to their lack of familiarity with the local hazards and conditions and the barriers of their language and literacy. In other word, they may be more reliant on authorities, emergency managers and responders for emergency events.

Language is a key component of social vulnerability. Although English remains the primary spoken and written language in Canada, the extent to which other languages are primary is considerable and increasing. In particular, the elderly and young children may either only understand their native language or not be fluent enough to understand most written and oral

communication in English. This becomes an issue for emergency management because immigrants tend to be highly affected by emergency response and disaster recovery with limited resources and support (Cutter et al., 2006; Dash, 2010; Gares & Montz, 2014; Betty Hearn Morrow, 2010).

Thus, it is urgent to identify the gaps within risk and disaster management to address the social vulnerability of immigrants geographically and temporally. Disaster preparedness, knowledge, education, response, and recovery must provide appropriate interventions and approaches for the needs of minority population before, during and after disaster periods (e.g. risk education, emergency information, materials, resources, supports, services, etc.).

### **1.3 Why the Chinese-speaking Immigrants in the City of Richmond?**

During the past two decades, the City of Richmond has experienced major transformations in population size and density, development patterns, economic conditions, and social characteristics. This phenomenon is largely the result of an influx of recent immigrants since the 1990s (see Chapter 2), which brings about a more diverse population as well as progressive social, economic, and built-environment development. Yet, these changes have a significant impact on the City's temporal trends of social vulnerability. Richmond's hazardscape has changed in profound ways for more people living in high-risk areas than ever before. Actually, according to the most recent Census of Canada in 2011, 48.5 percent out of the total population in Richmond were Chinese in ethnic origins; most of these people are immigrants as well as Chinese-speaking populations (refer to Chapter 1.5.2: Project Methodology). However, even though the City of Richmond has a large population of Chinese-speaking immigrants, their social vulnerability and perceptions of risk and disaster have not been investigated.

Immigrants who do not grow up in Canada might not be familiar with Canadian culture or be aware of the potential hazards in Canada. They perhaps have a different historical background regarding the experience of disasters, and they might be attracted by many different effects to dwell in disaster-prone areas. If people in the social network are relying on each other for information but no one has accurate information, then many people may make decisions based on false information when encountering an emergency event. They might not believe that disasters could really happen in Richmond, or they would just not know what to do even if they were warned in advance of an emergency event. As Richmond continues to play a significant role for the Chinese-speaking immigrant community in Metro Vancouver, it is important to recognize the social variability in those immigrants exposed to Richmond's potential hazards in order to develop place-based emergency plans with specific information regarding different cultural consideration.

#### 1.4 Project Objective & Research Questions

Hence, the aim of this project is to unveil the social vulnerability of Richmond's Chinese-speaking immigrants, and to understand how risk and disaster are viewed by them. It is hoped to develop a set of recommendations for improving the gaps within disaster and risk management in Richmond to deal with the uniqueness of the changing population.

In order to achieve the objective, the following sub-objectives will be completed:

- Analysis of the existing policies and plans regarding disaster and risk management associated with the specific consideration of immigrants in Richmond will be conducted.
- Basic understanding of the current City's profile in Richmond including demography and hazard assessment will be provided.
- The overall social vulnerability in the City of Richmond, based on census data, will be assessed. The assessment will reveal the key factors contributing to social vulnerability in Richmond and interpret the geolocational pattern of social vulnerability in Richmond.
- The research will explicitly include the critical risk perspectives, perceptions, and experiences of Chinese-speaking immigrants in Richmond. This may provide key information for the disaster and risk management in Richmond.

The research questions that this project would like to decipher and investigate are listed below:

- What and where is the overall social vulnerability in the City of Richmond? What are the key factors in social vulnerability indicators?
- What is the current condition of Chinese-speaking immigrants' social vulnerability?
- What are the risk and disaster attitudes, perceptions, experiences, and knowledge of Chinese-speaking immigrants in the City of Richmond?
- What can be done to reduce the social vulnerability and address the gaps within the risk and disaster management in the City of Richmond, based on the results of this project? How can this be achieved?

With this project, better understanding of social determinants of vulnerability and the interpretation of the spatial differentiations of vulnerability in Richmond can be acquired. This can assist risk and disaster managers, social service providers, and elected officials in designing realistic and customized strategies focusing at local community levels geographically, based on the complex dynamics of social systems associated with consequences of disaster.

## 1.5 Project Design & Rationale

### 1.5.1 Overview: Social Vulnerability Assessment and Indicators

As part of the product of social inequalities, social vulnerability is often hidden, complex, and place-sensitive. It is multidimensional and embedded in various human aspects of historical, cultural, social and economic processes (Adger, 2006; Cutter, 2010; Cutter & Finch, 2008; Fekete et al., 2009; Yoon, 2012; Tapsell et al., 2010). Many different approaches can be used to assess social vulnerability to disasters (Birkmann, 2006; Fuchs et al., 2012; Tapsell et al., 2010). Different approaches to assessing social vulnerability should be seen as complementarities rather than contradictions (Holand et al., 2011). In general, it can be referred to be some sort of composite indicators with a variety of attributes and factors, which are geographically and demographically exploratory and diagnostic in nature.

Based on the scale of analysis and the needs of researchers, the measures of indicators need to be identified and developed to characterize key elements of a complex system, to reflect the current situation, and to establish rate and direction of change (Thomas et al., 2010). Typically, there are three types of indicators that are able to reflect the level of social vulnerability (Cutter, 1996; Cutter & Finch, 2008; Cutter et al., 2003; Massmann & Wehrhahn, 2014; Noriega & Ludwig, 2012; Phillips & Fordham, 2010; Tapsell et al., 2010; Yoon, 2012; Y. Zhou et al., 2013):

- The most common and individual-level indicators that are rooted in reflecting social vulnerability temporally and geographically: social achieved status (e.g. poverty, education level, socioeconomic class, employment, occupation, housing tenure etc.) and social ascribed status (e.g. race and ethnicity, gender, age, disability, etc.);
- The factors related to community level that influences social vulnerability, including: lack of access to resources (e.g. funding, information, knowledge, and technology), limited access to political power and representation, social capital (e.g. social networks and connections), beliefs and customs, building stock and age, urbanization, type and density of infrastructure and lifelines, built environment, and so on;
- The incorporation of individuals and groups' risk perceptions and experiences.

Social vulnerability indicators can be examined by three main approaches:

- Quantitative approaches – depending on the needs and availability of resources, the selection of social vulnerability indicators can be done through (1) deductive approach based on a theoretical understanding of relationships and (2) an inductive approach based on statistical relationships (ibid.). Many case studies at different geographical scales have been implemented by combining statistical analysis (e.g. census data) and GIS mapping techniques to examine social vulnerability to hazards including coastal inundation, storm surge, hurricanes, flooding, earthquake, etc. (Cutter et al., 2000, 2003; A. Fekete, 2009;

Fox, 2008; Holand et al., 2011; Noriega & Ludwig, 2012; Wu et al., 2002; Yoon, 2012; Y. Zhou et al., 2013).

- Qualitative approaches – significant information, such as how people experience, perceive, and make sense of their lives with respect to disasters, can be gained through methods including interviews, focus groups, and other participatory approaches to assess underlying processes and causes of social vulnerability (Elder et al., 2007; Fekete, 2009; Massmann & Wehrhahn, 2014).
- Mixed-method approaches (i.e., combination of both approaches) – sometimes utilized to overcome advantages and disadvantages of the above approaches for more in-depth information in regard to the story behind the scene (Adger, 2006; Massmann & Wehrhahn, 2014; Thomas et al., 2010).

### 1.5.2 Project Methodology

Therefore, this project assessed the social vulnerability of the Chinese-speaking immigrants in the City of Richmond through the multiple-method research including multiple data collection methods. It should be kept in mind while reading this project that the Chinese-speaking immigrants in this project are not a homogeneous group but are rather differentiated by ethnicity (e.g. Han, Hainanese, Taiwanese, etc.), regional or linguistic family (e.g. Mandarin, Cantonese, Hokkien, etc.), or country of origin (e.g. Taiwan, Hong Kong, Vietnam, China Mainland, etc.). Despite their differences, this project refers to them as Chinese-speaking immigrants.

Inspired by Beck et al. (2012); the social vulnerability of Chinese-speaking immigrants in Richmond is conceptualized as the combination of three categories of elements:

- 1) Knowledge of the phenomenon and of the safety instructions to be adopted for disasters;
- 2) Constraints: distance from the sources of danger, emergency or rescue services and facilities, and, most importantly, socioeconomic and demographic characteristics and social networks; and
- 3) Risk and disaster perception.

Based on the above conceptualized elements, three corresponding methods are used in this project to conduct the social vulnerability assessment of Chinese-speaking immigrants in Richmond:

- 1) Literature and policy review (i.e., plans, policies, other City documents, etc.);
- 2) Application and analysis of the Social Vulnerability Index (SoVI) Model (applied at the scale of 2011 Census Data of Dissemination Areas); and
- 3) Development and administration of a household-level survey (with 101 responses in total, response rate of 87%).

The specific and detailed descriptions of the above methods are provided in the subsequent chapters: Chapter 2 (i.e., literature and policy review), Chapter 3 (i.e., the SoVI Model) and Chapter 4 (i.e., household-level survey).

## **1.6 Project Report Structure**

This chapter has presented the reviews of social vulnerability associated with risk and disaster management and immigrants as well as the project objectives and questions. The specific context of Richmond's current City Profile, its overall demographic characteristics, its facts regarding immigrants, and its disaster profiles related to the relevant risk and disaster policies, plans, and strategies about its immigrants' concerns are presented in Chapter 2.

Data from Census Canada with specific relevance to social vulnerability factors (i.e., constraints) were analyzed (see Chapter 3). Thematic maps of place-based social vulnerability patterns in Richmond based on the social vulnerability index (SoVI) model were generated using geographic information system (ArcGIS) software (see Chapter 3).

Chapter 4 shows the results of a survey (i.e., primary data collection) which was used to assess household-level information on Chinese-speaking immigrants' risk perceptions, attitudes, experiences and knowledge. The results of the survey provided additional and important elements to measure the social vulnerability of Chinese-speaking immigrants in Richmond.

Discussion is presented in Chapter 5. Finally, recommendations and next steps are suggested (see Chapter 6), and conclusions are summarized (see Chapter 7).



## Chapter 2: City of Richmond Overview

The City of Richmond, an island city in Metro Vancouver, is the location of Metro Vancouver's International Airport. It is about 10 km from Downtown Vancouver, and 25 km from the US border (Figure 2-1). The city has a land area of 129.27 km<sup>2</sup>.



**Figure 2-1.** The map of the City of Richmond's geographical location. Source: City Profile - Richmond, link: <http://www.richmond.ca/discover/maps.htm>

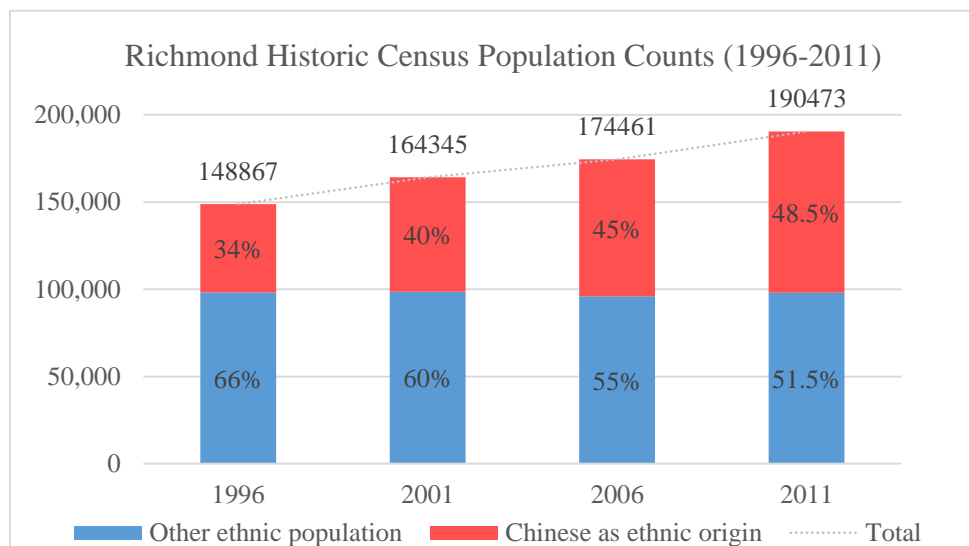
### 2.1 Demographic Review in the City of Richmond

The population in Richmond is diverse in terms of population growth, population structure, and the range of ethnic groups. This section examines this distinct demographic pattern in comparison with Metro Vancouver to understand the context of social vulnerability in Richmond.

#### Population Growth

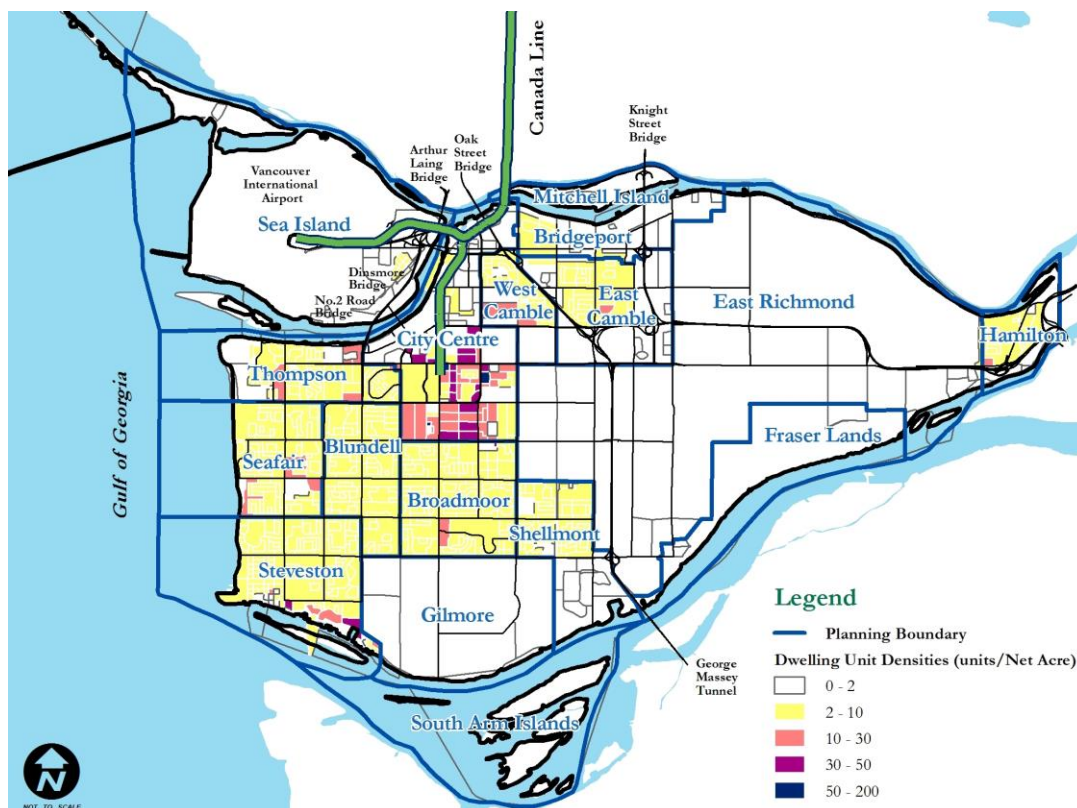
Richmond is the fourth largest municipality in Metro Vancouver by population, with a population of 190,473 persons and a population density of 1473.5 people per km<sup>2</sup> (City of Richmond, 2014c). Since the late 1990's, Richmond has been experiencing growth and change at a rapid pace (see Figure 2-2), transforming from a small, rural community to a bustling, urban centre with a higher proportion of its population and dwelling units centralized around the City Centre which connects to the Canada Line (see Figure 2-3). Between 1991 and 2011, population growth rate city-wide was about 2.1 percent per year (City of Richmond, 2014d). This contrasts the population growth rate of Metro Vancouver, which was lower at 1.9 percent per year (ibid.). Within Richmond, communities like City Centre, Steveston, Shellmont, West Cambie, and

Broadmoor experienced the fastest growth between 2006 and 2011, among which, City Centre accounted for more than half of the total population growth in Richmond (ibid.).



**Figure 2-2.** Richmond historic proportion of population trend by ethnic group from 1991 to 2011. Source: BC Stats, 2012, link:

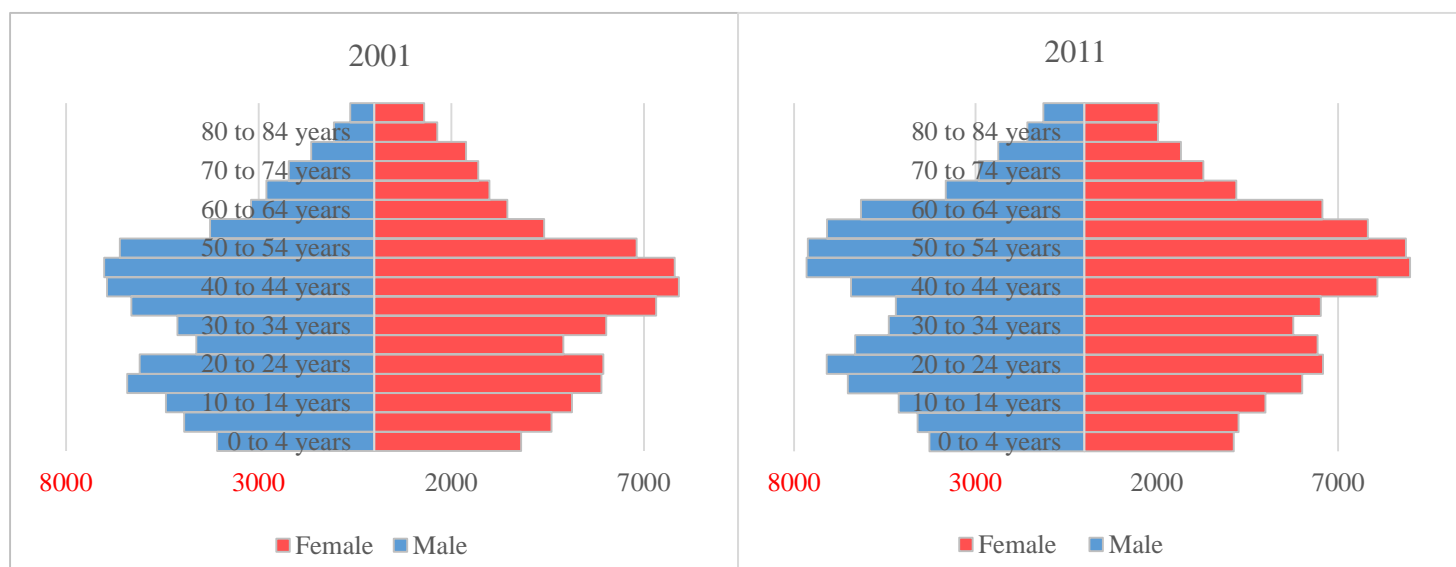
<http://www.bcstats.gov.bc.ca/StatisticsBySubject/Census/MunicipalPopulations>



**Figure 2-3.** Map of Net Dwelling Unit Densities in Richmond, 2011. Source: Census of Canada, 2011, link: <http://hdl.handle.net/10573/42747>

## Population Structure

In 2011, 14.4 percent of the population in Richmond was aged 14 and under, and 13.7 percent was aged 65 and over, compared with 15.3 and 13.5 percent in Metro Vancouver, respectively. Meanwhile, the percentage of the working age individuals in Richmond was 72.0 percent, compared with 71.2 percent in Metro Vancouver. Between 2001 to 2011, Richmond exhibited an aging population; both the number of seniors and the median age of the population increased (see Figure 2-4). Notably, the proportion of females in the population exceeded males in all age groups of over 20 years during 2011 (see Figure 2-4); the sex ratio was 0.92 in Richmond, compared with 1.05 in Metro Vancouver (Statistics Canada, 2012b).

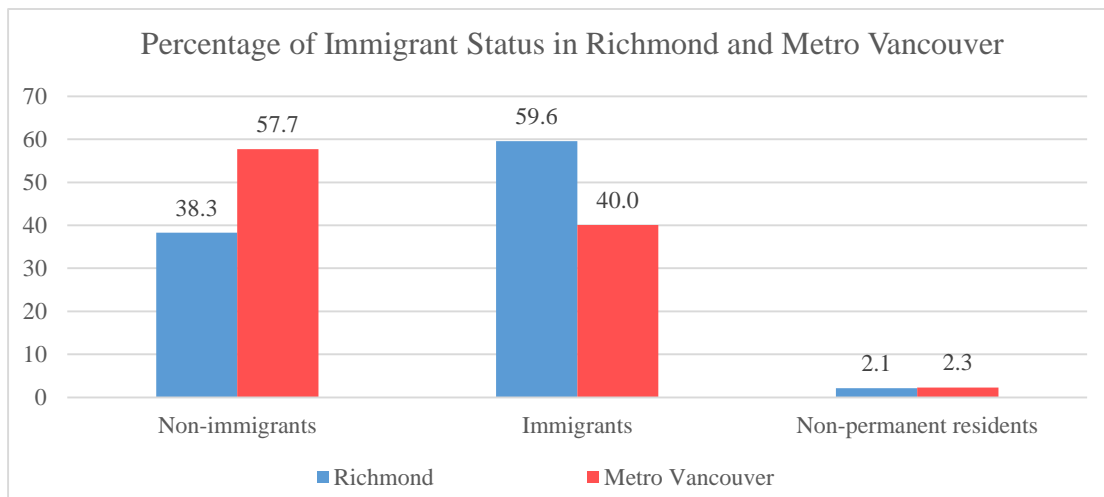


**Figure 2-4.** The age and sex distribution of Richmond in 2001 and 2011. Source: Statistics Canada, 2012, 2013

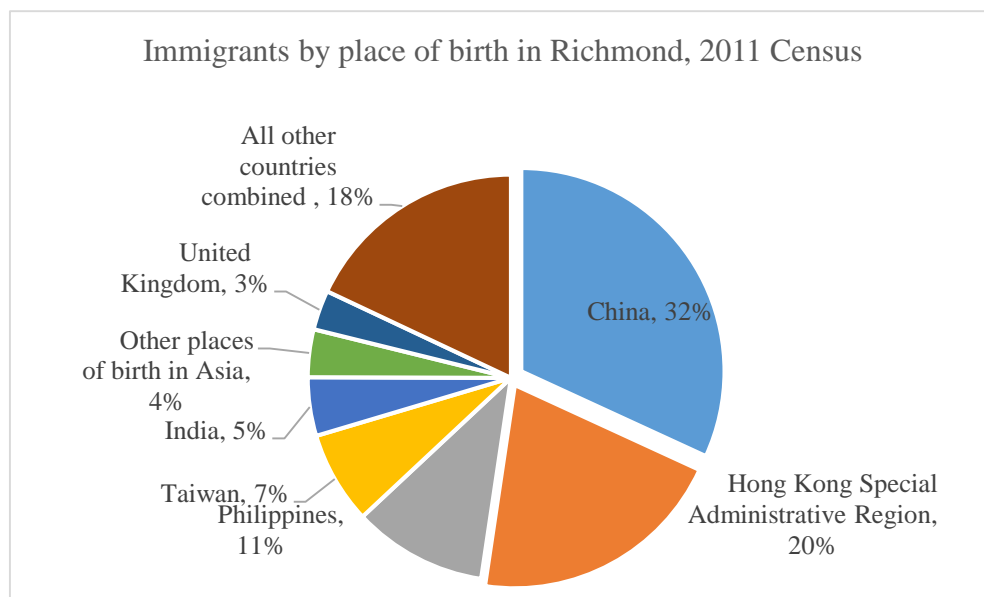
## Facts about Immigrants and Chinese-speaking immigrants

Much of the recent population change in the population structure of Richmond is associated with immigrants. Generally speaking, around 70.4 percent (133,320 individuals) of Richmond's total population was recognized as visible minority in 2011; most of which were Chinese and South Asian in origin. Based on City of Richmond's estimation (City of Richmond, 2014b), City Centre, Broadmoor, Thompson and Seafair Planning Areas received the greatest number of recent immigrants between 2006 to 2011.

According to the 2011 National Household Survey (NHS), about 38 percent of Richmond residents were Canadian-born, 112,880 (59.6%) of the residents in Richmond were foreign-born (immigrants), and the remaining 2 percent were non-permanent residents. In comparison, immigrants only account for 40 percent of the total population in Metro Vancouver (see Figure 2-5). Nearly 58 percent of the immigrants in Richmond were 25 years or older at time of immigration, while 35 percent were 5 to 24 years old at time of immigration (ibid.).



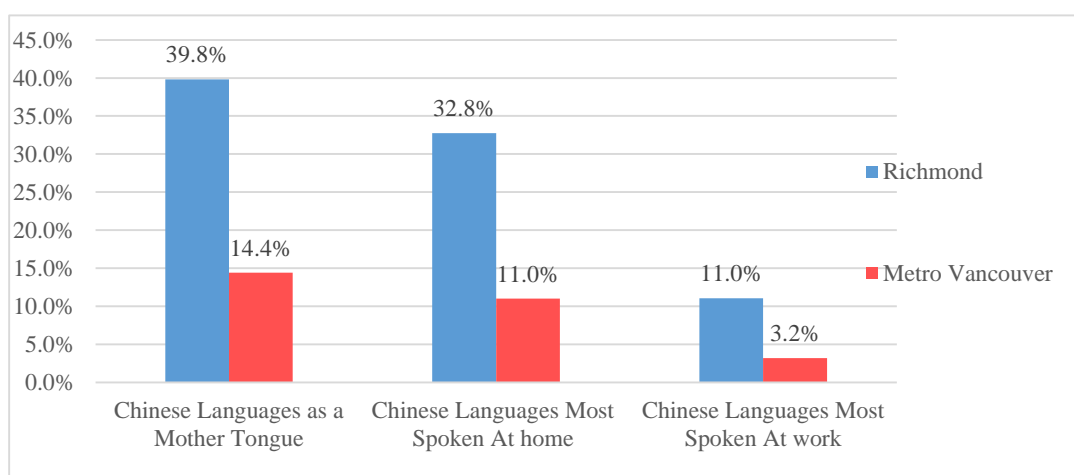
**Figure 2-5.** Percentage of Canadian born (non-immigrants), foreign born (immigrants) and non-permanent residents in Richmond and Metro Vancouver in 2011. Source: Statistics Canada, 2012a.



**Figure 2-6.** Countries of origin for Richmond's immigrants, 2011. Source: Statistics Canada, 2012a

The proportion of the City's population that is of ethnic Chinese origin has grown rapidly from 34 percent in 1996 to 40 percent in 2001 to 45 percent in 2006 (City of Richmond, 2014a). In 2011 Chinese as ethnic origin accounted for the largest visible minority group in Richmond (91,885 persons, 48.5% out of the total population in Richmond), with the overall sex ratio of 0.90 (Statistics Canada, 2012a). Remarkably, Richmond has the highest proportion of Chinese to total population in Canada. West Cambie, Thompson, City Centre, and Blundell are the planning areas in which more than 50 percent of the total population is Chinese as a visible minority.

Regarding the place of birth of immigrants living in Richmond, China and Hong Kong Special Administrative Region accounted for over 52 percent of the total immigrant population in Richmond (Figure 2-6). There were around 75,520 Richmond residents (39.8% of total population) whose mother tongue was a Chinese language (e.g. Cantonese, Mandarin, and Chinese, n.o.s.) in 2011 (Figure 2-7). Richmond has the largest percentage of residents who claim Chinese as their mother tongue compared to other municipalities in the Lower Mainland. In Metro Vancouver, the percentage of residents who claim Chinese as their mother tongue is 15 percent (ibid.). As for non-official languages spoken most often at home, 32.8 percent among Richmond's population spoke Chinese languages (Statistics Canada, 2012a); for languages used most often at work, 11 percent among Richmond's population aged 15 and over used Chinese languages. Table 3-1 summarizes facts of Chinese-speaking immigrants in Richmond.



**Figure 2-7.** Chinese Languages Spoken in Richmond and Metro Vancouver. Source: Statistics Canada, 2012a

**Table 2-1. Facts about Chinese-speaking immigrants in Richmond**

	Number of Individuals (% of total population in Richmond; sex ratio)
Chinese Ethnic Origin	91,885 (48.5%; 0.90)
Chinese as visible minority	89,045 (47.0%, highest proportion in Canada; 0.90)
Chinese-born or Hong Kong-born Immigrants	59,090 (31.2%; 0.86)
Mother tongue as a Chinese Language	75,520 (39.8%; 0.87)
Chinese Languages spoken most often at home	60,590 (32.8%; 0.86)
Chinese Languages used most often at work	11,220 (11.0%, total population aged 15 and over ; 1.13)

## 2.2 Risk & Disaster Management Overview in Richmond

### 2.2.1 Risk & Disaster Governance Structure in the City of Richmond

Risk and disaster management in Richmond is a cooperative effort undertaken by its Emergency Management Office under the department of Law & Community Safety, Richmond's protective service agencies and other City departments. The Emergency Management Office is responsible for the emergency programs ensuring the protection of life, public infrastructure, private property and the environment in the event of an emergency or disaster (City of Richmond, 2010). The main mandate of the Office can be categorized into four major measures with different plans and programs, based on the concept of the disaster management cycle: mitigation, preparedness, response and recovery.

### 2.2.2 Risk & Disaster Fact Basis and Risk Analysis

One of the significant challenges, outlined by Metro Vancouver Regional Growth Strategy (Metro Vancouver, 2010), to which the lower mainland must face is the response to *climate change impacts and natural hazard risks*. The City of Richmond's Emergency Management Office with its Emergency Planning Committee has identified the potential local risks and disasters (City of Richmond, 2011b) that are most likely have severe impacts on the city's infrastructure, operations, economy, residents, businesses, and daily life:

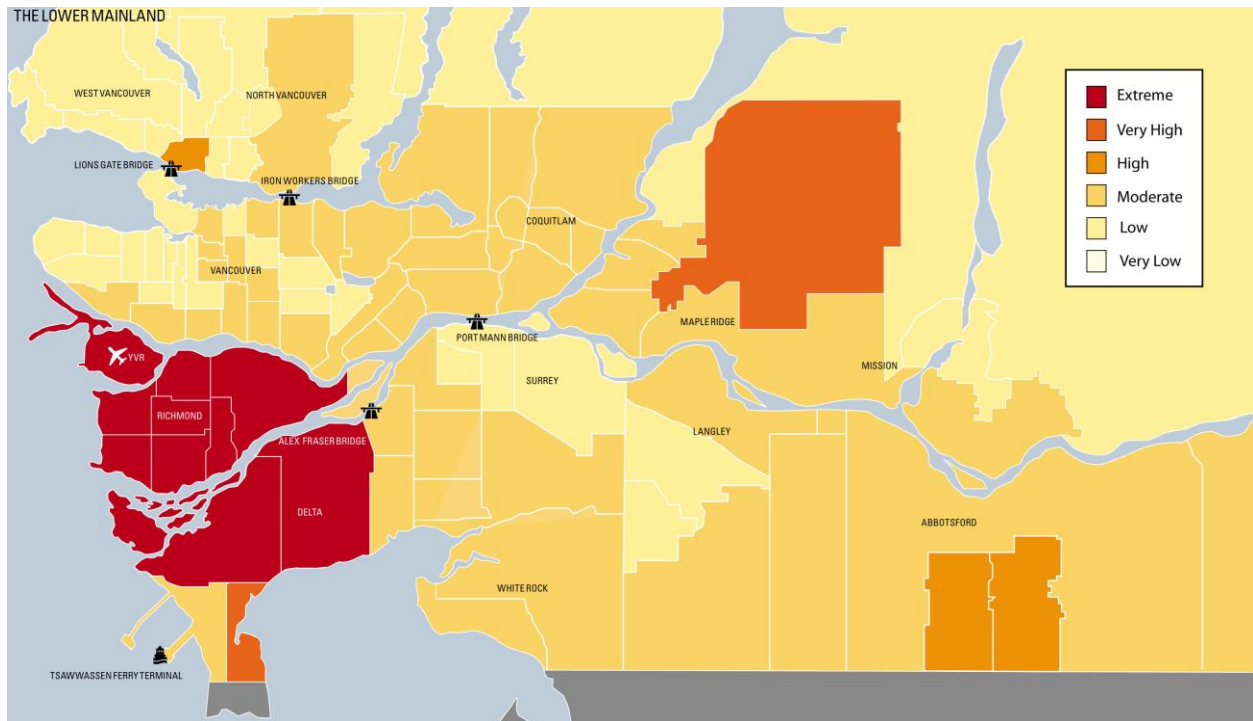
- Earthquakes
- Floods
- Severe weather
- Fires
- Tsunamis
- Air crashes
- Pandemic diseases
- Heatwaves

A considerable number of studies analyzing the above risks with respect to the physical vulnerability have been conducted for Metro Vancouver; however, there have been growing concerns regarding increasing risks associated with pandemic diseases (e.g. SARS, Ebola, etc.) and heatwaves due to warming climate. In particular, Richmond has greater physical vulnerability to earthquakes, floods, severe weather events, tsunamis and air crashes than other municipalities in Metro Vancouver. The following part of this section presents some insights on the key hazards which Richmond may have higher chances of encountering.

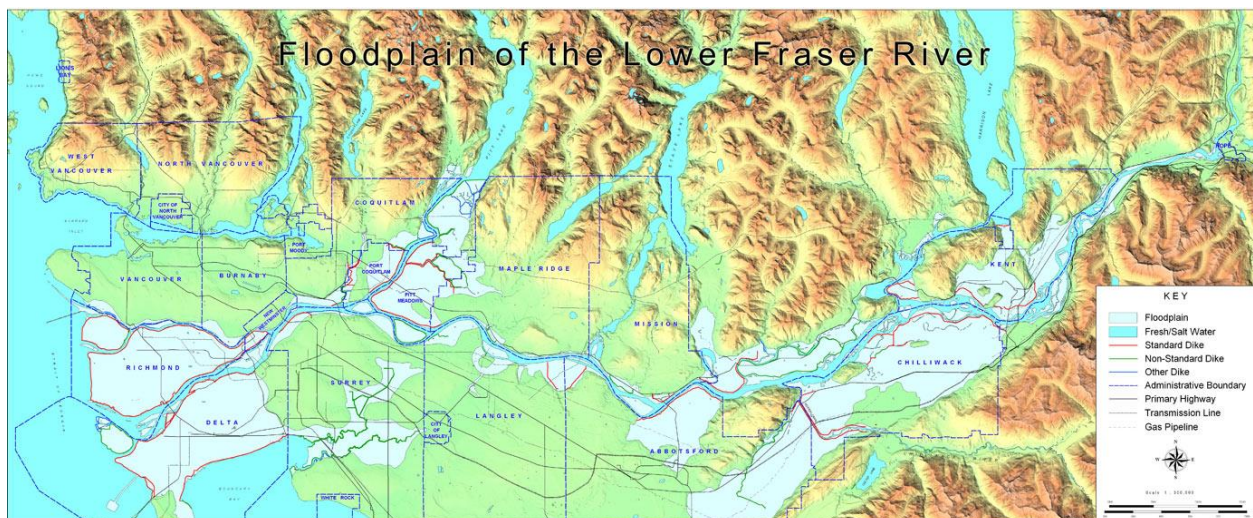
#### Seismic Hazards

Many studies have shown that Richmond is facing a higher seismic risk, in terms of strong ground motion and soil liquefaction, because of its proximity to the potential seismic sources, its soft and less densified soil material and geological structure, and its higher population density (Adams & Halchuk, 2004; Cassidy & Rogers, 2004; Chang et al., 2012; Lutemauer et al., 1994; Ventura & Schuster, 1994). The estimated seismic risk map (Figure 2-8) shows that Richmond is one of the municipalities in Metro Vancouver most vulnerable to seismic hazards.





**Figure 2-8.** Estimated seismic risk map of Metro Vancouver. Source: Institute for Catastrophic Loss Reduction, 2003, link: [http://www.bcbusiness.ca/files/EarthquakeMap\\_Aug.pdf](http://www.bcbusiness.ca/files/EarthquakeMap_Aug.pdf)



**Figure 2-9.** Floodplain in Richmond and lower mainland. Source: Fraser Basin Council, n.d., link: [http://www.fraserbasin.bc.ca/water\\_flood\\_fraser.html](http://www.fraserbasin.bc.ca/water_flood_fraser.html)

### Floods, Severe Weather Events, and Tsunamis

In spite of the fact that there has been no historical record of tsunamis or major flooding events in Richmond (City of Richmond, 2013b; Clague & Orwin, 2005), Richmond is still under a higher risk of inundation, including low-lying flooding, severe weather events (e.g. storm



surges), or tsunamis, because of the effects of climate change<sup>1</sup>. Effects of climate change such as the increase in strength and frequency of extreme weathers and sea level rise (BC MFLNRO, 2014) may be more detrimental to Richmond due to its geographic location (in the floodplain of the Fraser River Delta; Figure 2-9) and low average elevation (just about one meter above sea level; see Appendix B) (Etkin, 1998; Groulx et al., 2004; McBean & Henstra, 2003; Rothman et al., 1998; White & Etkin, 1997). In addition, Richmond is also facing an average subsidence rate of 1 to 2 mm/year, making it more vulnerable to the risk of inundation (Thomson et al., 2008).

### **Air crash**

As for technological disasters, air crash is one of the most worrisome risks that the City of Richmond is most likely to encounter. As the host of the Vancouver International Airport (YVR), one of the busiest airports in Canada, Richmond is subject to increased risk of air crash due to its location under the aircraft flight routes, especially for taking-off and landing throughout the year (see Appendix C). Actually, there were two major air crash incidents that happened in Richmond in 2007<sup>2</sup> and 2011<sup>3</sup>.

## **2.3 Emergency Program and Immigrants in Richmond**

Based on the analytical results of the studies on the above hazards and physical vulnerability, the City of Richmond has prepared for those hazards by implementing extensive measures to cope with the potential negative impacts. The key initiatives of the Emergency Programs can be categorized in the disaster management cycle:

### **Mitigation <sup>4</sup>**

The initiatives of mitigation in Richmond focus mostly on hard measures. For the mitigation of earthquakes' impacts, all new buildings in Richmond are required to meet the latest BC Building Code to ensure public safety by preventing major failure and loss of life (City of Richmond, 2010). All the buildings in Richmond are designed to resist major earthquakes without collapse. In addition, all new structures in Richmond are required to be built on densified or improved ground with foundation systems, which can mitigate the potential risk of liquefaction (ibid.).

As for the mitigation of flooding, Richmond has implemented full-fledged hard-measures to prevent high-tides or river floods due to extreme weather events. These included 49 km-long dikes, which provide protection for a 1 in 200 year flood event, and a 920 km-long drainage system, comprised of pump stations, flood boxes, irrigation structures and storm sewers, which provide protection for a 1 in 10 years rainstorm (City of Richmond, 2013b).

---

<sup>1</sup> According to BC MFLNRO (2014), by the end of this century, the size of flood that used to occur only once every 50 years will become the type of flood with the present return periods from 200 to 500 years.

<sup>2</sup> <http://www.canada.com/vancouver/news/story.html?id=a8e3aed8-6cd1-4ee4-9b58-5e3e574ee931&k=29808>

<sup>3</sup> <http://globalnews.ca/news/752505/final-report-into-fatal-2011-richmond-plane-crash-to-be-released-today/>

<sup>4</sup> <http://www.richmond.ca/safety/prepare/city/hazards.htm>

## Preparedness, Response & Recovery

Richmond has initiated several plans and programs to facilitate effective emergency preparedness and response. The city has prepared several emergency plans, including an emergency management plan, functional plans, threat specific plans, and divisional plans, all of which will guide the city's actions to prepare for, respond to and recover from major shocks. Emergency preparedness in Richmond focuses on its community awareness<sup>5</sup>, training and exercises by providing *emergency preparedness workshops*, delivering *special publications* on local risks for activities of community-based emergency mitigation and preparedness, and hosting *special events* to raise community awareness.

For the sake of conducting emergency operations to respond to emergency incidents, Richmond establishes its Emergency Operations Centre (EOC) for emergency response. Disaster response routes<sup>6</sup> and emergency social services (ESS)<sup>7</sup> with volunteer participation are the critical components in Richmond's emergency response. ESS is the heart of emergency response and recovery. By cooperating with the Emergency Management Office, ESS provides short-term methods to preserve the emotional and physical well-being of evacuees and response workers/volunteers in an emergency, such as reception centre(s)<sup>8</sup> for immediate needs and temporary relief for individuals and families.

## Services Focusing on Immigrants

Richmond also provides the Evacuation Plan and the Business Disaster Response and Recovery Guide for its emergency response. These initiatives point out the importance of special provisions and needs for immigrants or people with non-English or limited-English abilities (City of Richmond, 2008, 2011a). The reception centres of ESS can also provide multi-cultural services to meet the special needs of Richmond's unique demography. For raising community awareness, Richmond has held personal emergency preparedness workshops in Mandarin/Cantonese with the corporation of S.U.C.C.E.S.S. in 2005<sup>9</sup> and 2006<sup>10</sup>, and the CCM Centre, cooperating with the city, has held three "safety expos"<sup>11</sup> to engage Chinese-speaking immigrants in Richmond in emergency preparedness and awareness since 2007. However, the focus of emergency management on serving immigrants in Richmond is still limited in terms of providing emergency materials, education and services in different languages. Almost all the materials (e.g. websites, publications, information, etc.) regarding the emergency management

---

<sup>5</sup> <http://www.richmond.ca/safety/prepare/city/overview.htm>

<sup>6</sup> <http://www.richmond.ca/safety/prepare/city/routes.htm>

<sup>7</sup> <http://www.richmond.ca/safety/prepare/city/ess.htm>

<sup>8</sup> <http://www.richmond.ca/safety/prepare/city/reception.htm>

<sup>9</sup> [http://www.richmond.ca/\\_\\_shared/assets/Emergency\\_Preparedness\\_Week\\_Event\\_Poster\\_200511009.pdf](http://www.richmond.ca/__shared/assets/Emergency_Preparedness_Week_Event_Poster_200511009.pdf)

<sup>10</sup> <http://www.richmond.ca/cityhall/council/about/messages/annualaddress06.htm?PageMode=HTML>

<sup>11</sup> <http://www.voice-news.ca/?p=448>

cycle are only available in English. In particular, only three emergency materials in Richmond have Chinese-language translation versions: the Emergency Numbers Brochure<sup>12</sup>, the New Comers' Guide<sup>13</sup>, and the Electrical and Fire-Safety Program Brochure<sup>14</sup>. The former two are used mainly for informing and educating people about dialing 9-1-1; the later one is mainly used to inform people about the program's legal issues.

## 2.4 Potential Risk & Disaster Influence & Vulnerability in Richmond

In addition to mitigating unexpected impacts from the “big one” disasters by the hard measures, it is also essential for the Emergency Programs in Richmond to focus on soft measures. This can be done by providing targeted aid which caters to Richmond's unique demography (i.e., significant proportion of Chinese-speaking immigrants), as well as by understand their risk perceptions, disaster preparedness, knowledge and experiences. After all, race and ethnicity are critical factors that not only influence how warning is processed, but also what types of protective or preparedness measures are taken. Thus, it is necessary to reevaluate if risk communication materials with relation to preparedness, response, and recovery are in Chinese or if they are culturally sensitive to the Chinese-speaking immigrants in Richmond.

In addition, Richmond is facing two social challenges. First, Richmond has an overall poverty rate of over 22 percent with the second highest child poverty rate in Canada (City of Richmond, 2013a). Second, the 2008 Canadian Health Literacy study points out that more than 60 percent of Richmond residents had a health literacy level<sup>15</sup> below level 2 out of 5. Thus, immigrants are a particularly vulnerable population due to their language barrier. Under the circumstance where community members lack English proficiency or have limited English education and ability, the efficacy of emergency programs will be obstructed. The politics of language diversity in Richmond, particularly the use of billboards, signs and advertisement materials exclusively in Chinese languages in the City, has created the controversy<sup>16</sup> within the City Hall and in the Business Improvement Associations that could spill over into the Disaster Preparedness field.

With an understanding of the background of the existing emergency program and the general challenges of the risk and disaster management in Richmond, the following chapter investigated the underlying factors of social vulnerability by two different methods (mixed-methods): 1) SoVI model and 2) household-level survey.

---

<sup>12</sup> [http://www.richmond.ca/\\_\\_shared/assets/emergencynumberschinese8827.pdf](http://www.richmond.ca/__shared/assets/emergencynumberschinese8827.pdf)

<sup>13</sup> [http://www.richmond.ca/\\_\\_shared/assets/Newcomer\\_s\\_Guide\\_2012\\_Chinese\\_-\\_Updated33152.pdf](http://www.richmond.ca/__shared/assets/Newcomer_s_Guide_2012_Chinese_-_Updated33152.pdf)

<sup>14</sup> [http://www.richmond.ca/\\_\\_shared/assets/Electrical\\_and\\_Fire-Safety\\_Program\\_Brochure\\_-\\_Chinese18474.pdf](http://www.richmond.ca/__shared/assets/Electrical_and_Fire-Safety_Program_Brochure_-_Chinese18474.pdf)

<sup>15</sup> Level 1 – very poor literacy skills; level 2 – a capacity to deal only with simple, clear material involving uncomplicated tasks; level 3 – adequate to cope with the demands of everyday life and work in an advanced society; levels 4 and 5 – strong skills; source: <http://www.ccl-cca.ca/CCL/Reports/HealthLiteracy.html>

<sup>16</sup> <http://news.nationalpost.com/2014/10/19/richmond-b-c-considers-banning-chinese-only-signs-amid-uproar-over-citys-un-canadian-advertisements/>

## Chapter 3: Social Vulnerability Scores & Mapping

This chapter presents findings of the Social Vulnerability Index analysis that was conducted in order to identify the key causes of social vulnerability and their geographical distributions in the City of Richmond.

### 3.1 Social Vulnerability Index: Indicators & Proxy Variables

All data for the indicators and proxy variables of social vulnerability in Richmond were taken from Statistics Canada. These include the 2011 Census of Canada and the 2011 National Household Survey which were accessed through the ABACUS datasets (via the UBC Library) and CANSIM databases.

The Social Vulnerability Index (SoVI) is used in this project to determine the place-based social vulnerability in Richmond. The SoVI, a quantitative comparative method, is a relative measure of the overall or potential strengths and weaknesses of place-based social vulnerability which contains no hazard information (exposure to disasters) (Cutter et al., 2003; Fekete, 2009). The process of generating the SoVI is to apply a number of measurable social vulnerability indicators with proxy variables, and use factor analysis to identify the underlying factors that make locations socially vulnerable to disasters (ibid.). This project includes 1) the social vulnerability indicators and proxy variables used by Fox (2008) who assessed the SoVI in the City of Vancouver, and 2) other indicators of proxy variables to adjust to the scale and context of Richmond. Table 3-1 below summarizes the social vulnerability indicators and proxy variables chosen for this study.

**Table 3-1 Summary of Included Indicators and Proxy Variables (34 in total)**

Indicator	Variable
Socioeconomic Status	<ul style="list-style-type: none"> <li>Household median income after tax</li> <li>Individual median income after tax</li> <li>% Low income population (after tax)</li> <li>% Households spending 30% or more of their total income on shelter costs</li> <li>Unemployment Rate</li> </ul>
Race & Ethnicity	<ul style="list-style-type: none"> <li>% Population without knowledge of Official Language</li> <li>% Population Immigrants from 2006 to 2011</li> <li>% First generation population</li> <li>% Population speaking non-official language mostly at home</li> <li>% Population without Canadian citizenship</li> </ul>
Gender	<ul style="list-style-type: none"> <li>% Women with low income</li> <li>% Female participation rate</li> </ul>
Residential Property	<ul style="list-style-type: none"> <li>% Dwellings constructed before 1980</li> <li>% Dwellings requiring major repair</li> </ul>

Indicator	Variable
	<ul style="list-style-type: none"> <li>• Median value of owned dwelling (\$)</li> <li>• % of total dwellings that are apartments in buildings with five or more storeys</li> <li>• Dwelling units per square kilometre</li> </ul>
Renters	<ul style="list-style-type: none"> <li>• % Dwellings rented</li> </ul>
Family Structure	<ul style="list-style-type: none"> <li>• Average household size</li> <li>• Average number of children at home</li> <li>• % Single parent families</li> <li>• % one-person household</li> </ul>
Education	<ul style="list-style-type: none"> <li>• % Population (25 yrs+) with high school or less education level</li> </ul>
Occupation	<ul style="list-style-type: none"> <li>• % Population employed as non high-skilled occupations</li> </ul>
Population Density	<ul style="list-style-type: none"> <li>• Population per square kilometre</li> </ul>
Population Change	<ul style="list-style-type: none"> <li>• % of movers</li> </ul>
Social Dependence	<ul style="list-style-type: none"> <li>• % total income from government transfer</li> <li>• % population relying on public transit</li> </ul>
Age	<ul style="list-style-type: none"> <li>• % Population aged less than 15 years old</li> <li>• % Population aged 65 years old and over</li> <li>• Median population age</li> </ul>
Emergency service	<ul style="list-style-type: none"> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest medical service (e.g. fire halls, hospitals, and ambulance stations)</li> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency shelter (e.g. schools, community centres, and city centre)</li> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency response team (e.g. police station and fire halls)</li> </ul>

### 3.2 Process of Conducting the SoVI Model

The social vulnerability scores and mapping in this project were refined through a ten step process developed by Cutter (2011), as outlined below:

- 1) Selection of social vulnerability variables (dataset) (see Table 3-1).
- 2) Normalization of the variables' units.
- 3) Verification of the dataset's accuracy (see Appendix D.1).
- 4) Standardization of the input variables with z-scores.
- 5) Extraction of a set of components (or factors) that contribute significantly to the dataset by principal component analysis (PCA; factor analysis) (see Table 3-2; see Appendix D.2 and D.3 for detailed information).

- 6) Examination of the correlation between the resulting factors and their corresponding individual variables.
- 7) Interpretation and adjustment of the resulting factors to be aligned with the tendency (increase or decrease) of the corresponding dominant variables on social vulnerability (see Table 3-2).
- 8) Extraction of the component (factor) scores for the corresponding Dissemination Areas.
- 9) Generation of the overall SoVI score with an additive model and sign adjustment (see Table 3-2).
- 10) Mapping of the SoVI scores using standard deviation with 5 divergent classes for illustrating area of high, medium, and low social vulnerability (see Figure 3-2).

**Table 3-2. Dimensions of Social Vulnerability: factors, factor labels, loadings, sign adjustment, and variance explained by factor analysis**

Sign Adjustment	Factor	Factor Label (name)	Dominant Variables	Correlation (loadings)	Variation Explained
+	1	Household & Dwelling, Density of Built Environment	<ul style="list-style-type: none"> <li>• Average household size</li> <li>• % one-person household</li> <li>• Average number of children at home</li> <li>• Dwelling units per square kilometre</li> <li>• Median value of owned dwelling (\$)</li> <li>• Population per square kilometre</li> <li>• % of total dwellings are apartments in buildings with five or more storeys</li> </ul>	-.887 .811 -.809 .782 -.755 .692 .483	26.05%
+	2	Socioeconomic Status	<ul style="list-style-type: none"> <li>• % Women with low income</li> <li>• % Low income population (after tax)</li> <li>• % Households spending 30% or more of their total income on shelter costs</li> <li>• Household median income after tax</li> <li>• Individual median income after tax</li> <li>• % Dwellings rented</li> <li>• Unemployment rate</li> </ul>	.817 .789 .741 -.732 -.564 .490 .374	13.47%
+	3	Race & Ethnicity	<ul style="list-style-type: none"> <li>• % Population speaking non-official language mostly at home</li> <li>• % Population without knowledge of Official Language</li> <li>• % First generation population</li> <li>• % Dwellings constructed before 1980</li> </ul>	.861 .808 .803 -.675	8.89%
-	4	Population age	<ul style="list-style-type: none"> <li>• % Population aged 65 years old and over</li> <li>• Median population age</li> <li>• % Female participation rate</li> <li>• % Population aged less than 15 years old</li> </ul>	-.869 -.853 .611 .591	7.12%

Sign Adjustment	Factor	Factor Label (name)	Dominant Variables	Correlation (loadings)	Variation Explained
+	5	Occupation, Education and Social Dependence	<ul style="list-style-type: none"> <li>• % Population employed as non high-skilled occupations</li> <li>• % Population (25 yrs+) with high school or less education level</li> <li>• % total income from government transfer</li> <li>• % population reply on public transit</li> </ul>	.810 .725 .472 .442	6.02%
+	6	Population change & Mobility	<ul style="list-style-type: none"> <li>• % Population of immigrants from 2006 to 2011</li> <li>• % Population without Canadian citizenship</li> <li>• % of movers</li> </ul>	.782 .712 .529	5.61%
+	7	Emergency Services	<ul style="list-style-type: none"> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest medical service</li> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency response team</li> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency shelter</li> </ul>	.900 .865 .598	3.16%
+	8	Single family and Housing Quality	<ul style="list-style-type: none"> <li>• % Single parent families</li> <li>• % Dwellings requiring major repair</li> </ul>	.639 .484	3.12%

### 3.3 Dominant components of Social Vulnerability

Table 3-2 presents the resulting eight composite components (or factors) with the dominant variables of social vulnerability in Richmond. They explain 73.44 percent of the variance in the input data. The factor labels (names) of the resulting factors were interpreted by the common themes among the dominant variables that load significantly within a factor. Variables were categorized to factors based upon the variables' correlation value; the higher the absolute value of the correlation (loading) the larger the effect of the corresponding variable on the factor. In the case of this project most variables were significant within the factors in representing the social vulnerability in Richmond. As shown in Table 3-2, the resulting factors of social vulnerability in Richmond in 2011 were:

- *Household, dwelling, and density of built environment* (26.05% of the variance), identifying 7 variables, mostly related to household size, housing and population density, and housing values.



- *Socioeconomic status* (13.47% of the variance), identifying 7 variables, including income, housing cost, renter, and unemployment rate. The socioeconomic factor affects the capacity to prepare for emergencies, absorb losses and recover from changes.
- *Race and ethnicity* (8.89% of variance) and *population change and mobility*, with 4 and 3 variables respectively, emphasizing non-official language mostly spoken at home, official-language comprehension, first generation population, recent immigrants, population without Canadian citizenship, and movers.
- *Population age* (7.12% of variance; with 4 variables), highlighting the areas where there were higher elderly population associated with lower female participation rate.
- *Occupation, education, and social dependence* (5.61% of the variance), with four variables, indicating the areas with more people of lower education level (e.g. high school or less), non high-skilled occupations (e.g. sales or personal service) and higher social dependence (e.g. government transfer income, dependence on public transit).
- *Emergency services* (3.16% of the variance; with 3 variables) indicating the areas with the lack of proximate medical services, emergency response teams and shelters.
- *Single family and housing quality* (3.12% of the variance), indicating the areas of higher lone-parent families and more dwellings requiring major repair.

All of these eight factor reflect that the areas might be more vulnerable for the lack of ability and resources to prepare, response, and recover throughout the periods of disaster cycle. These might in turn result in potentially higher structural, non-structural and life losses once an emergency event occurs.

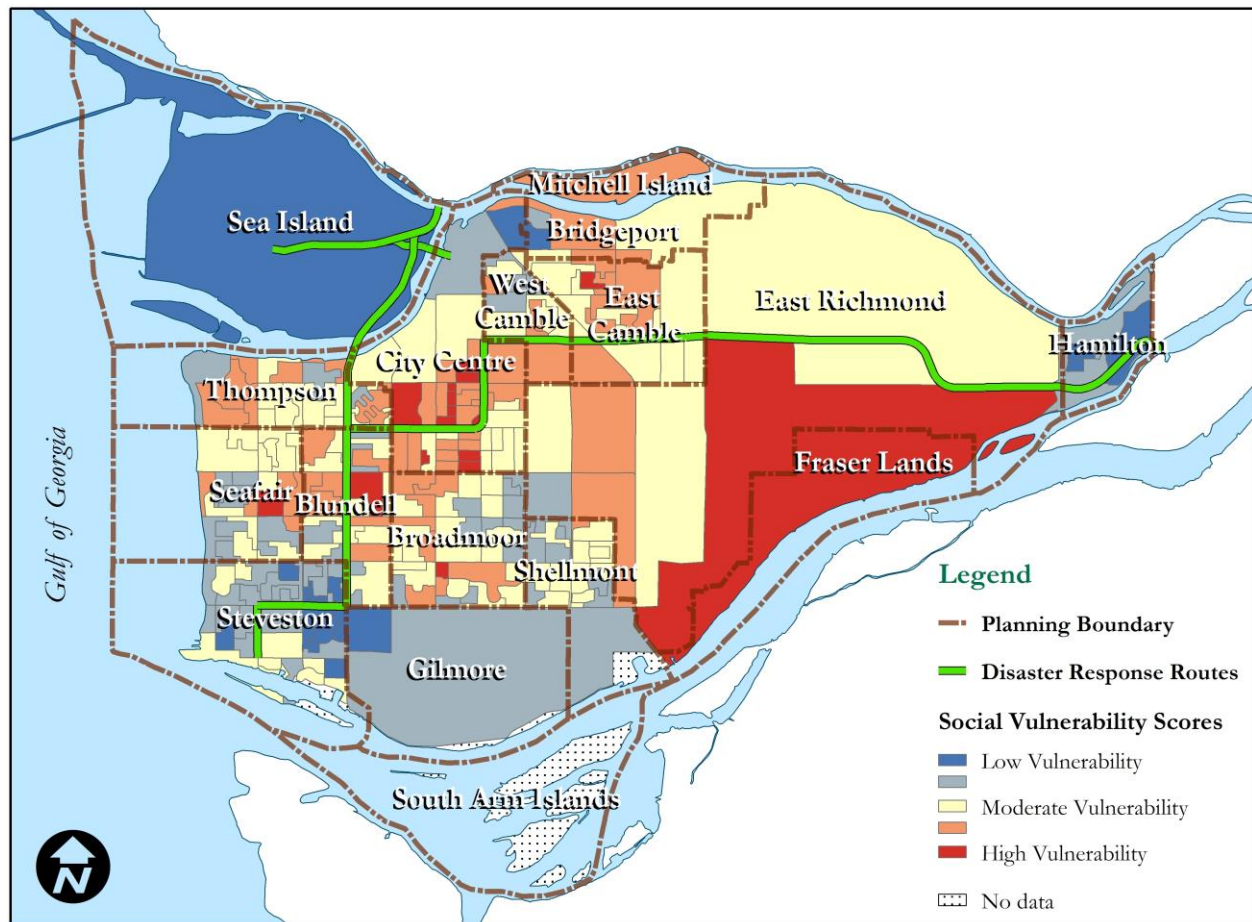
In general, all resulting factors with most of the dominant variables are considered to increase social vulnerability in Richmond. The scores of the overall SoVI for the eight factors were then generated by adding them with the sign adjustment and were mapped by dissemination areas along with standard deviations from mean. A clearer view on the spatial distribution of SoVI in Richmond is shown in Figure 3-1.

### **3.4 Spatial Distribution of Social Vulnerability in Richmond**

Figure 3-1 shows the spatial distribution of overall social vulnerability in Richmond. As signified by a score above 1.5 standard deviation from the mean, the map shows three main clusters of highest social vulnerability: Central (City Centre and Blundell), Northern (Mitchell Island, Bridgeport, and West and East Cambie), and Southeastern Richmond (Southern East Richmond and Fraser Lands). Communities including Western Thompson, Eastern Seafair, and Western Broadmoor also score higher on the social vulnerability scale. Sea Island, Steveston, Gilmore, and Hamilton are the areas labeled with the less social vulnerability.

The scores for each individual factor can also be used for mapping spatial distribution of each social vulnerability factor. The maps are helpful for identifying more specific aspects of social

vulnerability. Appendix E presents each of the resulting eight factor maps from the PCA. The findings of the maps of each social vulnerability factor are summarized as follow:



**Figure 3-1.** . Spatial Distribution of Overall Social Vulnerability Scores (SoVI) in the City of Richmond by Dissemination Areas and community planning boundaries, based on 2011 Census of Canada Data.

- City Centre and Southern Richmond showed the highest vulnerability in Factor 1 (*household, dwelling, and density of built development*).
- City Centre, Sothern West and East Cambie, Eastern Blundell, Broadmoor, Southern East Richmond, and Southwestern Steveston were most vulnerable in Factor 2 (*socioeconomic status*), whereas in general western Richmond (communities along the seashore of Georgia Strait) and Hamilton were less vulnerable.
- City Centre and its peripheries of communities scored highest in Factor 3 (*race and ethnicity*), whereas the vulnerability decreases with the distance from City Centre.
- The main cluster of highest vulnerability of Factor 4 (*population age*) located at western Richmond (Blundell and its peripheries of areas, including western City Centre, Seafair, and Broadmoor), whereas Northern Richmond, Hamilton, Gilmore, and Sea Island were less vulnerable in Factor 4.

- The highest vulnerability scores of Factor 5 (*occupation, education, and social dependence*) located at Bridgeport, West Cambie, East Cambie, City Centre, and Shellmont, whereas Western Thompson, Seafair, Steveston and Gilmore were less vulnerable in Factor 5.
- Communities along the seashore of Georgia Strait (i.e., Thompson and Seafair) and some areas in City Centre, Blundell, Broadmoor, and Shellmont, were displayed with the highest vulnerability in Factor 6 (*population change and mobility*), whereas Northern Richmond, Sea Island, East Richmond, Fraser Lands and Hamilton had the least vulnerability.
- Almost all communities in Richmond, except for City Centre, Broadmoor, Shellmont, Steveston, Sea Island, and Hamilton, scored high vulnerability in Factor 7 (*emergency services*).
- Factor 8 (*single family and housing quality*) displayed high vulnerability in Central Richmond (Southern City Centre, Blundell and its peripheries of areas, and Shellmont), West Cambie and East Cambie, whereas Northern City Centre and communities along Fraser River were less vulnerable in factor 8.

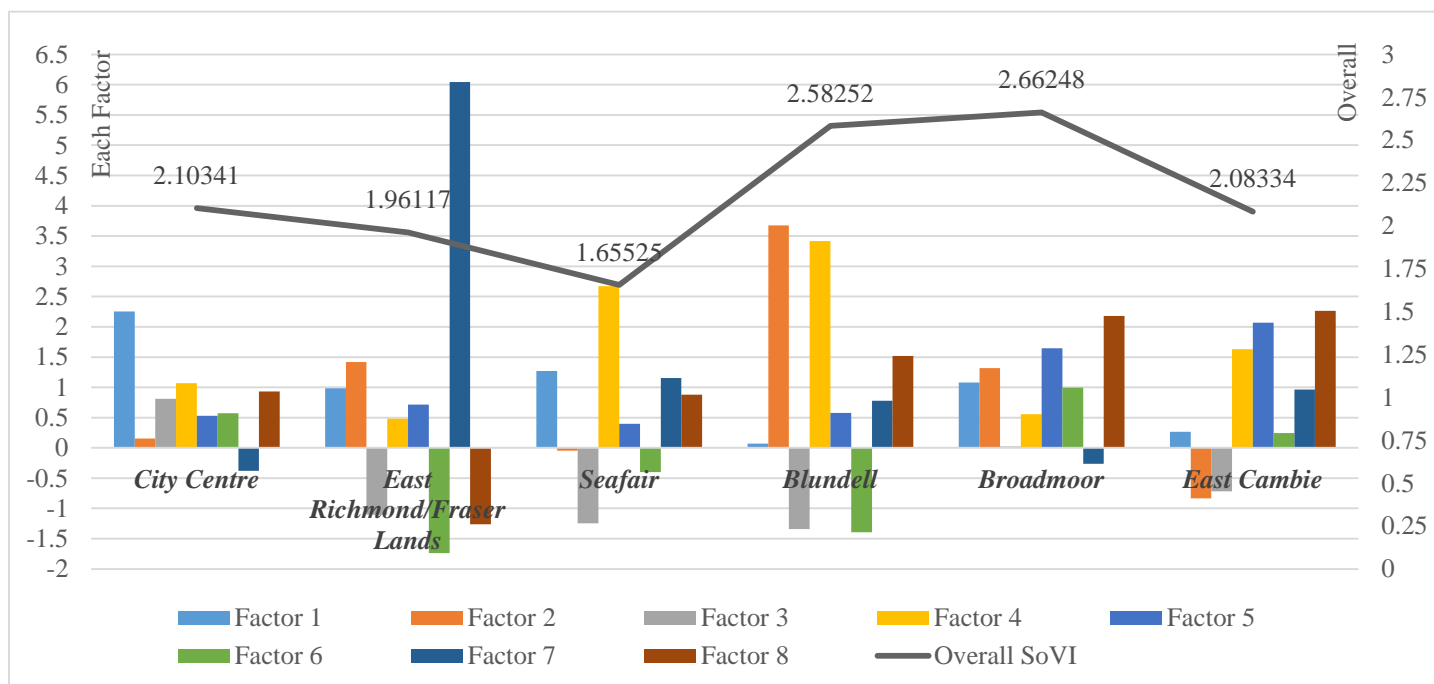
Apparently, the City centre and its peripheries exhibit highest levels of the overall social vulnerability for their greater population growth, diverse population structure, elderly population and density of built environment. In general, the geographic pattern of the overall social vulnerability was displayed and resembles Factors 2, 4, and 5 (see Figure 3-1 and Appendix E); those factors scores were highest in City Centre, its peripheries, and southeastern Richmond, compared with southwestern Richmond which had lower social vulnerable scores. The following section is presented to understand the relationship between planning communities with high SoVI scores and the corresponding causes.

### 3.5 Highly Vulnerable Areas: SoVI Mapping

The mean of all SoVI scores in Richmond's dissemination areas is 0.00 (Standard Deviation = 2.83). The scores range from -6.79 to 8.20 (high social vulnerability). Planning communities with seventeen dissemination areas with the highest SoVI level are identified: City Centre, East Cambie, Seafair, Blundell, Broadmoor, East Richmond, and Fraser Lands.

For the sake of having a clear view, the highest SoVI areas in City Centre are investigated as a whole by averaging the values of each SoVI factor in the areas. Figure 3-2 shows the standard deviation from the mean of each factor score by the planning communities with dissemination areas of highest overall SoVI score. Appendix F shows the detailed statistic data of the social vulnerability variables with the corresponding highest SoVI dissemination areas. Table 3-3 summarizes the dissemination areas with highest SoVI level and the dominant social vulnerability factors along with key variables in Richmond. The findings of Figure 3-2 are presented below.

City Centre exhibits high vulnerability levels in all factors<sup>17</sup> except for Factor 7. City Centre particularly has the highest vulnerability in Factor 1 because the dissemination areas in City Centre have higher population density (up to 25,000 people per square kilometer; z-score = 4.67), higher building density, more apartments with five or more storeys (up to 97.8%; z-score = 5.45), and larger proportion of one-person households (up to 49.4% of total households; z-score = 3.1). City Centre is also more vulnerable in Factors 4 and 8, for having higher proportion of elderly population and dwellings requiring major repair.



**Figure 3-2.** The standard deviation from the mean of factor scores by highly vulnerable planning community in Richmond.

East Richmond and Fraser Lands are notably more vulnerable in Factors 2 and 7. The dissemination area (59153616) with highest score of Factor 7 is not only far from the key emergency services (e.g., medical sectors, fire halls, emergency shelters, etc.), but also has a higher proportion of lower income population and renters.

High social vulnerability in Seafair results from Factors 1, 4 and 7. The dissemination area (59151080) in particular has higher elderly population (28.5% of population aged 65 or more; z-score = 2.6) and lower female labor force participation rate (44.4%; z-score = -1.2).

<sup>17</sup> Factor 1 - household, dwelling, and density of built environment; factor 2 - socioeconomic status; factor 3 - race and ethnicity; factor 4 - population age; factor 5 - occupation, education, and social dependence; factor 6 - population change; factor 7 - emergency services; factor 8 - single family and housing quality.

Factors 2, 4, and 8 caused the overall high social vulnerability in Blundell. The dissemination area (59153352) has the highest proportion of elderly population in Richmond (34.7% with median age of 54.2; z-score = 3.71) and only 31.4 percent of female labour force participation rate (z-score = -2.45). The area also has high low income population (54.5%; z-score of 2.84), high proportion of renters (64.8%; z-score = 2.6), as well as unemployed rate (15.9%; z-score = 2.05). There are also more lone-parent families (16.8%; z-score = 1.68) and more dwellings requiring major repair (16.5% of dwellings; z-score = 1.81) in Blundell.

The dissemination area (59153107) in Broadmoor is the most socially vulnerable area in Richmond. The area has positively high scores in all factors except for Factor 7. Key variables result in the high social vulnerability in this area include: high proportion of one-person households (36%; z-score = 1.91), high population density (12357 people/km<sup>2</sup>; z-score = 1.67), high low income population (38.2%; z-score = 1.45), high unemployment rate (18.1%; z-score = 2.48), high proportion of government transfer income (20.3%; z-score = 2.04), high population with non-high skilled occupation (62.7%; z-score = 2.17), high proportion of population relies on public transit (37.5%; z-score = 2.45), high recent immigrant population (16.8%; z-score = 1.05), high proportion of dwellings requiring major repair (13.9%; z-score = 1.43), and high proportion of lone-parent families (14.1%; z-score = 0.93).

In East Cambie, the high social vulnerability is resulted particularly from Factor 4, 5, and 8. The dissemination area (59151002) has high elderly population (29%; z-score = 2.7), high population with only lower-level education (46.7%; z-score = 1.62), high proportion with government transfer income (19%; z-score = 1.75), and high proportion of dwellings requiring major repair (25.8%; z-score = 3.15).

**Table 3-3. Summary of highest SoVI dissemination areas and the dominant SoVI factors in Richmond.**

Planning Community	Dissemination Areas	Dominant Factors	Key Social Vulnerability Variables
City Centre	59151148, 59151149, 59151139, 59153409, 59153411, 59153412, 59151002, 59151002, 59151145, 59153345, 59153398, 59153114, 59153529	Factor 1 Factor 4 Factor 8	<ul style="list-style-type: none"> <li>• Median value of owned dwelling (\$)</li> <li>• % of total dwellings are Apartments in buildings with five or more storeys</li> <li>• Dwelling units per square kilometre</li> <li>• Population per square kilometre</li> <li>• % one-person household</li> <li>• % Population aged 65 years old and over</li> <li>• Median population age</li> <li>• % Dwellings requiring major repair</li> </ul>
East Richmond/ Fraser Lands	59153616	Factor 1 Factor 2 Factor 7	<ul style="list-style-type: none"> <li>• Median value of owned dwelling (\$)</li> <li>• % one-person household</li> <li>• % Low income population (after tax)</li> <li>• Household median income after tax</li> </ul>

Planning Community	Dissemination Areas	Dominant Factors	Key Social Vulnerability Variables
			<ul style="list-style-type: none"> <li>• Individual median income after tax</li> <li>• % Dwellings rented</li> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest medical service (e.g. fire halls, hospitals, and ambulance stations)</li> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency shelter (e.g. schools, community centres, and city centre)</li> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency response team (e.g. police station and fire halls)</li> </ul>
Seafair	59151080	Factor 1 Factor 4 Factor 7	<ul style="list-style-type: none"> <li>• Median value of owned dwelling (\$)</li> <li>• % one-person household</li> <li>• % Population aged 65 years old and over</li> <li>• Median population age</li> <li>• % Female participation rate</li> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency response team (e.g. police station and fire halls)</li> </ul>
Blundell	59153352	Factor 2 Factor 4 Factor 8	<ul style="list-style-type: none"> <li>• Household median income after tax</li> <li>• Individual median income after tax</li> <li>• % Women with low income</li> <li>• % Low income population (after tax)</li> <li>• % Households spending 30% or more of their total income on shelter costs</li> <li>• Unemployment Rate</li> <li>• % Dwellings rented</li> <li>• % Population aged 65 years old and over</li> <li>• Median population age</li> <li>• % Female participation rate</li> <li>• % Dwellings requiring major repair</li> <li>• % Single parent families</li> </ul>
Broadmoor	59153107	Factor 1 Factor 2 Factor 5 Factor 6 Factor 8	<ul style="list-style-type: none"> <li>• Median value of owned dwelling (\$)</li> <li>• Dwelling units per square kilometre</li> <li>• Population per square kilometre</li> <li>• % one-person household</li> <li>• Household median income after tax</li> <li>• Individual median income after tax</li> </ul>

Planning Community	Dissemination Areas	Dominant Factors	Key Social Vulnerability Variables
			<ul style="list-style-type: none"> <li>• % Women with low income</li> <li>• % Low income population (after tax)</li> <li>• % Households spending 30% or more of their total income on shelter costs</li> <li>• Unemployment Rate</li> <li>• % Dwellings rented</li> <li>• % Population employed as non high-skilled occupations</li> <li>• % of movers</li> <li>• % total income from government transfer</li> <li>• % population rely on public transit</li> <li>• % Population without Canadian citizenship</li> <li>• % Population Immigrants from 2006 to 2011</li> <li>• % of movers</li> <li>• % Dwellings requiring major repair</li> <li>• % Single parent families</li> </ul>
East Cambie	59153627	Factor 4 Factor 5 Factor 7 Factor 8	<ul style="list-style-type: none"> <li>• % Population (25 yrs+) with high school or less education level</li> <li>• % Population aged 65 years old and over</li> <li>• % Female participation rate</li> <li>• % total income from government transfer</li> <li>• % Population employed as non high-skilled occupations</li> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest medical service (e.g. fire halls, hospitals, and ambulance stations)</li> <li>• Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency response team (e.g. police station and fire halls)</li> <li>• % Dwellings requiring major repair</li> </ul>

### 3.6 Limitations

Data availability is one of the most crucial factors influencing indicator selection (Yoon, 2012). Due to the spatial scale of the census and limited resources, there are many social vulnerability variables of critical indicators that are not accessible or available for revealing the hidden reality of social vulnerability factors in Richmond, such as a lack of access to resources (e.g. information, political power, healthcare), building stock, and individual health status. In addition, society and its socioeconomic status are dynamic and very sensitive to demographic change within and outside of the local community, besides, the generic data of census does not always reflect reality. Variables within a system may not capture the issues that make individuals or localities vulnerable to multiple stresses. Hence, the social vulnerability index developed in this

project, which used 2011 census data, can only present a partial picture of social vulnerability in Richmond.

Moreover, a methodological limitation of this project is that it fails to apply different weights to vulnerability indicators/factors. Since not all factors (i.e., indicators) are equal, social vulnerability index will be more representative with a defensible weighting scheme (ibid.).



## Chapter 4: Household-level Survey Questionnaires

This chapter presents the results of the survey questionnaires as well as the demographic backgrounds of the respondents. The design and procedures of the survey questionnaires are also provided as follow.

### 4.1 Survey Questionnaires & Procedures

#### Survey Questionnaires

The survey included one screening question about participants' background, fourteen questions relevant to risk and disaster, as well as sixteen questions regarding participants' basic household-level demographic information, such as educational achievement, family structure and language, for further analysis and understanding of coupled social vulnerability factors (see Appendix G). The recruitment and survey materials and the consent form (cover letter) were provided in both English and Chinese (including traditional Chinese and simplified Chinese as options).

Questions from the survey in this project that were relevant to risk and disaster covered respondents' risk and disaster awareness, attitudes, and knowledge, experiences with disasters, social network availability, community and public engagement, emergency preparedness and responding behavior, and trust in public institutions (based on the Survey of Emergency Preparedness and Resilience (SEPR) in Canada). For example, respondents were asked to provide their concerns in regard to disaster types affecting Richmond, knowledge of the risk and disaster management plan, and willingness and ability to respond to a disaster.

Most of the questions in the survey were Likert-scale<sup>18</sup> questions. For example, a question asked "For each of the following disasters, how likely do you think it would be to directly affect your family?". Disasters named in the survey were based on the disasters that are most likely to affect Richmond.

#### Survey Sampling & Recruitment

The survey, which is conducted through non-representative and convenience sampling process, focuses on the population of Chinese-speaking immigrant population in the City of Richmond, who are associated with the S.U.C.C.E.S.S.<sup>19</sup> programs. Since the survey inquired about the household, all the participants were adults (aged 19 or over) who represented their family<sup>20</sup> to answer the survey questionnaires. The recruitment took place through the contact persons in the S.U.C.C.E.S.S. Richmond, BC Division from August 26<sup>th</sup> to September 26<sup>th</sup>, 2014 (1 month).

---

<sup>18</sup> The Likert scale (Babbie, 2007) is a psychometric scale commonly and widely used in questionnaires of social survey research. When responding to a Likert questionnaire item, respondents specify level of feeling to a statement/question. Generally, the level of agreement or disagreement is measured. The respondent has the option of selecting one answer from available options which vary from a "maximum" positive to a "minimum" negative.

<sup>19</sup> Website of S.U.C.C.E.S.S: <http://www.successbc.ca/>

<sup>20</sup> Family in this survey referred to family members living with participants in Metro Vancouver.

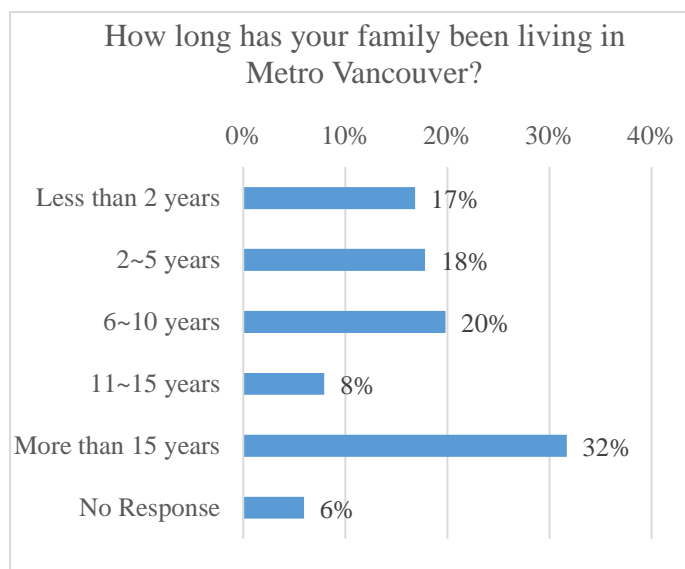
The S.U.C.C.E.S.S. is an organization dealing with immigration issues, especially for Chinese-speaking immigrants. It supports the needs of immigrants living and working in Canada through both internal (i.e., Chinese-speaking immigrants/members) and external (i.e., inter-agency) social networks.

The contact persons in the S.U.C.C.E.S.S. Richmond assisted in delivering the survey questionnaires with a cover letter (i.e., consent form) to the participants who are the customers, volunteers, students, and staff of S.U.C.C.E.S.S., through five workshops and one English class. In total, there are 101 respondents out of 115 surveys delivered (response rate = 87.8%).

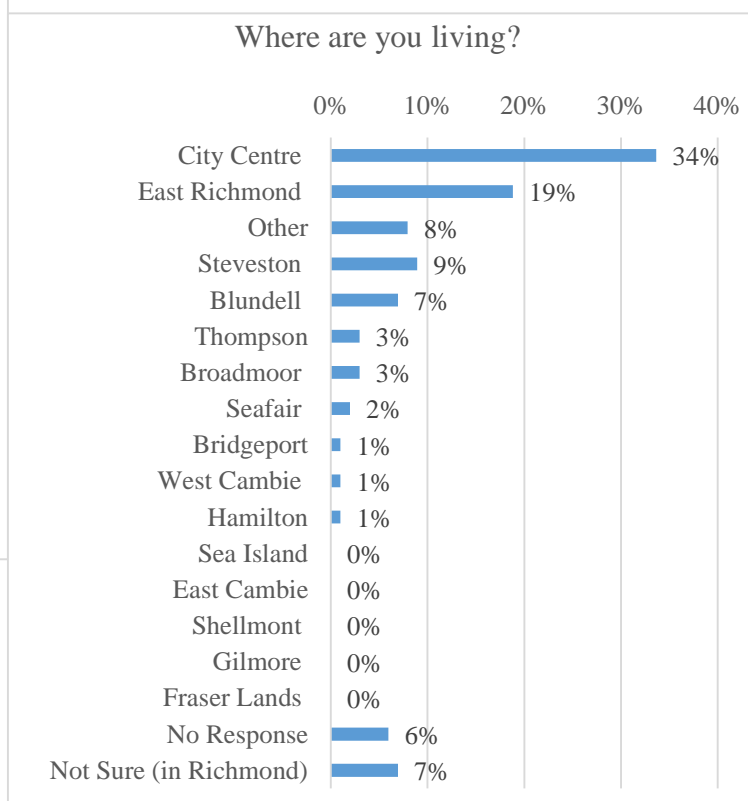
## 4.2 Characteristics of Survey Respondents

### Family Residency & Status

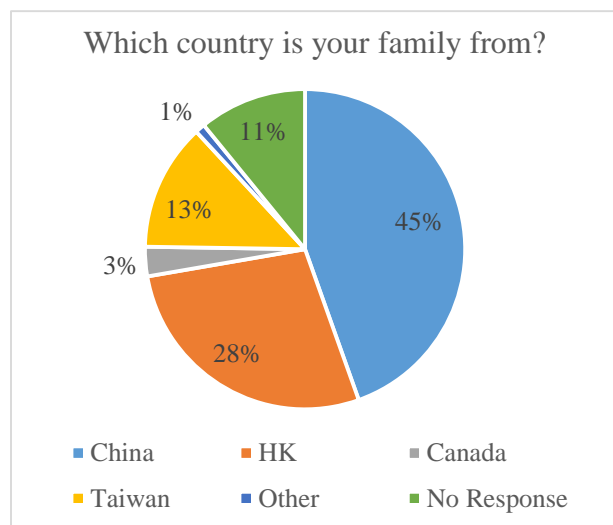
Around 32 percent of the survey respondents' families have been living in Metro Vancouver for more than 15 years. (see Figure 4-1). As expected, most of the survey respondents are living in Richmond (around 86%), particularly in City Centre (34%) (see Figure 4-2). The majority of the respondents are from China (45%) or Hong Kong (28%), and 17 percent are from countries including Taiwan (13%), Canada (3%), and the Philippines (1%) (see Figure 4-3). As for current immigration status, 52 percent of the respondents are Canadian citizens, 39 percent are permanent residents, and 2 percent are temporary residents (Figure 4-4).



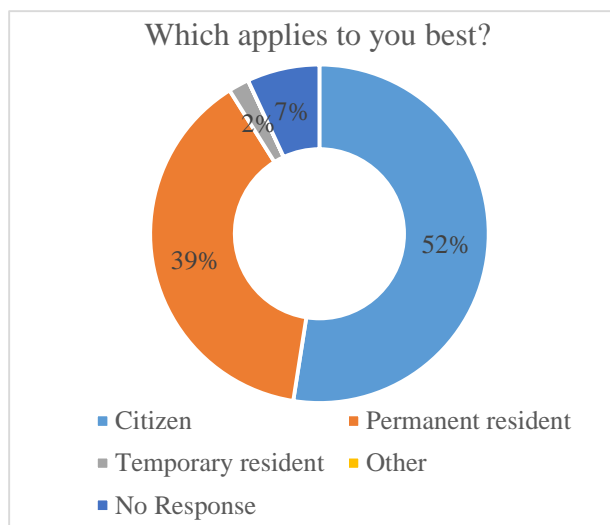
**Figure 4-1.** Length of time survey respondents have lived in Metro Vancouver.



**Figure 4-2.** Ares survey respondents are living in Metro Vancouver.



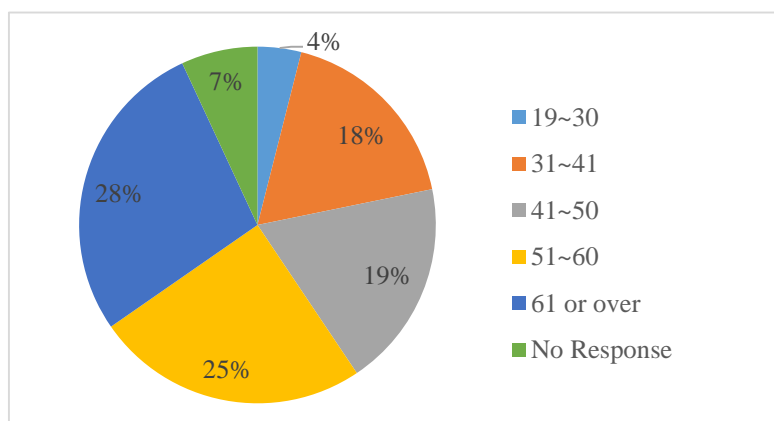
**Figure 4-3.** Current immigration of status survey respondents.



**Figure 4-4.** Country survey respondents' family are originally from.

## Gender & Age

Women account for 73 percent of the total survey respondents. The mean age of the respondents is 51 to 60 years. The respondents aged 61 or more account for 28 percent of the total participants, and only 4 percent are in the age group of 19 to 30 (see Figure 4-5) (see Chapter 4-4; p.45 for further discussions).

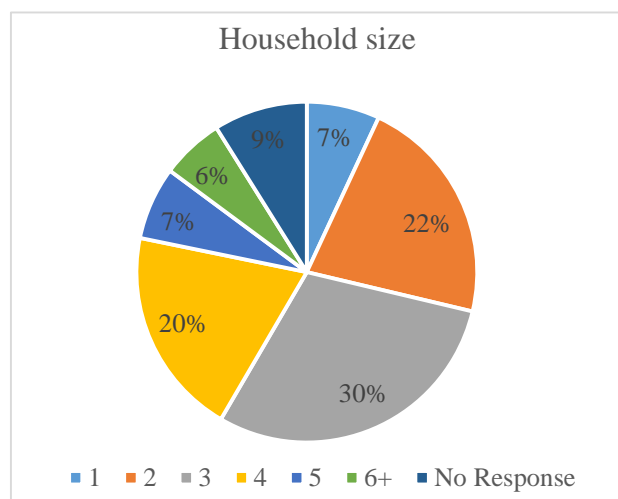


**Figure 4-5.** Survey respondents by age group.

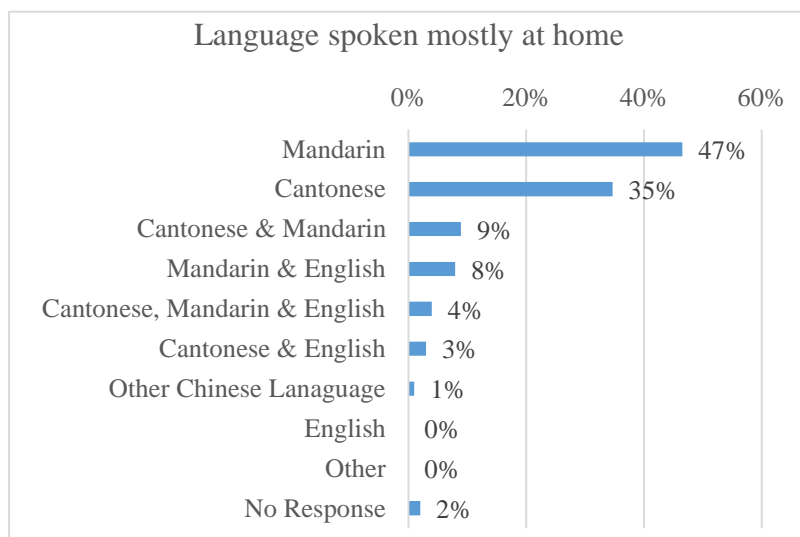
## Language & Education

Mandarin and Cantonese are the languages mostly spoken at the survey respondents' home (47% and 35%, respectively). Approximately 15 percent of the respondents are living in a multi-language family which uses Cantonese, Mandarin, or English combined (see Figure 4-6). Approximately 57 percent of the respondents' families have at least one member with English

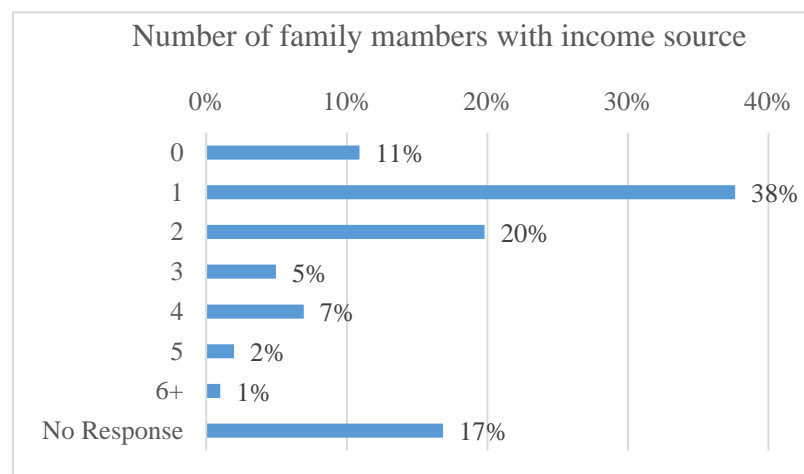
full-aspect proficiency, and 16 and 7 percent have at least one member with English conversation and reading proficiency, respectively; however, 7 percent do not have any members with English proficiency. In general, the respondents are relatively well educated; approximately 65 percent of the respondents have a postgraduate or higher-level degree, compared with 29 percent of high school degree or less.



**Figure 4-7.** Household size of survey respondents.



**Figure 4-6.** Language spoken mostly at survey respondents' home.



**Figure 4-8.** Income source status of survey respondents' household.

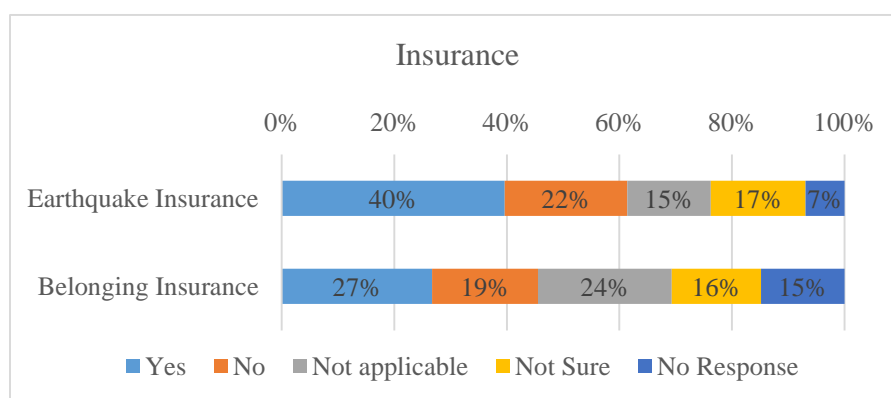
## Household & Income

Figure 4-7 shows that the majority of the survey respondents belong to 2, 3, and 4 person households. Approximately, 29 percent of the respondents' households have children, and 30 percent have elderly. Figure 4-8 shows that 11 percent of the respondents' households have no family member with income source. Households with only one person with income source account for 38 percent of the total respondents, and 35 percent have at least two household

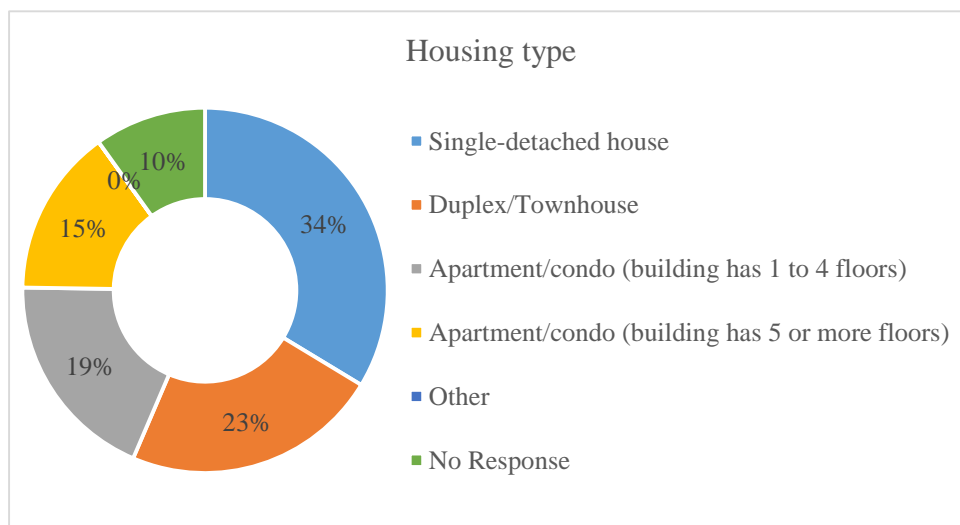
members with income source. Nevertheless, nearly 43 percent of the respondents claimed to be low-income families, and 38 percent mid-income.

## Housing & Insurance

Approximately, 67 percent of the respondents' families own their residences, compared with 25 percent who rent their residences. About 27 percent of the respondents have insurance for their belongings, and 40 percent have earthquake insurance, compared with 19 percent without belonging insurances and 22 percent without earthquake insurances (see Figure 4-9). As for housing type (Figure 4-10), the respondents live in a mix of housing types: single-detached home (34%), duplex/townhouse (23%), low-rise apartment/condo (19%), and high-rise apartment/condo (15%).



**Figure 4-9.** Insurance status of survey respondents' housing.



**Figure 4-10.** Survey respondents by housing type.

### 4.3 Questionnaires Regarding Risk, Emergency, and Disaster

#### Perception and Attitude of Risk and Emergency in Community

The results show that earthquakes, floods, and fires are the top three disasters of concern to respondents that might potentially affect their community (very concerned and somewhat concerned), followed by tsunamis and air crashes. Pandemic diseases and extreme weather events were stated of somewhat concerned by the respondents, and heat waves were stated the least concerned (see Figure 4-11).

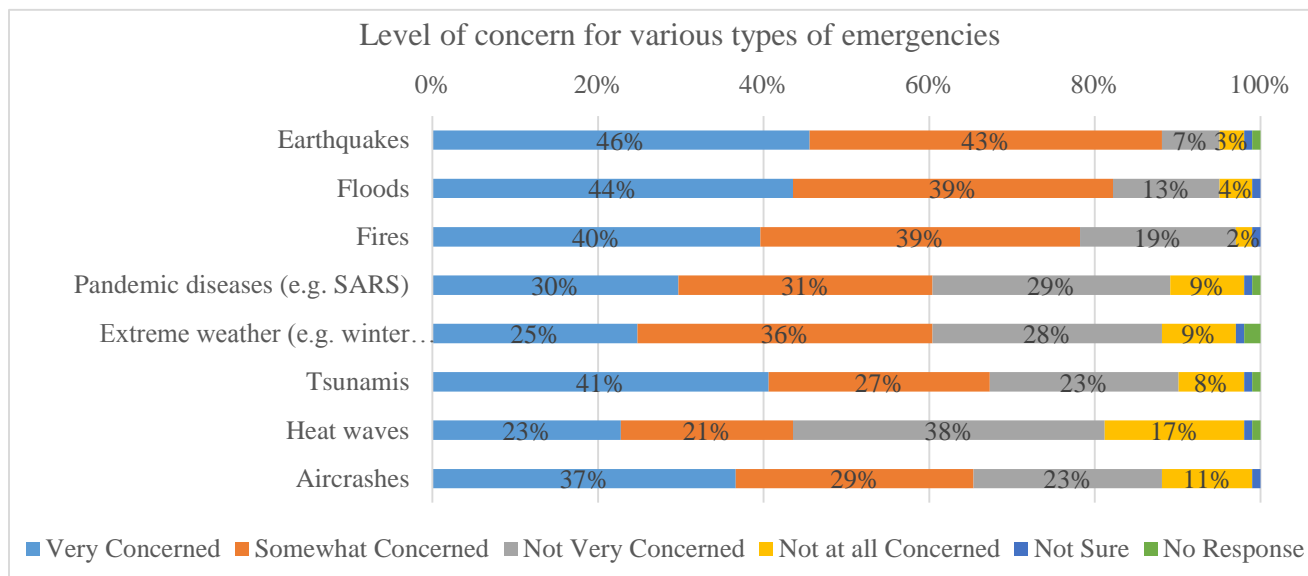


Figure 4-11. Survey respondents' level of concern regarding disasters in Community.

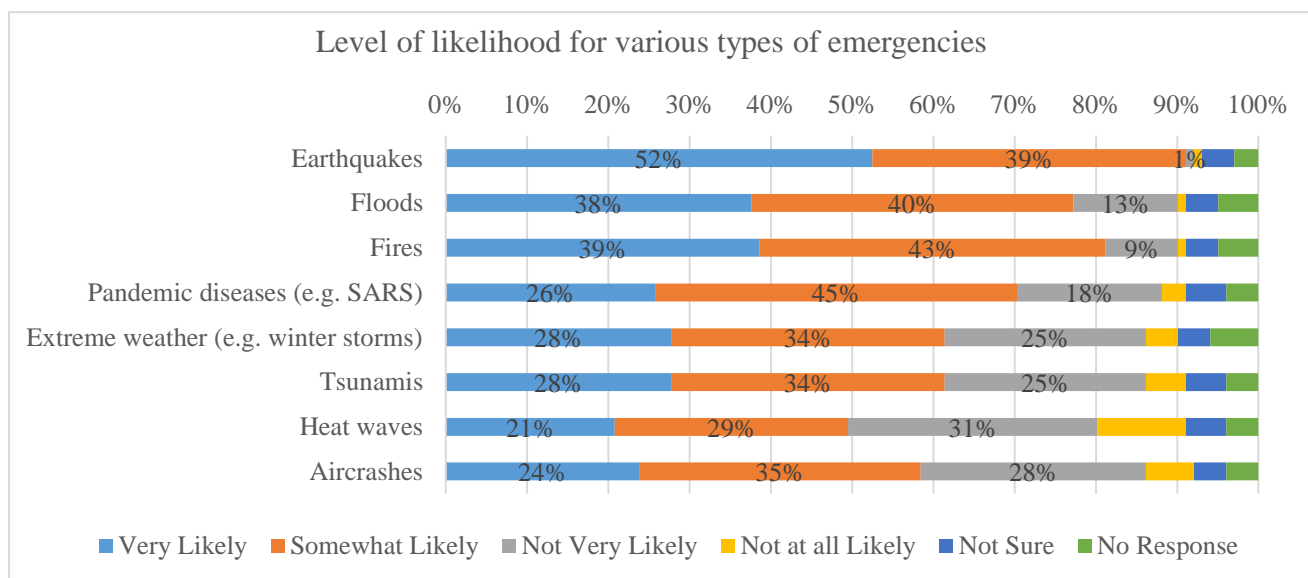


Figure 4-12. Level of likelihood survey respondents conceive disasters to directly impact their family.

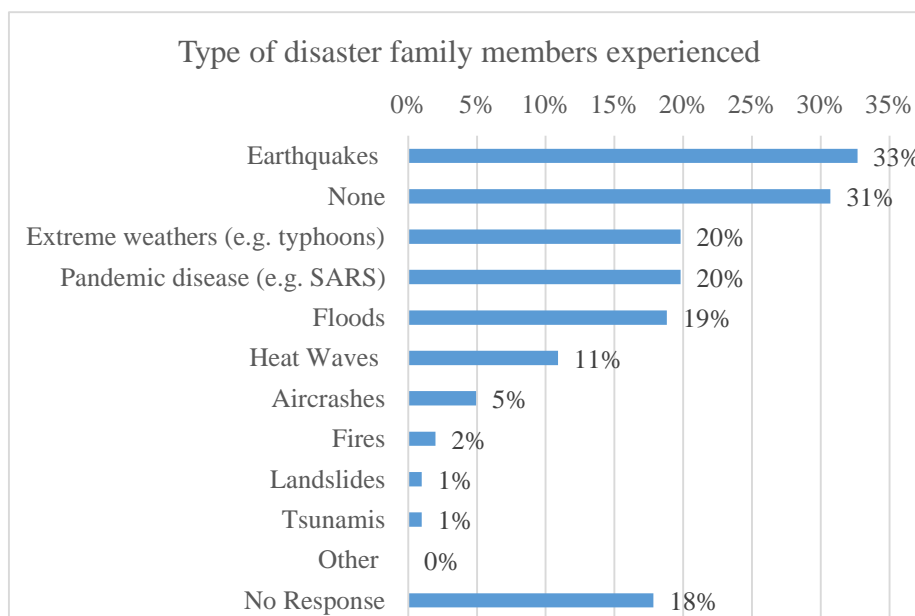
Earthquakes, fires, and floods were stated by the respondents to be the top-three disasters most likely to affect respondents' families directly (see Figure 4-12). Respondents stated pandemic disease was the fourth disaster most likely to affect them directly. Extreme weather events, tsunamis, and air crashes were stated of somewhat likely to impact respondents' families. The respondents, nonetheless, stated that heat waves are least likely to directly impact their families.

### ***Discussion of Survey Findings***

Most of the respondents are aware of all different types of potential disasters, except for heat waves, that might happen in Metro Vancouver. In general, respondents' concern regarding disasters is similar to the level of likelihood that they feel those disasters might directly impact their families. In summary, earthquakes are the type of disaster that respondents are most concerned with (89% of very or somewhat concerned; 91% of very or somewhat likely to have direct impact), whereas heat waves were the least.

### **Risk and Disaster Experience**

Earthquakes are the most experienced disaster by the respondents; 33 percent of the respondents or one of their family members have experienced earthquakes (see Figure 4-13). It is followed by extreme weather events, pandemic diseases, and floods which are experienced by 20 percent of the respondents or their families. Notably, 31 percent of the respondents or their families have never experienced any disasters.



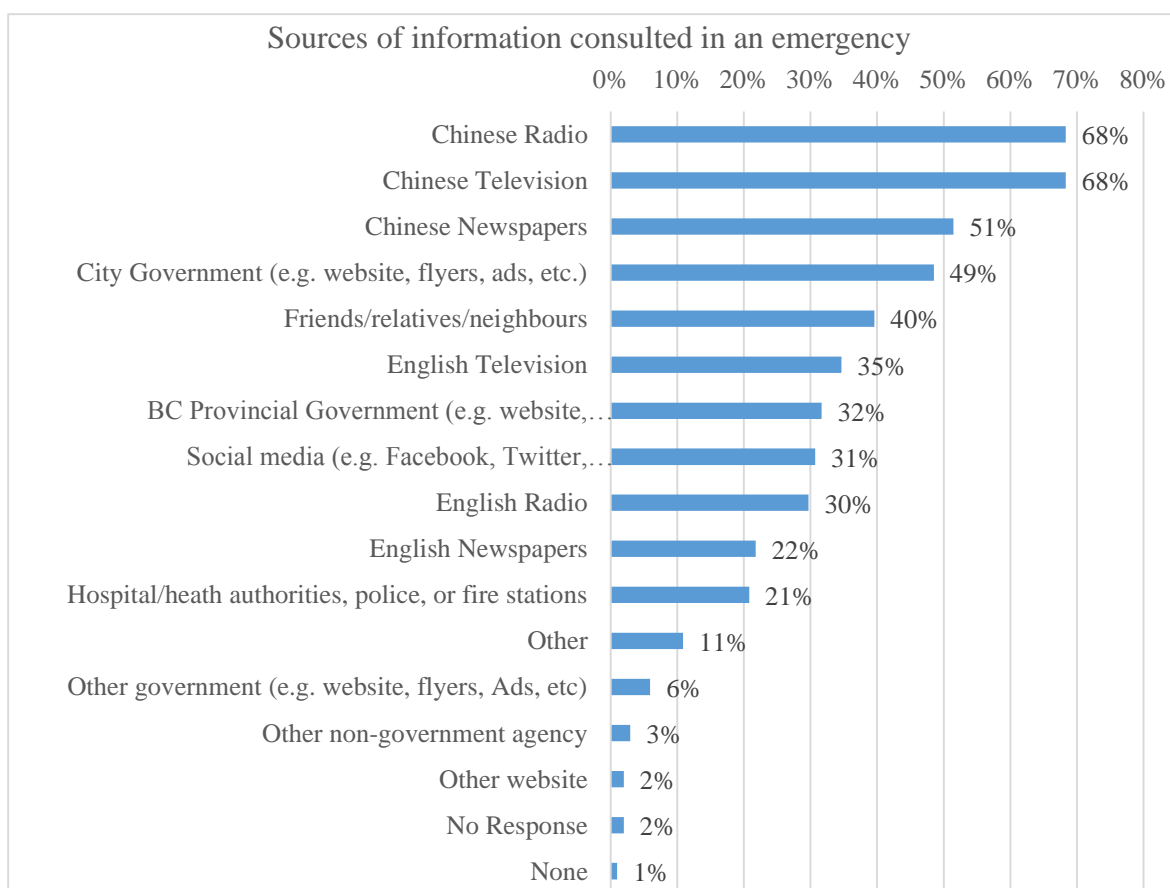
**Figure 4-13.** Disasters experienced by survey respondents or their members.

### Discussion of Survey Finding

There are 18 percent of the respondents who did not respond to this question; it is not known whether they skipped the question due to lack of experience with disasters or simply because they refused to answer the question. However, it can be seen that around half of the total respondents have experienced at least one type of disasters that might happen in Metro Vancouver. Earthquakes are the most experienced disaster by the respondents; this reflects the result of respondents' awareness of the disasters that might happen in Metro Vancouver.

### Information Source of Risk, Emergency, and Disaster

Figure 4-14 shows that Chinese radio and Chinese television are the most preferred outreach sources by the respondents (68%). Chinese newspapers and the City government are the third and fourth most preferred information sources by the respondents during an emergency event (51% and 49%, respectively). On the list of information sources before an emergency event (see Figure 4-15), respondents' most frequently preferred sources is the City government (around 80%), followed by BC Provincial government (around 50%) and friends/relatives/neighbours (around 43%).

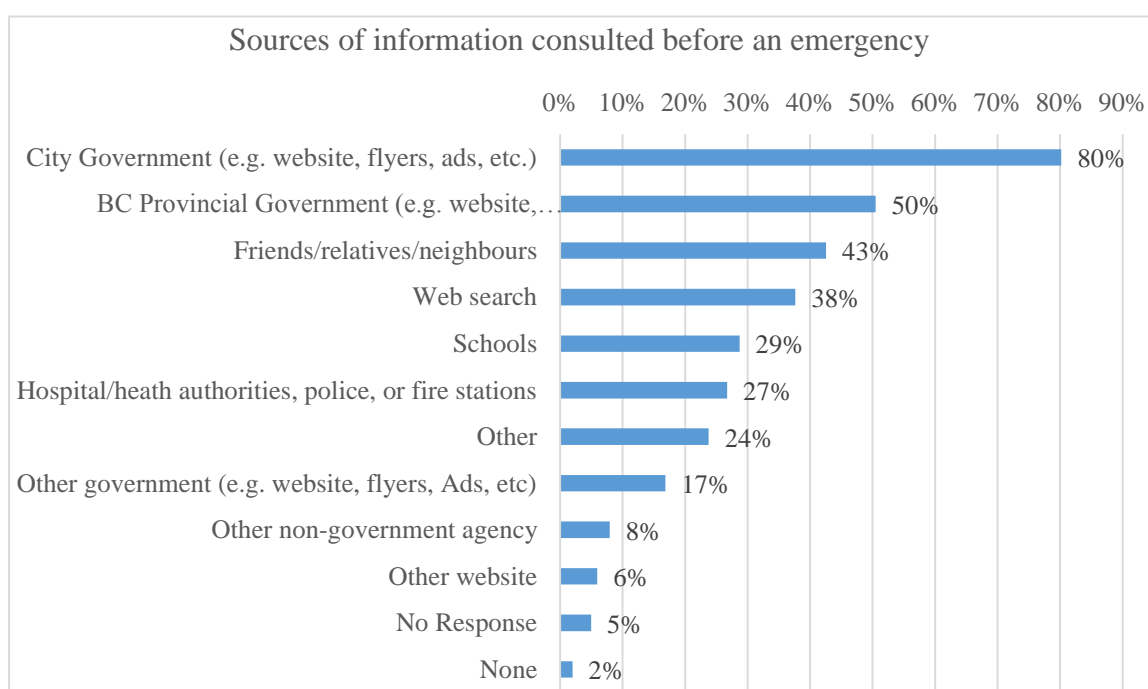


**Figure 4-14.** Survey respondents' preferred sources of information regarding emergency response.



### Discussion of Survey Findings

For the respondents, the official government (e.g. City or Provincial governments) is the most reliable and preferred source of emergency information before and during an emergency. Mass media, especially Chinese language ones, is the most preferred channel by the respondents to receive emergency information during an emergency. The application of mobile devices is also a potential tool for sharing emergency information (e.g. Chinese social media App). WeChat. Red Cross, Vancouver Coastal Health, and the S.U.C.C.E.S.S were also mentioned. Notably, every listed source of information was selected by at least some of the respondents; this indicates that it is necessary to have broader diversity of disaster risk communication tools.



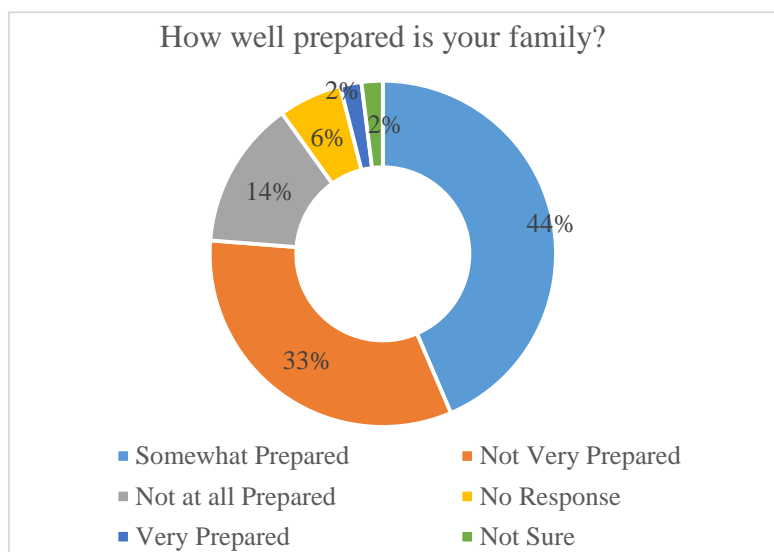
**Figure 4-15.** Survey respondents' preferred sources of information regarding emergency preparedness.

### Emergency Preparedness and Risk Reduction

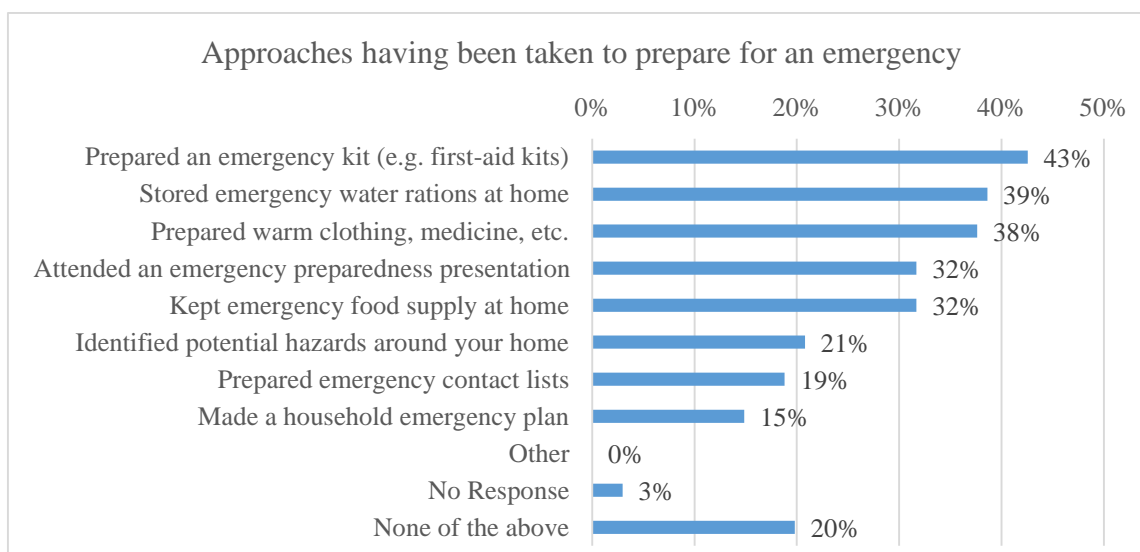
Only 46 percent of the respondents indicated their family is prepared for an emergency (44% “somewhat prepared” and 2% “very prepared”), and 47 percent of the respondents feel their families are either not very prepared (33%) or not prepared at all for an emergency (14%) (see Figure 4-16).

Figure 4-17 shows that respondents have taken emergency preparedness approaches including preparing emergency kits (43%), storing emergency water (39%), warm clothing and medicine (38%) at home, attending emergency preparedness presentations (32%) and keeping emergency food supply at home (32%). However, there are still 20 percent of the respondents' families that have not yet taken any emergency preparedness measures.

Figure 4-18 shows that having not made “it” (i.e., emergency preparedness) a priority is the most frequently reported barrier that prevents respondents’ families from emergency preparedness (34%), and 26 percent of the respondents pointed out they do not know what to do, followed by not understanding the information regarding the approaches (12%). However, 32 percent of the respondents did not respond to this question.



**Figure 4-16.** Level of preparedness for an emergency by survey respondents’ family.

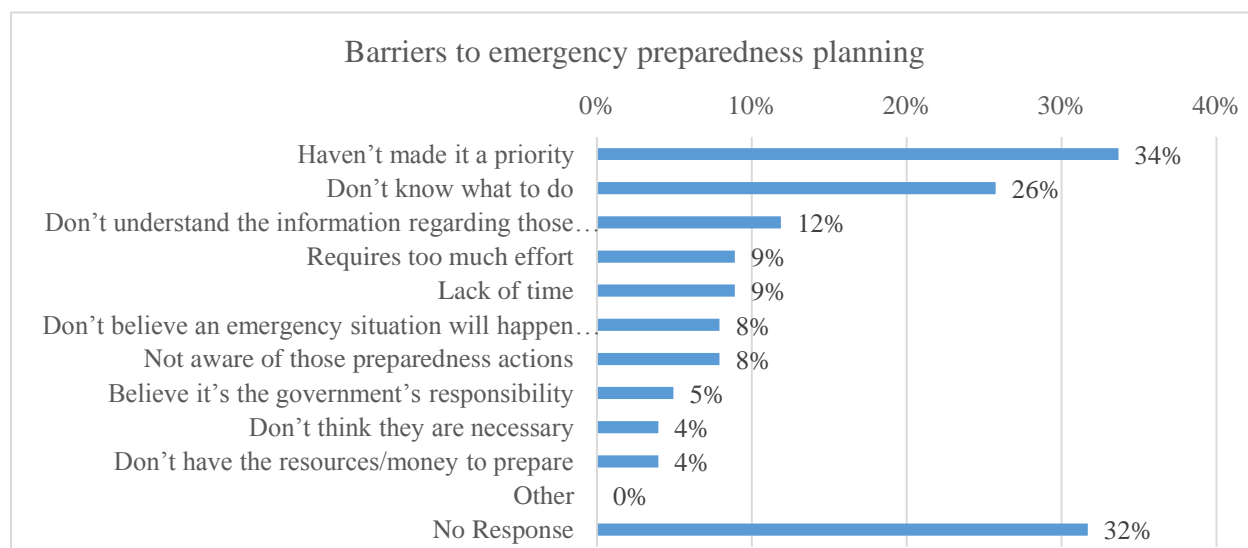


**Figure 4-17.** Emergency preparedness approaches taken in respondents’ family.

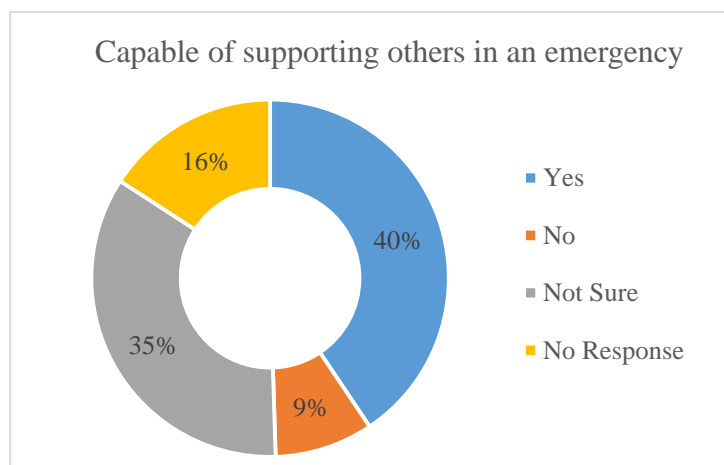
### Discussion of Survey Findings

The level of preparedness for an emergency might have been interpreted differently by the respondents, based upon their experience and level of understanding of disaster preparedness. To

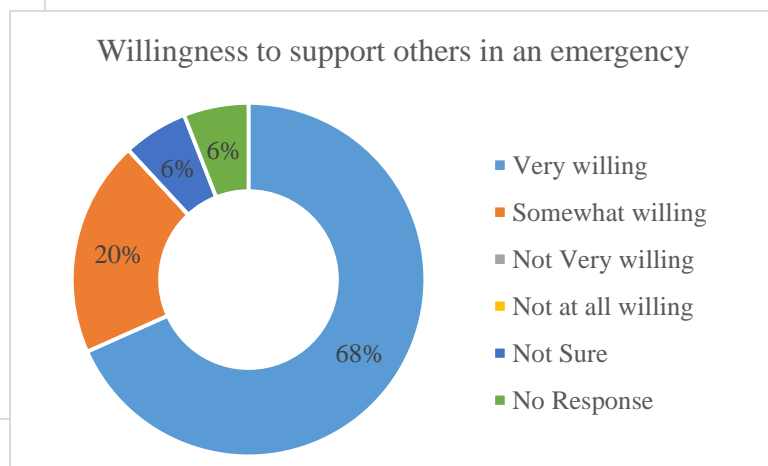
some extent, it also reflects respondents' disaster knowledge. Almost half of the respondents indicated their families are unprepared for an emergency. The main barrier seems to be their lack of interest in prioritizing emergency preparedness in their families' daily life. Even so, there are still 77 percent of the respondents' families that have taken some kind of approach to prepare for an emergency.



**Figure 4-18.** Survey respondents' barriers to emergency preparedness approaches.



**Figure 4-19.** Survey respondents' feeling of capability in supporting others in an emergency.

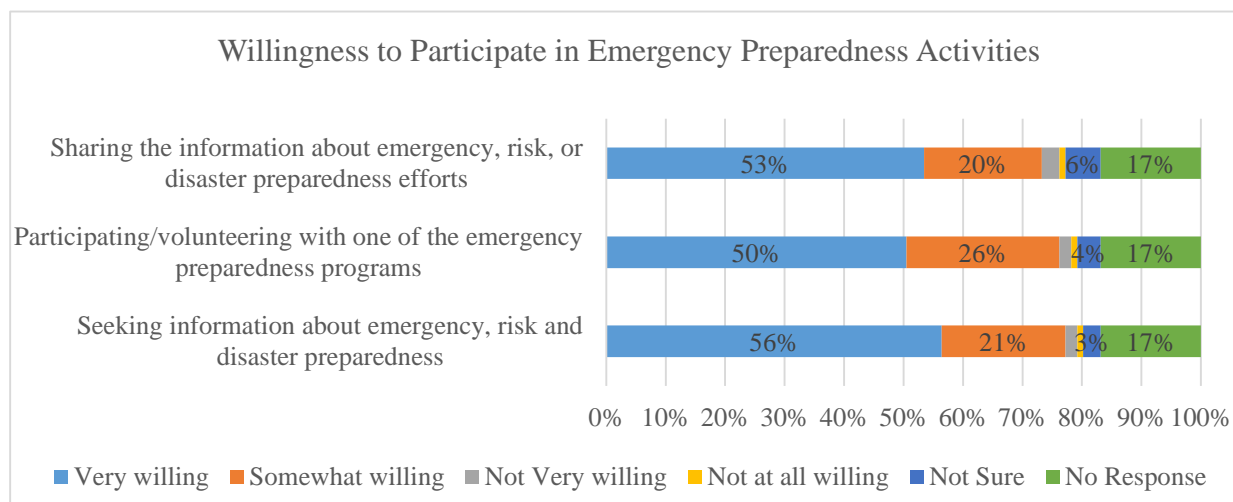


**Figure 4-20.** Survey respondents' willingness to support others in an emergency.

## Community and Public engagement

Many respondents (40%) feel their families could support others in an emergency, but 35 percent are not sure if they could be of help in an emergency (Figure 4-19). As for willingness to help in an emergency, 88 percent of the respondents are willing (very willing or somewhat willing) to

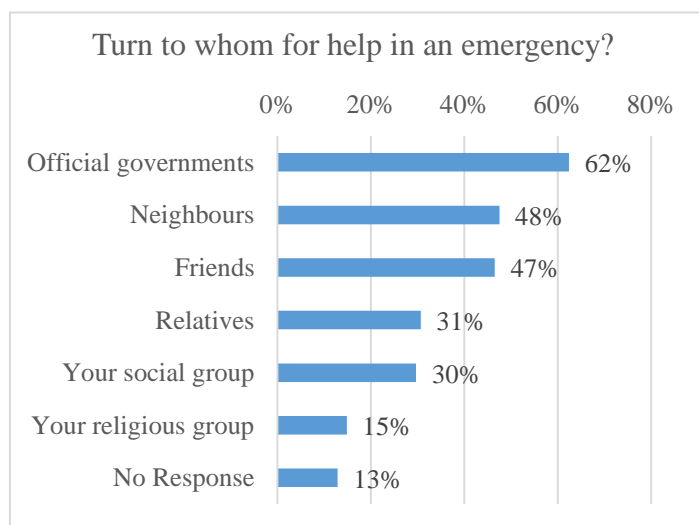
support others during an emergency (Figure 4-20). In addition, at least 73 percent or more of the respondents are willing to participate in emergency preparedness activities, such as sharing emergency information and news, participating in emergency preparedness programs, and seeking emergency relevant information (see Figure 4-21).



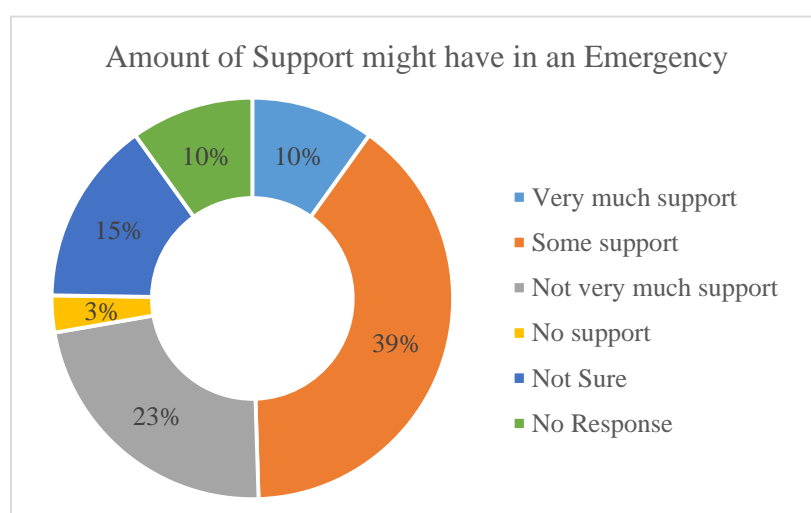
**Figure 4-21.** Survey respondents' willingness to participate in emergency preparedness activities.

### Discussion of Survey Findings

In general, a significant portion of the respondents indicated their families are capable and willing to support others in an emergency, and also willing to participate in some kind of emergency preparedness activity. This is an important finding, suggesting that the survey respondents have a high sense of community and public engagement.



**Figure 4-22.** Survey respondents' choices for support in an emergency.



**Figure 4-23.** Amount of support survey respondents felt their family might have in an emergency.

## Responding and Social Network Availability

Official governments are the top choice that the respondents (62%) would turn to for support in an emergency event (see Figure 4-22), followed by their neighbours (48%) and friends (47%). On the other hand, 10 and 39 percent of the respondents indicated their family might have very much and some support in an emergency, respectively; however, 23 and 15 percent of which stated they wouldn't have very much support or are not sure (Figure 4-23).

## Discussion of Survey Findings

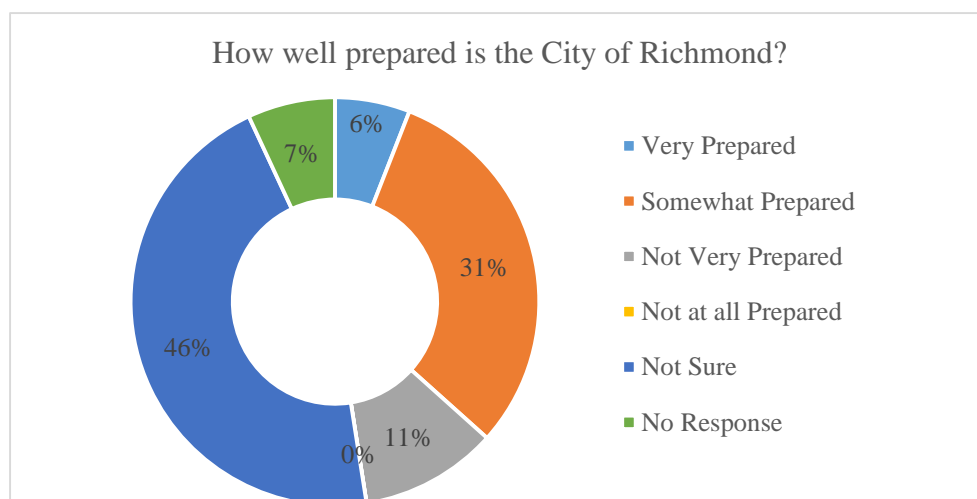
Similar to the results of source of emergency information, the respondents would rely on the official governments in responding to an emergency event. The level of social network availability can be inferred from the response of the level of support that the respondents might have during an emergency. Thus, the result presents a moderate social network availability of the respondents; nearly half of the respondents indicated they would have at least some support from others during an emergency.

## Confidence in Public Institutions

Up to 46 percent of the respondents are not sure how well prepared the City of Richmond is for an emergency. Actually, less than 36 percent of the respondents thought the City of Richmond was prepared for an emergency, and 11 percent even thought the city is not very prepared (Figure 4-24).

## Discussion of Survey Findings

Most of the respondents are still not familiar with emergency and risk management in the City of Richmond, and many of them even are not fully confident of it.



**Figure 4-24.** Survey respondents' assessments of City of Richmond's level of emergency preparedness.

#### 4.4 Limitations

The household survey has some shortcomings. First of all, participants' risk perceptions may be affected by the availability heuristic used by participants in assessing their own perceptions in the survey. For instance, respondents may report higher level of risk concern than usual upon seeing the survey questions. Second, the participants in this project (non-representative samples) cannot accurately represent the Chinese-speaking immigrants in Richmond or Metro Vancouver; the degree of risk perceptions depends on class, gender, location, and other particular conditions shaped by economic, social and political processes.

Moreover, the majority of the survey respondents are older women; the reason behind it might be that the survey were conducted on weekdays in the daytime when household breadwinners (who tends to be males) are working while female household members are more available to attend services provided by S.U.C.C.E.S.S (e.g. meetings, workshops, classes, etc.). Their responses are actually unable to represent the other gender of all family members. On the other hand, the respondents are not only talking about themselves but speaking on behalf of other family members who might actually report differently on the survey questionnaires.

Furthermore, low response rate to some questions in this survey also remains a weakness that hinders further quantitative research using regression models or statistical methods for finding correlations between the answers and respondents' demographic characteristics. Last but not least, the survey questionnaires were simplified due to the concern about the survey length; only limited questions out of all relevant questions were chosen for the survey. A lengthier and more complete questionnaire could have provided a clearer and more critical understanding of respondents' risk perceptions, but with a potential tradeoff of having a lower response rate.

## **Chapter 5: Synthesis and Discussion**

### **5.1 Project Limitations**

As Wisner et al. (2004) mentioned, social vulnerability is a complex phenomenon that is difficult to quantify, mainly because '[i]t involves a combination of factors that determine the degree to which someone's life, livelihood, property and other assets are put at risk by a discrete and identifiable event (or a series/'cascade' of such events) in nature or in society'. Moreover, there is no universally accepted way of formulating the linkages between social (i.e., human) and natural systems. In spite of the above limitations, the theoretically presumed indications of vulnerability in this project are valid, based on the findings of Fekete (2009). For instance, certain social groups like the elderly, the financially weak or the high-density area (urban) residents are higher vulnerable groups for lack of ability and resource to deal with emergency events.

On the other hand, the results of survey, which is not intended to be definitive, can at least reveal some factors contributing to the social vulnerability of the Chinese-speaking immigrants in Richmond. Therefore, the results of this project can help decision-makers, emergency managers, or planners have a concise, overall and most updated picture of the social vulnerability status (e.g. how, where and what) with respect to Chinese-speaking immigrants in Richmond and even in Metro Vancouver for constituting new risk and disaster elements in sustainable development strategies in responding to the changing environment.

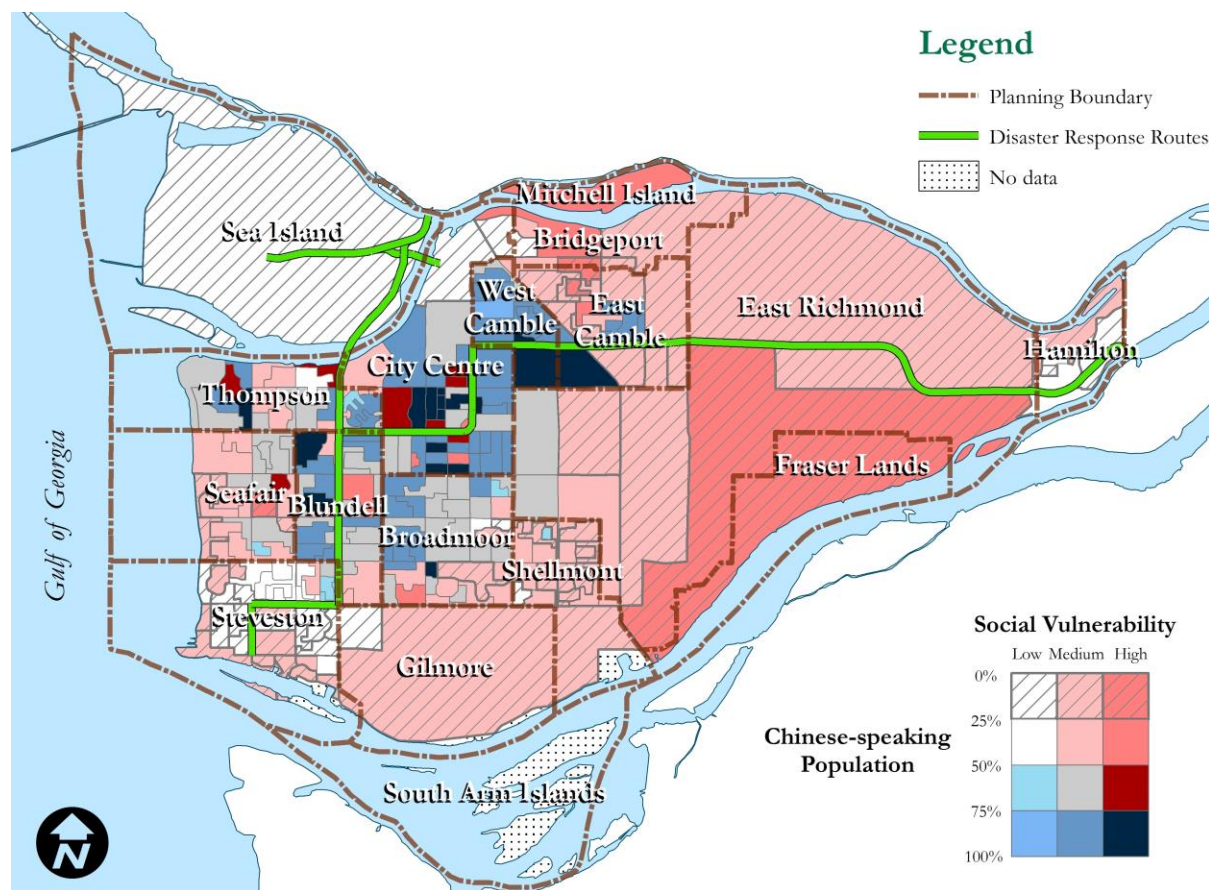
### **5.2 Chinese-speaking Immigrants' Vulnerability in Richmond**

As mentioned above, social vulnerability is composed of three components: 1) knowledge of disaster phenomenon and safety instructions, 2) risk and disaster perception, and 3) status of physical hazards and non-structural characteristics (i.e., socioeconomic, demographic, and other social factors). To probe these components associated with Richmond's Chinese-speaking residents, further analysis of the SoVI map and the risk perception survey will be discussed in this section.

Richmond's Chinese-speaking residents tend to choose to live in the west side of Richmond, especially in City Centre and its surrounding planning areas (Appendix H). Figure 5-1 shows the distribution of percentage population of Chinese-language mostly spoken at home overlapped with the overall SoVI level by dissemination areas. City Centre, West and East Cambie, Western Thompson, Blundell, and Broadmoor are shown to have both high social vulnerability and high proportion of Chinese-speaking population. To further investigate the social vulnerability of Chinese-speaking immigrants in Richmond, more analysis is needed. The correlation coefficients were calculated between the percentage population of Chinese-language mostly spoken at home and the overall SoVI score by dissemination areas, as well as between the Chinese-speaking population and each factor score. The results found limited relationship between Chinese-

language speaking population and overall social vulnerability and other SoVI factors in Richmond (correlation coefficient = 0.412; p-value = 0.000); however, Chinese-language speaking population and the factor of race and ethnicity are highly correlated, with a correlation coefficient of 0.875 (p-value = 0.000). It reflects Richmond's unique demography, which shapes Richmond's social and economic development.

This points out that Chinese-speaking immigrants are part of the social vulnerability factors in Richmond, however, it doesn't necessarily mean that Chinese-speaking immigrants in Richmond are either more or less socially vulnerable. However, social vulnerability to natural hazards is affected by multi-dimensional factors. Therefore, understanding the relative contributions of identified social factors to the overall social vulnerability presents important implications for a local community in emergency preparation response, recovery, and mitigation (Zhou et al., 2013). It is thus necessary to have further research on the Chinese-speaking immigrants in Richmond to obtain a more detailed and in-depth understanding of the social vulnerability of this population.



**Figure 5-1.** The distribution of percentage population of Chinese-language mostly spoken at home overlapped with the overall SoVI level by dissemination areas.



Although the results of the survey in this project are not intended to be definitive, they allow us to have a rough idea of Richmond's Chinese-speaking immigrants' perceptions and knowledge of risk and disaster associated with their social vulnerability. The results show that Chinese-speaking immigrants in Richmond in general are aware of the potential disasters that may happen to Metro Vancouver. Furthermore, around 50 percent of them and their family members have experienced at least one among the potential disasters that might happen in Richmond (see Chapter 4).

Chinese-speaking immigrants also show a high level of willingness to support others in an emergency and to participate in emergency preparedness activities, indicating that they are supportive of the community and public engagement. However, the survey also shows that having more attention on improving Richmond's Chinese-speaking immigrants' social network availability and level of emergency preparedness is necessary. Finally, Chinese-speaking immigrants in Richmond indicated a high level of dependency on the official government as a source of emergency information and a provider of help in an emergency event. Nonetheless, it is also found out that they lack confidence or feel uncertain regarding emergency management in the City of Richmond.

## **Chapter 6: Next Step: Planning Implications & Recommendations**

Taking into account the perspectives and knowledge of different cultural and ethnic groups is integral to understanding emergency preparedness and risk management for sustainable livelihood development. This section presents the applications of the results of this project, and provides short-, mid-, and long-term recommendations on improving the emergency preparedness and risk management in the City of Richmond and Metro Vancouver as a whole. Further potential studies, based on the findings of this project, are also discussed at the end of this section.

### **6.1 Planning Implications**

The findings of this project can be utilized in practice for moving forward to sustainable livelihood development in the local community (i.e., the City of Richmond), and can also be taken as a reference in a larger scale (since Chinese-speaking populations are one of the largest ethnic communities in Metro Vancouver) for its disaster and risk management planning of all four disaster preparedness phases - mitigation, preparedness, response, and recovery. A broader picture of vulnerability with respect to sustainable development can also be filled with the valuable information provided by this project regarding the identification of geographically differential vulnerability in Richmond.

The results of the social vulnerability index (SoVI) model identified key social vulnerability factors in Richmond, producing the social vulnerability maps. These maps have also highlighted areas with high levels of overall social vulnerability and different social vulnerable factors in an emergency event. In addition, this project has also increased basic understanding of the Chinese-speaking immigrants' perceptions, experiences, and knowledge of risk and disaster in Richmond, which is critical for effective disaster risk communication and education strategies. When combined with additional municipal data, such as resource accessibility (e.g. information, political power, healthcare), infrastructure services (e.g. lifeline), building stock, or individual health status, the abovementioned information from this project can benefit further assessment of potential needs in highly vulnerable areas in Richmond, as well as for developing programs tailored to specifically meet those needs.

As mentioned in Turner et al. (2003), comprehensive vulnerability assessment helps direct attention to coupled human-environment systems. The connection between community's sustainability and its vulnerability is inseparable and sensitive with its spatiotemporal and functional scales (ibid.). The analysis of current local disaster and risk management in Richmond in Chapter 2 indicates that current emergency preparedness and response services and materials do not coordinate with the special socioeconomic and demographic characteristics in Richmond. Hence, by building upon the benefits of the applications of social vulnerability studies, many potential opportunities for better outcomes can be realized; higher vulnerable communities

would benefit from the applications linking different socioeconomic and demographic factors, disaster risk reduction and development efforts.

## **6.2 Recommendations and Moving Forward**

Some recommendations are presented in this section to emergency and risk management in the City of Richmond for possible action steps. These recommendations are in line with the ultimate goals and objectives of this project for achieving livelihood sustainability development in Metro Vancouver as a whole. It is expected that the project will be used by various stakeholders in disaster management at the regional and municipal scales. Broadly speaking, users of this project may include:

- Government organizations
- NGOs in Richmond (e.g. Chinese-speaking community associations, temples, charities, etc.)
- Richmond Red Cross
- Donor agencies
- Other stakeholders working on disaster management and community development in Richmond as well as Metro Vancouver.

The main focus of the recommendations as a result of this work are to:

- 1) Promote local disaster and risk management programs with possible preventive hard and soft measures to address the unique cultural, socioeconomic, and demographic characteristics of Richmond residents.
- 2) Strengthen awareness in the community about the need to implement actions that encourage local population to prioritize risk and emergency preparedness in their households, in order to prevent a “big one” in the future.
- 3) Facilitate local community engagement and public participatory process throughout the emergency management cycle, both educationally and culturally in Richmond.
- 4) Improve communication strategies with technical and social information about emergency issues and topics.
- 5) Support building trust in the public sectors and building a culture of safety and resilience in Richmond.

It is therefore highly recommended that Richmond should take the following actions:

### **In the short term (less than 2 years)**

1. Increase local communities’ risk management capacity and awareness by providing targeted audience with effective emergency information and preparedness sessions (i.e., public education campaigns) and delivery systems (e.g. Chinese TV, radio, newspapers,

etc.) with more appropriate materials (e.g. in Chinese language or more visual and graphic messages).

- Meanwhile, community members' emergency responding behaviors can also be induced to desired direction so as to reduce the risks of emergency events.
  - It in turn will encourage the local populations to prioritize risk reduction and emergency preparedness in their household plans.
2. Enhance community participation and engagement through empowerment by promoting community members to participate in emergency preparedness activities, and receiving feedback from the grassroots through further household surveys, workshops or open house events.
    - The inputs for risk reduction planning can be gained, which is beneficial to developing indicators for monitoring and evaluation of changes in vulnerability and capacity of the community (Twigg, 2007).
    - By giving affected communities a voice and recognizing their further risk perception, meaningful disaster risk management and long-term sustainable livelihood security can be achieved to address the local specific needs.
  3. Improve risk communication and strategies of disaster/emergency response and recovery by taking into account the findings of this project, in order to address the unique cultural diversity in Richmond for efficacy in risk reduction policies and local community resilience.
    - Part of this can be done by a centralised information system or a common standardised communication system in Cantonese and Mandarin among the disaster risk management function, intra-governmental and inter-agency interactions (i.e., culture and diversity department, NGOs) and local communities (i.e., Chinese-speaking population).
  4. Finalize the comprehensive vulnerability map by overlaying both social factors (i.e., the result of this project) and potential hazard exposures.
    - With this map, the needs of both Richmond's physical and social resource (e.g. human and financial) can be determined, mobilized and allocated to ensure the implementation of risk management measures, especially for the areas of higher vulnerability.
  5. Build trust and share the most updated information with communities' key stakeholders in a simplified way and in different languages on what people should be aware and understood for emergency and risk managements in Richmond's local conditions.

6. Compare the results of the survey in this project with other similar surveys that were tested on other cultural or ethnic groups in Metro Vancouver<sup>21</sup>, so as to conduct disaster risk management more effectively by understanding the difference of risk perceptions, experiences, and behaviors within different cultures and ethnic groups.

### **In the mid-term (2 to 4 years)**

1. Inspect and build a network with local NGOs, community-based and faith-based organizations, and the private sectors (e.g. religious and cultural groups), to assist disaster risk management.
  - The network of racial and ethnic minorities will allow better communication, relationships, effective partnerships, and safer communities with higher mutual trust.
  - Build relationship between the local Chinese-language communities and the Emergency Social Service Team in Richmond to provide better fit in emergency preparedness, response, and recovery services. For example, setting up community kitchens for people in the evacuation centres can address cultural diversity after a disaster event.
  - Explore ways to facilitate and engage minority communities in emergency preparedness. Minority communities can help themselves prepare better in many ways due to their sharing of similar culture and closer network.
2. Build partnership with academic and research institutions to conduct further studies on updated situations of vulnerability and capacity in Richmond, with the focus on its social demography and special role (i.e., Chinese-cultural community) in Metro Vancouver.
  - Similar studies of risk perception on people outside of Richmond could be conducted. Since censuses are normally conducted for where people live (at night), not necessarily, where they work, visit, shop, do leisure activities, study, etc. (daytime), the census may severely underestimate the likely affected population if a disaster occurs during the day.
  - Understand further Chinese communities' social networks including the transportation, social care services (e.g. child and day care, health care, etc.), and even entertainment to strengthen disaster response and recovery management.
  - Weighted social vulnerability model should be developed to better reflect the local conditions of social vulnerability by interviews and discussions with experts, decision makers, and other key stakeholders.

---

<sup>21</sup> e.g. The Emergency Preparedness Questionnaire: Topline Report. Prepared for John Chapman, on May 2014.

3. Encourage both private and public schools in Richmond to enhance community emergency preparedness education and information delivery to improve emergency preparedness efficacy through students' networks, their families.
4. Inspect and upgrade the capacity and resilience of the emergency/evacuation facilities and shelters in Richmond (e.g. fire halls, community centres, schools, religious centres, etc.) to cope with the population growth and reduce post-disaster impacts.
  - Establish an inventory of possible local emergency shelters, including religious centres like temples, churches, or mosques.
5. Continue promoting residents' level of English literacy and ability, and implement English literacy assessment (i.e., reading and listening level) at the local scale to understand the current situation of official language education in Richmond.
  - Incorporate disaster-related terms, concepts, or themes into the curriculums of English classes (e.g. conversation, reading, listening, etc.) to provide learners with substantive topics relevant to emergency preparedness and response.

#### **In the long-term (more than 4 years)**

1. Build a culture of safety and resilience in Richmond (OECD, 2010).
  - Reinforce legitimacy of public sector initiatives such as the investment in more resilient infrastructures, the provision of cooperation with neighbouring municipalities, academic and cultural institutions, and provincial government sectors for disaster risk reduction research, and the introduction of more strict compulsory measures, such as land-use planning and stricter building codes.
  - Build public acceptance for stricter regulations and insurance programs for risk reduction, such as hazard insurance or fund.
2. Update measures of structural, non-structural, and disaster risk reduction across the different stages of the disaster life cycles with the above mentioned strategies (Dash, 2010). Appendix I summarizes the list of disaster risk reduction measures that can be combined with the work of this project.
3. Continue the process of monitoring and evaluating the efficacy of the above strategies, so as to further reduce the underlying risk and vulnerability factors in the long term.

## Chapter 7: Summary

Today, one of the most challenging disaster and risk management issues for First World countries like Canada is addressing the rapid dynamics of change with respect to the complex socioeconomic and demographic characteristics. The combination of these complex elements of life and livelihood generates social vulnerability, the factors of which vary in time, spatial scale and location. As an environmental justice issue, it is essential for local policy makers to understand that considering demographic and socioeconomic composition of the local community members is critical to effectively mitigating the impact of disasters at the city level.

This study assesses one of the components of vulnerability (e.g. exposure, sensitivity, and adaptive capacity) – social vulnerability – using various research methods, with a case study focus on the City of Richmond, British Columbia. The City of Richmond has a unique socioeconomic and demographic composition due to its high proportion of Chinese-speaking residents, and has played an important role as a cultural centre in the Chinese-speaking community of Metro Vancouver. With this in mind, this study has not only assessed the general social vulnerability in Richmond, but also has focused on its Chinese-speaking immigrants' perceptions and knowledge of risk and disaster, as well as their experiences with it, to further reveal their hidden social vulnerability.

There are three methods used in this project to conduct the social vulnerability assessment: literature and policy review (i.e., plans, policies, other City documents, etc.), the Social Vulnerability Index (SoVI) Model (applied at the scale of 2011 Census Data of Dissemination Areas), and a household-level survey (with 101 responses in total). The findings of each method are presented as follow:

1. The literature review shows that even though the emergency programs in Richmond have been developed throughout the emergency cycle, the current emergency programs do not fully address the unique and diverse social characteristics and culture in Richmond, especially as concerns the provision of emergency materials, education and services in different languages (see Chapter 2); almost all the materials (e.g. publications, websites, information) regarding the emergency cycle (i.e., mitigation, preparedness, response and recovery) are only available in English.
2. Based on 34 possible vulnerability variables, the SoVI model indicated eight main social vulnerability factors that Richmond is facing (see Chapter 3): 1) *household, dwelling, and density of built environment*, 2) *socioeconomic status*, 3) *race and ethnicity*, 4) *population age*, 5) *occupation, education, and social dependence*, 6) *population change and mobility*, 7) *emergency services*, and 8) *single family and housing quality*. The model also maps and highlights the areas of highest social vulnerability, including Richmond City Centre, East Cambie, Seafair, Blundell, Broadmoor, East Richmond, and Fraser Lands (Chapter 3). In addition, Chinese-speaking immigrants are part of the social

vulnerability landscape in Richmond. The identified social vulnerability factors are consistent with the broader hazards literature, confirming this result of the SoVI.

3. The results of the survey provided in Chapter 4 reveal that:

- 1) Most of the Chinese-speaking respondents are aware of all potential hazards in Metro Vancouver in terms of their level of concern and level of likelihood their households might directly have impact from those disasters, if any. Respondents were most aware of the possibility of earthquake, and least aware of the possibility of a heat wave;
- 2) Around 50 percent of the respondents indicated that they and/or members of their families have experienced one or more than hazard types that might strike Metro Vancouver. Notably, 33 percent have experienced earthquakes;
- 3) Government authorities play a paramount role in emergency full-cycle management for the respondents as a source of information, organizer of preparedness activities, and provider of emergency responses and recovery;
- 4) Almost half the respondents' families are not yet prepared for an emergency. A primary barrier to emergency preparedness was a lack of interest among respondents in prioritizing emergency preparedness in their daily lives;
- 5) The respondents showed a high-level sense of community and public engagement in terms of willingness to support others in an emergency and to participate in emergency preparedness activities;
- 6) The respondents, majority are first-generation immigrants, indicated moderate levels of social networks being available to their families; and
- 7) Respondents indicated high unfamiliarity and low confidence towards the City's emergency programs, suggesting a challenge in addressing social vulnerability in Richmond.

Based on the findings, a set of recommendations is presented to reduce current social vulnerability with respect to disaster and risk management in Richmond (Chapter 6), specifically it is recommended that the City:

1. Promote local disaster and risk management programs with possible preventive hard and soft measures to address the unique cultural, socioeconomic, and demographic characteristics of Richmond residents.
2. Strengthen awareness in the community about the need to implement actions that encourage local populations to prioritize risk and emergency preparedness in their households, in order to prevent a "big one" in the future.



3. Facilitate local community engagement and public participatory process throughout the emergency management cycle, both educationally and culturally in Richmond.
4. Improve communication strategies with technical and social information about emergency issues and topics.
5. Support building trust in the public sectors and building a culture of safety and resilience in Richmond.

To conclude, social vulnerability to natural hazards is affected by multi-dimensional factors. Therefore, understanding the relative contributions of identified social factors (including the risk perceptions of the local residents) to the overall social vulnerability presents important implications for a local community in emergency preparation response, recovery, and mitigation. It is hoped that the City of Richmond and Metro Vancouver as a whole can be closer to the sustainable livelihood development with the findings of this project.

## Bibliography

- Adams, J., & Halchuk, S. (2004). A review of NBCC 2005 seismic hazard results for Canada - the interface to the ground and prognosis for urban risk mitigation. In *57th Canadian Geotechnical Conference* (p. Session 6C). Quebec: Natural Resources Canada.
- Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, 16(3), 268–281. doi:10.1016/j.gloenvcha.2006.02.006
- BC MFLNRO. (2014). *Simulating the Effects of Sea Level Rise and Climate Change on Fraser River Flood Scenarios Final Report* (p. 202).
- Beck, E., André-Poyaud, I., Davoine, P.-A., Chardonnel, S., & Lutoff, C. (2012). Risk perception and social vulnerability to earthquakes in Grenoble (French Alps). *Journal of Risk Research*, 15(10), 1245–1260. doi:10.1080/13669877.2011.652649
- Birkmann, J. (2006). Measuring vulnerability to promote disaster-resilient societies : Conceptual frameworks and definitions. In J. Birkmann (Ed.), *Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies* (1st ed., Vol. 01, pp. 7–54). United Nations University Press.
- Carter-Pokras, O., Zambrana, R. E., Mora, S. E., & Aaby, K. a. (2007). Emergency preparedness: knowledge and perceptions of Latin American immigrants. *Journal of Health Care for the Poor and Underserved*, 18(2), 465–81. doi:10.1353/hpu.2007.0026
- Cassidy, J. F., & Rogers, G. C. (2004). Variation in ground shaking on the Fraser River delta ( Greater Vancouver , Canada ) from analysis of moderate earthquakes. In *13th World Conference on Earthquake Engineering* (p. 7). Vancouver: Natural Resources Canada.
- CECI. (2011). *Framework on community based disaster risk management in Vietnam* (pp. 1–85). Retrieved from <http://www.preventionweb.net/english/professional/publications/v.php?id=21159>
- Chang, S. E., Gregorian, M., Pathman, K., Yumagulova, L., & Tse, W. (2012). Urban growth and long-term changes in natural hazard risk. *Environment and Planning*, 44(4), 989–1008. doi:10.1068/a43614
- City of Richmond. (2008). *Evacuation Plan*. Richmond.
- City of Richmond. (2010). *Emergency Management Plan* (p. 211). Richmond. Retrieved from [http://www.richmond.ca/\\_\\_shared/assets/emergency\\_management\\_plan23713.pdf](http://www.richmond.ca/__shared/assets/emergency_management_plan23713.pdf)
- City of Richmond. (2011a). *Business Disaster Response & Recovery Guide* (p. 83). Richmond. Retrieved from [http://www.richmond.ca/\\_\\_shared/assets/recovery8645.pdf](http://www.richmond.ca/__shared/assets/recovery8645.pdf)
- City of Richmond. (2011b). Planning Overview. Retrieved August 09, 2014, from <http://www.richmond.ca/safety/prepare/city/overview.htm>
- City of Richmond. (2013a). *District Literacy Plan: Richmond 2013* (Vol. 38, pp. 1–5). Richmond.
- City of Richmond. (2013b). Flood Protection in Richmond. Retrieved August 11, 2014, from <http://www.richmond.ca/safety/prepare/city/hazards/flood.htm>
- City of Richmond. (2014a). *Ethnicity Hot Facts* (p. 4). Richmond. Retrieved from [http://www.richmond.ca/\\_\\_shared/assets/2006\\_Ethnicity20987.pdf](http://www.richmond.ca/__shared/assets/2006_Ethnicity20987.pdf)
- City of Richmond. (2014b). *Immigration Hot Facts* (p. 3). Richmond. Retrieved from [http://www.richmond.ca/\\_\\_shared/assets/Immigration6252.pdf](http://www.richmond.ca/__shared/assets/Immigration6252.pdf)
- City of Richmond. (2014c). Population & Demographics. Retrieved August 10, 2014, from <http://www.richmond.ca/discover/about/demographics.htm>

- City of Richmond. (2014d). *Population Hot Facts* (p. 5). Richmond. Retrieved from [http://www.richmond.ca/\\_\\_\\_shared/assets/Population\\_Hot\\_Facts6248.pdf](http://www.richmond.ca/___shared/assets/Population_Hot_Facts6248.pdf)
- Clague, J. J., & Orwin, J. (2005). *Tsunami Hazard to North and West Vancouver, British Columbia* (p. 25).
- Cutter, S. L. (1996). Vulnerability to Environmental Hazards. *Progress in Human Geography*, 20(4), 529–539. doi:10.1177/030913259602000407
- Cutter, S. L. (2010). Geophysical Hazards. doi:10.1007/978-90-481-3236-2
- Cutter, S. L. (2011). The SoVI Recipe.
- Cutter, S. L., Carolina, S., Boruff, B. J., & Shirley, W. L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*, 84(2), 242–261.
- Cutter, S. L., Emrich, C. T., Mitchell, J. T., Boruff, B. J., Gall, M., Schmidtlein, M. C., ... Melton, G. (2006). The Long Road Home: Race, Class, and Recovery from Hurricane Katrina. *Environment: Science and Policy for Sustainable Development*, 48(2), 8–20. doi:10.3200/ENV.48.2.8-20
- Cutter, S. L., & Finch, C. (2008). Temporal and spatial changes in social vulnerability to natural hazards. *Proceedings of the National Academy of Sciences of the United States of America*, 105(7), 2301–6. doi:10.1073/pnas.0710375105
- Cutter, S. L., Mitchell, J. T., & Scott, M. S. (2000). Revealing the vulnerability of people and places: a case study of Georgetown County, South Carolina. *Annals of the Association of ...*, 90(4), 713–737. Retrieved from <http://onlinelibrary.wiley.com/doi/10.1111/0004-5608.00219/abstract>
- Dake, K. (1991). Orienting Dispositions in the Perception of Risk: An Analysis of Contemporary Worldviews and Cultural Biases. *Journal of Cross-Cultural Psychology*, 22(1), 61–82. doi:10.1177/0022022191221006
- Dash, N. (2010). Race and Ethnicity. In B. D. Phillips, D. S. K. Thomas, A. Fothergill, & L. Blinn-Pike (Eds.), *Social Vulnerability to Disasters* (p. 406). New York: CRC Press.
- Donner, W., & Rodríguez, H. (2008). Population Composition, Migration and Inequality: The Influence of Demographic Changes on Disaster Risk and Vulnerability. *Social Forces*, 87(2), 1089–1114. doi:10.1353/sof.0.0141
- Dunning, C. M., & Durden, S. (2011). *Social Vulnerability Analysis Methods for Corps Planning* (p. 105).
- Elder, K., Xirasagar, S., Miller, N., Bowen, S. A., Glover, S., & Piper, C. (2007). African Americans' decisions not to evacuate New Orleans before Hurricane Katrina: a qualitative study. *American Journal of Public Health*, 97 Suppl 1, S124–9. doi:10.2105/AJPH.2006.100867
- Etkin, D. (1998). Climate Change and Extreme Events: Canada. In *Canada Country Study: Climate Impacts and Adaptation* (Volume VII., pp. 35–82). Ottawa: Environmental Canada.
- Fekete, A. (2009). Validation of a social vulnerability index in context to river-floods in Germany. *Natural Hazards and Earth System Science*, 9(2), 393–403. doi:10.5194/nhess-9-393-2009
- Fekete, A., Damm, M., & Birkmann, J. (2009). Scales as a challenge for vulnerability assessment. *Natural Hazards*, 55(3), 729–747. doi:10.1007/s11069-009-9445-5
- Fox, J. C. (2008). *Vulnerable Populations: A Spatial Assessment of Socail Vulnerability to Earthquakes in Vancouver, British Columbia*. University of British Columbia.

- Fuchs, S., Birkmann, J., & Glade, T. (2012). Vulnerability assessment in natural hazard and risk analysis: current approaches and future challenges. *Natural Hazards*, 64(3), 1969–1975. doi:10.1007/s11069-012-0352-9
- Gares, C. E., & Montz, B. E. (2014). Disaster Vulnerability of Migrant and Seasonal Farmworkers: A Comparison of Texas and North Carolina. *Southeastern Geographer*, 54(1), 36–54. doi:10.1353/sgo.2014.0000
- Gierlach, E., Belsher, B. E., & Beutler, L. E. (2010). Cross-cultural differences in risk perceptions of disasters. *Risk Analysis*, 30(10), 1539–49. doi:10.1111/j.1539-6924.2010.01451.x
- Groulx, B. J., Mosher, D. C., Luternauer, J. L., & Bilderback, D. E. (2004). *Fraser River Delta, British Columbia: Issues of an Urban Estuary* (Bullentin., p. 317). Natural Resources Canada.
- Holand, I. S., Lujala, P., & Rød, J. K. (2011). Social vulnerability assessment for Norway: A quantitative approach. *Norsk Geografisk Tidsskrift - Norwegian Journal of Geography*, 65(1), 1–17. doi:10.1080/00291951.2010.550167
- Jones, E. C., Faas, A. J., Murphy, A. D., Tobin, G. a, Whiteford, L. M., & McCarty, C. (2013). Cross-cultural and site-based influences on demographic, well-being, and social network predictors of risk perception in hazard and disaster settings in Ecuador and Mexico: predictors of risk perception in hazard and disaster settings in Ecuador and Mexic. *Human Nature*, 24(1), 5–32. doi:10.1007/s12110-013-9162-3
- Lindell, M. K., Prater, C., & Perry, R. W. (2007). *Introduction to Emergency Management* (1st ed.). Wiley.
- Lindell, M. K., & Prater, C. S. (2004). Assessing Community Impacts of Natural Disasters, 4(4).
- Lutemauer, J. L., Barrie, J. V, Christian, H. A., Clague, J. J., Evoy, R. W., Hart, B. S., ... Woeller, D. J. (1994). Fraser River delta : geology , geohazards and human impact. *Geological Survey of Canada*, (Bulletin 481), 197–220.
- Massmann, F., & Wehrhahn, R. (2014). Qualitative social vulnerability assessments to natural hazards: examples from coastal Thailand. *Revista de Gestão Costeira Integrada*, 14(1), 3–13. doi:10.5894/rgci418
- McBean, G., & Henstra, D. (2003). *Climate Change, Natural Hazards and Cities* (p. 18). Toronto. Metro Vancouver. (2010). *Regional Growth Strategy Metro Vancouver 2040: Shaping Our Future* (p. 73).
- Mileti, D. S., & Gailus, J. L. (2005). Sustainable Development and Hazard Mitigation in the United States: Disasters by Design Revisited, 1999, 491–504.
- Morrow, B. H. (1999). Identifying and mapping community vulnerability. *Disasters*, 23(1), 1–18. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/10204285>
- Morrow, B. H. (2010). Language and Literacy. In B. D. Phillips, D. S. K. Thomas, A. Fothergill, & L. Blinn-Pike (Eds.), *Social Vulnerability to Disasters* (p. 406). New York: CRC Press.
- Noriega, G. R., & Ludwig, L. G. (2012). Social vulnerability assessment for mitigation of local earthquake risk in Los Angeles County. *Natural Hazards*, 1341–1355. doi:10.1007/s11069-012-0301-7
- Novelo-casanova, D. A., Antonio-nakamura, Y. A., Valdés-pérez, V., & Pineda-loperena, G. (2012). Measuring Social Vulnerability from Risk Perception Case Study: The Nonoalco-tlateloloco Housing Complex Deamaged During the Mexian 1985 Major Earthquake. *Humanities and Social Sciences Review*, 1(4), 253–262.

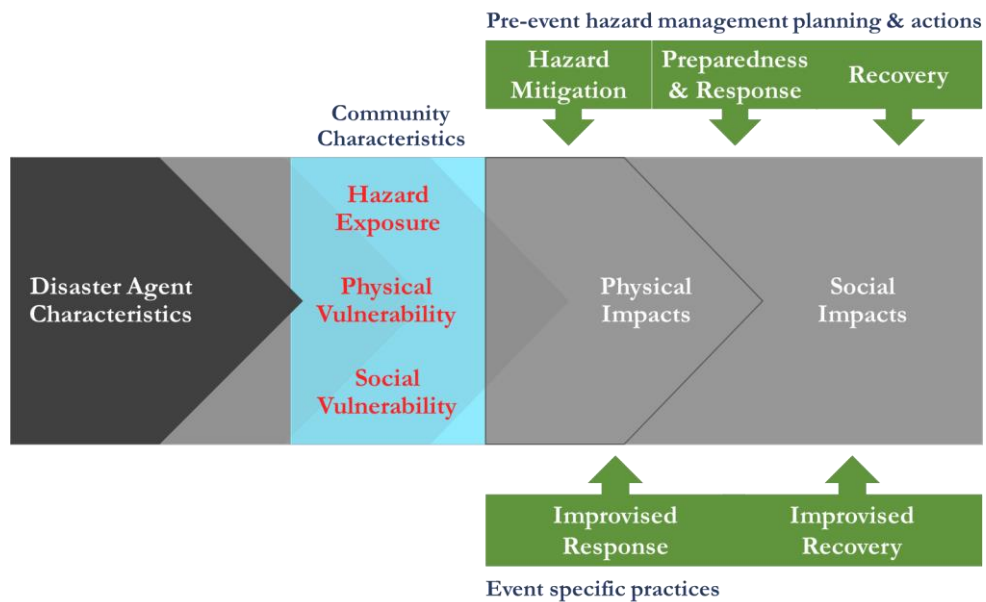
- OECD. (2010). *Policy Handbook on Natural Hazard Awareness and Disaster Risk Reduction Education* (p. 26).
- Perrow, C. (2007). Shrink the Targets. In *Charles Perrow: The Next Catastrophe*. Princeton University Press.
- Phillips, B. D., & Fordham, M. (2010). Introduction. In B. D. Phillips, D. S. K. Thomas, A. Fothergill, & L. Blinn-Pike (Eds.), *Social Vulnerability to Disasters* (p. 406). New York: CRC Press.
- Prelog, A. J., & Miller, L. M. (2013). Perceptions of Disaster Risk and Vulnerability in Rural Texas. *Journal of Rural Social Sciences*, 28(3), 1–31.
- Rothman, D. S., Demeritt, D., Chiotti, Q., & Burton, I. (1998). Costing Climate Change: The Economics of Adaptations and Residual Impacts for Canada. In *Canada Country Study: Climate Impacts and Adaptation* (Volume VII., pp. 1–30). Ottawa: Environmental Canada.
- Slovic, P. (1987). Perception of risk. *Science*, 236(4799), 280–258. Retrieved from <http://www.sciencemag.org/content/236/4799/280.short>
- Statistics Canada. (2012a). *2011 National Household Survey*. Greater Vancouver and Richmond. Retrieved from <http://www12.statcan.gc.ca/nhs-enm/2011/dp-pd/prof/details/page.cfm?Lang=E&Geo1=CD&Code1=5915&Data=Count&SearchText=Richmond&SearchType=Begins&SearchPR=01&A1=All&B1=All&Custom=>
- Statistics Canada. (2012b). Richmond, BC. Census Profile. 2011 Census. Retrieved August 08, 2014, from <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E>
- Statistics Canada. (2013). 2001 Census of Population. Retrieved August 08, 2014, from <http://www12.statcan.gc.ca/english/census01/products/standard/profiles/Rp-eng.cfm?TABID=2&LANG=E&APATH=3&DETAIL=1&DIM=0&FL=A&FREE=0&GC=0&GID=430722&GK=0&GRP=1&PID=56136&PRID=0&PTYPE=55430,53293,55440,55496,71090&S=0&SHOWALL=0&SUB=0&Temporal=2001&THEME=57&VID=0&VNAMEE=&VNAMEF=&D1=0&D2=0&D3=0&D4=0&D5=0&D6=0>
- Takao, K., Motoyoshi, T., Sato, T., Fukuzondo, T., Seo, K., & Ikeda, S. (2004). Factors determining residents' preparedness for floods in modern megalopolises: the case of the Tokai flood disaster in Japan. *Journal of Risk Research*, 7(7-8), 775–787. Retrieved from <http://www.tandfonline.com/doi/abs/10.1080/1366987031000075996>
- Tapsell, S., McCarthy, S., Faulkner, H., & Alexander, M. (2010). *Social vulnerability to natural hazards. CapHaz-Net WP4 Report*. Middlesex University, London. Retrieved from [http://caphaz-net.org/outcomes-results/CapHaz-Net\\_WP4\\_Social-Vulnerability2.pdf](http://caphaz-net.org/outcomes-results/CapHaz-Net_WP4_Social-Vulnerability2.pdf)
- Thomas, D. S. K., Stephens, P. K., & Goldsmith, J. (2010). Measuring and Conveying Social Vulnerability. In B. D. Phillips, D. S. K. Thomas, A. Fothergill, & L. Blinn-Pike (Eds.), *Social Vulnerability to Disasters* (p. 406). New York: CRC Press.
- Thomson, R. E., Bornhold, B. D., & Mazzotti, S. (2008). *An Examination of the Factors Affecting Relative and Absolute Sea Level in Coastal British Columbia* (p. 56). Sidney.
- Turner, B. L., Kasperson, R. E., Matson, P. a, McCarthy, J. J., Corell, R. W., Christensen, L., ... Schiller, A. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences of the United States of America*, 100(14), 8074–9. doi:10.1073/pnas.1231335100
- Twigg, J. (2007). *Characteristics of a Disaster-resilient Community A Guidance Note* (Version 1., Vol. 1, p. 40).

- United Nations International Strategy for Disaster Reduction (UNISDR). (2009). *2009 UNISDR Terminology on Disaster Risk Reduction* (p. 30).
- Ventura, C. E., & Schuster, N. D. (1994). Seismic Risk and Hazard Reduction in Vancouver, British Columbia. In B. E. Tucker, M. Ö. Erdik, & C. N. Hwang (Eds.), *Issues in Urban Earthquake Risk* (pp. 221–236). Kluwer Academic.
- White, R., & Etkin, D. (1997). Climate Change, Extreme Events and the Canadian. *Natural Hazards*, 16(1997), 135–163.
- Wisner, B., Blaikie, P., Cannon, T., & Davis, I. (2003). *At Risk : natural hazards, people's vulnerability and disasters* (2nd ed., p. 134). London: Routledge.
- Wu, S.-Y., Yarnal, B., & Fisher, A. (2002). Vulnerability of coastal communities to sea-level rise : a case study of Cape May County , New Jersey , USA. *Climate Research*, 22, 255–270.
- Xu, J., Zhang, Y., Liu, B., & Xue, L. (2014). Risk Perception in Natural Disaster Management. In *2014 International Conference UNESCO Chair in Technologies for Development: What Is Essential?* Lausanne.
- Yoon, D. K. (2012). Assessment of social vulnerability to natural disasters: a comparative study. *Natural Hazards*, 63(2), 823–843. doi:10.1007/s11069-012-0189-2
- Zhou, Q., Li, J., & Zhao, J. (2003). Study on index system of assessment of public disaster perception in the western China. *Chinese Geographical Science*, 13(3), 284–288. doi:10.1007/s11769-003-0032-5
- Zhou, Y., Li, N., Wu, W., & Wu, J. (2013). Assessment of provincial social vulnerability to natural disasters in China. *Natural Hazards*, 71(3), 2165–2186. doi:10.1007/s11069-013-1003-5

## Appendices

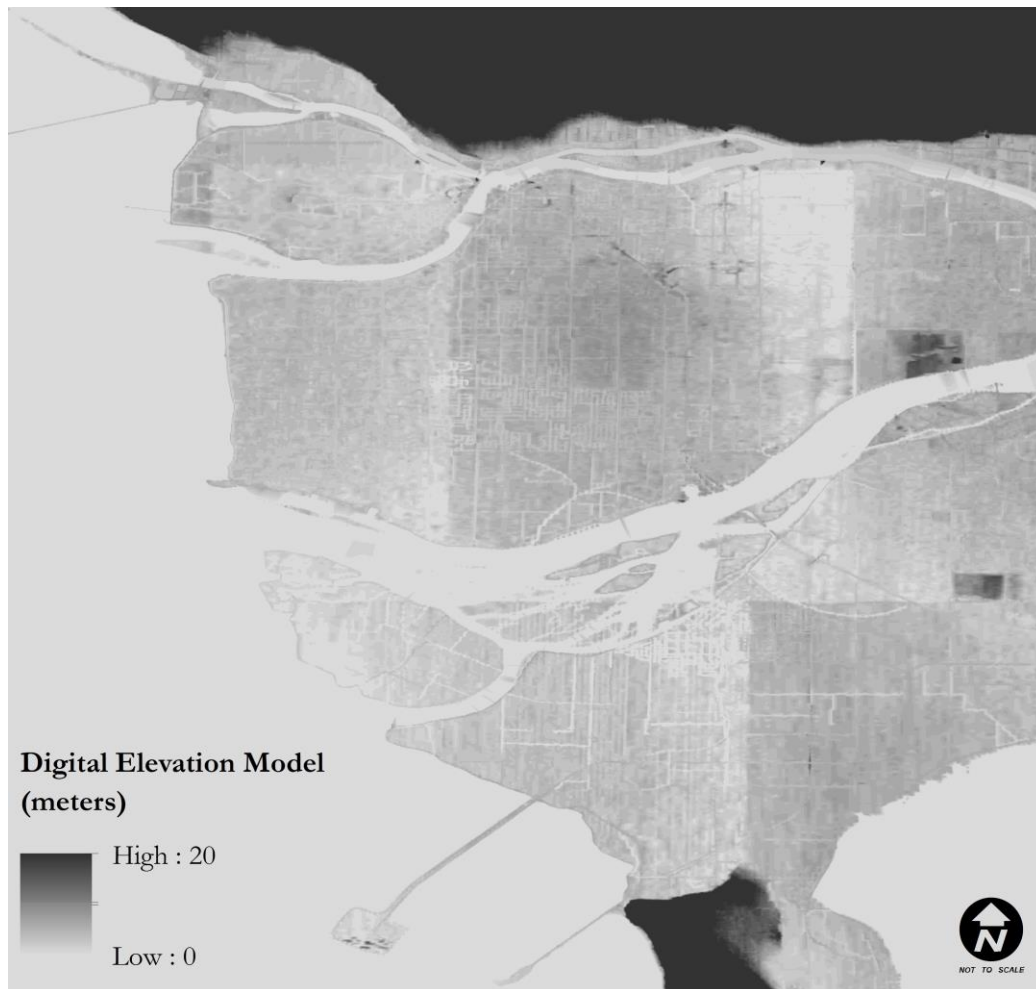
### Appendix A Disaster Impact Model

After Source: Lindell & Prater, 2004; Lindell et al., 2007



## Appendix B Elevation Map of the City of Richmond

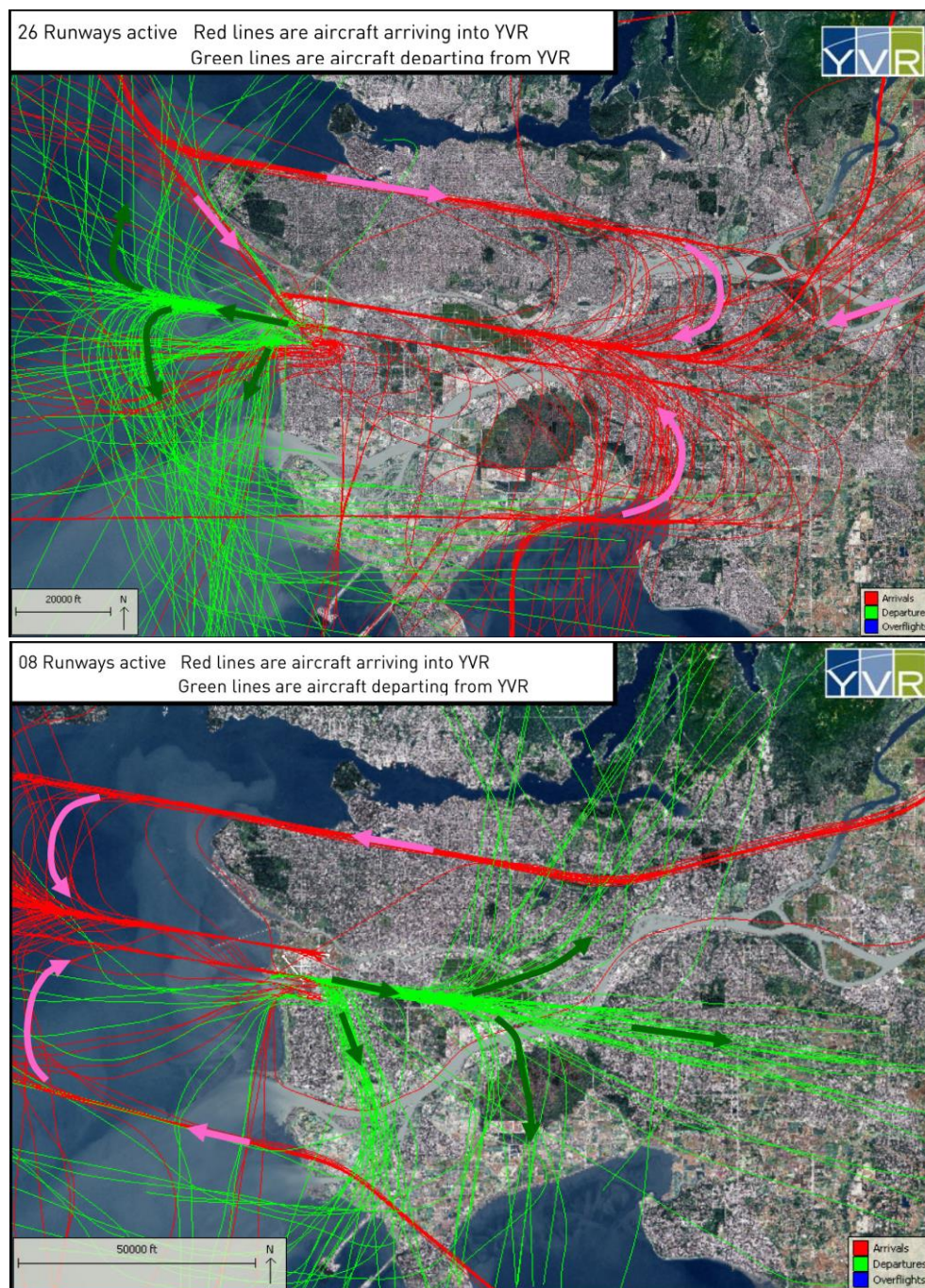
Source: GeoBase, link: <http://www.geobase.ca/geobase/en/find.do?produit=cded>





## Appendix C Vancouver YVR Airport – Aircraft Flight Routes

Source: [http://www.yvr.ca/Libraries/ENV\\_Docs/Aircraft\\_Flight\\_Routings\\_-\\_Final.sflb.ashx](http://www.yvr.ca/Libraries/ENV_Docs/Aircraft_Flight_Routings_-_Final.sflb.ashx)



**Appendix D****D.1 Descriptive Statistics for Social Vulnerability Variables in Richmond**

	N	Range	Minimum	Maximum	Mean	Std. Deviation
% Population (25 yrs+) with high school or less education level	246	.5168	.0806	.5974	.308173	.0981031
% Women with low income	243	.5870	.0000	.5870	.217148	.1252756
Median value of owned dwelling (\$)	246	1794642	.0000	1794642	746922	269726
% Population Immigrants from 2006 to 2011	246	.4174	.0000	.4174	.090360	.0739036
% Dwellings rented	246	1.0000	.0000	1.0000	.175528	.1817502
% Households spending 30% or more of their total income on shelter costs	243	.7308	.0000	.7308	.328261	.1320485
Household median income after tax	243	131000	22185	153185	68870	22432
Unemployment Rate	246	.2460	.0000	.2460	.055154	.0506808
% Low income population (after tax)	243	.5600	.0000	.5600	.211025	.1175572
% Dwellings constructed before 1980	246	.9600	.0000	.9600	.390107	.2962474
% Dwellings requiring major repair	246	.4493	.0000	.4493	.039869	.0691744
% Population employed as non high-skilled occupations	246	.6545	.0000	.6545	.363671	.1201922
% total income from government transfer	243	.2830	.0160	.2990	.111695	.0447751
% Female participation rate	246	.5810	.2610	.8420	.569488	.1041092
% First generation population	246	.7162	.1597	.8758	.598809	.1527511
% Population without Canadian citizenship	246	.5185	.0000	.5185	.151277	.0955080
% population rely on public transit	246	.4032	.0000	.4032	.164516	.0857410
% of movers	246	.4862	.0000	.4862	.131568	.0798953
% of total dwellings are Apartments in buildings with five or more storeys	246	1.0000	.0000	1.0000	.043723	.1717988
Average household size	246	2.2000	1.7000	3.9000	3.005691	.4798471
% Single parent families	246	.2151	.0263	.2414	.107503	.0359771
% Population without knowledge of Official Language	246	.2500	.0000	.2500	.099997	.0506503
Population per square kilometre	246	24970	30	25000	5289	4229
% Population aged less than 15 years old	246	.2063	.0411	.2474	.146753	.0325763
% Population aged 65 years old and over	246	.4258	.0388	.4646	.137272	.0565025
Dwelling units per square kilometre	246	11239	11	11250	1942	1995
Median population age	246	29.4	33.0	62.5	42.7	4.2
% one-person household	246	.4940	.0000	.4940	.161293	.1075061
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest medical service	246	9.53320	.33160	9.86480	2.6570255	1.29395120
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency shelter	246	9.53320	.33160	9.86480	2.8058440	1.52911031

	N	Range	Minimum	Maximum	Mean	Std. Deviation
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency response team	246	7.37481	.00792	7.38273	1.0643922	.92172817
% Population speaking non-official language mostly at home	246	.7118	.0318	.7437	.407527	.1443432
Average number of children at home	246	1.1	.5	1.6	1.163	.2003
Individual median income after tax	243	37882	10882	48764	23726.74	6715.755

**D.2 Total Variance Explained by Social Vulnerability Factors in Richmond**

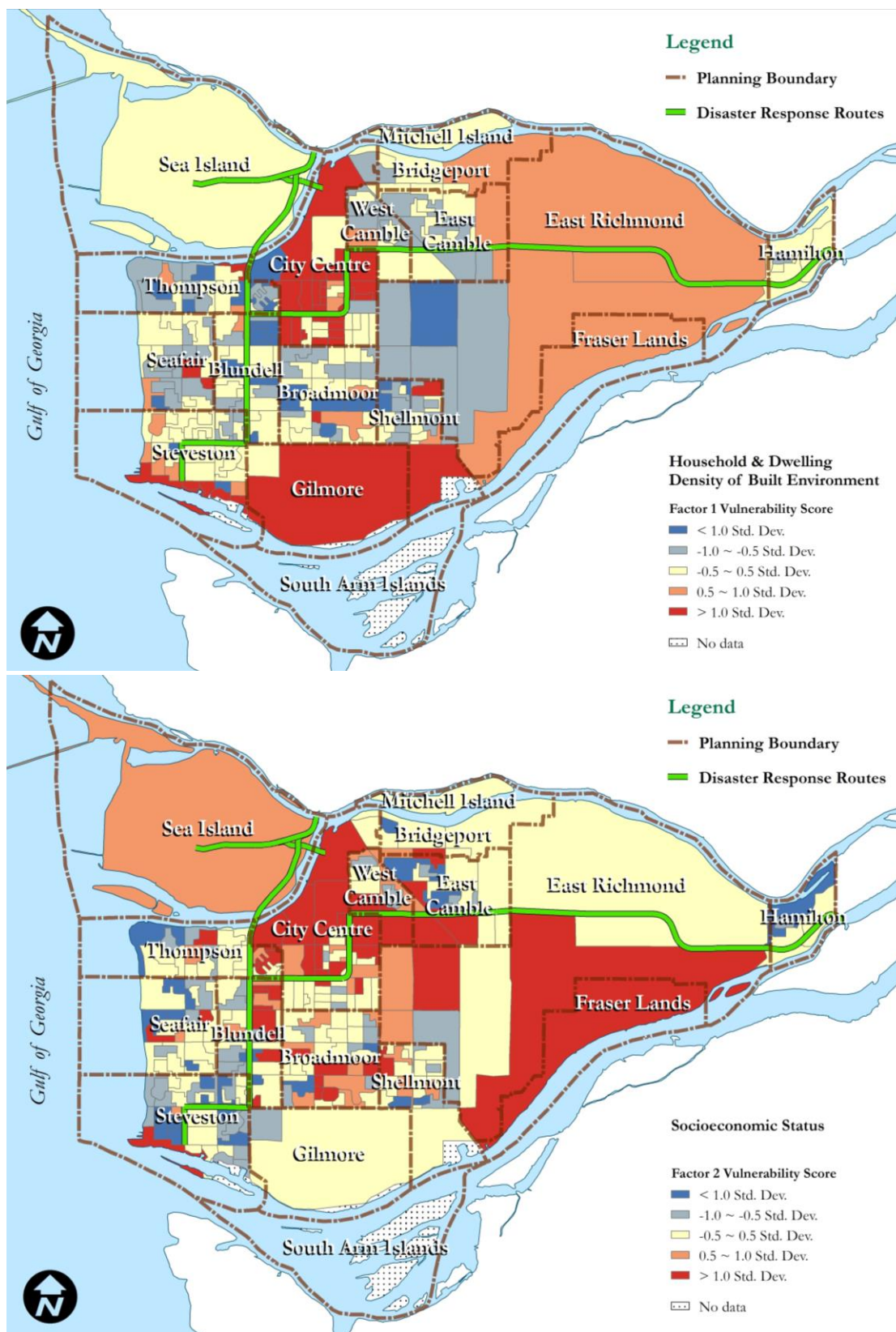
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.856	26.048	26.048	8.856	26.048	26.048	4.846	14.252	14.252
2	4.580	13.471	39.519	4.580	13.471	39.519	4.594	13.512	27.763
3	3.024	8.894	48.414	3.024	8.894	48.414	4.265	12.545	40.308
4	2.419	7.116	55.529	2.419	7.116	55.529	3.105	9.131	49.440
5	2.047	6.021	61.550	2.047	6.021	61.550	2.302	6.769	56.209
6	1.908	5.610	67.161	1.908	5.610	67.161	2.286	6.725	62.934
7	1.073	3.157	70.318	1.073	3.157	70.318	2.173	6.390	69.324
8	1.062	3.123	73.440	1.062	3.123	73.440	1.400	4.117	73.440
9	.976	2.872	76.312						
10	.830	2.441	78.754						
11	.801	2.357	81.110						
12	.712	2.093	83.203						
13	.685	2.014	85.217						
14	.559	1.645	86.862						
15	.530	1.558	88.420						
16	.469	1.380	89.800						
17	.431	1.268	91.068						
18	.422	1.240	92.308						
19	.359	1.056	93.364						
20	.328	.964	94.327						
21	.297	.874	95.201						
22	.286	.840	96.041						
23	.236	.695	96.736						
24	.208	.613	97.348						
25	.182	.536	97.884						
26	.165	.486	98.370						
27	.147	.433	98.804						
28	.115	.338	99.141						
29	.105	.310	99.451						
30	.071	.209	99.660						
31	.050	.148	99.808						
32	.034	.100	99.907						
33	.023	.067	99.974						
34	.009	.026	100.000						

**D.3 Rotated Component/Factor Matrix of Social Vulnerability Variables in Richmond**

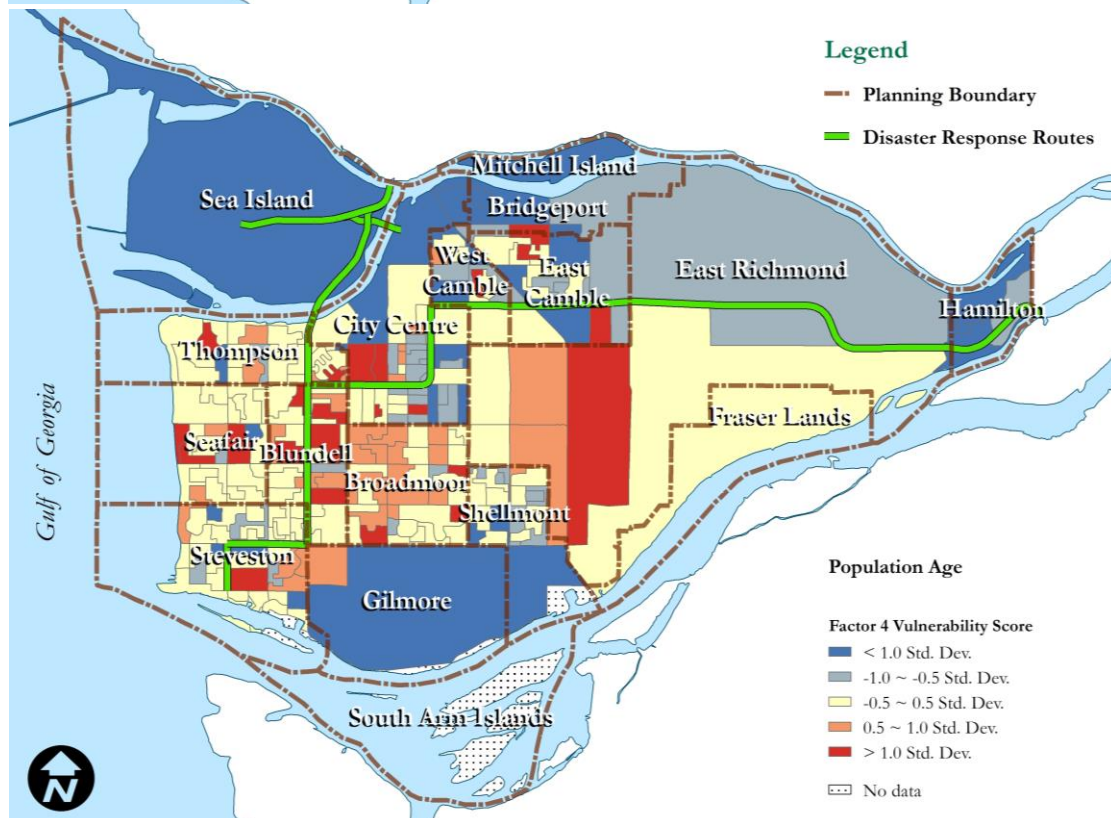
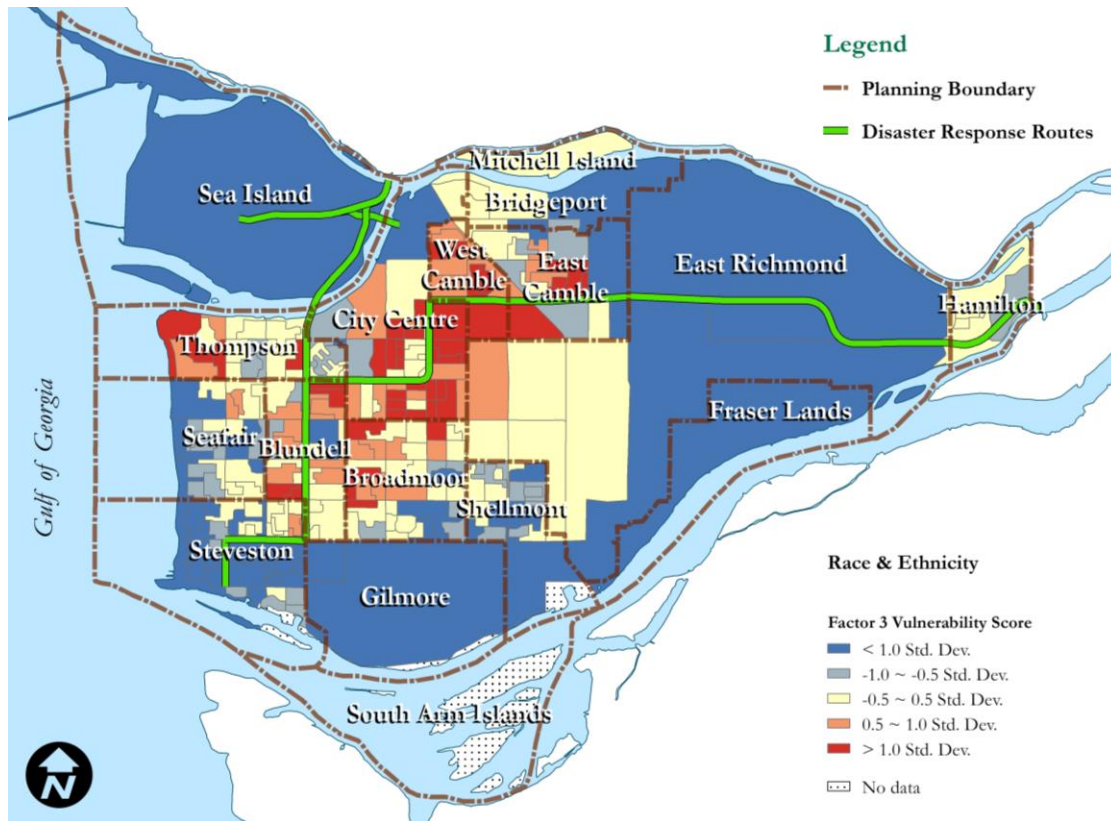
Component	1	2	3	4	5	6	7	8
Average household size	<b>-.887</b>	-.220	.171	.207	.076	-.063	.030	.022
% one-person household	<b>.811</b>	.256	-.195	-.235	.142	.141	.019	.042
Average number of children at home	<b>-.809</b>	-.059	-.006	.336	.117	.052	-.049	.203
Dwelling units per square kilometre	<b>.782</b>	.004	.344	.021	-.008	.195	-.137	.247
Median value of owned dwelling (\$)	<b>-.755</b>	-.191	.034	-.178	-.268	.142	.125	-.255
Population per square kilometre	<b>.692</b>	-.034	.411	.090	-.008	.208	-.170	.294
% of total dwellings are apartments in buildings with five or more storeys	<b>.483</b>	.268	.301	-.066	.135	.076	-.149	-.460
% Women with low income	.120	<b>.817</b>	.363	-.083	-.028	.199	-.043	-.036
% Low income population (after tax)	.115	<b>.798</b>	.398	-.077	-.002	.219	-.024	-.004
% Households spending 30% or more of their total income on shelter costs	.132	<b>.741</b>	.323	.095	.068	.134	.084	-.100
Household median income after tax	-.302	<b>-.732</b>	-.214	.141	-.232	-.123	.038	-.123
Individual median income after tax	.169	<b>-.564</b>	-.543	.112	-.333	-.120	.099	-.107
% Dwellings rented	.297	<b>.490</b>	-.250	.146	.372	.343	-.048	.037
Unemployment rate	.109	<b>.374</b>	-.025	.102	.017	.072	.003	.250
% Population speaking non-official language mostly at home	-.013	.289	<b>.861</b>	.005	.171	.179	-.035	-.011
% Population without knowledge of Official Language	-.025	.273	<b>.808</b>	-.093	.161	.213	-.034	-.081
% First generation population	-.005	.314	<b>.803</b>	.019	.125	.238	-.057	.088
% Dwellings constructed before 1980	-.176	-.030	<b>-.675</b>	-.191	.313	.164	-.102	.017
% Population aged 65 years old and over	.230	-.063	-.163	<b>-.869</b>	.019	-.111	.004	-.005
Median population age	.167	-.211	-.126	<b>-.853</b>	-.175	-.185	-.018	.050
% Female participation rate	.215	-.315	-.230	<b>.611</b>	.037	-.213	.007	.092
% Population aged less than 15 years old	-.395	-.068	-.373	<b>.591</b>	-.057	.140	.030	.226
% total income from government transfer	.097	.454	-.035	-.514	<b>.472</b>	.027	-.160	.148
% Population employed as non high-skilled occupations	.078	.125	.010	.166	<b>.810</b>	-.035	.024	.177
% Population (25 yrs+) with high school or less education level	-.078	-.006	.166	-.108	<b>.725</b>	-.063	.190	-.026
% population reply on public transit	.259	.112	.139	.214	<b>.442</b>	.281	-.228	.083
% Population of immigrants from 2006 to 2011	.024	.297	.289	.090	-.011	<b>.782</b>	.014	.006
% Population without Canadian citizenship	.095	.471	.326	.081	.006	<b>.712</b>	-.038	-.058
% of movers	.326	.406	-.032	.144	-.024	<b>.529</b>	.029	-.120
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest medical service	-.029	-.010	.089	-.017	.069	.040	<b>.900</b>	.046
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency response team	-.162	-.108	-.033	-.036	.005	.086	<b>.865</b>	.034
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency shelter	.006	.131	-.204	.202	.032	-.341	<b>.598</b>	-.169
% Single parent families	.203	.014	.045	-.113	.220	-.100	.023	<b>.639</b>
% Dwellings requiring major repair	.005	.362	.016	.272	.047	.062	-.101	<b>.484</b>



## Appendix E Maps of Social Vulnerability Factors in Richmond

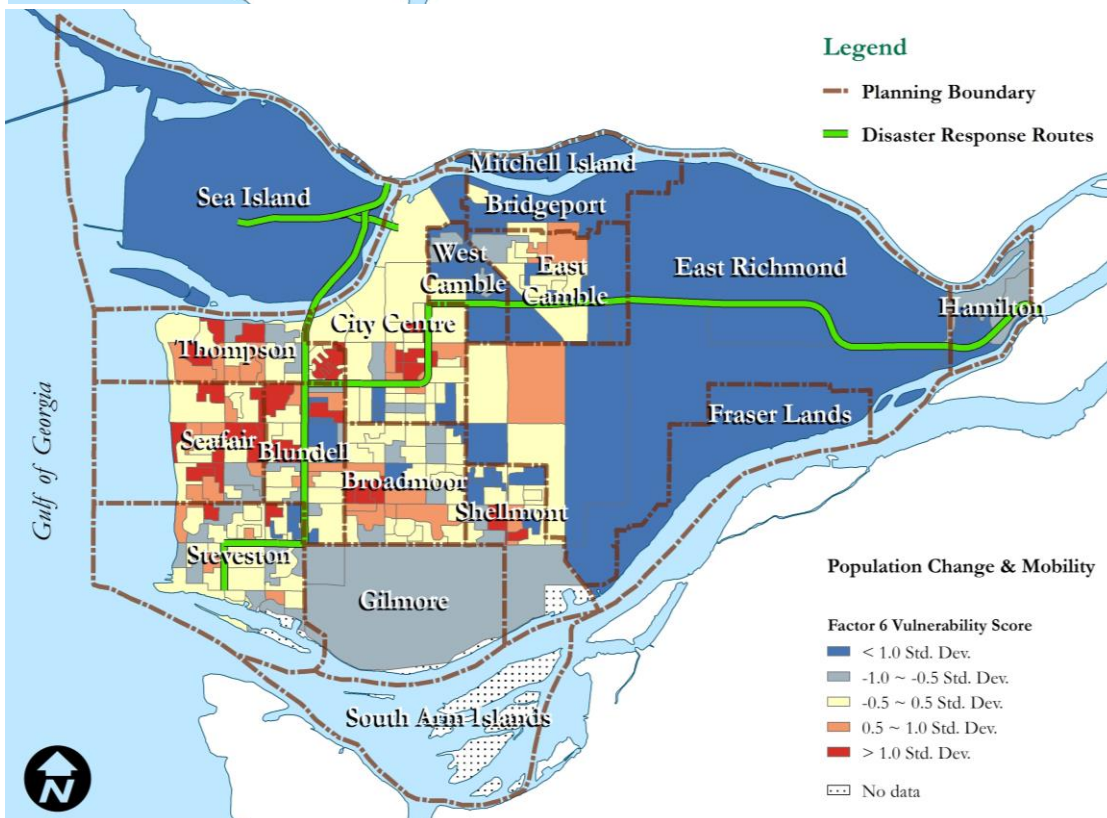
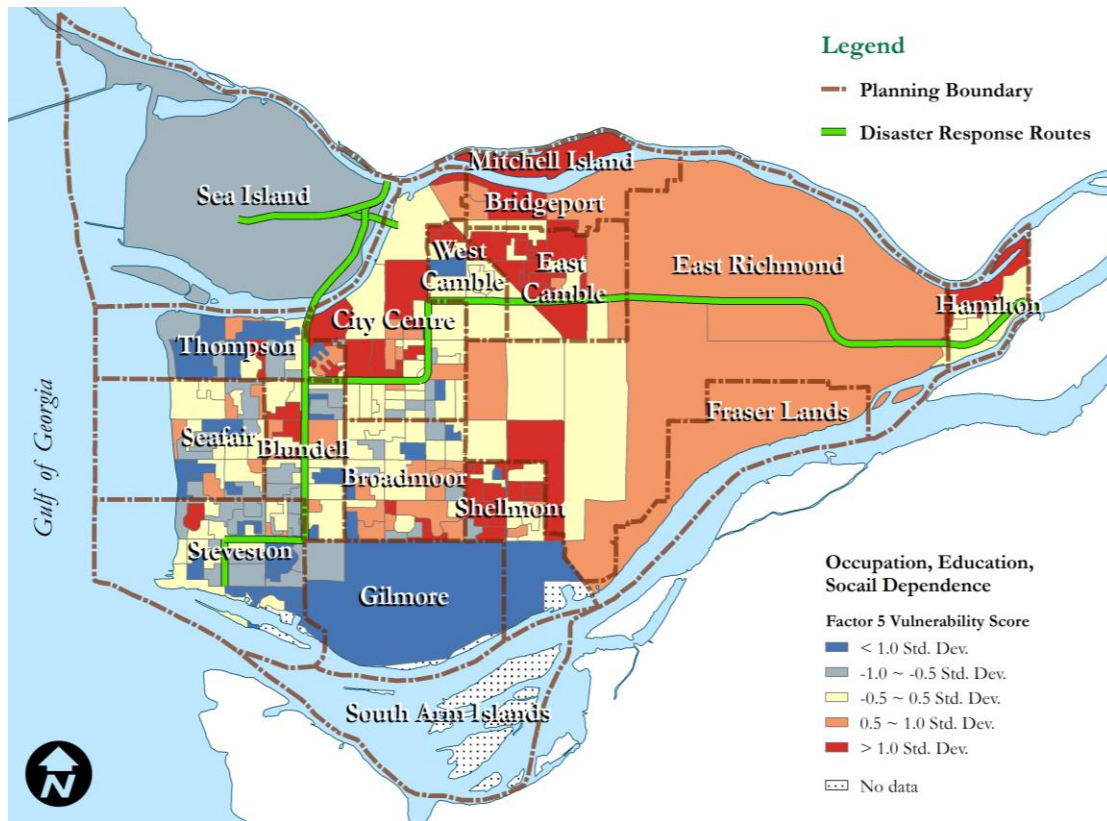


## Appendix E Continued



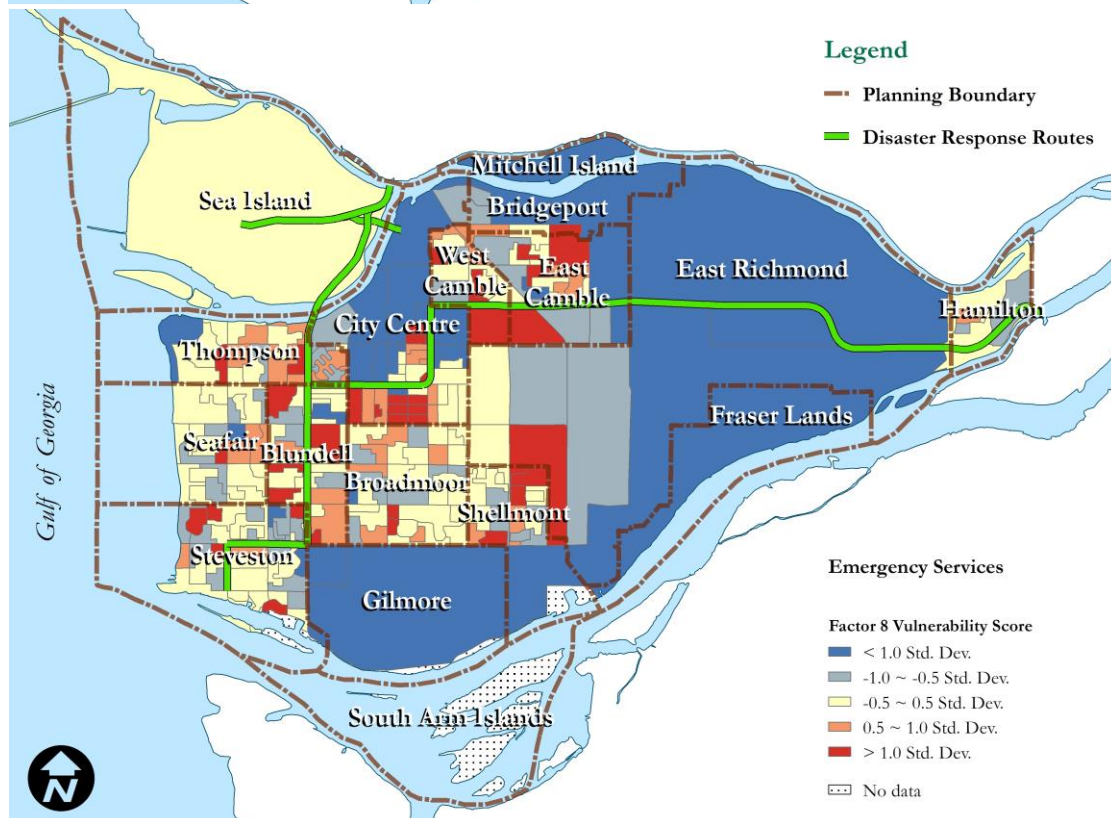
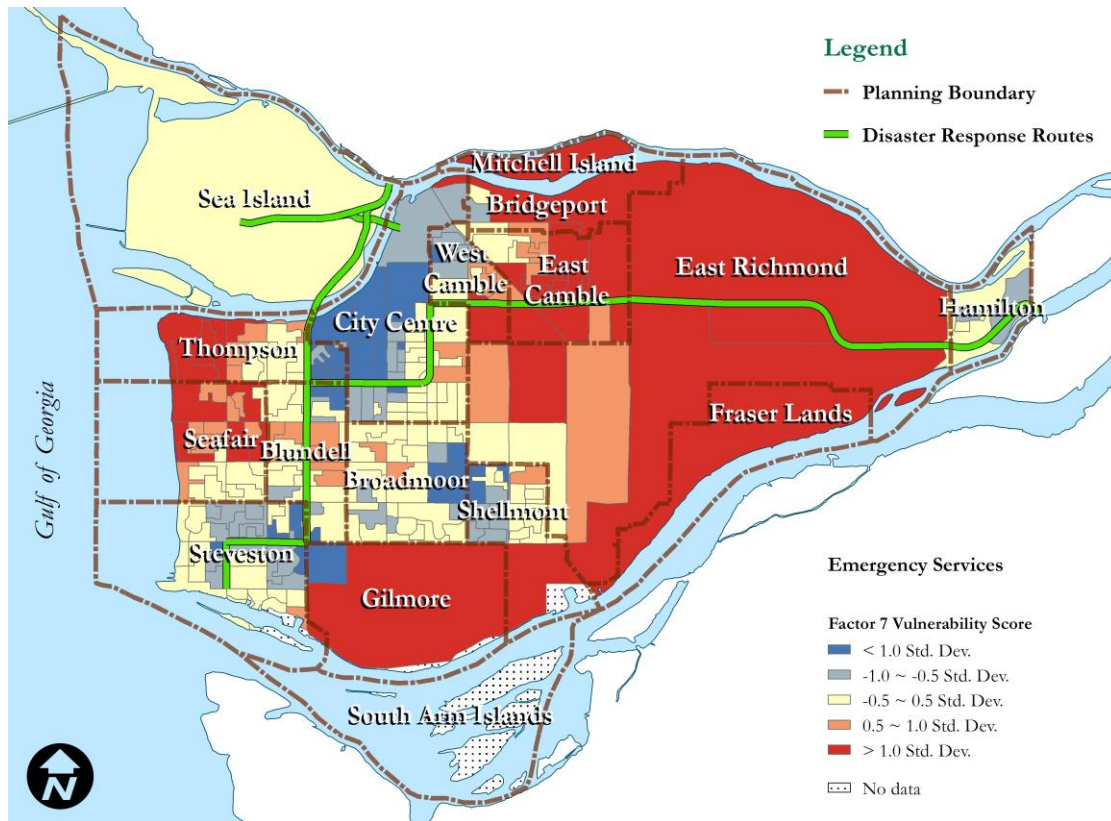


## Appendix E Continued





## Appendix E Continued



**Appendix F Statistic Data of the Social Vulnerability Variables with the Highest SoVI Dissemination Areas in Richmond**

Geocode	59153616	59151080	59153352	59153107	59151148	59151149	59151139	59153409	59153411
Average household size	2.5	2.1	2.2	2.4	1.8	2.5	1.9	2.2	2.3
% one-person household	30.51%	37.07%	36.45%	36.62%	47.69%	29.32%	44.62%	26.67%	32.91%
Average number of children at home	0.9	0.8	1	1.2	0.6	1	0.9	0.7	0.9
Dwelling units per square kilometre	17.7	2636.4	1337.5	5142.9	8125.0	8312.5	4125.0	11250.0	9750.0
Median value of owned dwelling (\$)	578428	280456	674557	189980	300429	320220	299404	369796	358445
Population per square kilometre	44.4	5590.9	3312.5	12357.1	14687.5	20437.5	7937.5	25000.0	22125.0
% of total dwellings are apartments in buildings with five or more storeys	0.00%	0.00%	32.71%	0.00%	0.77%	0.00%	7.58%	97.78%	38.46%
% Women with low income	23.90%	14.80%	58.70%	40.40%	27.80%	25.80%	36.90%	49.10%	24.30%
% Low income population (after tax)	23.80%	13.80%	54.50%	38.20%	28.90%	26.90%	38.10%	45.00%	28.40%
% Households spending 30% or more of their total income on shelter costs	40.35%	37.61%	51.40%	50.70%	29.23%	35.34%	55.38%	45.65%	33.77%
Household median income after tax	57415	45239	22185	32449	41868	48972	25408	32862	37756
Individual median income after tax	21625	25584	15535	16874	25812	21680	13447	15470	16057
% Dwellings rented	25.42%	3.39%	64.81%	56.94%	10.77%	17.16%	69.70%	40.00%	38.46%
Unemployment rate	4.80%	0.00%	15.90%	18.10%	4.80%	3.60%	5.50%	0.00%	5.10%
% Population speaking non-official language mostly at home	22.97%	20.33%	36.60%	57.80%	37.87%	59.33%	51.97%	71.00%	62.71%
% Population without knowledge of Official Language	3.38%	4.49%	12.77%	19.19%	8.94%	13.46%	15.08%	25.00%	22.03%
% First generation population	46.94%	44.72%	50.64%	71.68%	57.02%	76.76%	68.50%	80.00%	81.58%
% Dwellings constructed before 1980	40.68%	88.89%	71.56%	76.06%	0.00%	0.00%	63.08%	0.00%	41.03%
% Population aged 65 years old and over	18.24%	28.46%	34.72%	16.76%	35.74%	11.31%	14.96%	20.00%	17.51%
Median population age	45.9	53.2	54.2	44.3	57.6	42.2	42.6	43.1	44.9
% Female participation rate	56.20%	44.40%	31.40%	51.30%	48.40%	63.90%	48.30%	41.30%	53.80%
% Population aged less than 15 years old	10.14%	9.76%	13.58%	12.14%	6.81%	12.54%	11.81%	8.00%	9.60%
% Population (25 yrs+) with high school or less education level	36.05%	34.15%	49.04%	29.59%	24.76%	30.18%	46.38%	27.42%	26.79%
% total income from government transfer	13.90%	18.60%	28.10%	20.30%	20.70%	9.50%	25.80%	15.30%	14.80%
% Population employed as non high-skilled occupations	47.62%	35.34%	31.88%	62.65%	40.00%	43.52%	65.45%	25.58%	44.00%

Geocode	59153616	59151080	59153352	59153107	59151148	59151149	59151139	59153409	59153411
% population rely on public transit	9.09%	13.89%	10.91%	37.50%	16.28%	27.43%	38.00%	22.50%	18.68%
% Population of immigrants from 2006 to 2011	6.76%	6.10%	3.40%	16.76%	1.28%	6.42%	14.17%	12.00%	16.40%
% Population without Canadian citizenship	8.11%	4.47%	8.51%	23.70%	8.12%	14.07%	22.83%	22.00%	27.51%
% of movers	10.88%	9.76%	7.69%	18.02%	12.02%	15.36%	20.80%	24.00%	12.17%
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest medical service	9.373	3.202	3.651	3.599	2.983	3.301	1.563	2.134	2.213
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency response team	9.373	5.588	3.651	1.489	2.983	3.092	1.563	1.396	1.475
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency shelter	7.157	1.310	1.592	0.594	0.868	0.562	0.577	0.017	0.303
% Single parent families	0.068	0.103	0.168	0.141	0.077	0.128	0.108	0.133	0.127
% Dwellings requiring major repair	0.00%	11.11%	16.51%	13.89%	16.92%	11.28%	10.61%	0.00%	0.00%

## Appendix F Continued

Geocode	59153412	59151002	59151145	59153345	59153398	59153114	59153529	59153627
Average household size	2.1	2.3	2	2.2	2.2	1.8	1.7	2.9
% one-person household	35.59%	26.00%	46.38%	33.33%	33.33%	46.34%	49.40%	27.59%
Average number of children at home	0.9	0.9	0.9	0.8	0.9	0.5	0.6	1.2
Dwelling units per square kilometre	9666.7	6125.0	8625.0	9187.5	8812.5	7000.0	1909.1	1450.0
Median value of owned dwelling (\$)	219232	349412	200344	268294	278920	375252	299393	649350
Population per square kilometre	20666.7	14375.0	16750.0	21062.5	19187.5	12166.7	3693.2	5000.0
% of total dwellings are apartments in buildings with five or more storeys	39.66%	0.00%	0.00%	0.00%	0.00%	0.00%	61.90%	0.00%
% Women with low income	43.10%	58.10%	38.50%	29.50%	33.30%	14.00%	34.40%	0.00%
% Low income population (after tax)	42.70%	55.30%	37.80%	27.90%	35.20%	11.10%	33.60%	2.40%
% Households spending 30% or more of their total income on shelter costs	59.32%	52.27%	37.68%	42.95%	40.43%	21.43%	36.88%	16.67%
Household median income after tax	32468	24940	47439	45796	39334	37692	32345	54814
Individual median income after tax	18125	13387	20093	22498	18739	20899	18910	21424

Geocode	59153412	59151002	59151145	59153345	59153398	59153114	59153529	59153627
% Dwellings rented	18.97%	72.00%	23.53%	44.59%	38.57%	0.00%	40.88%	23.33%
Unemployment rate	0.00%	24.60%	5.10%	10.80%	9.00%	11.50%	3.20%	16.30%
% Population speaking non-official language mostly at home	58.87%	57.39%	38.81%	48.66%	52.77%	34.72%	49.32%	44.71%
% Population without knowledge of Official Language	17.74%	11.30%	8.21%	18.99%	16.61%	5.48%	14.73%	9.41%
% First generation population	73.60%	80.00%	70.37%	71.52%	73.29%	54.79%	73.97%	54.12%
% Dwellings constructed before 1980	55.17%	14.29%	42.65%	28.38%	40.71%	0.00%	86.25%	87.10%
% Population aged 65 years old and over	16.94%	8.70%	7.46%	13.95%	17.92%	39.73%	46.46%	29.00%
Median population age	45.5	39.8	41.2	41.6	43.6	61	62.5	45.5
% Female participation rate	61.70%	51.00%	80.30%	72.30%	43.10%	32.60%	44.30%	67.60%
% Population aged less than 15 years old	9.68%	12.17%	14.18%	11.57%	11.40%	4.11%	4.62%	13.00%
% Population (25 years+) with high school or less education level	38.27%	28.38%	32.29%	38.36%	37.71%	48.00%	19.85%	46.67%
% total income from government transfer	15.00%	14.40%	8.90%	12.70%	17.70%	29.90%	26.70%	19.00%
% Population employed as non high-skilled occupations	48.68%	35.09%	46.39%	46.57%	56.25%	30.77%	54.84%	47.92%
% population reply on public transit	37.14%	22.50%	24.36%	24.86%	34.40%	0.00%	32.46%	15.79%
% Population of immigrants from 2006 to 2011	23.20%	41.74%	16.30%	10.19%	19.54%	0.00%	12.33%	0.00%
% Population without Canadian citizenship	29.60%	46.09%	27.41%	20.68%	25.73%	4.11%	22.60%	20.00%
% of movers	13.82%	35.09%	22.96%	21.63%	23.28%	13.89%	5.84%	14.29%
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest medical service	2.221	2.623	2.376	2.647	2.667	1.605	0.912	4.091
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency response team	1.791	1.560	2.376	1.284	0.993	1.605	0.912	4.091
Distance (km) along the road network from Dissemination Areas' geometric centroids to closest emergency shelter	0.459	0.710	1.128	0.985	0.173	0.617	0.840	0.990
% Single parent families	0.085	0.160	0.087	0.116	0.106	0.098	0.095	0.103
% Dwellings requiring major repair	6.90%	4.00%	44.93%	14.86%	20.57%	0.00%	5.63%	25.81%

## Appendix G Survey Questionnaires (English version)

### Survey Questionnaire



### Consent Form

#### Risk Perception and Disaster Preparedness of Chinese Immigrants in Metro Vancouver: A Case Study Applied in the City of Richmond

The purpose of this research project is to understand the Chinese immigrants' risk and disaster attitudes, perceptions, and experiences in the City of Richmond. This is a research project being conducted by Wei-Chung Chen, a Graduate Student, under the supervision of Professor Stephanie E. Chang at the School of Community and Regional Planning at the University of British Columbia.

You are invited to participate in this research project because you are a Chinese immigrant living in the City of Richmond. The information you provide will support us to improve the risk and disaster management in the City of Richmond. The survey questions will be about your family household background, experiences, perceptions, and attitudes toward risk and disaster. There are no known risks if you decide to participate in this research study. Your participation in this research study is voluntary. You may choose not to participate. If you decide to participate in this research survey, you may withdraw at any time without any consequence.

The survey questionnaire will take approximately 5~10 minutes to complete. Your responses will be confidential. This survey is anonymous. The results of this study will be used for scholarly purposes and may be shared with Chinese immigrant organizations, the City of Richmond, and the University of British Columbia.

By completing the survey, you are voluntarily agreeing to participate in the study. If you have any questions about the research study, please contact, Wei-Chung Chen, through phone at 778-896-7575 or via email at [lavinotw@alumni.ubc.ca](mailto:lavinotw@alumni.ubc.ca).

Contact for Complaints: Who can you contact if you have complaints or concerns about the study? If you have any concerns or complaints about your rights as a research participant and/or your experiences while participating in this study, contact the Research Participant Complaint Line in the UBC Office of Research Ethics at 604-822-8598 or if long distance e-mail [RSIL@ors.ubc.ca](mailto:RSIL@ors.ubc.ca) or call toll free 1-877-822-8598.

#### CONSENT: Checking on the "agree" box below indicates that:

- you have read the above information and voluntarily agree to participate
- you are at least 19 years of age

If you do not wish to participate in the study, please decline participation by not answering the survey.

☐ Agree; I consent to my full participation in this study

Survey Date: \_\_\_\_\_

Please note: "Family" in this survey refers to family members living with you in Metro Vancouver.

### Part I: Background Confirmation

1. Do you consider yourself a Chinese immigrant? ☐ Yes ☐ No, if no, please do not complete this survey

### Part II: Survey

1. How concerned are you, if at all, about the following types of disasters in your neighbourhood:

Type of Disaster	Not at all concerned	Not very concerned	Somewhat concerned	Very concerned	
Earthquakes	1	2	3	4	Not Sure
Floods	1	2	3	4	Not Sure
Fires	1	2	3	4	Not Sure
Pandemic disease (e.g. SARS)	1	2	3	4	Not Sure
Severe weather (e.g. winter storms)	1	2	3	4	Not Sure
Tsunamis	1	2	3	4	Not Sure
Heat waves	1	2	3	4	Not Sure
Air crashes	1	2	3	4	Not Sure

Version 3.1: Aug 14, 2014

1

## Survey Questionnaire

2. For each of the following disasters, how likely do you think it would be to directly affect your family?

Type of Disaster	Not at all likely	Not very likely	Somewhat likely	Very likely	
Earthquakes	1	2	3	4	Not Sure
Floods	1	2	3	4	Not Sure
Fires	1	2	3	4	Not Sure
Pandemic disease (e.g. SARS)	1	2	3	4	Not Sure
Severe weather (e.g. winter storms)	1	2	3	4	Not Sure
Tsunamis	1	2	3	4	Not Sure
Heat waves	1	2	3	4	Not Sure
Aircrashes	1	2	3	4	Not Sure

3. When preparing for an emergency, which of the following information sources, if any, would you consult? (check all that apply)

- ☐ City Government (e.g. website, flyers, ads, etc.)      ☐ BC Provincial Government (e.g. website, flyers, ads, etc.)  
☐ Friends/relatives/neighbours      ☐ Hospital/health authorities, police, or fire stations  
☐ Schools      ☐ Web search  
☐ Other government (e.g. website, flyers, Ads, etc) (Please specify): \_\_\_\_\_  
☐ Other non-government agency (Please specify): \_\_\_\_\_  
☐ Other website (Please specify): \_\_\_\_\_  
☐ Other (Please specify): \_\_\_\_\_  
☐ None

4. In the event of an emergency, which sources of information, if any, would you go to for updates and/or information? (check all that apply)

- ☐ Chinese Radio      ☐ English Radio  
☐ Chinese Television      ☐ English Television  
☐ Chinese Newspapers      ☐ English Newspapers  
☐ City Government website      ☐ BC Provincial Government website  
☐ Friends/relatives/neighbours      ☐ Hospital/health authorities, police, or fire stations  
☐ Social media (e.g. Facebook, Twitter, Google+, Instagram, etc.)  
☐ Other government (e.g. website, flyers, ads, etc.) (Please specify): \_\_\_\_\_  
☐ Other non-government agency (Please specify): \_\_\_\_\_  
☐ Other website (Please specify): \_\_\_\_\_  
☐ Other (Please specify): \_\_\_\_\_  
☐ None

5. Which of the following disasters, if any, have you or anyone in your family ever personally experienced? (check all that apply)

- ☐ Earthquakes    ☐ Floods      ☐ Fires      ☐ Landslides      ☐ Severe weathers (e.g. typhoons)  
☐ Tsunamis      ☐ Pandemic disease (e.g., SARS)    ☐ Heat waves      ☐ Aircrashes  
☐ Other (Please specify): \_\_\_\_\_      ☐ We have never experienced any disaster

6. How well prepared do you feel your family is, if at all, to deal with an emergency situation (such as an earthquake, flood, fire, etc.)?

Not at all prepared	Not very prepared	Somewhat prepared	Very prepared	
1	2	3	4	Not Sure

7. Which of the following emergency preparedness steps, if any, have you taken to prepare for an emergency situation? Please select all that apply.

- ☐ Attended an emergency preparedness presentation      ☐ Made a household emergency plan  
☐ Identified potential hazards around your home      ☐ Kept emergency food supply at home  
☐ Prepared an emergency kit (e.g. first-aid kits)      ☐ Stored emergency water rations at home  
☐ Prepared emergency contact lists      ☐ Prepared warm clothing, medicine, etc.

**Survey Questionnaire**

☐ Other (Please specify): \_\_\_\_\_ ☐ None of the above

8. Please indicate what is keeping your family from the above emergency preparedness (check all that apply):
- |  |  |
|--|--|
| <input type="checkbox"/> Don't believe an emergency situation will happen in our neighbourhood | <input type="checkbox"/> Don't understand the information regarding those preparedness |
| <input type="checkbox"/> Don't think they are necessary  | <input type="checkbox"/> Don't have the resources/money to prepare                     |
| <input type="checkbox"/> Not aware of those preparedness actions                               | <input type="checkbox"/> Lack of time  |
| <input type="checkbox"/> Requires too much effort  | <input type="checkbox"/> Haven't made it a priority                                    |
| <input type="checkbox"/> Believe it's the government's responsibility                          |  |
| <input type="checkbox"/> Don't know what to do   | <input type="checkbox"/> Other (Please specify): _____                                 |

9. Do you feel that your family could go to your neighbours for help in the event of an emergency?
- ☐ Yes ☐ No ☐ Not sure

10. How willing is your family to help others if an emergency event happened in your neighbourhood?

Not at all willing	Not very willing	Somewhat willing	Very willing	
1	2	3	4	Not Sure

11. How likely is your family to get involved in the following activities related to emergency preparedness?

	Not at all likely	Not very likely	Somewhat likely	Very likely	
Seeking information about emergency, risk and disaster preparedness	1	2	3	4	Not Sure
Participating/volunteering with one of the emergency preparedness programs (e.g. free emergency courses, Emergency Social Services, Neighbourhood Emergency Assistance Team, etc.)	1	2	3	4	Not Sure
Sharing the information about emergency, risk, or disaster preparedness efforts	1	2	3	4	Not Sure

12. Who would your family turn to for support/help if an emergency event happened? (check all that apply)

☐ Official governments ☐ Friends ☐ Neighbours ☐ Relatives  
☐ Your religious group ☐ Your social group ☐ Other (Please specify): \_\_\_\_\_

13. How much support from the above sources would your family expect to receive if an emergency event happened?

No support	Not very much support	Some support	Very much support	
1	2	3	4	Not Sure

14. How well prepared do you feel the City of Richmond is, if at all, to deal with an emergency situation?

Not at all prepared	Not very prepared	Somewhat prepared	Very prepared	
1	2	3	4	Not Sure

**Part III: Family Background and Information**

1. How long has your family been living in Metro Vancouver?
- ☐ Less than 2 years ☐ 2~5 years ☐ 6~10 years ☐ 11~15 years ☐ More than 15 years
2. Which country/city do you and your family come from? \_\_\_\_\_
3. In which area/neighbourhood of Richmond do you and your family live?
- |  |                                       |                                      |                                      |  |                                      |
|--|---------------------------------------|--------------------------------------|--------------------------------------|--|--------------------------------------|
| <input type="checkbox"/> Sea Island    | <input type="checkbox"/> Bridgeport   | <input type="checkbox"/> West Cambie | <input type="checkbox"/> East Cambie | <input type="checkbox"/> Thompson          | <input type="checkbox"/> City Centre |
| <input type="checkbox"/> Blundell      | <input type="checkbox"/> Seafair      | <input type="checkbox"/> Broadmoor   | <input type="checkbox"/> Shellmont   | <input type="checkbox"/> Steveston         | <input type="checkbox"/> Gilmore     |
| <input type="checkbox"/> East Richmond | <input type="checkbox"/> Fraser Lands | <input type="checkbox"/> Hamilton    | <input type="checkbox"/> Not sure    | <input type="checkbox"/> Other City: _____ |                                      |
4. Which language does your family mostly use at home?

### Survey Questionnaire

- ☐ Cantonese   ☐ Mandarin   ☐ Other Chinese language   ☐ English   ☐ Other (Please specify): \_\_\_\_\_
5. Which of the following best describes your family?  
☐ Your family has at least one member with English full-aspect proficiency (i.e. speaking, reading, writing, listening)  
☐ Your family has at least one member with English conversation proficiency (i.e. speaking and listening)  
☐ Your family has at least one member with English written proficiency (i.e. reading and writing)  
☐ Your family does not have any members with English proficiency
6. Please indicate the number of people in your family:  
\* My family has \_\_\_\_\_ persons, including \_\_\_\_\_ children (aged 12 and under) and \_\_\_\_\_ elderly (aged 65 and over)
7. Please identify whether your family rents or owns your home:  
☐ Own   ☐ Rent   ☐ Other (Please specify): \_\_\_\_\_
8. Is your house or building covered by earthquake insurance?  
☐ Yes   ☐ No   ☐ Not applicable   ☐ Not sure
9. Does your family have renter insurance for the contents in your home?  
☐ Yes   ☐ No   ☐ Not applicable   ☐ Not sure
10. What is the housing type of your home?  
☐ Single-detached house   ☐ Duplex/Townhouse   ☐ Apartment/condo (building has 1 to 4 floors)   ☐ Apartment/condo (building has 5 or more floors)  
☐ Other: \_\_\_\_\_
11. How many members in your family currently have income resources (e.g., employment wages, pension, government assistance)? \_\_\_\_\_
12. Which of the following best describes your family?  
☐ Low-income Family   ☐ Mid-income Family   ☐ High-income Family   ☐ Not applicable   ☐ Not sure
13. What is your current status?  
☐ Citizen   ☐ Permanent resident; landed immigrant   ☐ Temporary resident; work visa or student visa   ☐ Other (Please specify): \_\_\_\_\_
14. Please identify your age:  
☐ 19~30   ☐ 31~40   ☐ 41~50   ☐ 51~60   ☐ 61 or over
15. Please identify your gender:  
☐ Male   ☐ Female   ☐ Other   ☐ Prefer not to answer
16. Please identify the highest level of education that you have completed:  
☐ Elementary   ☐ Junior High   ☐ High School   ☐ College or University   ☐ Graduate  
☐ Other (Please specify): \_\_\_\_\_

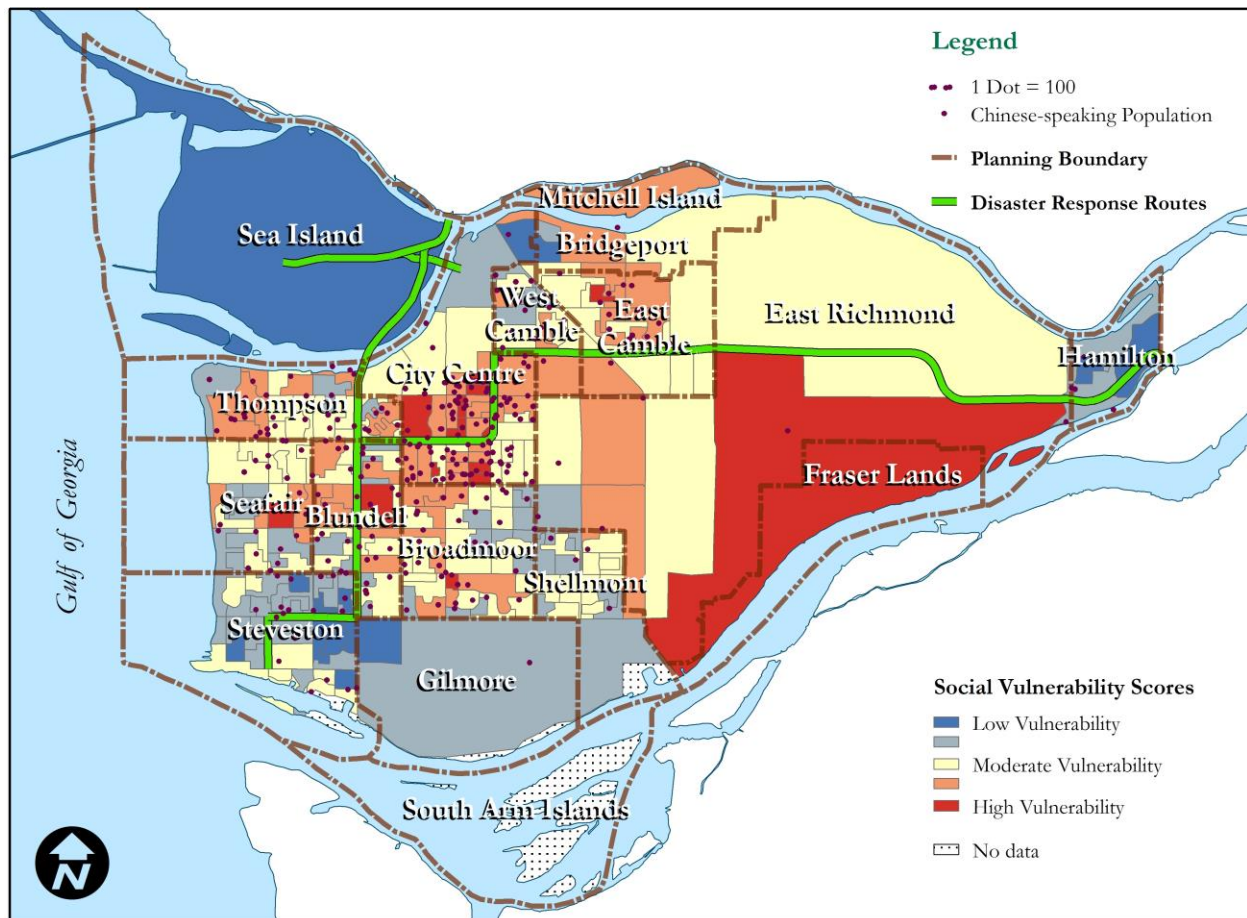
---

**Thank you for your time and participation !!**

**Please feel free to leave any comment or to contact with the researcher if you require any further questions or support. Please contact, Wei-Chung Chen, through phone at 778-896-7575 or via email at [lavinotw@alumni.ubc.ca](mailto:lavinotw@alumni.ubc.ca).**



## Appendix H Map of Chinese-speaking Population Distribution with SoVI Scores in Richmond



## Appendix I Summary of List of Disaster Risk Reduction Measures before, during and after Disasters.

After Source: CECI, 2011

<i>Before a disaster</i>	<i>During a disaster</i>	<i>After a disaster</i>
<p><b>Infrastructure:</b> Upgrading, repairing and disaster proofing houses, public buildings, dykes and other important infrastructure to be disaster-resilient</p> <p><b>Communication system:</b> Development of early warning systems, communication systems, hazard and vulnerability maps for different types of disasters, rescue and evacuation.</p> <p><b>Policy and strategy:</b> Development of related policies, development of action plan, communication plan, on disaster prevention and mitigation annually.</p> <p><b>Training and awareness raising:</b> Establishment of rescue team and simulation; education program, equipment of knowledge on disaster and capacity building on disaster preparedness for communities, especially for schools.</p> <p><b>Other disaster preparedness activities:</b> Prepare emergency equipment (boat, life vest, radio, etc.), storage of supplies such as stocking food, water and medical supplies.</p>	<p><b>Emergency response:</b> Activate emergency response plan; mobilize search and rescue teams.</p> <p><b>Evacuation:</b> Evacuation of people to safe places; assistance to elderly, children and disabled to reach safety.</p> <p><b>Health care:</b> Health, food relief.</p> <p><b>Environment and sanitation:</b> Ensure clean water and sanitation.</p>	<p><b>Recovery support after disaster to ensure basic services for communities:</b> Temporary houses, health care, water and sanitation and hygiene, transportation, productions, etc.</p> <p><b>Improvement of infrastructure:</b> Repair, improvement of dyke, bridges, roads, etc.</p> <p><b>Communication:</b> Awareness raising, disease prevention and hygiene</p>

© Wei-Chung Chen  
UBC SCARP | November 2014  
Supported by S.U.C.C.E.S.S

