Seismic Risk Assessment of Vancouver's Building Stock

Prepared for GIST 8150

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Abstract

The city of Vancouver is located in a seismically active region, making the resilience of its building stock a critical area of study for urban planning and emergency management. This project undertakes a comprehensive seismic risk assessment by integrating multiple datasets and applying a systematic, multi-hazard methodology. The primary objective was to develop a composite risk index, first at the individual building level and then aggregated to the neighbourhood scale (Statistics Canada Census Dissemination Area), by quantifying key physical vulnerability, exposure, and social vulnerability factors.

A significant challenge was the integration of disparate datasets from BC Assessment, OpenStreetMap, and individual Jurisdiction building datasets, which contained numerous null values and inconsistent schemas. To overcome this, a robust data imputation and cleaning workflow was developed using a series of rule-based models in Python (arcpy). These models intelligently estimated critical missing attributes such as structural type, building area, occupancy class, and population.

The core of the analysis involved calculating a physical risk score for each building based on vulnerability (height, construction) and exposure (population, size, density). This building-level data was then aggregated to SAUID polygons, calculating key statistics such as mean risk score, total building counts, and dominant building typologies for each area. Finally, this physical risk data was joined with a Social Vulnerability Index (SoVI) to create a holistic view of community-level risk. The final deliverables include an ArcGIS Web Map with information pop-ups; a voice-annotated powerpoint; and this detailed report. The results provide a powerful, data-driven tool to identify high-risk neighbourhoods where physical infrastructure vulnerability and social vulnerability intersect, potentially enabling the prioritization of mitigation and preparedness efforts.

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1. Introduction

1.1 The Regional Seismic Threat

The City of Vancouver's location within a high-hazard seismic zone on the Pacific Ring of Fire necessitates a deep understanding of the potential risks posed to its built environment. The region faces three distinct and significant earthquake threats, each with unique characteristics that influence the nature of the risk:

1. Megathrust Earthquakes (Cascadia Subduction Zone): A potential magnitude 9.0 event on the Cascadia subduction zone. This scenario is characterized by very long-duration shaking (up to 3-5 minutes) and significant long-period ground motions that pose a substantial threat to tall buildings and long-span bridges.
2. Deep Intraslab Earthquakes: A magnitude ~7.0 event occurring within the subducting Juan de Fuca plate, 45-70 km beneath the surface. This is considered the most likely significant seismic threat for Vancouver and produces a damaging mix of frequency content.
3. Shallow Crustal Earthquakes: A magnitude ~7.2 event occurring on a shallow fault within the North American plate. Though less frequet, such an event could be locally devastating due to intense, high-frequency shaking near the city's core.

While regional seismic hazard is well-documented, the actual risk to the community varies dramatically from one building to the next. This project addresses the critical need for a detailed seismic risk assessment that moves beyond hazard mapping to integrate the crucial factors of structural vulnerability and community exposure.

1.2 Existing Research and Identified Gaps

Several robust, open-source databases and reports cover earthquake hazard and risk in Vancouver. A review of these sources revealed the specific gap this project aims to fill:

- City of Vancouver Seismic Risk Report (RTS 16091): Provides an excellent single-scenario (M7.2 Georgia Strait) risk assessment for buildings within the City of Vancouver proper. However, its scope is limited to a single scenario and a single jurisdiction, and it does not include a detailed critical infrastructure layer.
- OpenDRR National Human Settlement Layer (NHSL): Offers a powerful national-scale model of physical exposure and social vulnerability at the census dissemination area level. Its primary limitation is that its physical exposure is calculated using statistical estimates based on similar types of neighbourhoods, so it lacks individual building data and footprint, and is not intended for site-specific assessment.
- Metro Vancouver Seismic Microzonation Mapping Project (MVMMSP): This project produced an outstanding series of probabilistic hazard maps detailing ground shaking amplification, liquefaction susceptibility, and landslide potential. However, it explicitly focuses on hazard and does not include an inventory of the built environment or an assessment of risk.

The primary gap identified is the need for a **site-specific, building-level physical risk assessment for the entire Metro Vancouver region**, created from authoritative data sources, which can then be integrated with social vulnerability data from sources like SoVi BC, and then eventually with the excellent hazard data from MVMMSP to create a bivariate Seismic Risk-Hazard analysis.

1.3 Project Goals and Objectives

The primary goal of this project is to create a comprehensive, analysis-ready dataset of seismic risk for individual buildings across Vancouver and aggregate this information to the neighbourhood (DAUID) level to combine with the NHSL SoVi index, creating a holistic risk analysis.

2. Project Statement

This project develops and applies a systematic methodology to calculate a composite seismic risk index, first for the complete building stock of Vancouver and then aggregated to SAUID polygons to provide a neighbourhood-scale perspective. The final product is a comprehensive geodatabase containing both the scored building features and the final SAUID risk layer, visualized through thematic maps that highlight areas of highest combined physical and social risk.

3. Profile of Project Sponsor

This is a self-directed project undertaken for the GIST 8150 Capstone Project at the British Columbia Institute of Technology (BCIT). The project leverages publicly available data (NHSL, OSM, Municipal Data) as well as data provided through Western University ArcGIS Online Seismic Hazard Group (BCA Assessment Folio Building Data) with access provided through the course instructor, Gurdeep Singh.

4. Project Objectives

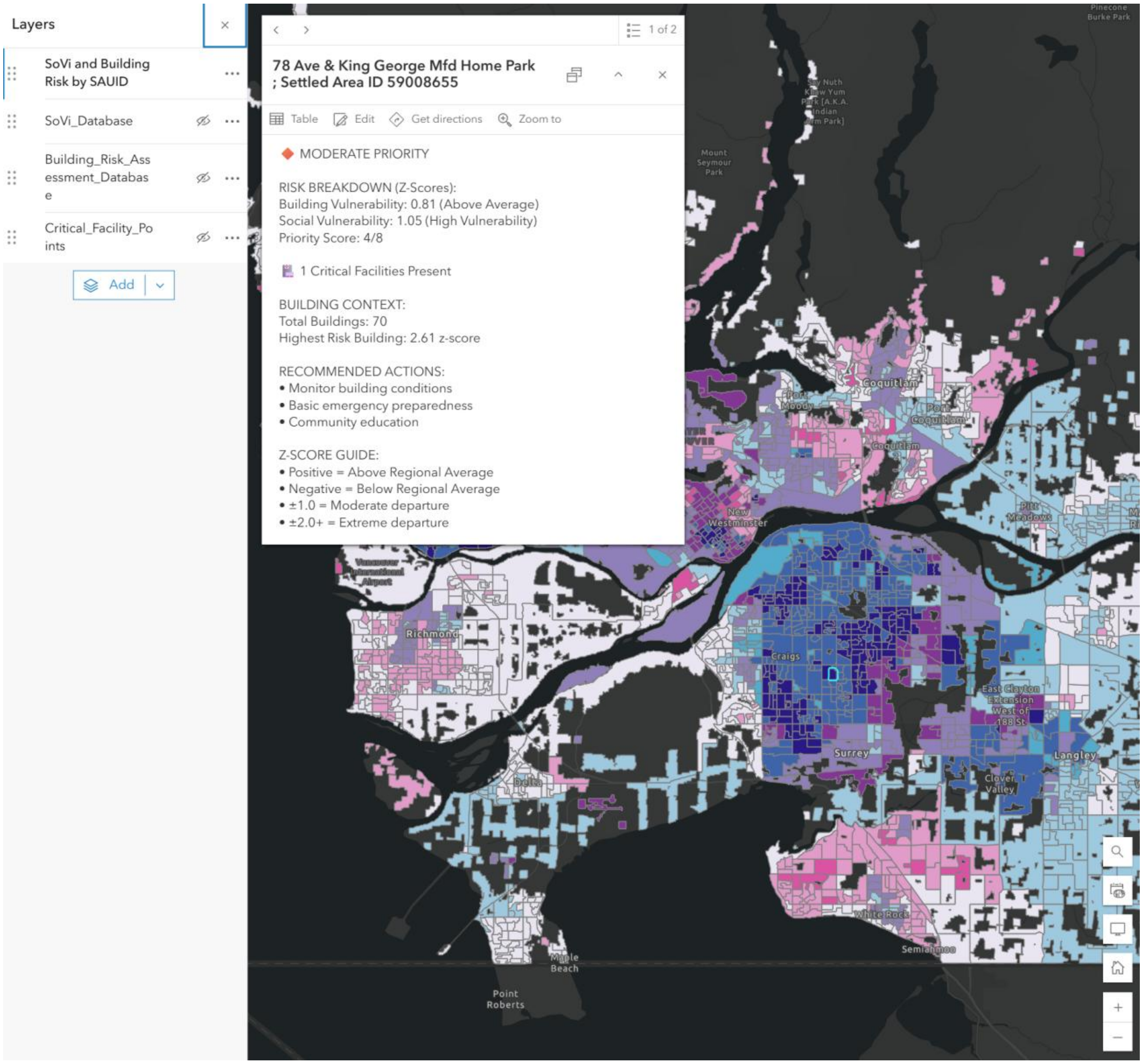
4.1. Project Objectives

The primary objective is to calculate a composite seismic risk index for each building in the study area and aggregate the results to the SAUID level. This is achieved through the following sub-objectives:

1. Data Integration and Harmonization: To integrate and merge multiple disparate building datasets (BCA Commercial, BCA Residential, and OSM-derived) into a single, cohesive feature class.
2. Data Cleaning and Imputation: To perform extensive data cleaning and develop a sophisticated, rule-based imputation workflow to populate critical missing attributes.
3. Building-Level Risk Assessment: To quantify the physical vulnerability and exposure of each building based on its characteristics (height, construction, population, size, density).
4. Neighbourhood-Level Aggregation: To aggregate the building-level risk scores and attributes to SAUID polygons, calculating summary statistics to characterize each neighbourhood.
5. Social Vulnerability Integration: To join the aggregated physical risk data with a pre-existing Social Vulnerability Index (SoVI) to create a holistic view of community risk.
6. Visualization and Reporting: To produce clear thematic maps and a detailed final report documenting the project's methodology, findings, and recommendations.

4.2. Project Deliverables

1. Final Project Report: This document, detailing the project from conception through to its results and conclusions.
2. Voice-Annotated PowerPoint: A presentation summarizing the project's purpose, methodology, and key findings.
3. ArcGIS Web Map: A series of layers visualizing the final aggregated risk scores, including bivariate maps showing the intersection of physical and social vulnerability with comprehensive popups.



An example of the web map app, with the comprehensive pop-ups for each SAUID.

5. Project Background

Seismic risk is a function of three core components: **Hazard**, **Vulnerability**, and **Exposure**. As defined in preliminary project notes, "Hazards are the physical phenomena, while risks are the potential consequences when those hazards interact with human systems, structures, and communities" [cite: Capstone.pdf]. This project focuses on quantifying the vulnerability and exposure components to create a detailed risk profile.

- **Physical Vulnerability:** The intrinsic characteristics of a building that make it susceptible to damage from a hazard. This project models vulnerability using building height, construction materials and design (STRUCTURAL).

- **Social Vulnerability:** The susceptibility of social groups to the impacts of hazards, as well as their ability to respond to and recover from the stress. This is represented by the SoVI index.
- **Exposure:** The value or importance of an asset located in a hazard zone. This project models exposure using building population, building size (Building_Area_Num), and building density (RASTERVALU).

6. Project Data / Programming Environment

6.1. Data Sets and Data Dictionary / Tools & Languages

Data Sources:

Dataset Name	Source	Format	Description
BCA Commercial & Residential	BC Assessment	GDB Feature Class	Detailed attribute data for properties, including MANUAL_CLASS_CODE and ACTUAL_USE_CODE.
non_BCA_and_osm_buildings	OpenStreetMap / Other	GDB Feature Class	Building footprints with supplementary attributes like type_1 and fclass, crucial for imputation.
SAUID Polygons & SoVI Data	Statistics Canada / OpenDRR	GDB Feature Class	Settled Area ID polygons containing Social Vulnerability Index scores.
Building Density Raster	OSM Building Points	Raster	A kernel density raster created from OSM building points to represent urban density.

Data Dictionary for Final SAUID Feature Class:

Field Name	Data Type	Description & Purpose

SAUID	Text	Unique Identifier for the Settled Area polygon. The primary key for joining.
MEAN_Score_Vulnerability_Total	Double	The average Physical Vulnerability Score of all buildings within the SAUID.
MEAN_Score_Exposure_Total	Double	The average Physical Exposure Score of all buildings within the SAUID.
MEAN_Risk_Score_Final	Double	The average final physical risk score for buildings within the SAUID. **Primary physical risk indicator.**
MAX_Risk_Score_Final	Double	The maximum (highest) risk score of any single building within the SAUID, indicating the presence of high-risk structures.
SUM_Critical_Facility_Count	Double	The total count of critical facilities within the SAUID.
B_Medical	Double	SoVI: The number of doctors per 100,000 population.
B_Emergenc	Double	SoVI: The distance to emergency response facilities (km).
ECONOMIC	Double	SoVI: The economic component of the Social Vulnerability Index.
SOCIAL	Double	SoVI: The social component of the Social Vulnerability Index.
COMMHEALTH	Double	SoVI: The community health component of the Social Vulnerability Index.
BUILTENV	Double	SoVI: The built environment component of the Social Vulnerability Index.

SVI	Double	The total Social Vulnerability Index score for the SAUID. **Primary social risk indicator.**

Tools & Languages:

- Software: ArcGIS Pro 3.x
- Primary Language: Python 3 (via arcpy site package)
- Key Python Libraries: arcpy, numpy, collections.Counter

6.2. Study Area

This seismic risk assessment encompasses 25 jurisdictions within the Metro Vancouver Regional District, representing one of Canada's most seismically active and densely populated urban regions. The study area extends from the mountainous North Shore communities to the Fraser River delta, covering approximately 2,900 square kilometers of diverse terrain in southwestern British Columbia.

The study area includes a comprehensive range of municipal governance structures:
Major Urban Centers:

- City of Vancouver (provincial largest city, ~630,000 residents)
- City of Surrey (fastest-growing major city, ~520,000 residents)
- City of Burnaby (urban core, ~250,000 residents)
- City of Richmond (delta location, ~220,000 residents)

Mid-Sized Cities: Coquitlam, Delta, Langley (City), New Westminster, North Vancouver (City), Port Coquitlam, Port Moody, Maple Ridge, Pitt Meadows, White Rock
Specialized Jurisdictions:

- Districts: North Vancouver, West Vancouver (mountainous, higher-income)
- Township: Langley (mixed urban-rural)
- Villages: Anmore, Belcarra, Lions Bay (small, often mountainous communities)
- First Nation: Tsawwassen First Nation (treaty lands)
- Island Municipality: Bowen Island (ferry-accessible)

The study area presents unique challenges for earthquake risk assessment:

- Geological Diversity: Ranges from soft Fraser River delta sediments (high amplification potential) to bedrock mountainous areas
- Building Stock Variation: Spans from historic pre-1940s construction in Vancouver to modern developments in Surrey and Richmond
- Population Density Gradients: From ultra-dense Vancouver neighborhoods (>10,000/km²) to rural areas in eastern municipalities
- Critical Infrastructure Concentration: Major ports, airports, highways, and lifelines serving the broader region

This jurisdictional diversity provides an ideal case study for comparative seismic risk analysis, allowing examination of how municipal governance, development patterns, building codes, and socioeconomic factors influence earthquake vulnerability across a coherent metropolitan region facing common seismic hazards from the Cascadia Subduction Zone, Georgia Strait, and local crustal faults.

7. Project Methodology

The project was executed in four main phases: Data Preparation, Building-Level Risk Calculation, Aggregation to SAUID Level, and Visualization.

7.1. Data Input, Data Manipulation, Algorithms, Customization

Phase 1: Data Preparation & Imputation

This was the most complex and critical phase of the project, involving a series of custom Python scripts to create a complete and analysis-ready dataset from incomplete and inconsistent sources. The initial exploration of the non-BCA dataset revealed that key analytical fields like STRUCTURAL, Units, and POPULATION had over 90% null values, making imputation essential [cite: Statistics.pdf]. The process included:

1. **Data Integration and Cleaning:** The three source building datasets were merged. An initial cleaning script was run to remove join prefixes (e.g., SUM_) from field names and to selectively nullify attributes of duplicate records based on distance, flagging true repeats.
2. **Initial Imputation:** A series of scripts were run to fill obvious data gaps using the most reliable available data. This included populating null Total_Building_Units by finding the maximum value between COUNT_UNIT_NUMBER and ADDRESS_COUNT; correcting Storeys values using MAX_Storeys; and calculating a robust, composite building_area.
3. **Advanced Imputation (Rule-Based Modeling):** Recognizing that key fields like STRUCTURAL and POPULATION were almost entirely null in the non-BCA dataset, a sophisticated imputation model was developed. This model used the descriptive type_1 field (e.g., 'house', 'apartments', 'school') to assign a logical structural type, number of units, and population estimate based on the building's described use.
4. **HAZUS and Critical Facility Classification:** The final imputation step involved populating the General_Occupancy_Class, Specific_Occupancy_Class, and Critical_Facility_Type fields. A script with a comprehensive mapping dictionary was used to translate values from fclass, type_1, ACTUAL_USE_CODE, and MANUAL_CLASS_CODE into standardized descriptions.

Summary Statistics: Before and After Imputation

The impact of the imputation process was significant, transforming the dataset from one with critical data gaps into a complete, usable resource. The table below shows the reduction in null values for key fields in the non-BCA dataset.

Field	Null % (Before)	Null % (After)
STRUCTURAL	95.1%	0.0%
Units	98.8%	4.9%
POPULATION	93.8%	0.0%

Phase 2: Building-Level Risk Index Calculation

A Python script was developed to calculate a physical risk score for every building. For each building, the script calculated vulnerability scores (Height, Construction, Population) and exposure scores (Size, Density), summed them, and applied a multiplier for critical facilities to generate a Risk_Score_Final.

Phase 3: Aggregation to the SAUID Level

This phase transitioned the analysis from the building-level to the neighbourhood-level.

1. **Spatial Join:** The final scored building layer was spatially joined to the SAUID polygon layer.
2. **Dissolve and Summarize:** The resulting layer was dissolved by the SAUID field. During the dissolve process, summary statistics were calculated for each polygon to create the final analytical fields, as detailed in the data dictionary (e.g., MEAN_Composite_Risk_Score, Total_Buildings, MODE_Risk_Category).
3. **SoVI Integration:** The resulting SAUID layer, now containing the aggregated physical risk metrics, was joined to the SoVI BC data layer using the SAUID field as the common key.

7.2 Resources Used

Layer	Dataset	Format	Geometry	Key Attributes	Source/URL
Primary Building Data					

BCA Residential	BC Assessment Residential Properties	Vector/Feature Service	Polygon (Building Footprints)	YEAR_BUILT, STRUCTURAL, STOREYS, POPULATION, Building_Area_Num, ACTUAL_USE_CODE	https://bcgov03.maps.arcgis.com/home/item.html?id=2930a3ab4ad0401393dc7bf421cac66b
BCA Commercial	BC Assessment Commercial Properties	Vector/Feature Service	Polygon (Building Footprints)	YEAR_BUILT, MANUAL_CLASS_CODE, STOREYS, GROSS_BUILDING_AREA, Unit counts (APT, HOTEL, etc.)	https://bcgov03.maps.arcgis.com/home/item.html?id=2930a3ab4ad0401393dc7bf421cac66b
Critical Facilities					
OSM POIs	OpenStreetMap Points of Interest	Vector	Point	Fclass (facility classification)	OpenStreetMap
OSM Buildings	OpenStreetMap Building Footprints	Vector	Polygon	Building footprints outside BCA coverage	OpenStreetMap
Municipal Building Databases (Attribute Imputation)					
Burnaby Buildings	City of Burnaby	Vector	Polygon	Building attributes for	https://data.burnaby.ca/

	Building Outlines			imputation	datasets/burnaby::building-outlines/about
Coquitlam Buildings	City of Coquitlam Building Data	Vector	Polygon	Building attributes for imputation	https://data.coquitlam.ca/
New Westminster Buildings	City of New Westminster Buildings Inventory	Vector	Polygon	Building attributes for imputation	https://opendata.newwestcity.ca/datasets/newwestcity::buildings-inventory/about
North Vancouver Buildings	City of North Vancouver Building Data	Vector	Polygon	Building attributes for imputation	https://geoweb.dnv.org/data/
DNV Buildings	District of North Vancouver Building Data	Vector	Polygon	Building attributes for imputation	https://geoweb.dnv.org/data/
Port Coquitlam Buildings	City of Port Coquitlam Building Data	Vector	Polygon	Building attributes for imputation	https://maps.portcoquitlam.ca/Html5Viewer/index.html?viewer=Public.v1
Richmond Buildings	City of Richmond Building Data	Vector	Polygon	Building attributes for imputation	https://www.richmond.ca/services/digital/maps.htm
Surrey Buildings	City of Surrey Building	Vector	Polygon	Building attributes for imputation	https://data.surrey.ca/dataset/buildin

	Inventory				g-inventory
Vancouver Buildings	City of Vancouver Building Footprints	Vector	Polygon	Building attributes for imputation	https://opendata.vancouver.ca/explore/dataset/building-footprints-2009/export/
Social Vulnerability					
SoVI BC	Social Vulnerability Index for British Columbia	Vector/Feature Service	Polygon (SAUID)	SVIt_Score, Economic/Social/Health components, Distance to medical/emergency facilities	https://bcgov03.maps.arcgis.com/home/item.html?id=e5f8b999654c4bc19b2da0971f0a520c
Reference/Validation Data					
OpenDRR Physical Exposure	National Human Settlement Physical Exposure Model	Vector	Polygon (Census areas)	Estimated building counts, construction types, occupancy types, HAZUS taxonomy	https://github.com/OpenDRR/national-human-settlement/blob/main/physical-exposure/README.md
Geographic Context					
NHSL SAUID Boundaries	Settled Area Unit Identifiers	Vector	Polygon	Unique neighborhood identifiers for aggregation	Open Disaster Risk Reduction Platform · GitHub

7.3 Project Management Techniques

This project employed an adaptive, research-driven methodology that evolved organically based on data discovery. The approach prioritized flexibility and iterative development over rigid planning, acknowledging the exploratory nature of integrating diverse municipal datasets.

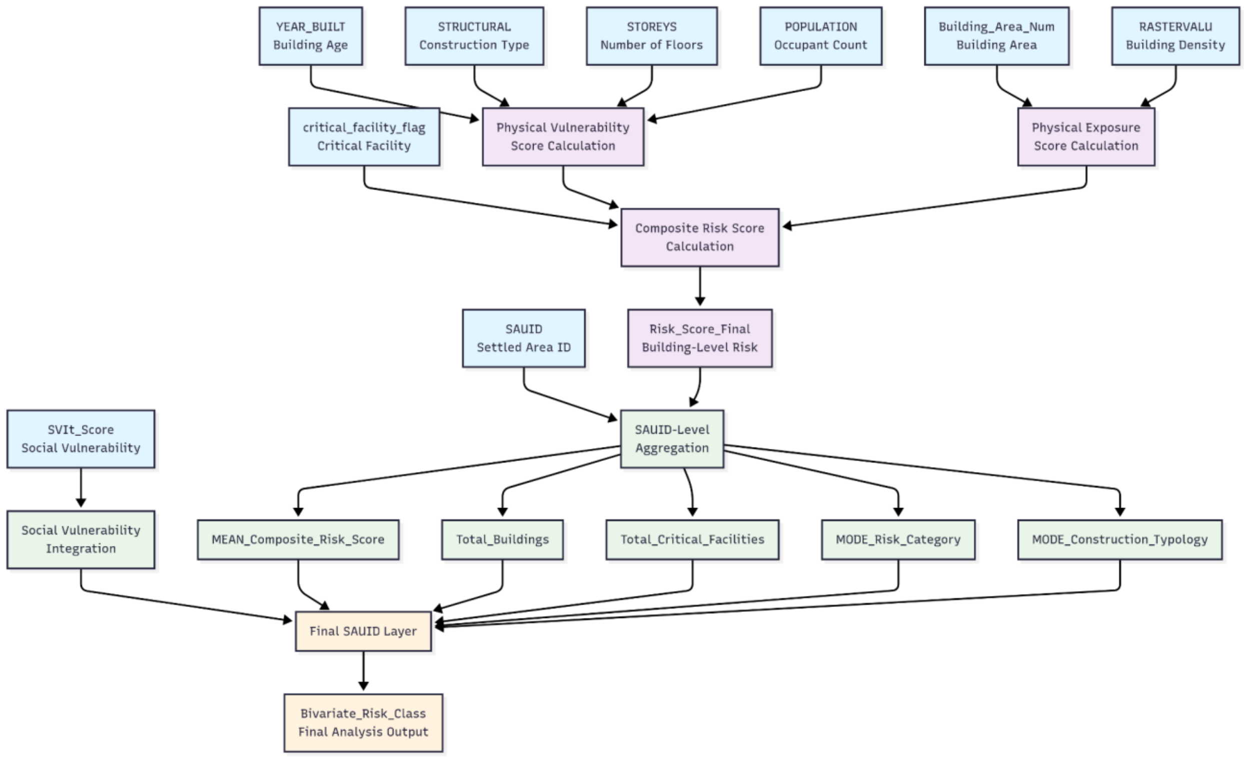
Research Approach: The project began with an extensive research phase (approximately 75% of total effort) focused on identifying existing risk assessment frameworks, cataloguing available data sources, and establishing data providers across multiple jurisdictions.

Iterative Data Integration: Rather than attempting to define a complete data schema upfront, the project employed a progressive data integration approach. As new datasets were discovered and accessed, the analytical framework was refined and expanded. This allowed for the incorporation of previously unknown data sources (such as individual municipal building inventories) that significantly enhanced the project's scope and accuracy.

Adaptive Scope Management: The project scope also evolved based on data quality assessments and analytical opportunities. Initial plans focused on estimated SAUID risk-level scoring using NHSL data, to basic building-level risk scoring using the newly discovered BCA Assessment Folio data, to comprehensive social vulnerability data (SoVI) and detailed municipal building attributes enabled expansion to neighbourhood-level aggregation and bivariate risk analysis.

Future-Oriented Planning: The methodology explicitly anticipated future enhancements, designing data structures and analytical workflows to accommodate additional hazard layers, scenario-specific risk modeling, and expanded geographic coverage. This forward-thinking approach ensures the project's long-term utility and extensibility.

7.4. Diagrams / Flow Charts



8. Data Management / Software Management

8.1. Back up Strategies

All project data, including the ArcGIS Pro project (.aprx), the geodatabase, and all Python scripts, were stored in a primary project folder on a cloud storage service (OneDrive) to prevent data loss.

8.2. Naming Conventions and Version Management

A clear naming convention was used. Python scripts were named descriptively based on their function (e.g., impute_structural.py, calculate_final_risk.py). Feature classes were versioned by appending a suffix (e.g., buildings_v1, buildings_v2_imputed, SAUID_final) after major processing steps to preserve a record of the workflow. Feature classes also

9. Project Results and Recommendations

The primary result of this project is the final SAUID-level feature class, which characterizes each neighbourhood in Vancouver by its aggregated physical building risk and its social vulnerability.

(Here, you will insert your final maps from Maps.pdf and describe the results. The focus

should now be on the SAUID-level maps.)

"The analysis reveals significant spatial clustering of risk at the neighbourhood level. Figure 1 shows a choropleth map of the MEAN_Composite_Risk_Score by SAUID. This map clearly identifies hotspots in areas like the Downtown Eastside and older parts of Kitsilano, where a high concentration of vulnerable building stock (e.g., unreinforced masonry) drives up the average physical risk.

Figure 2 presents a bivariate map, symbolizing each SAUID by both its physical risk (MEAN_Composite_Risk_Score) and its social vulnerability (SVI). This powerful visualization identifies the most critical areas for intervention: neighbourhoods that not only have physically vulnerable buildings but also populations that may struggle to recover from a disaster. These 'dual-risk' zones represent the highest priority for municipal policy and resource allocation."

Recommendations:

1. Prioritize Dual-Risk Zones: Municipal resources for seismic retrofitting, emergency preparedness outreach, and post-disaster support should be prioritized for the SAUIDs identified as having both high physical risk and high social vulnerability.
2. Inform Neighbourhood-Level Planning: The SAUID-level statistics can be used to inform Community Emergency Plans, identifying the dominant building types and the number of critical facilities in each neighbourhood.
3. Public Engagement: The simplified, neighbourhood-scale risk maps are ideal for public engagement campaigns to raise awareness and encourage preparedness at the community level.

10. Future Work

This project establishes a robust foundation for numerous future enhancements. The created geodatabase is a rich asset that can be expanded to produce an even more nuanced and actionable understanding of seismic risk in Vancouver.

- **Enhance the Hazard Component:** The most critical next step is to integrate the risk data with the spatially variable hazard data from the MVMMSP. By creating a composite hazard layer (combining liquefaction, shaking amplification, etc.) and intersecting it with the final SAUID layer, the model can account for how local ground conditions will exacerbate building damage.
- **Scenario-Specific Risk Assessment:** As outlined in the project proposal, a key future step is to develop "quasi-scenario" risk maps. This involves re-weighting the vulnerability components based on the characteristics of the three main earthquake threats. For example, for a Cascadia M9.0 scenario, the Height and Foundation vulnerability scores would be weighted more heavily to reflect the danger of long-

period shaking and liquefaction.

11. Conclusion

This project successfully developed and implemented a comprehensive methodology for assessing seismic risk, transitioning from a granular building-level analysis to a holistic neighbourhood-scale assessment. By systematically integrating disparate datasets, performing extensive rule-based data imputation, and aggregating the results, a powerful new dataset was created. The final product, which combines physical building risk with social vulnerability at the SAUID level, provides a critical tool for stakeholders to understand and mitigate the complex seismic risk facing Vancouver, ultimately enhancing regional resilience.

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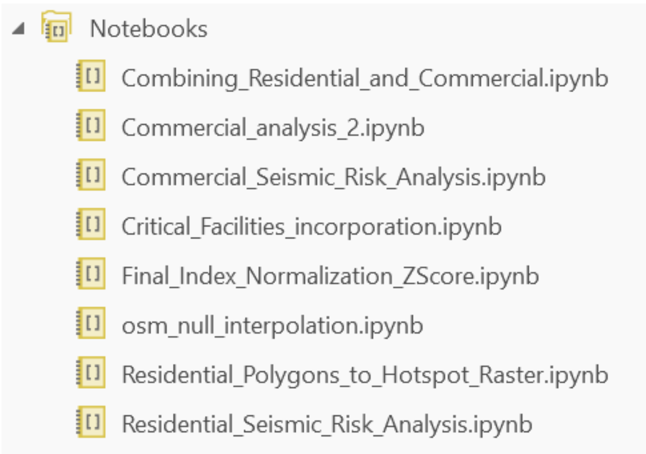
Appendices

Appendix A: Key Python Code Snippets



Snippet 1: Advanced Imputation Logic
This code block demonstrates the core logic for imputing STRUCTURAL, Units, and POPULATION based on the type_1 field.

```
# --- Rule-Based Model based on type_1 ---
if type1 in ('house', 'detached', 'cabin'):
    est_structural = 'W1'
    est_units = 1
    est_population = 3.0

elif type1 in ('apartments', 'residential'):
    est_structural = 'C1L' if s > 4 else 'W2'
    est_units = max(1, round(a / 90)) if a > 0 else 1
    est_population = est_units * 2.5

elif type1 in ('school', 'hospital', 'fire_station'):
    est_structural = 'C1L'
    est_units = 1
    est_population = max(1, round(a / 8)) if a > 0 else 1
# ... additional rules ...
```

Snippet 2: Critical Facility Calculation and Type Population
This code block shows the hierarchical logic for identifying critical facilities and populating the final count and type fields without a pre-existing flag.

```
# Determine critical status and populate descriptions
descriptions = []
```

```
# Hierarchically check each source field
if row[idx_fclass] in fclass_map: descriptions.append(fclass_map[row[idx_fclass]])
if row[idx_type1_src] in type_1_map:
descriptions.append(type_1_map[row[idx_type1_src]])
if row[idx_actual] in actual_use_code_map:
descriptions.append(actual_use_code_map[row[idx_actual]])
if row[idx_manual] in manual_class_code_map:
descriptions.append(manual_class_code_map[row[idx_manual]])

# Get unique descriptions and sort them for consistency
unique_descriptions = sorted(list(dict.fromkeys(descriptions)))
is_critical_flag = 1 if unique_descriptions else 0

# Calculate Critical_Facility_Count
total_count = is_critical_flag + (row[idx_join] or 0)
row[idx_count] = total_count

# Populate the Type fields
row[idx_type1] = unique_descriptions[0] if len(unique_descriptions) > 0 else None
row[idx_type2] = unique_descriptions[1] if len(unique_descriptions) > 1 else None
```