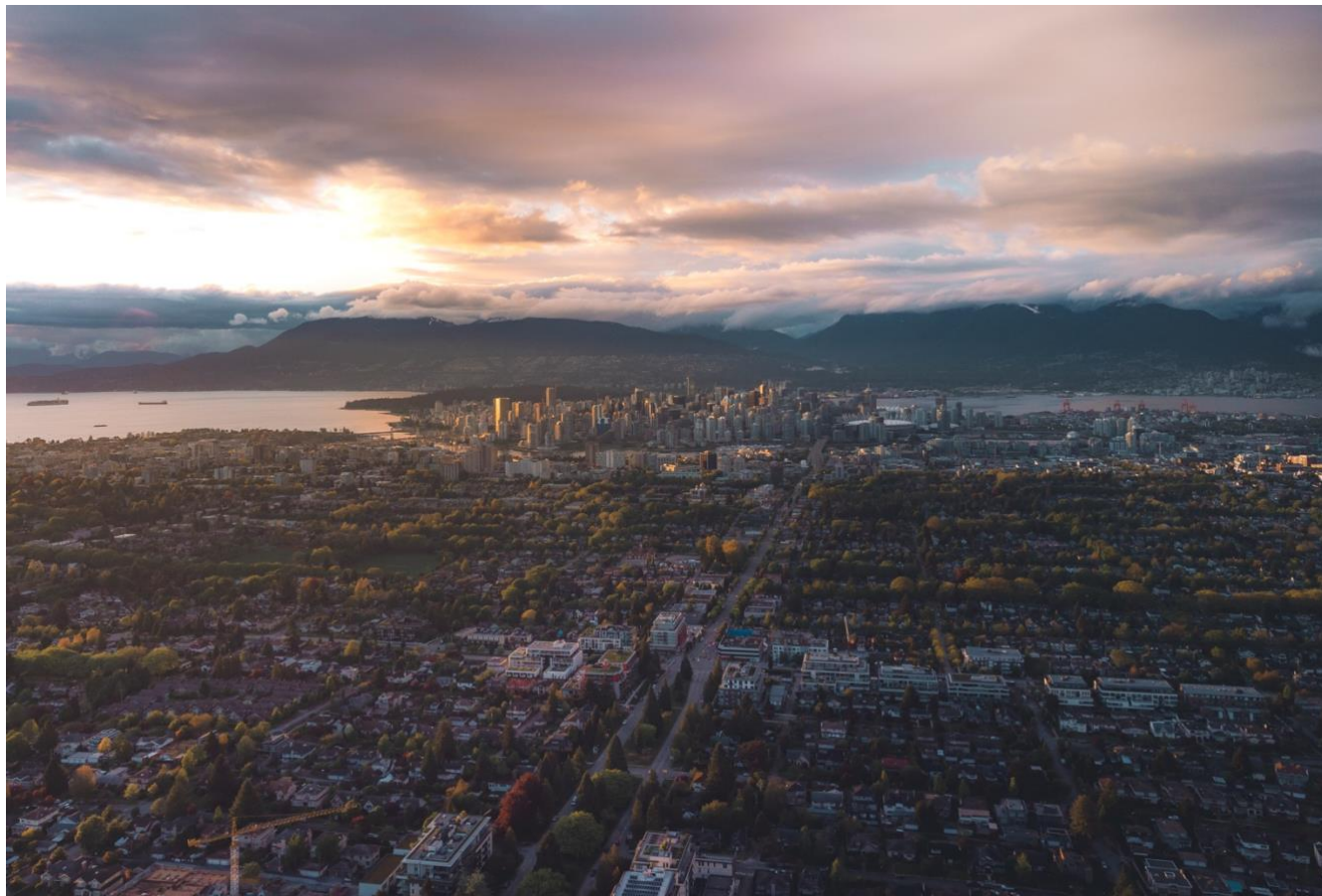# Benefits and Risks of Mapping Equity-Denied Groups to Inform Municipal Climate Policy

Best Practice Research

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Territorial Acknowledgements

I acknowledge that the work for this project took place on the traditional, ancestral, and unceded lands of the xwməθkwəy̓əm (Musqueam), Skwxwú7mesh (Squamish), and Səl̓ílwətaʔ/Selilwitulh (Tsleil- Waututh) Nations. As an uninvited guest on this land, it's with sincere and deep gratitude that I recognize the continuous presence of these Nations as original caretakers of this territory.

This report was not produced in consultation with these Nations, and as a result I recognize the colonial perspectives and limitations of this research. As I reflect on this project, I feel that more work needs to be done on decolonizing equity research and moving towards a future where we include more diverse ways of knowing. I believe that a just recovery of the social and natural environment requires equity and reconciliation at the core of planning and policy, and it's my hope that these Nations are central to envisioning this future.

Acknowledgements

Cover photo by Matt Wang via Unsplash

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Executive Summary

Within the City of Vancouver organization, there is growing awareness towards the intersectional impacts of climate change and the systemic inequities marginalized populations are facing. In 2021, the City Council approved the Equity Framework; a conceptual, grounded, and foundational document aimed at coordinating and defining the direction of equity work across departments. Maps and indices are common data visualization tools that are used to support planning and policies across different local, regional, federal, and international scales. Many maps and indices have been created and used by staff in multiple departments for this same purpose, but there is growing interest in what creating a centralized index would entail. It's within this context that the City is exploring the creation of a centralized dataset and accompanying map that illustrates how various equity indicators overlay with climate policy indicators. Prior to developing this index, information on the benefits and risks of mapping equity-denied populations is needed.

This report aims to fill a knowledge and coordination gap within the City's equity-mapping work by providing a foundational understanding of the benefits and risks associated with a centralized dataset, and how this can be used to inform and shape policy. A recurring theme of this report surrounded the concept of maps as "starting points"; that maps do not provide standalone evidence and require further contextualization work to be relevant. In the literature review, case studies, and conversations with practitioners, there was an emphasis on the need for an equitable mapping practice that involves and reflects communities more accurately than the current models.

Based on research findings, the recommended scenario is to move forward with developing an informed central equity index to be used as a starting point for further contextualization by project-specific approaches. This recommendation assumes the Equity Office would be leading the project, with a team most likely comprised of staff from ACCS's data team and/or an interdepartmental working group formed within the Equity and Decolonization of Data Community of Practice. The central index would form the basis for project-specific maps with the understanding that further data collection, qualitative research, and participatory/community mapping methodologies should be undertaken at this scale. To reduce the risk to communities, greater data, information, and resource sharing is strongly recommended. This approach to a centralized index for the City of Vancouver attempts to balance the needs and concerns expressed by staff. Importantly, it envisions a mapping practice that is grounded in equity and opportunity to help inform municipal climate policy

Introduction

Project Purpose

This research project aims to support the city's climate and equity work through best practice research to:

1. Identify examples of how the City of Vancouver and other municipalities or organizations have developed and used similar centralized datasets to inform climate policy
2. Utilize those findings to recommend process and standards for staff to follow in developing such a dataset and map

These objectives are framed within the context of the City's exploration into the creation of potential centralized datasets and maps that illustrate how various equity indicators (such as gender identity, racial identity, income, etc.) overlay with climate policy indicators (such as access to transit options, distribution of EV charging, tree canopy, etc.). This research aims to provide a starting point for further interdepartmental conversations among City staff about the opportunities and risks for creating more centralized datasets and maps as tools for integrating equity into policy.

Project Scope

This report is intended to serve as an introduction to the current landscape of equity-mapping practice across Canada and the United States to inform future research and municipal climate policy. To gain an understanding of the work being done in this field, the research entailed a thematic literature review, case study analyses, as well as focus groups and interviews with professionals/practitioners from Vancouver and elsewhere in Canada. These conversations offered significant insight into the direction and recommendations of this report.

Utilizing research findings to develop recommendations for a list of draft equity and climate indicators that could form the basis for a map to inform climate mitigation and adaptation projects was outside the scope of this project.

Background

We define equity as both an outcome and a process… Equity as an outcome is the condition that would be achieved if one's identity no longer predicted how one fares. Equity as a process is the replacement of policies, practices, attitudes, and cultural messages that reinforce differential outcomes or fail to eliminate them.[1]

Starting Point: In Conversation with City of Vancouver Staff

Early in the project focus groups were held with City of Vancouver staff – majority of whom were data and GIS practitioners/analysts - to discuss the benefits, risks, and effects of data and mapping practice in relation to wider professional and institutional equity goals.

What Was Shared:
- Imagining alternative mapping/planning frameworks from the status quo
- Reflecting on the colonial practice of equity research and the default extractive approach to data collection
- Thinking critically about what stories are being told through mapping alone, and who/what they represent
- Emphasizing the limited representational capabilities of maps and data
- A need for prioritizing race and disaggregating data to encompass intersectionality and breadth of identities
- Rethinking data custodianship and who maintains ownership over equity maps (i.e., including equity-denied communities in the process)
- The usefulness of a centralized dataset and map for standardization amongst different department projects
- Contemplating whether a map is the best way to communicate a story or issue
- Finding a way to keep qualitative and quantitative stories working hand in hand

The direction of this research was informed by these conversations and represents an important starting point for this report.

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[1] "Getting Our House in Order: The City of Vancouver's Equity Framework." Vanouver: City of Vancouver, (2021): 6.

Literature Review

Summary

It has often been cited that an important function of equity mapping is to display areas of priority for planners and policy makers in an effective and efficient manner. However, as explored in the following literature review, there remain challenges and areas of concern with regards to the methods, models, and interpretations of the concept of mapping equity. Based on the review, it appears there was no standardized way to appropriately select and display aggregated data on equity[2]. Rather, mixed method data collection and meaningful community participation was argued as an important objective in this manifestation of equity work. In some cases, it was argued that greater education on map interpretation can help prevent misunderstandings or potential for a priori policy justifications on the part of end users[3]. Moreover, a common sentiment amongst the literature was the significant underrepresentation of community values and social characteristics in conventional equity mapping methods which makes room for bias, oversimplification, and mischaracterization. The representational limitations involved in mapping suggests a natural limitation to their interpretation; although maps can support prioritization, they should be interpreted as starting points rather than as end products[4]. Using the literature as a basis for further independent research on the potential local dangers associated with equity mapping may be required to create alternative mapping techniques appropriate for certain contexts and scales. Ultimately, to achieve the goals of equity requires meaningful efforts to incorporate greater equity awareness from start to finish in mapping practice.

Common Objectives and Benefits to Conventional Equity Mapping

Often cited in the literature, the goal with equity mapping was to indicate areas of policy priority to address institutional and structural discrimination and equitably distribute public resources[5]. In addition, mapping can be beneficial by spatially defining intangible equity measurements. In other words, mapping can provide a useful tool by making "visible otherwise marginal experience and hidden histories" to create social change[6]. Qualitative information is typically epistemologically challenging to retain at scale, therefore by using quantitative data through proxy equity indicators, maps have served as an important reference tool to support decision-making[7]. That said, favouring

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[2] McMaster, Robert B., Helga Leitner, and Eric Sheppard. "GIS-Based Environmental Equity and Risk Assessment" (1997): 172–89; Talen, E.,"Geovisualization of Spatial Equity," (2011): 458-479.
[3] Besser, Diane. "What Does "Equity" Look Like?" (2014); Finio, Nicholas, et al., "Equity, Opportunity, Community Engagement, and The Regional Planning Process," (2020); de Sherbinin, Alex et al., "Climate Vulnerability Mapping," (2019).
[4] De Sherbinin et al., 2019; Lee, Charles. "A Game Changer in the Making?" (2022): 13.
[5] Besser, 2014; Maantay, Juliana. "Mapping Environmental Injustices" (2002): 161–71; McMaster et al., 1997.
[6] Firth, R. "Critical Cartography", (2015).
[7] Besser, 2014; De Sherbinin et al., 2019; Finio et al., (2020);
[7] Firth, 2015.

quantitative methods and approaches in decision-making models are representative of a Western epistemology, and one that should lead us to consider the different ways of knowing that would be required to engage in meaningful qualitative research.

Critical Cartography

Contemporary critical cartography questions assumptions that maps represent "natural," "neutral," or "objective information" by analyzing how they function within dominant social, cultural, and political systems[8]. From this perspective, the function of maps is not to simply reflect the world but to play a part in creating it.

There has been a call for GIS work in support of equity initiatives to do more than changing techniques and models and respond by disrupting colonialism and oppressive narratives through alternative ways of mapping[9]. To decolonize mapping requires a critical analysis of what seems like the inherent function of cartographic decisions/maps, and to question what seems obvious[10]. Given the significance of mapping towards informing research and policy priorities, it's important to critically examine the conventional techniques and develop more appropriate approaches to equity mapping at different scales, areas, and "thematic foci"[11].

Data, Mapping, and Imperfect Representations

A common issue found in the literature surrounds the bias selection of equity indicators and their application as imperfect proxies of complex social processes[12]. Data, especially that collected on people, is a human act which was done with an intention/purpose in mind[13]. Because it's necessary on the part of those developing a map to make decisions about what to include, justification for such decisions becomes important for determining the normalization of the information presented[14].

According to the literature, census and survey data on socioeconomic and demographic indicators such as race, age, gender, education, income, etc., are most frequently used to represent social vulnerability and equity[15]. Continual reproduction of these indicators has led to some concern over the potentially

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[8] Bellone, Tamara et al., "Mapping as Tacit Representations of the Colonial Gaze." (2020): 18–26.

[9] Elwood, Sarah. "Toward a Fourth Generation Critical GIS" (2022): 436–47.

[10] Bellone et al., 2020.

[11] De Sherbinin et al., 2019.

[12] Besser, 2014; De Sherbinin et al., 2019; Deng, Yongxin. "Challenges and Complications in Neighborhood Mapping" (2016): 229–48.

[13] Schwabish, Johnathan & Feng, Alice, "Do No Harm Guide" (2021): 1-50.

[14] Besser, 2014.

[15] de Sherbinin et al., 2019; Finio et al., 2020; Taleai, M., R. Sliuzas, and J. Flacke. "An Integrated Framework to Evaluate the Equity of Urban Public Facilities Using Spatial Multi-Criteria Analysis." (2014): 56–69.

miscalculated and simplification of equity mapping practices. Concerns have been raised towards the issue of "biased sampling, missing values, infrequency of updates" and data relevance[16] in the conventional equity mapping process and how this impacts their validity or generalizability[17]. With regards to the concern of missing values, some researchers have called for greater frequency in mapping uncertainty[18]. It's suggested that noting uncertainty can signal important gaps in information and ultimately draw attention to potentially larger issues of data collection which can inform future equitable research considerations[19].

> *Despite nearly 100 years of scholarly interest in neighbourhoods, the question of what precisely constitutes a neighbourhood remains unresolved and largely unexamined'. It represents a complex social and spatial concept in which unambiguous, meaningful, and consensual neighbourhood boundaries are difficult to define.[20]*

Many urban mapping, planning, and data are defined by operational units (e.g., census tracts, blocks, postal codes, neighbourhoods, etc.) administered by different levels of authority[21]. However, efforts to define neighbourhoods and metropolitan areas by conventionally identifiable population and spatial characteristics alone fails to understand whole socio-ecological systems of continuity, heterogeneity, and dynamism of space[22]. These concerns have drawn attention towards the need for neighbourhood boundaries informed by qualitative community perception studies[23]. It has been argued that "advancing knowledge of situation-specific neighbourhood scale is necessary to inform community development policies, urban planning practices, zoning, transportation policies, environmental risks, and neighbourhood-based health interventions"[24]. For example, in some U.S. cases it was found that neighbourhood maps drawn by residents were 30% smaller than the median U.S. census tract[25]. Without this contextualization, miscalculating the scale of neighbourhoods can run the risk of "measurement error, misspecification of models" or missed opportunities for policy impact[26].

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[16] In staff interviews from five different U.S. metropolitan cities which had developed equity maps, Finio et al. (2020) found that map maintenance and updates were challenging to keep up with because they were time consuming and required labour expenditures that extended beyond the resource capacity of these types of projects.

[17] De Sherbinin et al., 2019.

[18] De Sherbinin et al., 2019; Schwabish & Feng, 2021.

[19] Schwabish & Feng, 2021.

[20] Finlay, Jessica, et al., "'My Neighbourhood Is Fuzzy, Not Hard and Fast" (2022): 85–108.

[21] Finlay et al., 2022.

[22] Deng, 2016.

[23] To date, there has been wide variation in the research done on neighbourhood perception which has included methodologies such as community surveys, GIS calculated resident-drawn maps, and even mapping neighborhood social media networks (Finlay et al., 2022).

[24] Finlay et al., 2022.

[25] Finlay et al., 2022.

[26] Finlay et al., 2022.

Alternative Approaches to Equity Mapping

Researchers conducting equity data analysis and mapping projects have highlighted the underutilization of qualitative data, which they argue to be a rich source of in situ information[27]. Participatory and community mapping are some examples of alternative techniques which seek to democratize the mapping process in ways that account for local knowledge and allows the community to determine the values set forth in a research project[28]. Participatory mapping is an alternative method which "maps the un-mapped" by transforming data from a diverse set of contributors/participants into spatial attributes that would otherwise be unidentified by conventional mapping practices and datasets[29]. The term 'participatory' implies a bottom-up approach to mapping and planning; contribution can be defined in numerous ways throughout the data collection, ownership, and mapping process[30]. Community mapping involved a highly collaborative process whereby resident knowledge and assets are prioritized. It is a process "grounded by co-production of decision-making" and utilizes the place-based experiences and knowledges of community members so that services, plan, and policies reflect the values and needs to residents specific to their contexts[31]. Importantly, these types of maps may not even be visually similar to traditional, cartographic maps and can range from the ephemeral, drawn on paper, 3D modeled, or using satellite or aerial maps[32] (see figure 1 below for an example). Participatory mapping is an important tool for measuring intangible cultural information and has been applied to environmental projects on adaptive capacity[33], Indigenous land management[34], and natural capital to resolve conflicts and improve planning response.

> *Participatory mapping has also played a critical role in building human and social capital as it has, inter alia, helped demonstrate the interconnection and interdependence of individually held elements in the asset base of communities.*[35]

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[27] Deng, 2016.
[28] Firth, 2015; Zhang, Yang, & Drake, William. "Mapping Neighborhoods." (2014).
[29] Van, George et al., "Community and Participatory Mapping in Planning." (2020).
[30] Van et al., 2020.
[31] Van et al., 2020.
[32] Piccolella, et al., "Increasing Adaptive Capacity Through Participatory Mapping" (2013): 1-31.
[33] For an example of an agricultural, adaptive capacity project using participatory mapping, visit this link: https://www.ifad.org/documents/38714170/39135645/pm_v.pdf/d4a70072-4861-45dd-a2b6-5ede75b6e400
[34] For an example of an Australian-Indigenous participatory mapping project in the context of climate change see Appendix A.
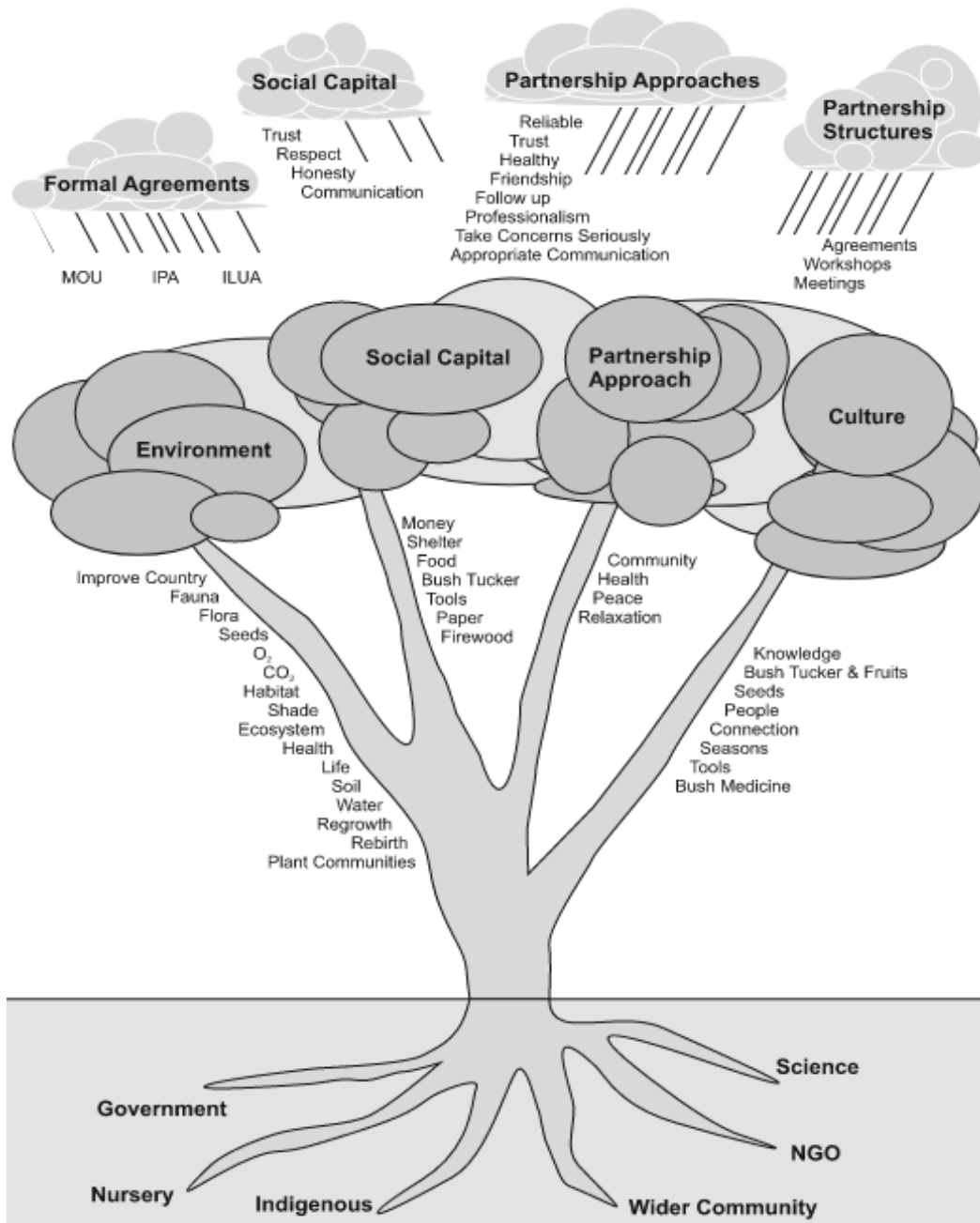[35] Paccolella, 2013: 3.

Figure 1: Example of participatory forest map created by participants in Robinson et al., (2015) workshop (Appendix A)

In general, there are six main functions of participatory/community mapping[36]:

1. To translate and communicate spatial knowledge to external actors
2. To "record/archive local knowledge"
3. To advocate for change
4. To increase community agency
5. To "address resource-related conflict"
6. To "enhance land-use planning and resource management decisions"

In addition, these mapping methods are often informed and driven by a set of principles, such as[37]:

- An intentional participatory process
- Inclusivity
- "Appropriate for needs, interests, and goals"
- "Accountability, transparency, and recognition of ownership"
- "Understands the socio-cultural, political, and economic context"
- "Synergistically collaborates with others"
- "Responsible, ethical, and sensitive"
- "Based upon an understanding of community mapping process, potential, and limitations"

Of course, methods requiring community-based data and prolonged engagement can be challenging and time-consuming for both community members and planners. There is also the potential risk that critical engagement can become burdensome to communities. With these approaches, it's worth strategizing how barriers to participation can be reduced within already-stressed communities. Strategizing the extent of engagement required for directed and useful impact, as well as setting relationship boundaries are important parts of participatory mapping projects. Ultimately, this approach can do more than diversify data collection; it can involve community education, build transparency, empower marginalized peoples, and develop policy actions representative of on-the-ground resident needs[38].

Measuring [in]equity and access has additional risks including the interpretation that communities are somehow disenfranchised or dispossessed with limited agency over their situations[39]. Damage-deficit research typically involves an extractive and transactive approach to research which "singularly defines a community"[40]. In these cases, specific neighbourhoods (e.g., Downtown Eastside) are typically over-

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[36] Van et al., 2020.
[37] Van et al., 2020.
[38] Zhang & Drake, 2014.
[39] Tuck, Eve. "Suspending Damage: A Letter to Communities."(2009): 409-428.
[40] Tuck, 2009: 413.

researched and seldom see the positive results or literature returning to their community[41]. Alternative ways of participatory research are being called for to facilitate growth and substantiated action rather than recycling the same stereotypes that damage-deficit research uses[42]. One such alternative is to research desires, adaptive capacities, or resiliency rather than deficits. Desire based approaches work to better understand the complexity and self-determination of the target groups or those most affected by the research being conducted, and it accounts for sentiments of hope and loss, local knowledge, and ideologies[43]. Intentional research and mapping design that extend beyond broad metrics of neighbourhood "inequity" offer opportunity to ensure equity is woven into the mapping, data, and planning processes, and informs whether actionable policy outcomes benefit communities in concrete ways.

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[41] Tuck, 2009.
[42] Tuck, 2009.
[43] Tuck, 2009.

Case Studies

A sampling of publicly accessible social and environmental equity maps from across Canada and the United States were reviewed and analyzed to assess existing methodologies, conceptualizations, goals, and functions of equity-mapping tools. Compilation of this information is intended to serve as an examination into conventional processes to help inform future mapping considerations for the City of Vancouver.

Canada

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources

Toronto Neighbourhood Equity Index (NEI)[44]	• Developed as part of the Toronto Strong Neighbourhood Strategy (2020) to achieve equitable social, economic, and cultural opportunities across the city
	• To identify neighbourhood improvement areas
		• To direct investments in NIAs with consistent programming through community enhancement partnership opportunities in city owned areas (e.g. community hubs and kitchens, dedicated green space, etc.)
		• To create consistent, evidence-based methodology
			• Urban HEART (WHO)[45]
			• Urban HEART @ Toronto[46]
				• Comprised of 15 equity indicators from 5 domains (from Urban HEART @ Toronto)
				• Equity indicators selection guidelines:
				  ○ Using broad overall neighbourhood outcomes and not factors like service impacts or population groups
				  ○ Using publicly available, neighbourhood-level data
				  ○ Whether indicators contain sufficient variance
				  ○ Using expert consensus by 80 experts and data users from Toronto to
				• NEI results are cross-referenced with social indicators and population characteristics for validity
				• NEI development steps:
					2011 National Household Survey, Canadian Census, Toronto Employment and Social Services, TDSB and TCDSB (school boards), Ontario Marginalization Index, Toronto Election & Registry Services, Toronto Open Data, Walkscore, Toronto Dinesafe University of Toronto, DMTI,

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[44] The Toronto NEI can be viewed here: https://www.toronto.ca/wp-content/uploads/2019/09/8ea7-NeighbourhoodEquityIndex2019.pdf

[45] World Health Organization's Urban HEART (Health, Equity, Assessment and Response Tool developed in 2010 is a standardized procedural tool for local policymakers and communities to gather data and plan appropriate response actions to address health inequities. It functions as a standard for urbanizing cities and regions to reference when developing tools and measuring equity concerns. See Appendix B to read more about the Urban HEART tool.

[46] Urban HEART @ Toronto is an adapted version of the WHO's Urban HEART guide. It was revised to address the equity concerns of Toronto and other similar, urbanized, jurisdictions. See Appendix C for more information.

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources

Toronto Neighbourhood Equity Index (NEI) Continued				1) Standardize indicator values
				2) Determine indicator weighting
				  a. Assigns each indicator a weight in proportion to its contribution towards describing the differences between neighbourhoods
				  b. Weighted using principal components analysis (PCA)[47]
				  c. Resulting weights emphasize indicators that differentiate neighbourhoods for selection
				3) Calculate neighbourhood equity score
				4) Derive neighbourhood equity benchmark
				• PCA statistical analysis used to overlay all indicators and domains/themes
					Canadian Community Health Survey, Canadian Institute for Health Information, Ontario Diabetes Database, Ontario Registered Persons Database, Ontario Ministry of Health and Long-Term Care, Discharge Abstracts Database

Calgary Equity Index (CEI)[48]	• A tool designed to monitor and identify equity disparities across communities
	• To help residents, planners, researchers, and decision-makers on equity issues
	• Validate City planning and programming
		• To prioritize engagement for resource allocation based on geographic need, including services, infrastructure, and overall quality of life
		• Function as a relative measure of opportunity and needs analysis
			• Urban HEART (WHO)
			• Urban HEART @ Toronto
				• Comprised of 20 indicators across 5 domains (from Urban HEART @ Toronto)
				• Equity indicators selection guidelines:
				  ○ Using 3 surveys from initial-final selection with expert consensus
				  ○ Guided by principles of representativeness, variability, quality, and validity
				  ○ Representativeness: indicator must be ≤ 80% of geographic areas
				  ○ Variability: calculated and reviewed descriptive statistics, histograms and graph distribution, standard deviation,
					Canadian Census, City of Calgary, Alberta Health Services, Calgary Police Services, Alberta Education, Walkscore

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[47] Principal components analysis (PCA) is a common statistical reduction technique for analyzing large datasets with high variance/dimensions into smaller factor sets which explain the variance in one sample. It increases interpretability while maintaining maximum information to enable multidimensional visualization

[48] The Calgary CEI can be viewed here: https://maps.calgary.ca/CalgaryEquityIndex/

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources
Calgary Equity Index (CEI) Continued				z-scores, population quintiles of each indicator data ○ Quality and validity: assessing data limitations and scope reviewed, missing percent calculated, representativeness of sample, impact of aggregation/disaggregation on data quality, appropriateness of indicators and calculation method consistency • CEI methodology includes user guidelines and terms of use for interpreting the index, which includes: ○ Having an initial programming screen ○ Index is not intended to be standalone evidence ○ Not to be used to measure outcomes • Includes notes on limitations, such as: ○ Index is an aggregate/averaging of data from multiple sources into a single score making it a simplification of occurrences ○ Requiring supplementary information for validation ○ Limits to applicability/reflection of communities in selected indicators • Development steps: 1) Create Community Service Areas (combination of adjoining census tracts with similar characteristics) for unit of analysis 2) Select indicators 3) Identify potential targets and indicators 4) Test/compare measures to determine benchmark target	

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources

Calgary Equity Index (CEI) Continued				5) Assign weight to indicators
				    a. Using standardized indicator values to fall between 0-1
				    b. Weigh the domains against the actual contribution it has in describing differences between CSAs calculated using PCA with varimax rotation
				6) Index score calculation
				• PCA statistical analysis used to overlay all indicators and domains/themes	

Ottawa Neighbourhood Equity Index[49]
 	
Ottawa Neighbourhood Equity Index Continued
	• Developed to address the need for a "holistic, systematic and defensible data tool" for the city at different scales
	• NEI is a tool to "help residents, planners, key stakeholders, and decision makers identify disparities between neighbourhoods and tackle them in a systematic and organized way"
		• To support cross-sector action and create equitable resource and program allocation at the local and systems-level
		• To identify trends on neighbourhood health disparities
		• Used to inform the Theory of Change which is an actionable guide to facilitating greater equity in neighbourhoods
				• Comprised of 17 equity indicators) from 5 domains (from Urban HEART @ Toronto)
				• Equity indicators selection guidelines:
				   o Relevance for Ottawa
				   o robustness (and not complicated)
				   o Feasibility
				   o Empirically valid
				   o Replicability
				   o Locally actionable and responsive to changes
				   o Comparability
				   o Sufficient internal variance
				   o Urban/rural relevancy
				   o Forward looking
				   o Reduced collinearity and compensability amongst indicators
				• Development steps:
				  1) Standardization of indicators
				  2) Weighing of indicators
				  3) Index Scoring
					Canadian Census, City of Ottawa, Paren-Resource Centre, Walkscore

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[49] The Ottawa NEI can be viewed here: https://neighbourhoodequity.ca/index2/

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources
				4) Benchmarking • PCA statistical analysis used to overlay all indicators and domains/themes	

Metro Vancouver Social Equity & Regional Growth Strategy[50]
 	
Metro Vancouver Social Equity & Regional Growth
	• Regional equity exploratory analysis building upon a 2019 report on social equity, and for the broader Metro 2050 Regional Growth Strategy
	• Develop a quantitative and spatial understanding of the existing inequities within the MVRD
		• Create clear, actionable recommendations to incorporate social equity into plans, policy, and programming in Metro 2050	• Advancing Equity and Inclusion: A Guide for Municipalities
			• City of Edmonton: The Art of Inclusion. Our Diversity & Inclusion Framework
			• City of Ottawa Equity & Inclusion Lens
			• City of Seattle Racial Equity
				• Comprised of 49 indicators measuring social equity and growth management
				• Criteria for indicator selection
				  ○ Regularity of use elsewhere
				  ○ Applicability to Metro Vancouver
				  ○ Data availability
				  ○ Repeatability in the future
				  ○ Client and team feedback
				• Domains:
				  ○ Demographics-related Indicators
				  ○ Conditions-related Indicators
				  ○ Economics
				  ○ Housing
				  ○ Education
				  ○ Environment
					Canadian census 2006 & 2016, My Health My Community Survey 2014 (Vancouver coastal and Fraser Valley), USGS 2020, Statistics Canada Proximity Measures 2020 (healthcare, transit), Elections BC 2018, Metro Vancouver 2016 & 2050, Human Early Learning Partnership

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[50] The Metro Vancouver Index can be viewed here: http://www.metrovancouver.org/services/regional-planning/PlanningPublications/MVSocialEquity-RegionalGrowthStudy.pdf

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources

Strategy Continued	region, as these relate to growth management
	• Synthesize the findings from quantitative (and qualitative) analyses
			Toolkit (Race & Social Justice Initiative)
			• City of Toronto Equity Lens
			• City of Vancouver (conversations with staff)
			• Equitable Development Principles & Scorecard
			• Global Diversity & Inclusion Benchmarks: Standards for Organizations Around the World
			• LA County Metro Equity Platform Framework
			• PlanH Equity Action Guide King County Equity Impact Review
				○ Access and Transportation
				○ Social Integration and Safety
				○ Health
				• PCA statistical analysis used to highlight areas with multiple, overlapping inequities
				  ○ PCA grouped and weighed the data based on similarities in variation and degree of correlation
				• All maps produced using natural breaks/equal intervals for determining the colour distribution and adjusted to the nearest value
				• The index maps purposes:
				  ○ Show where multiple unique factors intersected to contribute to inequity in a particular area
				  ○ Prioritization tool for further analysis
				• Stated limitations on:
				  ○ Data source accuracy and generalizability (StatsCan, My Health My Community, Early Development Instrument)
				  ○ Missing indicators (LGBTQIA2+, 16isabilities, clean air, food insecurity, graduation rates, regional crime, etc.)
					2017-2019, Metro Vancouver Employment Open Trip Planner, Open Trip Planner (BC Local Parks and Greenspace), Metro Vancouver LiDAR 2014-2017, Environics 2020, Food Flow Study (Dunn and Brad Street Business Data 2018), Province of BC Open Data 2017

City of Vancouver Park	• The Equity Initiative Zones is a tool to support the reduction of barriers to existing resources and project	• To help determine projects, programs, and resource prioritization in identified service area gaps (initiative zones)		• Composite map of Initiative Zones is comprised of three indicators: ○ Park provision (areas with low access to park space)	Vancouver Park Board Park Data, Park Provision Study 2016, 2041 Population Projections, City of

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources
Board Equity Initiative Zones[51]	prioritization by "exposing patterns, testing hypotheses and revealing a more nuanced portrait of service and community infrastructure distribution."	• To identify patterns in parks and recreation resource allocation which account for density, demand, and quality		○ Demand for low-barrier recreation (areas with a higher demand for low-barrier recreation services) ○ Urban forest canopy gaps (areas with a less robust urban forest) • Park provision indicator: ○ Distance to parks and population density within a 10-minute walk to each park ○ 10-minute walking distance was selected because when combined with density it was more representative of park access and demand • Demand for low-barrier recreation ○ Uses Leisure Access Program (LAP) registration data ○ LAP participants represent those interested in park services but experience barriers of access ○ Maps areas with 3x average number of LAP participants • Urban forest canopy ○ 'Urban forest coverage gaps' indicator as a proxy for quality of urban environment and the feeling of lack of access to nature and recreation ○ Uses LiDAR data to map canopy distribution (light detection and ranging – remote sensing method that uses light as pulsed laser to measure ranges to the earth)	Vancouver, Greenest City 2020 & Vancouver Park Board, Vancouver Urban Forest Strategy, Vancouver, BC, 2014
City of Vancouver Park Board Equity					

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[51] The Vancouver Park Board's Equity Initiative Zones can be viewed here: https://vancouver.ca/files/cov/vanplay-strategic-bold-moves-equity-chapter.pdf

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources

Initiative Zones Continued				• Additional goals of including disaggregated data of "equity analysis factors" such as (but not limited to):
				  ○ Car ownership, languages, wealth, people with disabilities, equity seeking groups, survey data, historical Park Board capital investment locations, Indigenous community health indicators, sociodemographic patterns, number of hours of free programming, indicators on disaster risk reduction and resilience
				  ○ Collaboration with communities will be helpful to informing the equity analysis factors and the appropriate application of the initiative zones tool and policy	

United States

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources
Portland Bureau of Transportation Equity Matrix[52]	• "Helps us embed the work of transforming systems that impact marginalized	• For program decision-making in priority areas	National equity best practices and guidelines from Portland's Office of	• Simple ranking index • Variables (indicators) on race, ethnicity, and income examined at census tract level	U.S. Census (specifically, the ACS 5 year estimates)[53]

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[52] The Portland Bureau of Transportation's Equity Matrix can be viewed here: https://pdx.maps.arcgis.com/apps/MapSeries/index.html?appid=ba500ae0b9554fc68104a2ff016e25fc

[53] ACS 5-Year Estimate Survey (U.S. Census Bureau) helps data users track changes at the neighbourhood level and functions as a "premier source for detailed population and housing information" across the U.S.; Data profiles cover basic, popular social, economic, demographic, and housing information.

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources

Portland Bureau of Transportation Equity Matrix Continued	groups and helps make these systems more equitable"	• To be used with/for other city projects	Equity and Human Rights	• Data on race, ethnicity, and income were scored because the data was more consistent and readily available
				• Race/ethnicity index and income index are both scored on a scale of 1-5; combined index scale of 1-10
				   o Higher the score, higher the percentage of IBPOC
				   o Lower the score, higher the median income per census tract
				• Uses jenks "natural breaks" classification
				   o lowers variance within a class
				   o maximized variance between classes
				   o makes clearer statistical clustering for analysis
				• English language proficiency is used as supplementary data to inform the combined index
				   o It's not included in the index because the data was deemed unreliable in consistency across scales	

Oakland California Environmental Justice Communities Map[54]	• In response to California Senate Bill 1000 which mandates jurisdictions to "identify objectives and policy to reduce the unique or compounded health risks	• Focus funding and target environmental justice initiatives	• CalEnviroScreen[56]	• Composite index of environmental justice indicators • Index uses 54 indicators in categories concerning:	U.S. Census (specifically, the ACS 5 year estimates), City of Oakland, CDC, State of

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[54] The Oakland EJ Communities Map can be viewed here: https://storymaps.arcgis.com/stories/0cba2fe7693540a19b08e4cc533738e3
[56] See Appendix D to read more about the CalEnviroScreen mapping tool.

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources

	in disadvantaged communities"[55]
	• To identify communities at an increased risk to environmental concerns
		• To spur discussion and engagement for Oakland's General Plan 2045 with inclusion of environmental justice elements		o Safety and tree canopy, housing, food, transportation, socioeconomics, health, climate change, hazardous materials, water, pollution/air quality
				• Each community is scored based on the weight of each indicator and evaluation
				• Indicator selection was done following Oakland's Racial Equity Impact Assessment. The assessment asked questions such as:
				   o How well does the indicator measure SB1000 topics?
				   o Does the indicator/metric reflect community priorities for change?
				• Emphasis on map as a starting point for discussion on lived experiences in communities
					California, EPA, CalEnviroScreen

Boston Tree Equity Map[57]	• To identify where new trees can be planted in the city/neighbourhoods in an equitable manner • A tool for residents, organizations, municipal officials, etc., to better understand tree canopy distribution and its	• Create equitable tree distribution and its benefits • Planting trees where tree equity locations were identified		• Series of maps on tree canopy cover, heat/land surface temperature, and population demographics • Tree equity map cumulates all 3 maps into an interactive map overlaying all data sets o In this map, users can explore the intersection of racial/ethnic minorities, tree canopy, household income, etc.	U.S Census, MassGIS (State of Massachusetts), City of Boston, Harvard, ESRI, HERE, Garmin, USGS, EPA, NPS

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[55] "SB-1000 Land use: general plans: safety and environmental justice", No. 1000 (2016): 93.

[57] The Boston Tree Equity Index can be viewed here: https://treeboston.org/tree-equity/ ; The Boston Tree Equity Map does not include any more publicly available information about its methodology but is a strong example of a well-developed mapping design that has incorporating communities' perspectives and intersectional climate issues in the urban context. The maps also include a good amount of information on the intentions and purpose of data collection.

Name	Conceptualization	Intended Outcomes	Based On	Methodology	Data Sources
	intersections with people and environmental justice				

Los Angeles Equity Indicators Tool[58]
 	
Los Angeles Equity Indicators Tool Continued
	• To "contribute to a broader vision/framework for equity by enabling equity as a factor in decision-making and through prioritizing collaboration with communities and transparency in decision-making"
	• Ensuring the LA County General Plan includes equitable distribution of the benefits of development (housing, safety, affordability, etc.) and reducing health disparities
		• To facilitate equitable growth and land use
		• To promote consistency in equity across departments
			• Best practices from equity tools developed by Pittsburgh, Portland, King County
			• CalEnviroScreen
				• Maps socioeconomic, demographic, and other areas of equity
				• Comprised of 10 indicators
				• Advisory committee consisting of community organizations/advocates, municipal government, etc. were involved in a consultation process
				• Includes percentage of IBPOC showing racialized patterns of inequity
				• Indicator selection based on general plan guiding principles
				    ○ Smart growth (e.g., diversity of land use)
				    ○ Community services (e.g., access to public facilities and services)
				    ○ Strong and diverse economy (e.g., living wage gap)
				    ○ Natural resources and sustainability (e.g., tree canopy)
				    ○ Healthy, livable and equitable communities (e.g., housing cost burden)
					U.S. Census, DRP (Department of Regional Planning), ESRI, ISD (Internal Services Department), HERE, Garmin, USGS, EPA, NPS

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[58] The LA Equity Indicators Tool can be viewed here: https://apps.gis.lacounty.gov/drp/m/?viewer=Equity

Indicator Selection:

- In many of the U.S. examples race was a priority indicator
    - E.g., The Portland Bureau of Transportation Equity Matrix led with metrics on race and ethnicity because they saw these inequities as "created and perpetuated by institutions such as government". They also felt that "focusing [their] work on racial and ethnic equity allows [them] to introduce a framework, tools, and resources [they] can then apply to other forms of marginalization. This may include discrimination or marginalization based on gender, ability, age, or sexual orientation."
- In the Canadian examples, many measured inequities through wide-ranging fields such as walkability, access to community space and healthy food, etc.
    - For example, the Toronto Neighbourhood Equity Index specifically noted that indicators were not population group measures (i.e., that being young or recently immigrating to Canada does not, on its own, constitute an inequity). Instead, the Toronto example measures the outcomes of inequities as they may relate to population groups which face inequity (e.g., unemployment due to age or immigration status).
- In some cases (such as Toronto, Seattle, and Portland) population or demographic information was offered as a secondary index to help contextualize patterns of inequity at different intersections but did not measure them directly in the composite indices.

Data Sources:

- All examples used census data as a central dataset for indicators/metrics which provides readily available and low-cost information
    - Generally, census data provides a very helpful high-level dataset on many domains of indicators relating to equity (especially for socioeconomic and demographic information)
- Some limitations with Canadian census data includes:
    - does not include full gender identity/expression and LGBTQIA+ intersections
    - does not measure wealth
    - does not include disabilities
    - does not include physical/mental health
    - does not include experiences
- Importantly, in the Canadian context, challenges with census data surround the categorizing and terminology of race indicators. Currently, the census does not include

direct measures of race but instead, it includes indicators correlating to race/ethnicity such as "visible minority". (Although this may be subject to change in future censuses as awareness of this challenge increases).

- In most cases, these limitations were addressed with additional data from municipalities, local health and police authorities, or state/provincial environmental organizations, etc.
    - For example, Ottawa's Neighbourhood Equity Index included mental health data provided by Ottawa Public Health

Community Engagement:
- The Toronto NEI, Metro Vancouver, Oakland EJ Communities Map, and LA Equity Index all noted the inclusion of an advisory council/committee/engagement process that included community members
    - For example, Oakland used the draft map to communicate with communities about their lived experiences and cross-reference this to the data visualized on the environmental equity map. To do so, they developed a website, as part of their General Plan, to create participatory community dialogue which worked in tandem with the index.

Transparency and Public Availability of Information:
- All Canadian examples provided documentation of the entire equity index development process including their methodology; all of which was accessible, understandable, and thorough
    - Canadian examples provided in-depth information about the limitations to quantitative data, data sets, biases, and some include intersectional, qualitative information in their reports
- Of the U.S. examples, some provided basic information about the development process (such as Portland, Boston, and LA) but were not as thorough as the Canadian examples
- Oakland's EJ Communities Map provided nearly complete information about the background, goals, data, methodology, and had the most extensive community engagement process amongst all the examples
- Some cases included interpretation controls (e.g., internal education or user guidelines/terms of use agreements) to limit any assumptions, misinterpretations, or misuse of the equity-maps
    - For example, when accessing Calgary's Equity Index, users are prompted with a "terms and conditions" notice. This agreement offers Calgary some control over the index's application (see figure 2 below)
    - Another example is Metro Vancouver's Social Equity and Regional Growth Study maps/index "terms of use" agreement. Metro Vancouver's requires users

requesting the index to agree to the terms of use; this condition allows them to track the use and application of their index.
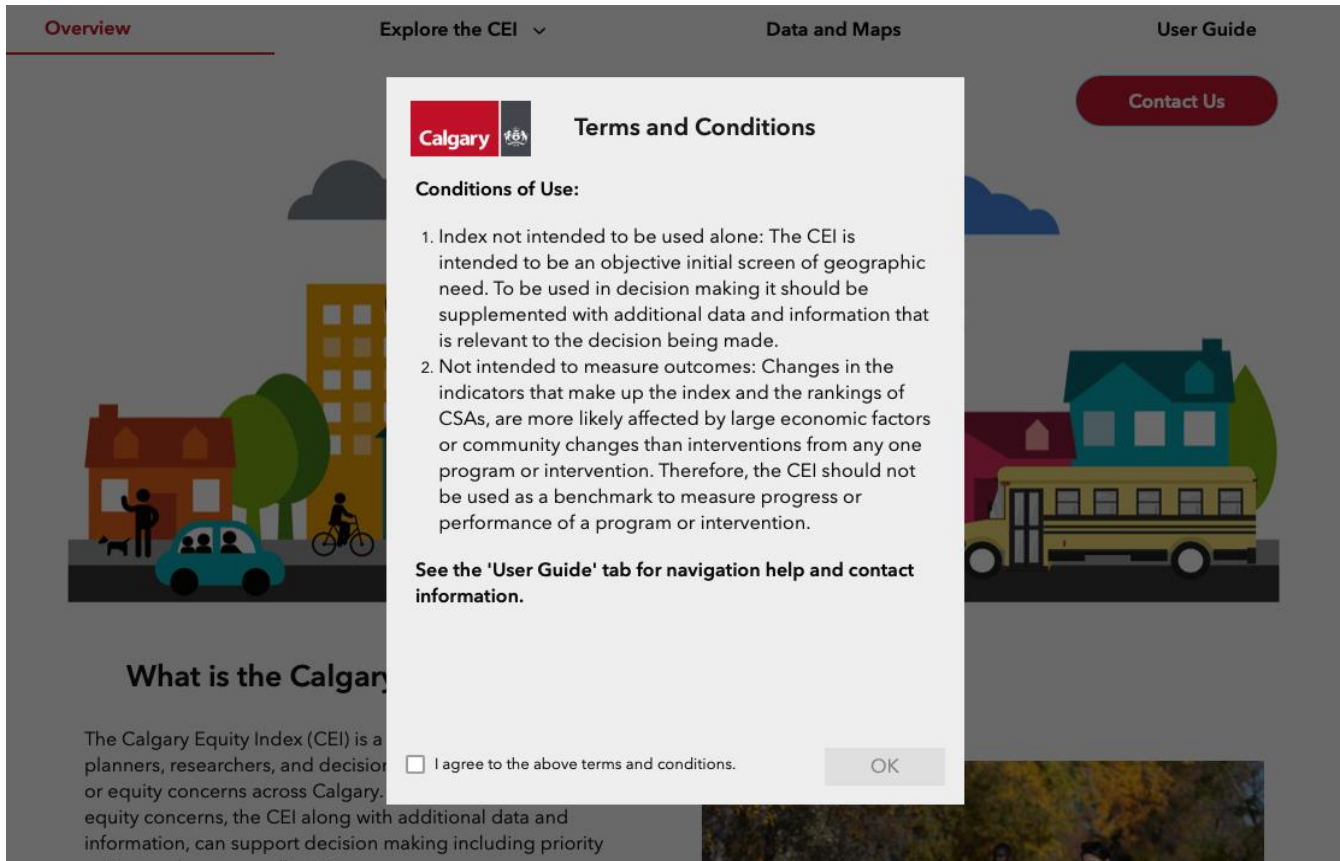
Figure 2: Screen capture of Calgary's Equity Index Terms and Conditions (taken from https://maps.calgary.ca/CalgaryEquityIndex/)

Index Development:

- All Canadian examples (except the Vancouver Park Board) used the statistical analysis process of Principal components analysis (PCA) because they all used a relatively larger list of indicators. This allows them to group and weigh indicators based on similarities, variation, and connections.
- Most Canadian examples, excluding Metro Vancouver and the Vancouver Park Board, followed the Urban HEART @ Toronto and the WHO's Urban HEART frameworks for their equity index development and indicator criteria
- Amongst the environmental based American examples, State-developed tool called CalEnviroScreen was commonly used to measure environmental justice

Summary

Benefits to Centralized Datasets and Mapping Equity

- Geographic Information Systems (GIS) are an effective way to communicate spatial relationships and display areas of priority for planners and policy makers
- Expert practitioners with a sound understanding of data science are more likely to be involved in the creation of centralized datasets and mapping and will therefore likely use appropriate methodologies. These methodologies can then become standardized for future mapping project across city departments
- Central indexes can provide internal accountability and consistency with regards to the interpretation and use of data

Risks to Centralized Datasets and Mapping Equity

- Oversimplification of complex social, cultural, and political systems and identities
- Systematic biases in conventional data and indicator selection
- Misinterpretation that maps offer standalone evidence for decision-making objectives
- Misinterpretation of marginalized experiences
- Typically, the larger scale of centralized maps do not allow for high levels of community participation or nuance

Ending Point: In Conversation with City of Vancouver Staff

Near the end of the research project, a second focus group was held with City of Vancouver staff. To get a better understanding of the spectrum of experiences and opinions on this topic, this focus group was attended by those working in the realm of environmental, sustainable, and resilience policy. Some individuals in the group expressed a concern about the risks of not moving forward with a centralized dataset and equity map. Those interested felt that centralizing this would standardize equity-informed mapping practice, approach, and methodology across City of Vancouver departments. In addition, a few expressed concerns about the responsibility of creating equity maps or indexes independently given their [limited] current knowledge of GIS, mapping, and data science.

These focus groups revealed an interesting tension between practitioners who create/analyze indexing and mapping tools, and those who apply them. On the one hand, earlier conversations with data practitioners focused on the risks of moving forward with centralized dataset and mapping. And on the other, sustainability and environmental policy and planners focused on the

benefits. Ultimately, this finding suggests a need for greater interdepartmental conversation before moving forward.

Recommendations [Next Steps]

Below is an exploration of two hypothetical trajectories stemming from this report:
1) creation of a centralized dataset and equity map,
2) creation of project-specific datasets and equity maps instead of using a centralized dataset and equity map.

For each scenario, a list of benefits, risks, and recommendations are offered as a starting point for further interdepartmental discussion and research.

Scenario A: Creating a Centralized Dataset and Map

This scenario imagines the creation and use of a centralized dataset to inform an equity map used by all departments at the City of Vancouver. In this scenario, it is assumed that the Equity Office is leading the project to develop the centralized dataset and map, with a team most likely comprised of staff from ACCS's data team and/or an interdepartmental working group formed within the Equity and Decolonization of Data Community of Practice. This would require a time and work plan commitment, as well as management support and buy-in for this team to set policy that other departments would follow. Some form of community governance process should be incorporated, such as a reference group to inform project goals, success criteria, and guidelines for how the data would be presented, interpreted, and used. This will streamline the access and use of information (for both practitioners and communities) and provide an important function of accountability across departments as they engage in this work. This would require time and financial resources to be allocated to the project.

Benefits to this scenario could include, but are not limited to:
- Working with informed practitioners to establish a standardized, sound, and appropriate index/mapping methodology. This can also reduce data resources amongst project teams and increase efficiency.
- Internal accountability across departments with regards to the interpretation and use of data
- [If in project scope] Opportunity to increase mapping and data literacy amongst staff and decision-makers
- Coordinated access and cross-departmental data/information sharing, resource, and expertise

Recommendations for Developing a Centralized Index:
- Create an adaptive community governance process which allows for residents' data interpretation, collection, needs analyses, and evaluation
  - This will benefit the selection of appropriate equity indicators and increase the likelihood of successful policy outcomes that are reflective of community desires, assets, values, and capacities
  - An indicator assessment process should strive to balance community input and standardization of equity goals/objectives[59]
- Transparency: naming uncertainty and acknowledging limitations regardless of whether there's an identified solution to them or not
- Data maintenance: within the project plan, set appropriate intervals for updating index data based on availability and capacity
  - This will maintain the relevancy and accuracy of the index to reflect evolving equity research and information
- Education/Training: [if within project scope] providing educational mapping resources and data equity training for those interested and working with the dataset[60]
- Interpretation: although this can only be controlled to a certain degree, including a 'terms and conditions' which outlines the index/map purpose, collection of data, and limitations can offer some control over its interpretation and application
- Refer to the Urban HEART @ Toronto framework[61]
  - This tool was developed to measure well-being in cities and to support health and social equity goals in a simple, evidence-based, inclusive, and sustainable manner and has been used in three other Canadian equity mapping projects

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[59] The Oakland Environmental Justice Community Mapping offers a good example of a community-informed indicator/methodology assessment process. To learn more visit https://cao-94612.s3.amazonaws.com/documents/Primer-on-Draft-EJ-Communities-Map.pdf.

[60] Urban Institute's *Do No Harm Guide (2021)* is a guide for data analysts and communicators to engage in data collection and visualization. To learn more visit: https://www.urban.org/research/publication/do-no-harm-guide-applying-equity-awareness-data-visualization ; We All Count has a Data Equity Framework providing systematic ways of analyzing data projects. To learn more visit: https://weallcount.com/the-data-process/

[61] See Appendix B and Appendix C for more information.

Scenario B: Project-Specific Datasets and Maps

This scenario imagines the development and application of equity-mapping tools for individual projects, planning, and departments/teams. In this scenario, it's assumed that each department or project team initiates and develops datasets and maps suitable to their specific project/department needs. This may involve staff from the Equity Office or ACCS's data team in an advisor role if capacity allows. Community involvement would depend on the project capacity, resources, and intention to engage but is strongly recommended to apply an equitable lens to each project.

Benefits to this scenario could include, but are not limited to:
- Deeper analysis of data and nuance for project-specific objectives by knowledgeable staff
- Project teams will likely have specific knowledge on the scope of data required for certain objectives, what the project and data limitations are, and how it will be presented (internally or externally). This can allow for greater internal control over the use and interpretation of the data collected for an intended project.
- Project-specific mapping can allow for participatory methodologies which are actionable at smaller scales

Recommendations for Developing Project-Based Maps:
- Participatory/community mapping methodologies: it's important to mention here that although community mapping and participation is beneficial, there is also the risk that individual project-specific datasets and maps can result in unnecessary duplication of data between teams, over-engagement with a subset of the population, and burdens for communities
  - A key consideration to reduce these risks is to increase information and data sharing between departments/teams
- If within scope, establishing a project model which includes at least one "data/mapping advisor" for teams developing a map
  - This can help ensure that sound mapping methodology is applied to independent projects and reduces the risk of interpretation errors
- Data maintenance: setting appropriate intervals within project planning for data updates to ensure relevancy and accuracy as new information becomes available
- Conducting effective qualitative research supplementary to quantitative data
  - How the qualitative data is treated (e.g., as a section in map reports, indexes, quantified into data for maps, additional websites, etc.) is up to individual discretion based on user needs/context

- Effective data collection: when appropriate, allocating resources to conduct additional data collection with communities to account for limited or missing data from larger, available datasets (e.g., limitations in the Canadian census)
- Interpretation: including a 'terms and conditions' which outlines the index/map purpose, collection of data, and limitations
  - It's also important to communicate how the map does not measure outcomes and should not be interpreted as such

Final Recommendations

Based on research findings, the ideal approach to equity mapping for the City of Vancouver would be to advance with both scenarios listed above. A recurring theme to this research project was how maps are not a means to an end but are instead useful starting points further investigation/reflection. As such, a centralized dataset and equity map would be most useful as a broad equity-index that enables identifies areas of prioritization for projects to conduct further research.

A centralized map has the potential to establish an informed methodology and standardization of mapping practice and increase mapping accountability across departments with regards to the interpretation and use of data. Coordinating efforts could also increase consistency and access by supporting cross-departmental data and information sharing, resources, and expertise. Coordinated work may also benefit the communities by providing clearer channels for feedback (e.g., as a reference group communicating with the Equity Office) while reducing the risk of unnecessary data duplication and over-engagement by individual projects.

Due to limitations of scale at a centralized dataset and map level, project-based maps will be required to provide contextual data and research. Project-based maps are an excellent opportunity to undertake grounded research and develop innovative participatory/community mapping methodologies. Providing both staff and communities with the opportunity to conduct more grounded research at a smaller scale can increase the accuracy and responsiveness of equitable planning and policies.

This approach offers a balance between the tensions shared by City staff from different departments and with varying needs, objectives, perspectives, and knowledge/expertise. Beyond this, it provides an opportunity to develop a more robust research and mapping practice drawing from the vision laid out in the City's Equity Framework.

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Appendices

Appendix A

Participatory Mapping to Negotiate Indigenous Knowledge Used to Assess Environmental Risk
Robinson, C.J., Maclean, K., Hill, R., Bock, E. Rist, P. (2015)

This journal article explores the scholarship of "usable knowledge" in the context of sustainability science, by identifying participatory mapping methodology which incorporates Indigenous epistemologies for environmental risk assessments.

> *"In order to understand and manage sustainability, diverse ways of knowing must be identified and incorporated, and this need has stimulated multiple new approaches to knowledge gathering, including 'actionable knowledge', 'working knowledge', 'situated knowledge', and 'multiple evidence base' approaches." (116)*

The authors suggest there is a growing interest in the ways environmental governance regimes are organized to include diverse ways of knowing and how planners and environmental policy can "translate these knowledge bases into environmental decision-making" (p. 117). The article offers suggestions on the "ideal" arrangement of participatory/community mapping with regards to indigenous people:

- Enable self-determination through use of indigenous science and methodologies
- Free, informed, and prior consent to research
- Research approaches that are open, diverse, and transformative; research design that is jointly established and relinquishes elitist and extractive data collection

The article offers two case studies of participatory mapping methods produced with Indigenous peoples in northern Australia. The maps were used as "boundary objects" [or, artifacts], which informed a method of shared knowledge production and action (p. 119). The mapping projects were conducted to gauge the "values, knowledge, and management aspirations" of this community in response to rapid environmental changes including issues like freshwater management (p. 120). This participatory methodology favoured desire-informed mapping practice. In each case, participants were tasked with mapping their understanding of rivers,

streams, forests, and trees and connect this map to their value systems, as well as community roles and responsibilities. Afterwards, the maps were combined and collaboratively evaluated into a single map (e.g., a shared watershed map was created from hand drawn maps). As the authors discuss, another significant outcome of this project was the ability for community reflection of the relationships between indigenous knowledge systems and the "social, environmental, and cultural pressures" of external forces (122). In their conclusion, the researchers argue that this participatory approach to mapping "brought together sustainability science and indigenous methodologies", and the maps themselves served as "useful guiding boundary objects [that] framed indigenous knowledge in culturally sensitive manner, emphasized the relationships between individual traditional owners, and explored how these relationships influenced their perspectives" (123).

Appendix B

World Health Organization: Urban HEART (Health, Equity, Assessment and Response Tool) (2010)

Urban HEART is best described as a guide for "local policymakers and communities through a standardized procedure of gathering relevant evidence and planning efficiently for appropriate actions to tackle health inequities" (WHO, 2010, p.12). It functions as a standard for urbanizing cities and regions to reference when developing tools and measuring equity concerns (e.g., creating maps and indexes). Its aim is to:

- identify and analyze health inequities between residents in different geographic locations in urbanizing cities as well as different socioeconomic groups
- facilitate decision-making for sustainable and effective planning and policy outcomes which reduce "inter and intra city health inequities" (p. 12).

Strategies developed using the Urban HEART framework are defined by 4 guiding principles/characteristics:

1. **Ease of use:** results can be intuitively understood and are presented simply and practically
2. **Comprehensive and inclusive:** indicators and their interpretation are assessed at different scales and sectors, and fosters communication and participation
3. **Feasible and sustainable:** using existing commonly appropriate data when available, and maintaining low-cost (individual uses may vary)
4. **Linking evidence to action:** results should be relevant for enabling decision-making and substantiated action

In addition to these principles, the WHO distinguishes a set of core elements for users developing equity tools. They are:

- **Reliability, transparency, completeness (sound evidence)**: indicate missing values, alternative/substituted data, or newly generated data processes; internal consistency across data sets
- **Intersectoral action:** appropriate linkage to the intersectoral relationships of inequity (e.g. linking the relationship between health and transportation, education, environment, etc.)
- **Community participation**: communities should be part of the tool planning, design, implementation, interpretation, and continuation

More specifically, the WHO's Urban HEART guide indicates 5 groupings (or domains) of relevant health equity indicators which users should look to (shown in Fig. 2 below). In addition to these main groupings, the guide offers a list of key criteria for specific indicator selection

based on cities which pilot tested Urban HEART. Based on their experiences, the following criteria was established:

- availability of data
- strength of indicator to measure inequality
- coverage of a spectrum of issues
- comparability and universality
- availability in other key urban and health tools

The Urban HEART guide includes additional broad information on post-assessment response strategies without restricting the local nature of equity concerns. Rather, they offer some key considerations for planning, policy, and programming in response to the results found in such tools, including:

- Go beyond the colour coding: these are a visual representation of data and provide a simplified aggregation of the real numbers behind them (take a closer look at the actual data)
- Go beyond the "reds" (or the "problem areas"): make sure to account for the "in betweens" and the degrees of inequity regardless of benchmarking or binary inclusion of areas
- Address the "positives": find out why certain areas achieved greater equity and encourage their continuation
- interpret data cautiously: data, its selection, and representation are not objective and therefore may not accurately or sufficiently depict the equity concerns on the ground in communities or amongst other stakeholders (make space for their interpretation and reflection of priorities)

Appendix C

Urban HEART @ Toronto (2014), City of Toronto

The Urban HEART @ Toronto is an adapted version of the WHO's Urban HEART guideline, addressing the equity concerns of Toronto and other similar, urbanized, jurisdictions. It's described as "a framework that a variety of organizations with diverse mandates can use together to maximize their collective impact on equity" (City of Toronto, 2014). Like the WHO, there are 5 indicator domains for already urbanized geographies:

1. physical environment and infrastructure
2. social and human development
3. economic opportunity
4. civic engagement
5. physical and mental health

This tool was developed to be used to measure well-being in cities and to support health and social equity goals in a simple, evidence-based, inclusive, and sustainable manner. The technical report for the HEART @ Toronto tool includes information on specific indicators required and those strongly recommended, as well as benchmarking procedures to be followed by users of HEART @ Toronto.

Appendix D

CalEPA, CalEnviroScreen
Faust, J. et al., 2017

CalEnviroScreen is an environmental justice mapping tool initiated by the California Environmental Protection Agency to identify communities vulnerable to - and suffering from - cumulative pollution impacts. The map was developed from the bottom-up using community participation and designed to respond to their interpretation of environmental equity. It uses health, environment, and socioeconomic data to score by census tract allowing comparison across communities in the state. Indicators were selected based on the representative quality and availability of data. Indicator criteria included (p. 9-10):

- "Whether it provides a measure relevant to the component it represents"
- "Should represent widespread concerns related to pollution in California"
- Taken together, "indicators should provide a good representation of each component"
- "Pollution burden indicators should relate to issues that may be potentially actionable"
- "Population characteristic indicators should represent demographic factors known to influence vulnerability to disease"
- "Data for the indicator should be available for the entire state at the census tract level geographical unit or translatable to census tract level"
- "Data should be of sufficient quality and be: complete, accurate, and current"

It's also designed to be used in conjunction with additional local data for deeper contextualization and analysis. The map design was informed by California communities based on the following six principles:

1. Science-based ("grounded" by quantified data)
2. Informed by lived experiences of the community
3. To be used and advocated by governments
4. Available to an entire region
5. Substantial and continual community participation
6. Served as a "third party validator" to back personal/community anecdotal evidence

By involving the community in its fullest extent, CalEPA developed a tool that was made for communities rather than applied to. It allowed the actual people impacted by environmental justice issues to interpret what environmental equity meant to them so that policy and advocacy initiatives which fruited from this map successfully reflected their needs and values.