Fraser Valley Regional District

Royal Roads UNIVERSITY

UNIVERSITY OF THE FRASER VALLEY
FOOD AND AGRICULTURE INSTITUTE

A Survey Study

Food Systems Hazards, Vulnerabilities and Impacts in the Lower Mainland BC

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Table of Contents

1. Project Background

The COVID-19 pandemic resulted in a variety of food systems impacts ranging from supply chain disruptions to loss of livelihoods and ability to access food. Such impacts revealed the vulnerabilities in our food systems, providing communities and regions with the opportunity to reflect on these vulnerabilities to determine how to enhance food systems resilience to a variety of disturbances and shocks.[1] When discussing the future impacts of climate change, Sally Uren[2] describes COVID-19 as being "a dress rehearsal for the kinds of disruption we are set to see in the next decade," and such disruptions are already occurring, as seen with the 2021 record-breaking heat waves and flooding events that occurred in British Columbia (BC). The Intergovernmental Panel on Climate Change's (IPCC) recent assessment report predicts future warming and disturbances to social, economic, and environmental systems,[3] further highlighting the imperative to improve food systems resilience. It is essential that communities and regions learn from the COVID-19 "dress rehearsal" and other exogenous shocks to identify critical food systems vulnerabilities, as such understanding will contribute to long-term planning for sustainability and resilience.

The Food and Agriculture Institute at the University of the Fraser Valley conducted a community-based participatory research effort in collaboration with the Fraser Valley Regional District (FVRD) and Royal Roads University, which aimed to better understand food systems vulnerabilities in the Fraser Valley region. The research involved (1) reflecting on the challenges and vulnerabilities that the COVID-19 pandemic has revealed about local and regional food and farming systems, and (2) exploring ways of increasing local/regional resilience to future shocks (e.g., climate change impacts, economic recessions, mass migration). The main research activities were a series of food systems stakeholder workshops, which respectively focused on:

1. Exploring local and regional food system vulnerabilities and impacts related to COVID-19,

2. mapping and assessing food system vulnerabilities and potential impacts from multiple environmental, socioeconomic, and political hazards (e.g., flooding, wildfires, loss of wildlife habitat and ecosystems, rapid population growth, economic recession, etc.), and

[1] Carey, R., Murphy, M., & Alexandra, L. (2020). COVID-19 highlights the need to plan for healthy, equitable and resilient food systems. Cities & Health, 1–4. https://doi.org/10.1080/23748834.2020.1791442

[2] Uren, S. (2020). COVID-19: A dress rehearsal for the climate emergency? Forum for the Future. https://www.forumforthefuture.org/blog/covid-19-climate-emergency

[3] IPCC, 2022: Summary for Policymakers [H.-O. Pörtner, D.C. Roberts, E.S. Poloczanska, K. Mintenbeck, M. Tignor, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem (eds.)]. In: Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press. In Press.

3. exploring approaches to prevent a worst-case scenario for future food systems by identifying and discussing ways of maintaining, enhancing and/or adding infrastructure, programs, and environmental features for strengthening food systems resilience.

The workshops involve a variety of stakeholders who are involved in different aspects of the food systems; however, the participant groups were limited in size, which created challenges for comprehensively engaging the region. To widen the engagement, a survey component was added to the research project, which collected thoughts and inputs from residents of the Fraser Valley and the broader Lower Mainland area in BC. The survey was delivered prior to the final workshop, and its outcomes were presented to workshop participants to inform the discussion on how to improve food systems resilience.

This report focuses on the survey findings and analysis. For information on the other aspects of this research, see the other reports produced through this work.[4, 5, 6] For more information on the research project, visit the project webpage:

www.ufv.ca/food-agriculture-institute/the-research/integrated-planning/food-systems-vulnerabilities

2. The Region

The research focused on the Fraser Valley; however, the survey engagement had a larger geographical reach, also including residents in the neighbouring Metro Vancouver region. As adjacent regions, the Fraser Valley Regional District (FVRD) and Metro Vancouver regions are highly interconnected through food flows, supply chains, commuting and shopping patterns, population dynamics, etc. Engaging residents in both regions thus provided a more comprehensive understanding on food systems impacts and concerns experienced in the area, as well as allowed for comparisons between interconnected, yet different, regional food systems.

The Fraser Valley and Metro Vancouver regions are part of the larger Lower Mainland region in BC (Figure 1), which is the population centre of the province. According to 2021 estimates, the combined population of the Lower Mainland is approximately 3.1 million, comprising over half of the province's total population. Metro Vancouver is much more populous than the Fraser Valley, with over 8 times as many residents (i.e., Metro Vancouver has a population of almost 2.8 million; Fraser Valley has a population of 340 thousand).

[4] Dring, C., & Newell, R. (2022). Building a foundation to resilient food systems in the Fraser Valley Region: Summary Report. University of the Fraser Valley. https://artemisfood.org/s/BuildingFoundationResilientFoodSystemsFraserValley_SummaryReport_May2022.pdf

[5] Dring, C., & Newell, R. (2022). Mapping Food System Impacts, Hazards, and Vulnerabilities in the Fraser Valley Region Workshop: Summary Report. University of the Fraser Valley. https://doi.org/10.13140/RG.2.2.31197.69604

[6] Dring, C., & Newell, R. (2021). Fraser Valley Food System Vulnerability Workshop: Summary Report. University of the Fraser Valley. https://doi.org/10.13140/RG.2.2.34634.08648

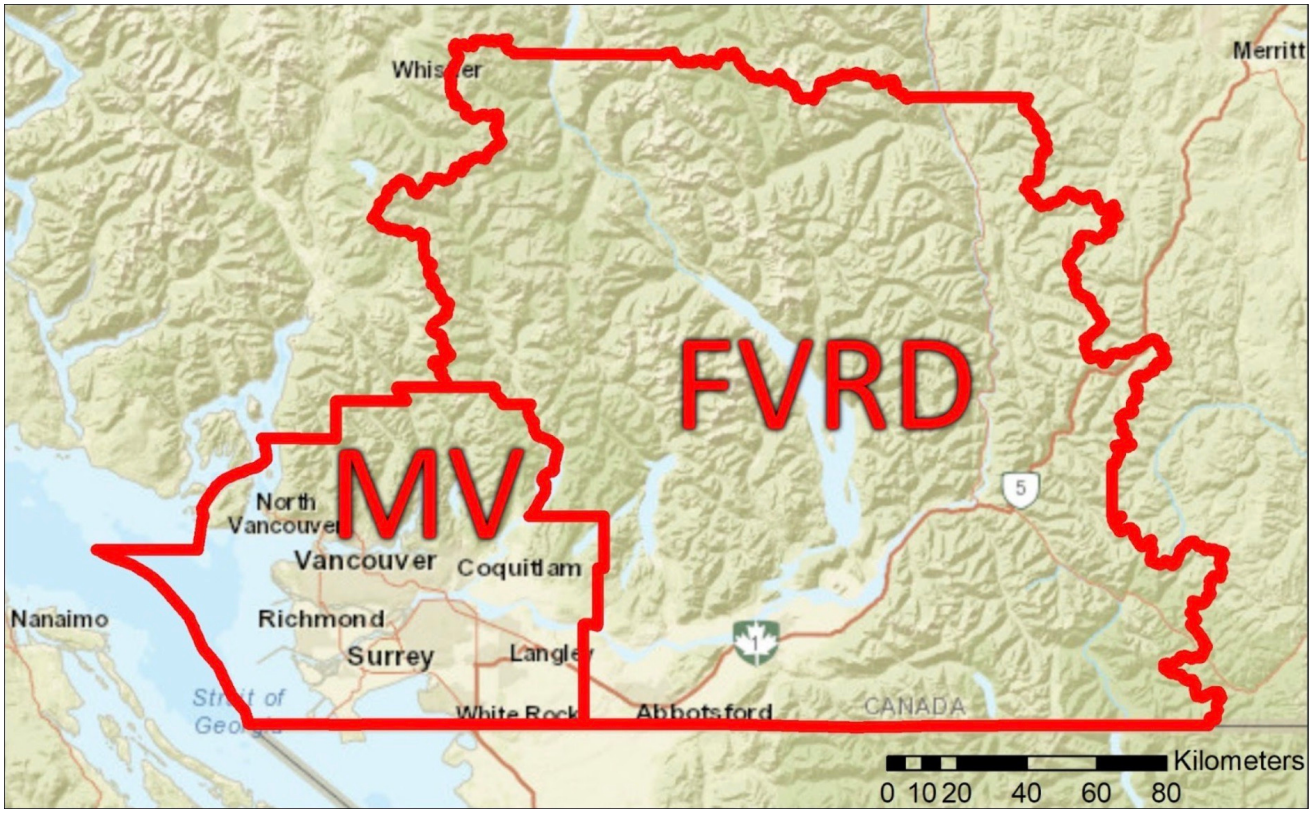

Figure 1. *Map of the Fraser Valley Regional District (FVRD) and Metro Vancouver (MV)*. Data sources: BC Data Catalogue, ESRI, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, METI, NGCC, and OpenStreetMap.

Commercial and agricultural activities are important in both regions; however, each has their strengths, with Metro Vancouver being a major commercial hub in Canada and the Fraser Valley being one of the most productive and economically important agricultural areas in the country. According to 2015 figures, the Fraser Valley produced 39% of BC's total gross farm receipts, $3.1 billion in annual economic activity, and support as an additional 18,000 full time jobs.[7] The Fraser Valley's close proximity to Metro Vancouver markets and the Lower Mainland's transportation infrastructure have supported this agricultural industry, and it is an industry of great economic and sociocultural importance to the region.

3. The Survey

The aim of the survey was to gain people's perspectives on and experiences with food systems vulnerabilities during the pandemic, as well as their concerns around future food system shocks and impacts. The survey was designed to align with the workshop series, and to this end, it explored the same issues (i.e. food system impacts, environmental, socioeconomic and political hazards) discussed in the workshops through a systems-

[7] FVRD (2017). Regional Snapshot Series: Agriculture Agricultural Economy in the Fraser Valley Regional District. Fraser Valley Regional District. https://www.fvrd.ca/assets/About~the~FVRD/Documents/RGS/AgricultureSnapshot.pdf

based and temporal lens. The first workshop examined food systems impacts of COVID-19 and other shocks across different timeframes (i.e., short-, medium-, and long-term), and the survey asked similar questions about both COVID-19 and other hazard impacts with respect to short-term (i.e., 0-5 years) and long-term (i.e., 5-20 years) time horizons. The second workshop explored food systems vulnerabilities to a variety of environmental, socioeconomic, and political hazards, and accordingly, the survey asked respondents about their concerns and thoughts on potential impacts from these same hazards. In this way, the survey complemented the workshop series, and served as a method of gaining a broader and richer perspective on the questions and topics explored in the workshop.

The survey consisted of four sections: (1) demographic questions, (2) food systems concerns revealed by COVID-19, (3) food systems impacts experienced due to the pandemic, and (4) concerns and thoughts about impacts arising from a variety of environmental, socioeconomic, and political hazards. A full copy of the survey can be found in Appendix 1. The survey was delivered with the assistance of a Canada-based data collection company, Decision Point Research, and eligible participants were those who are 18 or older and currently live in the Lower Mainland. Surveys were distributed in late January 2022 with response completion in early March 2022. The initial dataset consisted of 220 responses, and six responses were removed due to the place-of-residence being outside of the Lower Mainland or unclear (e.g., no answer or responses identify “British Columbia”). The final dataset consisted of 214 responses.

4. Analysis and Results

A series of statistical tests were conducted on the survey data to elucidate the significance of and relationships among food systems factors, impacts, and concerns. The sections below provide a brief summary of the analyses done and key outcomes. The discussion focuses on salient outcomes and statistically significant results.

4.1 Respondent Demographics

The survey’s demographic questions solicited responses about the respondents’ ages, gender, ethnicity, dwelling type, employment status, and household composition (Figure 2). Approximately 72% of the respondents were between the ages of 25 and 44, inclusive; 6% were younger than this range, and 22% were older. The vast majority of respondents identified to be of Asian descent (77%), followed by self-identifications of European (7%) and North American (5%). Gender composition leaned toward female participants (60%), with the others identifying as male (40%) and no respondents identifying as non-binary or “other”.

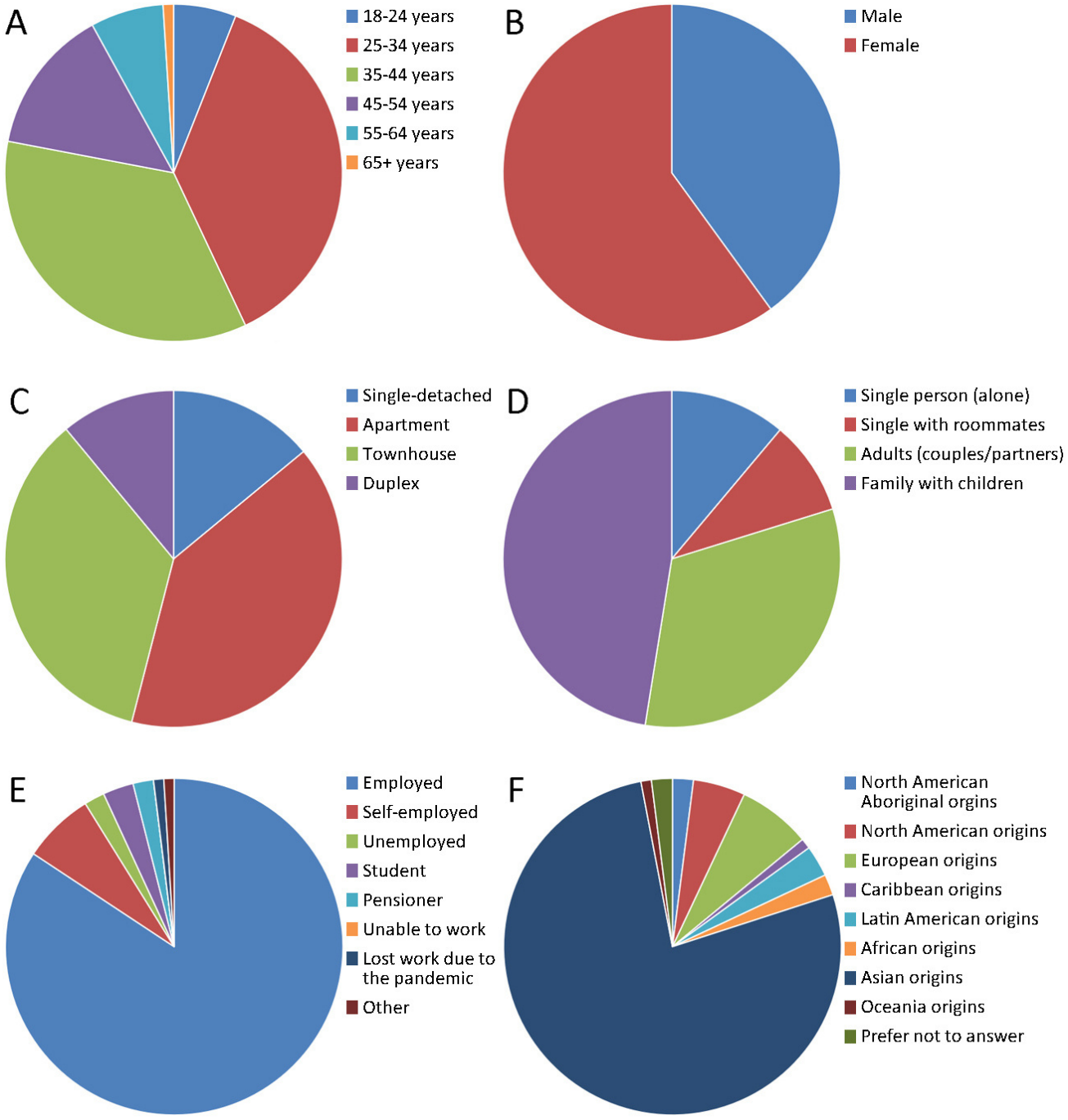

Figure 2. *Survey respondents' (a) age, (b) gender, (c) dwelling type, (d) households, (e) employment status, and (f) ethnicity.*

Many of the respondents lived in apartments (40%) and townhouses (35%), and fewer were in lower density units, such as duplexes (11%) and single-detached houses and single-detached houses (14%). Almost half of the respondents described their household composition to consist of a family with children (47%), and a third identified their household to consist of a family of only adults (32%), such as couples/partners. Most of the respondents were employed (86%), with 2% identifying as unemployed and 1% noting they lost work due to the pandemic.

The respondents lived in various places throughout the Lower Mainland (Figure 3); however, some municipalities were represented more than others. Among all represented municipalities, Surrey held the highest number of respondents (n=62), followed by Abbotsford (n=41), Vancouver (n=25), Burnaby (n=21), Langley (n=19), and Chilliwack (n=16). Other communities represented (n<10) include Coquitlam, Mission, New Westminster, Delta, Kent, Richmond, Maple Ridge, Harrison Hot Springs, Port Coquitlam, and Pitt Meadows (additionally, a few responses identified regions, such as “Fraser Valley”).

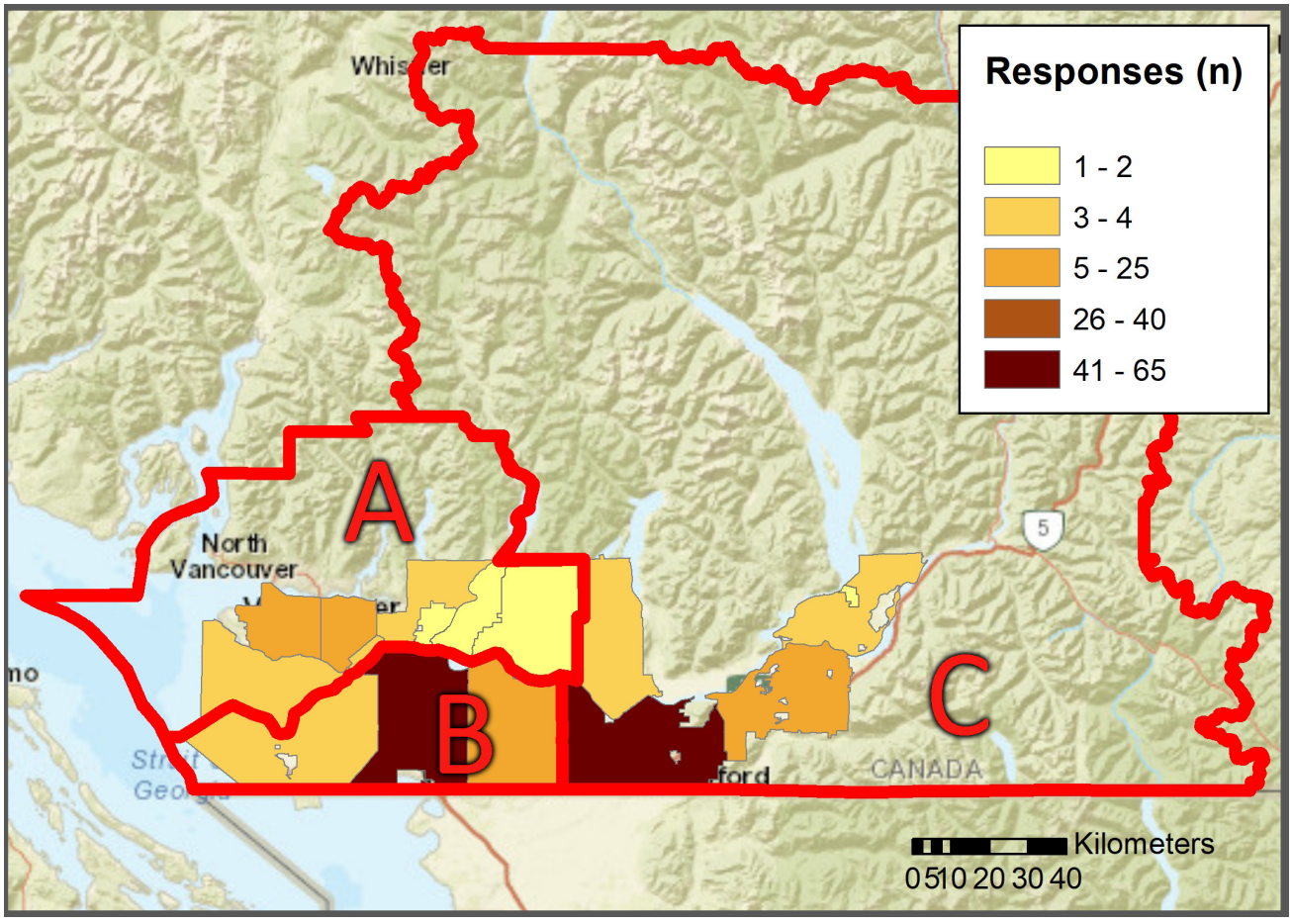

Figure 3. *Map of survey responses from (a) north Metro Vancouver, (b) south Metro Vancouver, and (c) Fraser Valley Regional District.* Data sources: BC Data Catalogue, ESRI, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, METI, NGCC, and OpenStreetMap.

Grouping the respondents regionally revealed that 31% live within the Fraser Valley, 29% are in Metro Vancouver communities north of the Fraser River (i.e., Vancouver, Burnaby, North Vancouver), and 40% are in communities south of the Fraser River (i.e., Surrey, Delta, Richmond). Categorizing Metro Vancouver subregions with respect to the Fraser River was done for some of the analyses (see 4.5 Geographic Differences) due to how these areas differ with respect to degrees of urbanization and agricultural activity, with municipalities north of the Fraser River in Metro Vancouver (for the most part) being more urban and with municipalities south of the Fraser River in Metro Vancouver having higher agricultural activity and more extensive farmland.

4.2 Concerns and Awareness of COVID-19 Impacts

Generally, survey respondents had slightly higher than average concerns about food production and food access. Respondents were asked whether the COVID-19 pandemic caused them concerns about their regional food system. Specifically, respondents were asked to rate their level of concern regarding (1) regional food production and (2) residents' ability to access food. Ratings were done on a scale of 1 (i.e., "low concern") to 5 (i.e., "high concern"), statistical evidence indicated that average concerns exceeded the mid-way point (i.e., 3) for both production ($df=213$, $t=7.37.$, $p<0.01$) and access ($df=210$, $t=4.25$, $p<0.01$). The level of concern was similar between food production ($M=3.58$) and access ($M=3.36$); however, statistical evidence indicates that respondents express slightly higher concern about production than access ($df=318$, $t=2.21$, $p=0.028$).

Respondents were asked about their awareness of different types of food systems impacts experienced during the pandemic. A list of food systems impacts was provided, and respondents were asked to select those of which they were most aware. The impacts listed were as follows:

1. Reduced food supply or shortages in marketplaces,
2. accessing emergency food services,
3. farmworker health impacts,
4. food processor health impacts,
5. loss of food service staff,
6. inability to bring in temporary farmworkers,
7. food loss and waste on farms,
8. reduced quality of food,
9. border closures and reduced food imports,
10. food redistribution efforts,
11. greater awareness of gaps in food system coordination, and
12. increased stress/mental health impacts.

As seen in Figure 4, the most commonly identified impact was “reduced food supply or shortages in marketplaces” (n=137). This was followed by “loss of food service staff” (n=96) and “border closures and reduced food imports” (n=95). Less commonly identified impacts were “greater awareness of gaps in food system coordination” (n=27) and “food redistribution efforts” (n=30).

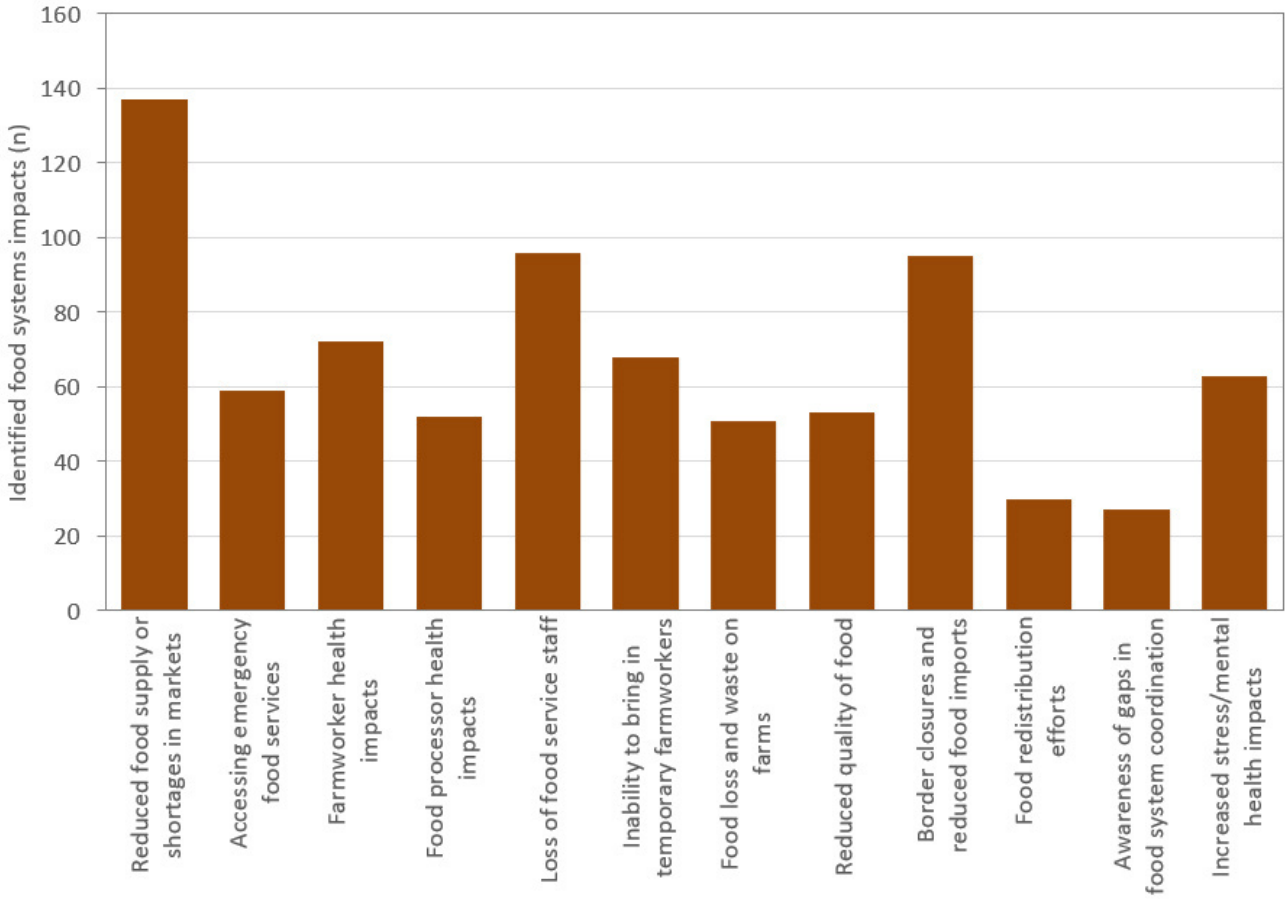

Figure 4. *Awareness of food systems impacts as identified by respondents.*

General awareness of food system impacts was not related to being involved in food system activities. The survey asked respondents whether they were involved in food-related activities (professionally, personally, or as a volunteer), such as growing food, food processing, food distribution, food retail, food access, and food education. Those who identified themselves as belonging to any one of these activities were classified as “food systems stakeholders” (n=88), and analysis was done to see if their food-related experience influenced the breadth of their awareness of food systems impacts. No statistical evidence was found to support this claim ($df=206$, $t=1.42$, $p=0.158$), that is, being a food systems stakeholder did not relate to the number of impacts of which a respondent was aware.

4.3 Impacts Experienced from COVID-19

The survey asked respondents whether they or family/friends had experienced any of these impacts from COVID-19:

1. General food unavailability,
2. preferred/cultural foods unavailability,
3. loss of employment,
4. inability to get to food markets/stores,
5. challenges using food delivery services,
6. inability to grow and produce food,
7. increased consumption of highly processed foods,
8. loss of livelihood due to food supply chain disruption,
9. loss of livelihood due to loss of employees,
10. increased demand on charitable food services,
11. diminished physical health from ongoing lack of food, and
12. diminished mental health from ongoing lack of food.

Respondents were asked to rate the severity of these impacts from 1 (“a little impact”) to 5 (“severely impacted”). Mean responses for the impacts ranged between 2.59 (“challenges using food delivery services”) and 2.90 (“increased consumption of highly processed foods”). This indicated that the population on average experienced low to moderate impact. No statistical evidence was found to support a claim that any one impact was experienced more severely than another ($df=11$, $F=1.70$, $p=0.068$).

Although impacts were overall seen to be low to moderate, the analysis showed that those who expressed more difficulty affording monthly food costs also experienced food systems impacts more severely. The strongest relationships were observed with “diminished physical health from ongoing lack of food” ($r = 0.42$), “diminished mental health from ongoing lack of food” ($r = 0.40$), and “inability to get to food markets/stores” ($r = 0.40$). Respondents were asked to rate (on a scale of 1 to 5) how easily they could afford food based on their household income, and correlation analysis exhibited statistically significant relationships with every type of impact ($p<0.01$). All relationships were positive (i.e., the more challenging it is to afford food, the higher the impact); however, some relationships were stronger than others. No particularly strong relationships (i.e., $r > 0.5$) were observed, but several were medium strength (i.e., $0.5 > r > 0.3$), and these can be seen in Figure 5.

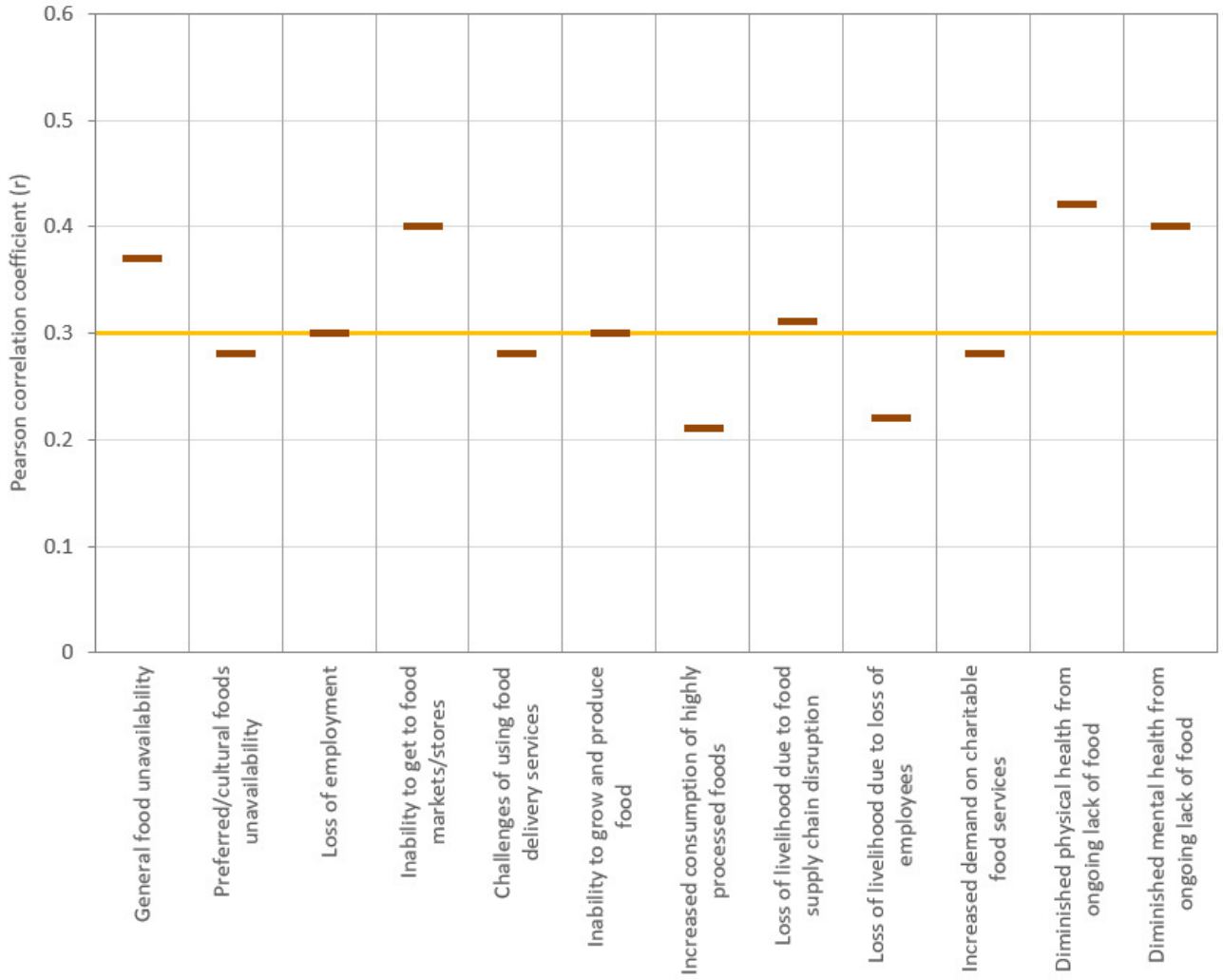

Figure 5. *Correlations between ability to afford food and food systems impacts experienced by respondents.* The y-axis represents the strengths of correlations. Data points under the orange line represent weak correlations, and data points above the line represent moderately strong correlations.

4.4 Hazards and Future Impacts

Respondents were asked about the degree to which they think different hazards will affect food systems in the near future (i.e., short-term, 0 to 5 years) and further in the future (i.e., long-term, 5 to 20 years). As with other questions, respondents were asked to provide ratings on a scale of 1 (i.e., "little to no impact") to 5 (i.e., "severe impact"). Each hazard was categorized as (1) environmental or (2) socioeconomic/political, and those explored included:

- **Environmental hazards:** (1) increased wildfires, (2) increased flooding, (3) increased drought, (4) increased air pollution, (5) loss of wildlife habitat and ecosystems, (6) increased soil contamination, and (7) increased water pollution

- **Socioeconomic/political hazards:** (1) future pandemics, (2) economic downturn/market crash, (3) rapid increase to the cost of living, (4) rapid population growth, (5) rapid exit of people leading to population decline, (6) threat of civil war, (7) threat of invasion from another country, and (8) multiple shocks happening at the same time

Analysis of the differences between responses on short-term and long-term impacts provided evidence suggesting that respondents feel impacts from most environmental hazards will increase in the future (Figure 7). This was the case for wildfires ($df = 205$, $t = -4.32$, $p < 0.01$), flooding ($df = 208$, $t = -2.54$, $p = 0.012$), drought ($df = 207$, $t = -4.34$, $p < 0.01$), air pollution ($df = 207$, $t = -4.52$, $p < 0.01$), loss of wildlife habitat and ecosystems ($df = 209$, $t = -3.38$, $p < 0.01$), and water quality ($df = 208$, $t = -4.89$, $p < 0.01$). The only environmental hazard that exhibited no statistically significant increase in anticipated impacts from short- to long-term was soil contamination.

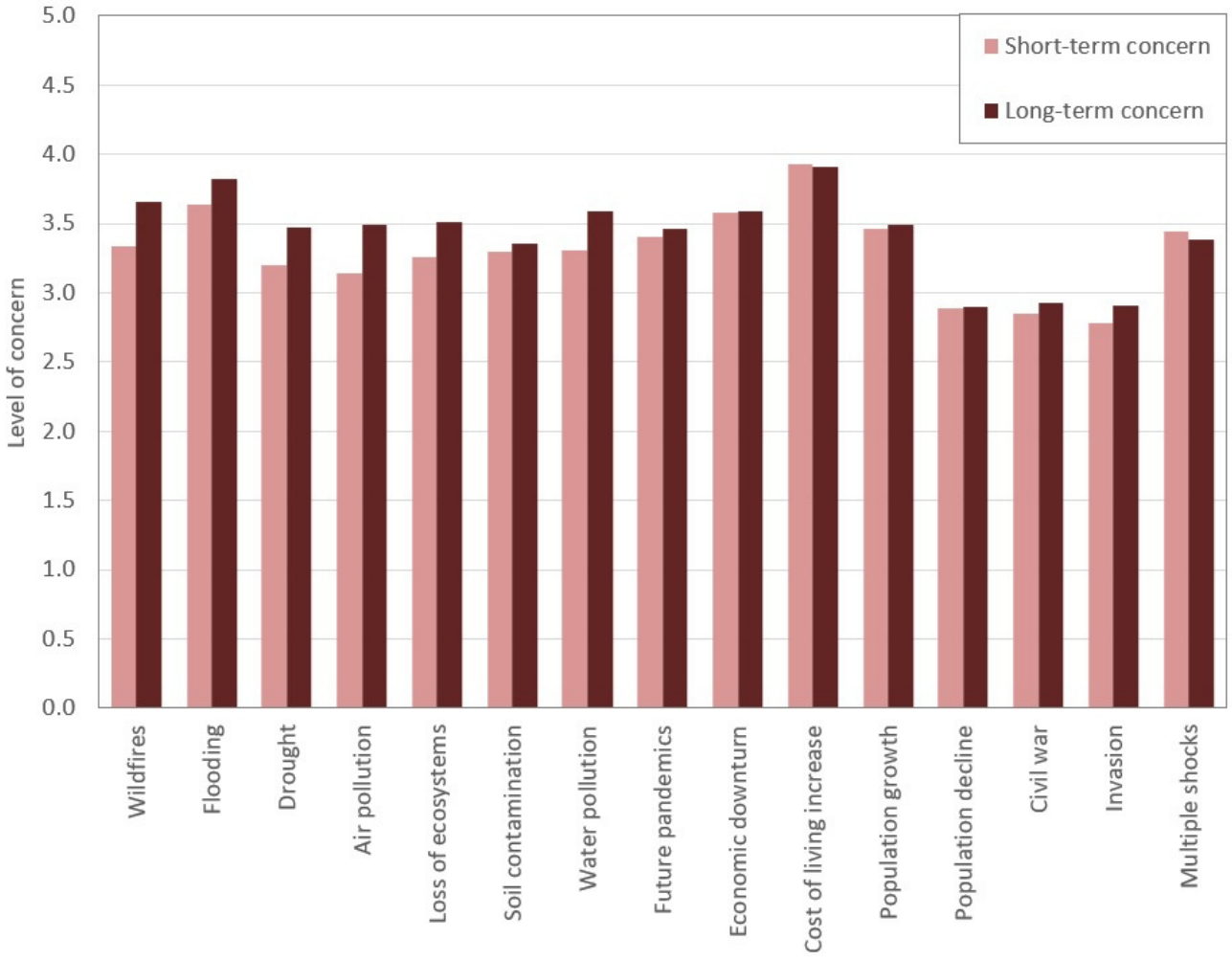

Figure 6. *Average level of concern about impacts from hazards in short- and long-term periods.*

In contrast, the analysis of socioeconomic/political hazards produced only one statistically significant result, which was associated with the threat of invasion from another country. This hazard shows an increase in perceived food system impacts from short- to long-term periods ($df = 208$, $t = -2.20$, $p = 0.029$).

The hazards of highest concern in the short term include increased flooding, economic downturn, and rapid increase in cost of living. In the short-term, anticipated impacts from flooding were statistically higher than drought, air pollution, population decline, civil war, and threat from invasion. Food systems impacts from economic downturn were anticipated to be higher than drought, air pollution, population decline, civil war, and threat from invasion. Impacts from increased cost of living were anticipated to be higher than wildfire, drought, air pollution, loss of wildlife habitat, soil contamination, water pollution, future pandemics, population growth, civil war, and threat from invasion.

In the long-term period, fewer statistically significant differences in anticipated impacts were observed. Flooding impacts were anticipated to be more severe than soil contamination, population decline, civil war, and threat from invasion. Impacts from economic downturn were anticipated to be greater than those from population decline, civil war, and threat from invasion. Impacts from increased cost of living were anticipated to be more severe than drought, air pollution, loss of wildlife habitat, soil contamination, future pandemics, population growth, civil war, and threat from invasion. With both the short- and long-term periods, impacts from population decline, civil war, and threat from invasion were anticipated to be less severe/of-a-concern than most other hazards. A comparison of the hazards exhibited statistically significant differences among anticipated food systems impacts from these hazards in both the short-term ($df = 14$, $F = 14.59$, $p < 0.01$) and long-term ($df = 14$, $F = 13.84$, $p < 0.01$) datasets (Figure 7).

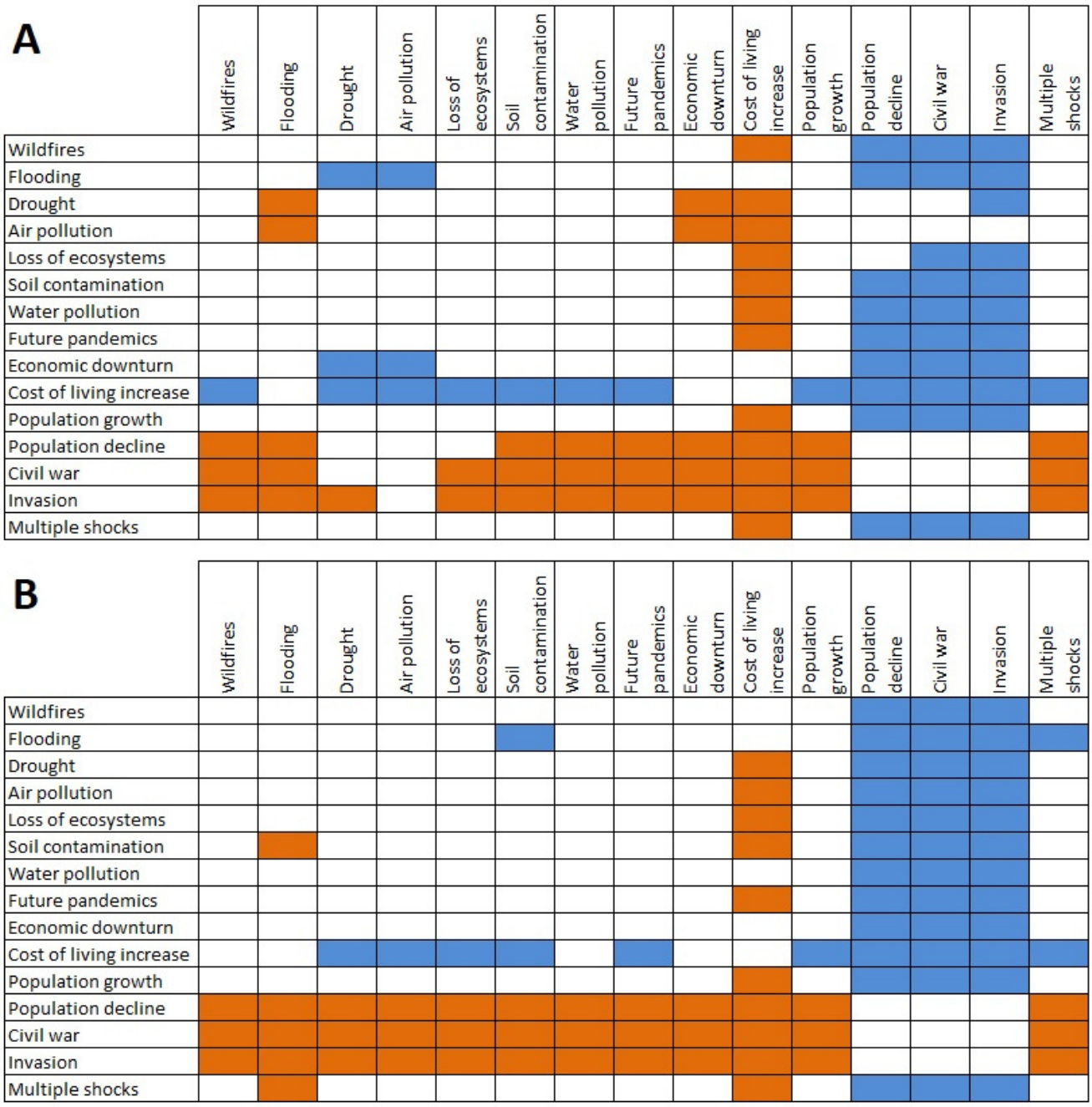

Figure 7. *Differences in levels of concern for hazards in (a) short- and (b) long-term periods.* Coloured cells indicate statistically significant differences. Orange cells indicate a left-hand column hazard is (on average) of less concern than a top row hazard. Blue cells indicate a left-hand column hazard is (on average) of more concern than a top row hazard.

A series of analyses were done to see if severities of anticipated impacts were perceived differently by the “food systems stakeholders” group than those not involved in food activities. The only statistically significant result observed involved short-term impacts related to the increased cost of living hazard. In this case, the average level of impact reported by the food systems stakeholder group was slightly lower than that of other respondents. It is worth highlighting that this finding only relates to the short-term impacts data, and a statistically significant difference was not observed with long-term impacts data.

4.5 Geographic Differences

A geographically-focused analysis was done to examine differences among the regions in the Lower Mainland in terms of experienced and anticipated impacts. The data were grouped according to whether respondents live in the FVRD, south Metro Vancouver, and north Metro Vancouver (see 4.1 Respondent Demographics). The analysis focused on survey questions regarding concerns about regional food production and residents’ access, current food-related COVID-19 impacts (i.e., those experienced by the respondents or their friends/family) and anticipated environmental, socioeconomic, and political hazards impacts.

Geographic differences were observed when examining future impacts due to hazards. The analysis of flooding impacts in the short-term data demonstrated that Fraser Valley residents anticipate greater impacts than the south Metro Vancouver residents ($df = 2$, $F = 4.31$, $p = 0.015$). In addition, north Metro Vancouver respondents anticipated greater impacts than south Metro Vancouver respondents due to future pandemics in both short-term ($df = 2$, $F = 3.91$, $p = 0.022$) and long-term ($df = 2$, $F = 4.86$, $p < 0.01$) periods. Similarly, impacts in the long-term due to economic downturn were anticipated to be more severe by north Metro Vancouver respondents than south Metro Vancouver respondents ($df = 2$, $F = 3.59$, $p = 0.029$).

The results found no statistically significant differences among the regions with respect to concerns about food production ($df = 2$, $F = 0.36$, $p = 0.699$) or access ($df = 2$, $F = 0.67$, $p = 0.513$). Similarly, no differences were observed among the regions with food-related impacts that were/are experienced due to the current pandemic.

4.6 Underlying Factors

Factor analyses were conducted on the current COVID-19 impacts and the anticipated hazard impacts to reveal underlying patterns in the data. Factor analysis is a statistical technique that identifies similar response patterns among a set of variables, and it can be used to group different “dimensions” in a complex dataset. When applied to the COVID-19

impacts, three factors were observed, access factors, economic factors, and health factors (Figure 8). The access factor relates to the ability of people to access foods. It includes the following concerns: general food unavailability, preferred/cultural foods unavailability, inability to get to food markets/stores, challenges using food delivery services, inability to grow and produce food, increased consumption of highly processed foods, and increased demand on charitable food services. The second factor centres on health concerns, and it consists of the survey responses related to questions about diminished physical and mental health from ongoing lack of food. The third factor is economic in nature, as it comprises the concerns about loss of employment, loss of livelihood due to food supply chain disruption, and loss of livelihood due to loss of employees. Survey items are arranged within the factor (i.e., the circle) to which they most relate, and they are positioned nearest to the factors that exhibited their second strongest relationship.

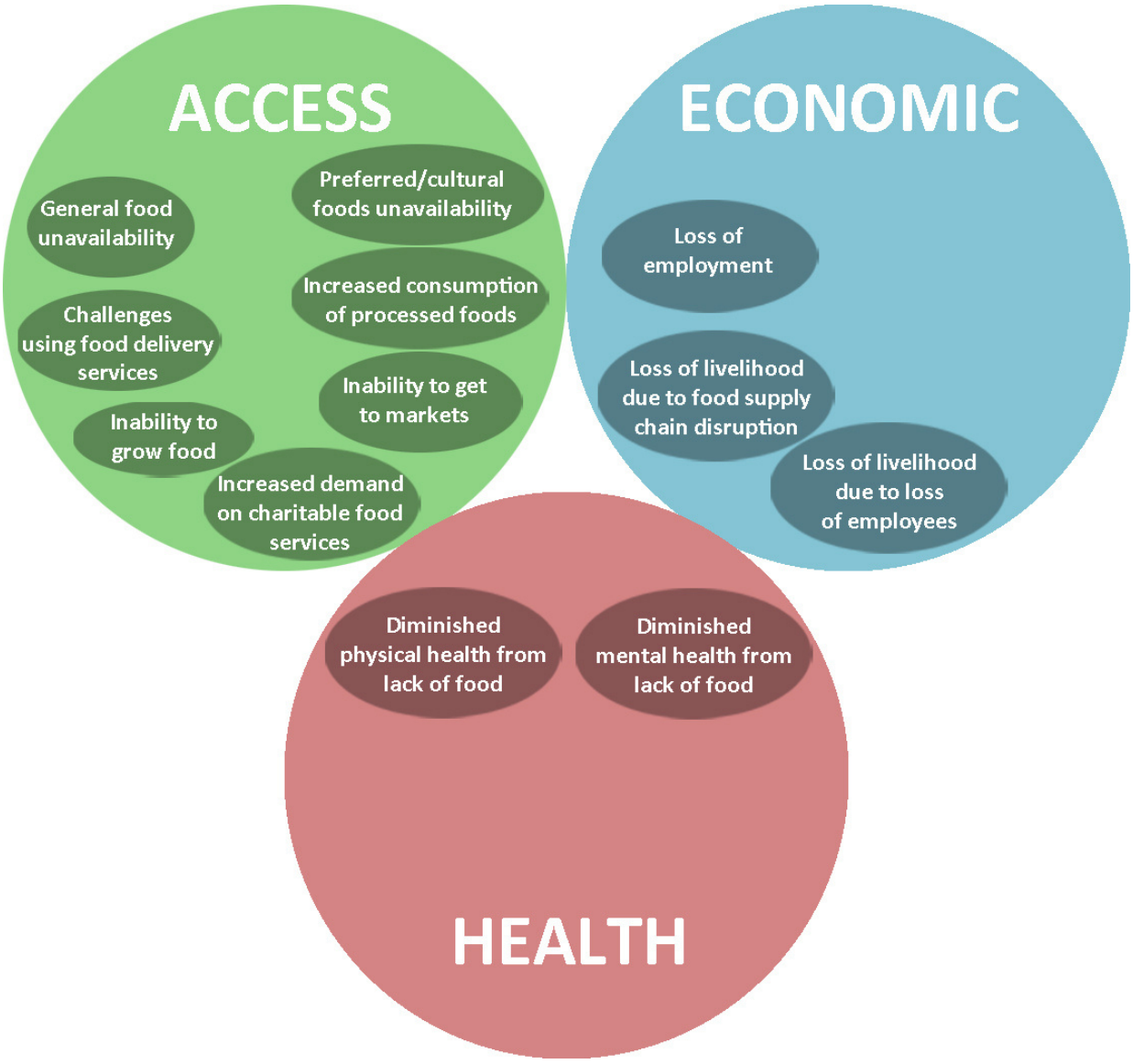

Figure 8. *Factors related to impacts to food systems from COVID-19.*

Figure 9 captures the results of the factor analysis conducted on the anticipated hazards impacts for both the short-term (A) and long-term (B) periods. Four factors were identified from the short-term impacts data (recent hazards, low-concern socioeconomic hazards, high-concern socioeconomic hazards, and environmental hazards) (Figure 9A). The recent hazards factor included wildfires, flooding, drought, air pollution, wildlife habitat loss, and the pandemic. At first glance, the pandemic appears to be unrelated to the other items; however, it is possible that this factor captures issues that are particularly current and pronounced in 2021 (e.g., in addition to COVID-19, BC experienced severe wildfires, flooding, heat waves, etc.). The second and third factors consist of socioeconomic/political hazards that were considered to be (respectively) less and more severe as per the anticipated impacts analysis discussed above (see 4.4 Hazards and Future Impacts). The fourth factor relates to environmental quality, specifically soil contamination and water pollution.

In terms of long-term impacts, three factors were identified (Figure 9B). The first factor captured all six environmental hazards. Similar to short-term impacts, the second and third factors consist of socioeconomic/political hazards that were considered by respondents to be less and more severe (respectively speaking) in terms of anticipated impacts. The major difference between the short- and long-term impacts with respect to the second and third factors is that the future pandemic item appears to be included in the high-concern factor when analyzing the long-term impacts data.

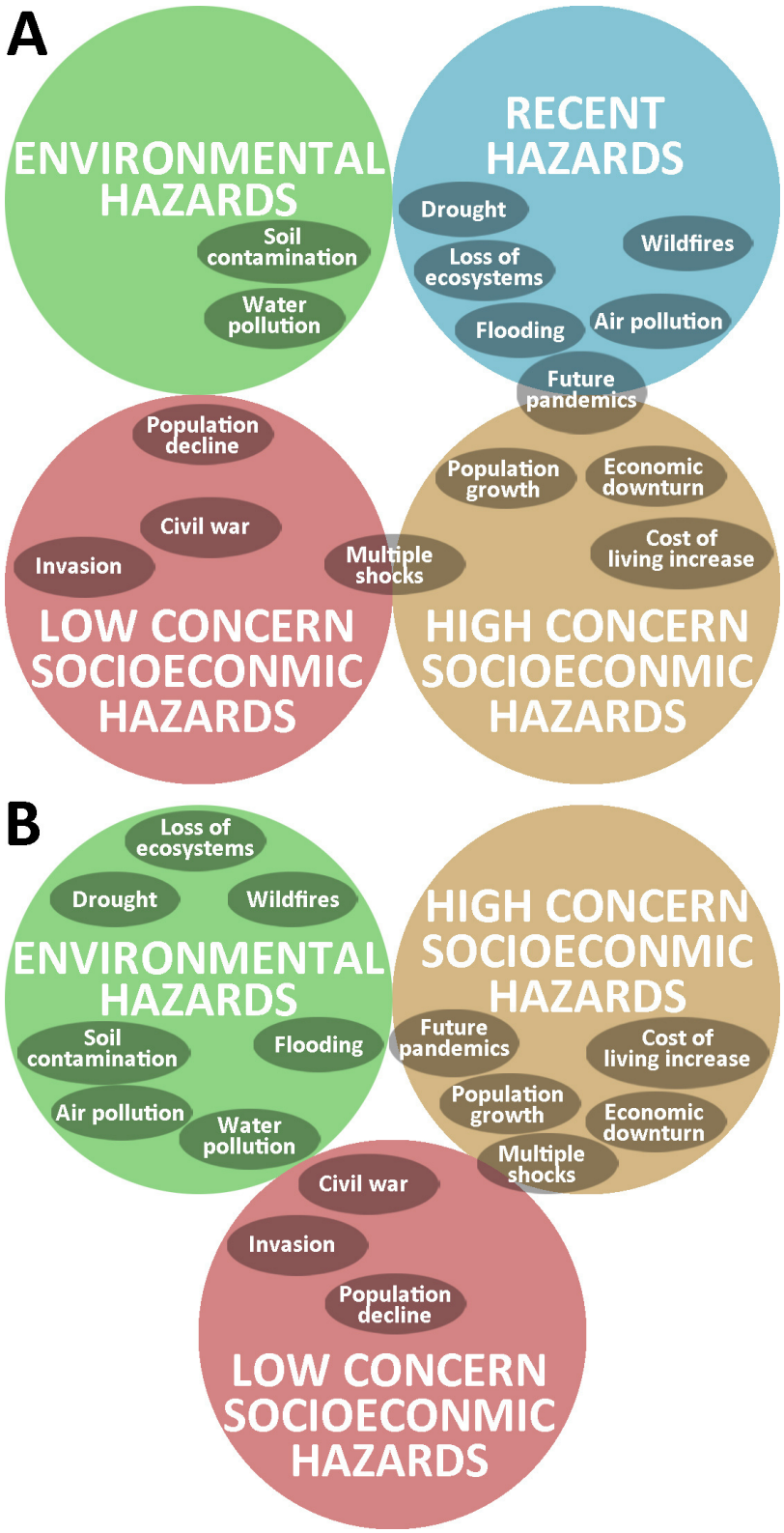

Figure 9. *Factors related to concerns about impacts to food systems from various hazards in (A) short- and (B) long-term periods.* Survey items are arranged within the factor to which they most relate, and they are positioned nearest to the factors that exhibited their second strongest relationship. Items that span factors showed relationships to these factors with similar strengths.

4.7 Identified Impacts and Further Comments

4.7.1 Environmental Hazard Impacts

Survey respondents were asked to rank different environmental hazards (1 - most impactful to 4 - least impactful) and to offer a rationale for their ranking. Several relationships are articulated that demonstrate different pathways and inter-connections between environmental hazard events, food system impacts, and broader contextual factors. Respondents noted damages to infrastructure arising from flooding and droughts results in cascading impacts to the transportation of food products across all of the supply chain. This includes disruptions from farms to sites of distribution and/or processing and disruptions of food imports from sites beyond the region to processors and/or retailers. These disruptions were described as the cause of increasing food prices.

The environmental hazards of flooding, droughts, wildfires and heat were associated with crop damages and loss of farmland again linked to diminished crop yields. These diminished crop yields, along with environmental pollution, were linked to health impacts. Two pathways are articulated by respondents. The first is the contamination of water sources and food products from pollutants arising from conventional farming practices (e.g. over application of fertilizers, broad-application pesticides for resistant pests). Intensive farming was also identified as damaging soil and reducing the water table. Secondly, diminished crop yields will increase food prices, which will force more consumption of heavily processed foods resulting in health impacts.

> *"With climate change and the disasters caused by temp fluctuations, there have already been impacts to the availability of natural resources required to grow food. Added to that, other socio economic events, makes the future seem uncertain."*

> *"Soil pollution directly reduces the nutrient density of the food / veggies we intake and causes more health concerns with contaminated soil. Severe / extreme weather such as flood and drought affect the seasonality of the produce and the logistics of the food delivery. It also reduces the quality and the quantity of the food. In the end, it would increase the food cost/price to compensate for the loss."*

Respondents offered additional concerns and comments around addressing environmental hazards and their impacts. With respect to conventional farming, respondents suggested exploration and advancement of alternative farming methods and the achievement of sustainable food systems. A cluster of responses focused on uncertainty with respect to the future, lack of preparation for future hazard events, and a need to address root causes. Some respondents noted a lack of control over the food system, but did not qualify who would be responsible for food system coordination and management.

"Global warming and damage to the biosphere are causing droughts, flooding and wildfires. We continue to over farm, damaging the soil and the water table. By the virtual elimination of crop diversity we're damaging the food chain."

"I basically see a loss of control happening and when it does the people will get selfish and greedy."

4.7.2 Socioeconomic and Political Hazards Impacts

Across the socioeconomic and political hazards impact ranking, explanations for responses demonstrated a range of inter-connected concerns and experiences. A primary concern was the increased cost of living and cost of food associated with perceived impacts from war, economic downturns and market crashes, and rapid population increase. Top of mind for respondents, given the recent invasion of the Ukraine by Russia was the effects of economic sanctions and fiscal policies impacting both the economy and food supply. As well, respondents noted concern around simultaneous socioeconomic and political hazard events occuring in tandem (e.g., pandemic and war). In particular, concerns were noted around the flow of goods across the border with the United States and potential trade tariffs imposed on Canadian products. Similarly, at the time of this report, the trucker protest and pandemic were linked to border closures leading to food shortages. Supply chain disruptions from political organizing by truckers, such as impeding food distribution by road, is a key vulnerability.

"War would mean closed off borders and then we cannot import or export hurting the economy and our food supplies."

"There are many protests going on in Ontario, so I think food shortages will be there as truck drivers are not working."

Economic downturns and market crashes were associated with highly ranked impacts of costs of living and cost of food. Particular concerns were around the costs of production, processing, and distribution being put on consumers. Further exacerbated by growing wealth inequality, respondents noted an additional effect of being unable to pay workers adequate wages, resulting in further downstream food insecurity impacts. As well, political instability and government mis-spending was seen as making market crashes worse leading to extreme hunger and reinforcing unfair distribution of wealth and resources. Respondents noted the negative societal effects of increasing inflation, cost of housing, and the price of food. For example, an identified increase in the price of food over the past year and that these prices remain the same as the effects of the pandemic wind down.

> *"The cost of food keeps increasing and quality food is already out of reach of many people. An economic crash would lead to immediate and extreme hunger for much of the population, in part due to an existing (and ever worsening) and incredibly unfair distribution of wealth/resources in our society. Political instability only exacerbates the foregoing factors."*

> *"Wealth inequality has the most devastating consequences on a huge majority of the country, and the world at large."*

Population increase was another area of concern. Several respondents noted that increasing population puts pressure on farmland conversion to housing which results in loss of habitat and less farmland to produce food for the region and export. The driver of population increase was linked to immigration and associated with an increase in housing costs. Associated was the lack of wage increases to offset identified cost increases (e.g., housing, food). These landscape changes also were noted to impact communities that rely on healthy environments for hunting and fishing. As one respondent observes, this ability to live off-the-land is diminishing.

> *"Our ability to hunt and fish as I was taught growing up is becoming harder and harder to do. We used to be able to live off the land and now even those opportunities are becoming scarce."*

Finally, general concerns from respondents reflect common feelings of powerlessness and fear for the future and for future generations. Several respondents noted that during hazard events, fear and self-interest increases and that they are uncertain if lessons learned during these events will be applied to future events. In addition, unintended consequences of human interventions are stated to exacerbate existing issues and impacts. Applying lessons learned and shoring up vulnerable areas of the food system is vital in ongoing emergency management.

> *"Based on what I've seen during this current pandemic, I don't see things being handled any better if another pandemic were to occur"*

> *"Whenever people start to feel a breakdown in society, they get scared and dangerous and they only want to protect their own"*

4.7.3 General Comments

Comments were provided from survey respondents that added additional insights and perspectives on food system impacts from COVID, environmental hazards, and socioeconomic and political hazards. Participants repeated the concerns around food

shortages for certain products as linked to the pandemic and to disruptions in imports. Additionally, labour shortages were identified as exacerbating the food supply chain, impacting food availability and food prices. As the pandemic continued, several participants noted inflation of food prices due to government bailouts and spending and to import restrictions and barriers. These higher food prices have continued to remain steady prompting calls for increases in wage to offset these costs of living.

> *"Food became expensive when COVID started because of shipping issues and now that price has remained the same even after shipping issues were resolved."*

> *"I am more concerned about food inflation which is a by-product of reckless government spending during the pandemic. I got zero dollars in benefits and am having to bear the brunt of the inflation."*

5. Discussion

Overall, the survey respondents expressed concern about the food system, indicating that COVID-19 has highlighted issues around production and supply. When asking about their awareness of specific issues, those that were most frequently identified include issues that are experienced/faced by the "average" person, such as shortages in marketplaces, as well as related issues that receive consistent media attention, such as supply chain problems. In contrast, more complex and abstract issues, such as food systems coordination and redistribution efforts, were not as frequently mentioned, suggesting that there may be a "blindspot" or at least lower awareness of these equally (if not more) serious problems. Such findings suggest that methods for increasing public understanding around challenges such as food systems coordination could be important for improving functionality.

On average, the respondents reported experiencing low-to-moderate food-related impacts due to the pandemic; however, it is critical to note that each impact analyzed correlated with people's ability to afford food based on their household income. In particular, the strongest relationships were found with physical and mental health impacts from ongoing hunger and inability to reach stores. These findings highlight the importance of understanding co-vulnerabilities (in this case, economic and food systems vulnerabilities) and that exogenous shocks will impact some more than others. An integrated planning perspective is valuable for understanding and addressing these co-vulnerabilities; for example, the findings here provide a case for applying an equity lens to integrated food and health planning and policy. The results also suggest that transportation and food systems planning should be considered together as well, due to an observed relationship between challenges affording food and reaching/accessing markets.

The examination of anticipated food systems impacts showed that many believe environmental hazards will increase in severity over time, as such increases were identified for all except soil contamination. Such findings suggest an awareness of the critical environmental issues facing our communities and regions, such as climate change and biodiversity loss, which is perhaps unsurprising due to the severe wildfires, extreme heat, and flooding experienced in BC in 2021. However, it is worth recognizing that soil contamination is linked to flooding, as floodwaters can spread and deliver contaminants to agricultural soils,[8] and while flooding impacts were expected to increase, this was not the case with soil contamination. Such results suggest a need for improving awareness and understanding around the linkages between critical sustainability issues to increase public literacy on agri-environmental sustainability.

The hazards analysis produced insights on what the more pressing concerns are for residents of the Lower Mainland. Flooding, cost of living, and economic downturn were identified as those that will exert the strongest impact on food systems in the future, and such responses are reflective of the issues that Lower Mainland residents experience now. In addition, a subregional analysis showed that concerns are more pronounced in some areas over others, such as flooding in the Fraser Valley and future pandemics in Metro Vancouver. The former makes sense due to the flooding experienced in the Fraser Valley in 2021. The latter could be reflective of the challenges residents in higher density cities experienced in the pandemic with respect to being in close proximity with one another.[9] Ultimately, it is important to view these survey responses through the lens of lived experiences, that is, the concerns expressed are reflective of challenges felt. Accordingly, communities and regions should both work locally and co-operate across jurisdictions to address (respectively) issues that are particular to certain places and peoples and those that are felt more widely, extending beyond municipal/regional district borders.

In addition to being reflective of local and regional issues and challenges, the survey results also indicate that respondents were considering global issues and dynamics when identifying future impacts. Interestingly, the only socioeconomic/political hazard that was identified as increasing impacts was threat from invasion. Although the results suggest a relatively low level of concern about this hazard, there was an increase from the short- to long-term time period. The survey was delivered during the start of the 2022 conflict in Ukraine, and it is possible respondents have a sense that what happened in that country (i.e., invasion by another nation) is possible in Canada on a long enough timeline. Comments and explanations from respondents draw attention to similar phenomena arising with the United States and were experienced during the trucker convoy protest in

[8] Ciesielczuk, T., Kusza, G., Poluszyńska, J., & Kochanowska, K. (2014). Pollution of flooded arable soils with heavy metals and polycyclic aromatic hydrocarbons (PAHs). Water, Air, and Soil Pollution, *225*(10), 45–52. https://doi.org/10.1007/s11270-014-2145-0

[9] Florida, R., Rodríguez-Pose, A., & Storper, M. (2021). Cities in a post-COVID world. Urban Studies, 004209802110180. https://doi.org/10.1177/00420980211018072

2022. Such findings show how current global issues, even if in “far away places”, could potentially stimulate thoughts around potential future challenges and concerns, which otherwise would not register as a possible local problem.

The factor analysis provided thematic understanding of the types of challenges and impacts the respondents experienced during COVID-19 and anticipated future hazards. With respect to current impacts, the three factors observed were food access, health, and employment, and each of these issues could form thematic areas for designing and implementing strategies for improving food systems sustainability and resilience. With respect to hazards, it was interesting to observe that the analysis of short-term anticipated impacts resulted in one more factor than the long-term analysis, and this factor seemed to relate to current/recent, pressing issues (e.g., wildfires, pandemics, floods, etc.). Additionally, the socioeconomic/political hazards analysis in both the short- and long-term impacts data analyses indicate thematic groupings of issues of lower concern (i.e., war, invasion, population decline) and those of higher concern (i.e., economic downturn, cost of living, population growth). The latter group of issues could be prioritized in planning and policy to achieve public buy-in and support. In conjunction, employing an integrated approach that determines policy and planning approaches that addresses the broader collection of hazards and relationships among them is necessary for long-term resilience planning.

6. Key Implications

The survey study detailed in this report produced multiple insights into the current issues and potential future challenges for food systems in the Lower Mainland. Such insights have implications and value for local and regional food systems planning, policy, and programming. This report concludes by presenting some of these key implications and recommendations based on this work:

- Identify the blindspots in people’s awareness of food systems issues (i.e., coordination and engagement), and engage in efforts to improve public knowledge on these critical issues.

- Design and implement integrated approaches to planning and policy that address co-vulnerabilities (e.g., food and economy), and recognize relationships among different planning domains, such as food, health, and transportation.

- Articulate to stakeholders and the broader public the linkages and relationships among hazards and impacts (e.g., flooding and soil contamination) to increase literacy around and appreciation for systems-based, integrated approaches to addressing agri-environmental issues.

- Engage stakeholders and the public in food systems issues that have place-based relevance and of local/regional concern, while also discussing global issues that highlight possibilities and provide “lessons” on the types of hazards/impacts which were previously thought to be irrelevant to local contexts (e.g., war, invasion).

- Understand the themes among and main factors within a collection of hazards and impacts. Use this thematic understanding to inform long-term integrated planning that strategically prioritizes policy objectives over different timeframes addressing a broad array of factors.

Appendix

Appendix 1. Survey

Thank you for your time and support to be part of this study.

We would like to invite you to participate in a project led by researchers at the University of the Fraser Valley, titled: Vulnerabilities and the future of food - Integrated food systems planning and resilience.

In this project, we reflect on the challenges and vulnerabilities that the COVID-19 pandemic has revealed about local and regional food systems in the Fraser Valley, and we explore ways of increasing local/regional resilience to future shocks. The project will produce useful knowledge on food concerns and challenges in the Fraser Valley, which will help the region implement practical policies and actions that can strengthen regional food security and production systems.

A letter of information for informed consent can be found here (please download and keep a copy for your records): https://changingtheconversation.ca/SurveyLetterConsent-VulnerabilitiesFutureFood.pdf

The survey has 20 questions and should take 10-15 minutes to complete.

Section 1. About Yourself

1. What is your age (in years)?

- 18-24 years
- 25-34 years
- 35-44 years
- 45-54 years
- 55-64 years
- 65+ years

2. What gender do you most identify with?

- Male
- Female
- Non-binary
- Other
- Prefer not to answer

3. What ethnic origin do you identify with?

- North American Aboriginal origins
- North American origins
- European (e.g. British Isles; French; Eastern European; Southern European)
- Caribbean
- Latin, Central and South American origins
- African origins (e.g. Central and West African; North African; Southern and East African)
- Asian origins (e.g. West Central Asian and Middle Eastern origins; South Asian; South East Asian; East Asian)
- Oceania origins (e.g. Australia; New Zealand, Pacific Islands)
- Prefer not to answer

4. How long have you lived in the Fraser Valley? (Example: Two years)

5. Which municipality or neighbourhood in the Fraser Valley do you live in?

6. What kind of accommodation or dwelling place do you live in? Select all that apply.

- Apartment/Condo
- Townhouse
- Duplex
- Farm
- Temporary
- Other
- Prefer not to say

7. What is your current employment status? Select all that apply.

- Employed
- Self-employed/business
- Unemployed
- Student
- Pensioner
- Unable to work
- Lost work due to the pandemic
- Other
- Prefer not to say

8. How easily are you able to afford the total monthly food costs based on your household income? Rate from 1 to 5 (1 – easily, 5 - difficult)

- 1 - Easily

- 2
- 3
- 4
- 5 – Difficult
- Prefer not to say

9. How would you describe your household composition?

- Single person (living alone)
- Single person (living with roommates)
- Family (adults only (18+))
- Family with young children
- Prefer not to say

10. If applicable, select any areas you are involved in any food-related activities or engagements (volunteer and/or employed)? Click as many as needed.

- Growing food
- Food processing
- Food distribution
- Food retail
- Food access
- Food education
- Other
- Not Applicable
- Prefer not to say

Section 2. Concerns about the Food System

11. Has the pandemic caused you concern about Fraser Valley food production? Rate from 1 to 5 (1 – low concern, 5 – high concern)

- Growing food
- Food processing
- Food distribution
- Food retail
- Food access
- Food education
- Other
- Not Applicable
- Prefer not to say

Please explain your answer to question 11.

12. Has the pandemic caused you concern about Fraser Valley residents' ability to access food? Rate from 1 to 5 (1 – low concern, 5 – high concern)

- 1 – Low concern
- 2
- 3
- 4
- 5 – High concern
- Not applicable

Please explain your answer to question 12.

Section 3. COVID-19 Impacts to Food Systems

The food system can be defined as the relationship between growing food, distributing food, processing food, selling food, and consuming food. This also can include government and non-profit policies, programs, and other efforts.

13. What impacts to food systems in the Fraser Valley from the COVID-19 pandemic are you most aware of? Select as many as known.

- Reduced food supply or shortages in marketplaces
- Accessing emergency food services (e.g., food banks, community meals, friends/family)
- Farmworker health impacts
- Food processor health impacts
- Loss of food service staff
- Inability to bring in temporary farmworkers
- Food loss and waste on farms
- Reduced quality of food
- Border closures and reduced food imports
- Food redistribution efforts (e.g., food waste to household)
- Greater awareness of gaps in food system coordination
- Increased stress/mental health impacts
- Other

14. Considering the recent COVID-19 pandemic. Have you, a family member, and/or friend experienced the following impacts? Select all that apply, and for those you select please rate from 1 to 5 (1 – impacted a little, 5 – impacted severely)

- General food unavailability
- Preferred/cultural foods unavailability
- Loss of employment

- Inability to get to food markets/stores
- Challenges of using food delivery services
- Inability to grow and produce food
- Increased consumption of highly processed foods (e.g. high salt/fat/sugar)
- Loss of livelihood due to food supply chain disruption
- Loss of livelihood due to loss of employees
- Increased demand on charitable food services (e.g., food banks, school programs)
- Diminished physical health from ongoing lack of food
- Diminished mental health from ongoing lack of food
- Other

Section 4. Exploring Other Impacts to Fraser Valley Food Systems

15. Over the next five years (0-5 years/short-term), which environmental hazards do you think are most likely to negatively impact food systems in the Fraser Valley? Select all that apply, and for those you select please rate from 1 to 5 (1 – little to no impact, 5 – severe impact)

- Increased wildfires
- Increased flooding
- Increased drought
- Increased air pollution
- Loss of wildlife habitat and ecosystems
- Increased soil contamination
- Increased water pollution
- Other

16. Beyond the next five years and the next few decades (5-20 years/long-term), which environmental hazards do you think are most likely to negatively impact food systems in the Fraser Valley? Select all that apply, and for those you select please rate from 1 to 5 (1 – little to no impact, 5 – severe impact)

- Increased wildfires
- Increased flooding
- Increased drought
- Increased air pollution
- Loss of wildlife habitat and ecosystems
- Increased soil contamination
- Increased water pollution
- Other

17. Name (in rank order) the top four impacts to the food system you anticipate happening because of environmental hazards.

- Impact 1
- Impact 2
- Impact 3
- Impact 4

Please explain your answer to question 17.

18. Over the next five years (short-term), which social, economic, or political hazards do you think are most likely to negatively impact food systems in the Fraser Valley? Select all that apply, and for those you select, please rate from 1 to 5 (1 – little to no impact, 5 – severe impact)

- Future pandemics
- Economic downturn/market crash
- Rapid increase to the cost of living
- Rapid population growth
- Rapid exit of people leading to population decline
- Threat of civil war
- Threat of invasion from another country
- Multiple shocks happening at the same time
- Other

19. Beyond the next five years and the next few decades (long-term), which social, economic, and political hazards do you think are most likely to negatively impact food systems in the Fraser Valley? Select all that apply, and for those you select, please rate from 1 to 5 (1 – little to no impact, 5 – severe impact)

- Future pandemics
- Economic downturn/market crash
- Rapid increase to the cost of living
- Rapid population growth
- Rapid exit of people leading to population decline
- Threat of civil war
- Threat of invasion from another country
- Multiple shocks happening at the same time
- Other

20. Name (in rank order) the top four impacts to the food system you anticipate happening because of social, economic, and/or political hazards.

- Impact 1
- Impact 2
- Impact 3
- Impact 4

Please explain your answer to question 20.

Section 5. Survey Wrap Up

Thank you for taking this survey! Please feel free to provide any additional thoughts or comments before submitting.

Appendix 2. Statistical Output

Report Section: 4.2 Concerns and Awareness of COVID-19 Impacts

One-sample test for food production and access (test value = 3)

					95% confidence interval of the difference	
Concern	**t-value**	**Degrees of freedom (df)**	**p-value**	**Mean difference**	**Lower**	**Upper**
Food production	7.37	213	< 0.000	0.58	0.43	0.74
Food access	4.25	210	< 0.001	0.36	0.19	0.53

Independent sample test comparing food production and access (equal variances assumed)

Levene's test for equality of variances		t-test for equality of means				95% confidence interval of the difference	
F-value	**p-value**	**t-value**	**df**	**p-value**	**Mean difference**	**Lower**	**Upper**
0.64	0.424	2.21	318	0.028	0.31	0.03	0.59

Independent sample test comparing awareness between food systems stakeholders and others (equal variances assumed)

Levene's test for equality of variances		t-test for equality of means				95% confidence interval of the difference	
F-value	**p-value**	**t-value**	**df**	**p-value**	**Mean difference**	**Lower**	**Upper**
1.64	0.202	1.42	206	0.158	0.5	-0.2	1.2

Report Section: 4.3 Impacts Experienced from COVID-19

One-way analysis of variance (ANOVA) test comparing mean scores among impacts

Variation test	Sum of squares	df	Mean square	F-value	p-value
Between groups	31.94	11	2.9	1.7	0.068
Within groups	4,301.38	2,512	1.71		
Total	4,333.32	2,523			

Tukey's post-hoc test comparing mean scores among impacts (all p-values > 0.05)

		Mean difference (row ID - column ID)											
ID	Description	1	2	3	4	5	6	7	8	9	10	11	12
1	Food unavailability	0	0.12	0.1	-0.06	-0.18	-0.04	0.13	-0.1	-0.17	-0.16	-0.17	-0.13
2	Cultural foods	-0.12	0	-0.02	-0.18	-0.3	-0.16	0.01	-0.21	-0.29	-0.28	-0.29	-0.25
3	Loss employment	-0.1	0.02	0	-0.15	-0.28	-0.14	0.03	-0.19	-0.27	-0.25	-0.27	-0.23
4	Inability access markets	0.06	0.18	0.15	0	-0.12	0.01	0.19	-0.04	-0.12	-0.1	-0.12	-0.07
5	Challenges with delivery	0.18	0.3	0.28	0.12	0	0.14	0.31	0.08	0.01	0.02	0.01	0.05
6	Inability grow food	0.04	0.16	0.14	-0.01	-0.14	0	0.17	-0.05	-0.13	-0.11	-0.13	-0.09
7	Highly processed foods	-0.13	-0.01	-0.03	-0.19	-0.31	-0.17	0	-0.23	-0.3	-0.29	-0.3	-0.26
8	Livelihood and supply chain	0.1	0.21	0.19	0.04	-0.08	0.05	0.23	0	-0.08	-0.06	-0.08	-0.03
9	Livelihood and employees	0.17	0.29	0.27	0.12	-0.01	0.13	0.3	0.08	0	0.02	0	0.04
10	Demand charitable services	0.16	0.28	0.25	0.1	-0.02	0.11	0.29	0.06	-0.02	0	-0.02	0.03
11	Physical health	0.17	0.29	0.27	0.12	-0.01	0.13	0.3	0.08	0	0.02	0	0.04
12	Mental health	0.13	0.25	0.23	0.07	-0.05	0.09	0.26	0.03	-0.04	-0.03	-0.04	0

Pearson's correlation analysis on ability to afford monthly food costs and food systems impacts

	Correlation with ability to afford food costs		
Impact	**Pearson (r)**	**p-value**	**number (n)**
General food unavailability	0.37	< 0.001	214
Preferred/cultural foods unavailability	0.28	< 0.001	207
Loss of employment	0.3	< 0.001	210
Inability to get to food markets/stores	0.4	< 0.001	212
Challenges of using food delivery services	0.28	< 0.001	212
Inability to grow and produce food	0.3	< 0.001	209
Increased consumption of highly processed foods	0.21	< 0.001	213
Loss of livelihood due to food supply chain disruption	0.31	< 0.001	208
Loss of livelihood due to loss of employees	0.22	0.001	208
Increased demand on charitable food services	0.28	< 0.001	209
Diminished physical health from ongoing lack of food	0.42	< 0.001	208
Diminished mental health from ongoing lack of food	0.4	< 0.001	208

Report Section: 4.4 Hazards and Future Impacts

Paired sample test comparing concerns about short-term and long-term impacts

					95% confidence interval	
Hazard	**Mean diff.**	**t-value**	**df**	**p-value**	**lower**	**upper**
Wildfires	-0.33	-4.32	205	< 0.001	-0.47	-0.18
Flooding	-0.17	-2.54	208	0.012	-0.31	-0.04
Drought	-0.27	-4.34	207	< 0.001	-0.4	-0.15
Air pollution	-0.36	-4.52	207	< 0.001	-0.52	-0.2
Loss of ecosystems	-0.23	-3.38	209	0.001	-0.37	-0.1
Soil contamination	-0.06	-0.84	208	0.402	-0.19	0.08
Water pollution	-0.28	-4.89	208	< 0.001	-0.39	-0.17
Future pandemics	-0.06	-0.8	205	0.424	-0.2	0.09
Economic downturn	0	-0.08	209	0.939	-0.13	0.12
Cost of living increase	0.02	0.41	209	0.683	-0.09	0.14
Population growth	-0.04	-0.57	208	0.569	-0.17	0.09
Population decline	-0.03	-0.44	206	0.663	-0.16	0.1
Civil war	-0.07	-1.15	205	0.25	-0.2	0.05
Invasion	-0.14	-2.2	208	0.029	-0.26	-0.01
Multiple shocks	0.05	0.82	209	0.415	-0.07	0.18

ANOVA comparing mean concerns-about-impacts scores for short- and long-term timeframes

Timeframe	Variation test	Sum of squares	df	Mean square	F-value	p-value
Short-term	Between groups	279.57	14	19.97	14.59	< 0.001
	Within groups	4,303.63	3,145	1.37		
	Total	4,583.20	3,159			
Long-term	Between groups	275.99	14	19.71	13.84	< 0.001
	Within groups	4479.57	3146	1.42		
	Total	4755.56	3160			

Tukey's test comparing concerns-about-impacts scores (mean difference = row ID - column ID)

Period	ID	Hazard	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Short-term	1	Wildfire	0	0.31	-0.14	-0.19	-0.08	-0.03	-0.03	0.07	0.25	0.6	0.13	-0.44	-0.48	-0.56	0.11
	2	Flooding	-0.31	0	-0.44	-0.5	-0.39	-0.34	-0.34	-0.24	-0.06	0.29	-0.18	-0.75	-0.79	-0.86	-0.2
	3	Drought	0.14	0.44	0	-0.06	0.06	0.1	0.11	0.2	0.39	0.73	0.26	-0.3	-0.34	-0.42	0.25
	4	Air	0.19	0.5	0.06	0	0.12	0.16	0.17	0.26	0.45	0.79	0.32	-0.25	-0.29	-0.36	0.3
	5	Wildlife	0.08	0.39	-0.06	-0.12	0	0.04	0.05	0.14	0.33	0.67	0.2	-0.36	-0.4	-0.48	0.19
	6	Soil	0.03	0.34	-0.1	-0.16	-0.04	0	0.01	0.1	0.29	0.63	0.16	-0.41	-0.45	-0.52	0.14
	7	Water	0.03	0.34	-0.11	-0.17	-0.05	-0.01	0	0.1	0.28	0.63	0.15	-0.41	-0.45	-0.53	0.14
	8	Pandemic	-0.07	0.24	-0.2	-0.26	-0.14	-0.1	-0.1	0	0.18	0.53	0.06	-0.51	-0.55	-0.62	0.04
	9	Economic	-0.25	0.06	-0.39	-0.45	-0.33	-0.29	-0.28	-0.18	0	0.35	-0.13	-0.69	-0.73	-0.81	-0.14
	10	Cost	-0.6	-0.29	-0.73	-0.79	-0.67	-0.63	-0.63	-0.53	-0.35	0	-0.47	-1.04	-1.08	-1.15	-0.49
	11	Growth	-0.13	0.18	-0.26	-0.32	-0.2	-0.16	-0.15	-0.06	0.13	0.47	0	-0.57	-0.61	-0.68	-0.02
	12	Exit	0.44	0.75	0.3	0.25	0.36	0.41	0.41	0.51	0.69	1.04	0.57	0	-0.04	-0.11	0.55
	13	War	0.48	0.79	0.34	0.29	0.4	0.45	0.45	0.55	0.73	1.08	0.61	0.04	0	-0.08	0.59
	14	Invasion	0.56	0.86	0.42	0.36	0.48	0.52	0.53	0.62	0.81	1.15	0.68	0.11	0.08	0	0.66
	15	Multiple	-0.11	0.2	-0.25	-0.3	-0.19	-0.14	-0.14	-0.04	0.14	0.49	0.02	-0.55	-0.59	-0.66	0
Long-term	1	Wildfire	0	0.17	-0.18	-0.16	-0.14	-0.3	-0.07	-0.19	-0.06	0.26	-0.16	-0.75	-0.73	-0.74	-0.27
	2	Flooding	-0.17	0	-0.35	-0.33	-0.31	-0.47	-0.24	-0.35	-0.23	0.09	-0.33	-0.92	-0.89	-0.91	-0.44
	3	Drought	0.18	0.35	0	0.02	0.04	-0.12	0.12	0	0.12	0.44	0.02	-0.57	-0.54	-0.56	-0.09
	4	Air	0.16	0.33	-0.02	0	0.02	-0.14	0.09	-0.03	0.1	0.42	0	-0.59	-0.57	-0.58	-0.11
	5	Wildlife	0.14	0.31	-0.04	-0.02	0	-0.16	0.08	-0.04	0.08	0.4	-0.02	-0.61	-0.58	-0.6	-0.13
	6	Soil	0.3	0.47	0.12	0.14	0.16	0	0.23	0.12	0.24	0.56	0.14	-0.45	-0.42	-0.44	0.03
	7	Water	0.07	0.24	-0.12	-0.09	-0.08	-0.23	0	-0.12	0.01	0.33	-0.09	-0.68	-0.66	-0.68	-0.2
	8	Pandemic	0.19	0.35	0	0.03	0.04	-0.12	0.12	0	0.12	0.44	0.02	-0.57	-0.54	-0.56	-0.08
	9	Economic	0.06	0.23	-0.12	-0.1	-0.08	-0.24	-0.01	-0.12	0	0.32	-0.1	-0.69	-0.66	-0.68	-0.21
	10	Cost	-0.26	-0.09	-0.44	-0.42	-0.4	-0.56	-0.33	-0.44	-0.32	0	-0.42	-1.01	-0.98	-1	-0.53
	11	Growth	0.16	0.33	-0.02	0	0.02	-0.14	0.09	-0.02	0.1	0.42	0	-0.59	-0.56	-0.58	-0.11
	12	Exit	0.75	0.92	0.57	0.59	0.61	0.45	0.68	0.57	0.69	1.01	0.59	0	0.03	0.01	0.48
	13	War	0.73	0.89	0.54	0.57	0.58	0.42	0.66	0.54	0.66	0.98	0.56	-0.03	0	-0.02	0.46
	14	Invasion	0.74	0.91	0.56	0.58	0.6	0.44	0.68	0.56	0.68	1	0.58	-0.01	0.02	0	0.47
	15	Multiple	0.27	0.44	0.09	0.11	0.13	-0.03	0.2	0.08	0.21	0.53	0.11	-0.48	-0.46	-0.47	0

Tukey's test comparing concerns-about-impacts scores (p-values)

Period	ID	Hazard	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Short-term	1	Wildfire	1	0.302	0.997	0.932	1	1	1	1	0.661	< 0.001	0.999	0.01	0.002	< 0.001	1
	2	Flooding	0.302	1	0.009	0.001	0.051	0.149	0.172	0.731	1	0.41	0.958	< 0.001	< 0.001	< 0.001	0.918
	3	Drought	0.997	0.009	1	1	1	1	1	0.906	0.049	< 0.001	0.588	0.324	0.152	0.02	0.698
	4	Air	0.932	0.001	1	1	0.999	0.987	0.982	0.599	0.008	< 0.001	0.24	0.689	0.438	0.098	0.328
	5	Wildlife	1	0.051	1	0.999	1	1	1	0.995	0.204	< 0.001	0.904	0.09	0.032	0.003	0.951
	6	Soil	1	0.149	1	0.987	1	1	1	1	0.432	< 0.001	0.986	0.028	0.008	< 0.001	0.995
	7	Water	1	0.172	1	0.982	1	1	1	1	0.474	< 0.001	0.991	0.024	0.007	< 0.001	0.997
	8	Pandemic	1	0.731	0.906	0.599	0.995	1	1	1	0.957	< 0.001	1	0.001	< 0.001	< 0.001	1
	9	Economic	0.661	1	0.049	0.008	0.204	0.432	0.474	0.957	1	0.14	0.999	< 0.001	< 0.001	< 0.001	0.996
	10	Cost	< 0.001	0.413	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.14	1	0.003	< 0.001	< 0.001	< 0.001	0.002
	11	Growth	0.999	0.958	0.588	0.24	0.904	0.986	0.991	1	0.999	0	1	< 0.001	< 0.001	< 0.001	1
	12	Exit	0.01	< 0.001	0.324	0.689	0.09	0.028	0.024	0.001	< 0.001	< 0.001	< 0.001	1	1	1	< 0.001
	13	War	0.002	< 0.001	0.152	0.438	0.032	0.008	0.007	< 0.001	< 0.001	< 0.001	< 0.001	1	1	1	< 0.001
	14	Invasion	< 0.001	< 0.001	0.02	0.098	0.003	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	1	1	1	< 0.001
	15	Multiple	1	0.918	0.698	0.328	0.951	0.995	0.997	1	0.996	0	1	< 0.001	< 0.001	< 0.001	1
Short-term	1	Wildfire	1	0.984	0.962	0.989	0.996	0.37	1	0.958	1	0.66	0.987	< 0.001	< 0.001	< 0.001	0.579
	2	Flooding	0.984	1	0.143	0.233	0.314	0.005	0.777	0.136	0.81	1	0.224	< 0.001	< 0.001	< 0.001	0.014
	3	Drought	0.962	0.143	1	1	1	1	1	1	0.999	0.01	1	< 0.001	< 0.001	< 0.001	1
	4	Air	0.989	0.233	1	1	1	0.997	1	1	1	0.03	1	< 0.001	< 0.001	< 0.001	1
	5	Wildlife	0.996	0.314	1	1	1	0.99	1	1	1	0.04	1	< 0.001	< 0.001	< 0.001	0.999
	6	Soil	0.37	0.005	1	0.997	0.99	1	0.788	1	0.75	< 0.001	0.997	0.009	0.023	0.013	1
	7	Water	1	0.777	1	1	1	0.788	1	1	1	0.24	1	< 0.001	< 0.001	< 0.001	0.923
	8	Pandemic	0.958	0.136	1	1	1	1	1	1	0.999	0.01	1	< 0.001	< 0.001	< 0.001	1
	9	Economic	1	0.81	0.999	1	1	0.75	1	0.999	1	0.27	1	< 0.001	< 0.001	< 0.001	0.902
	10	Cost	0.663	1	0.012	0.026	0.041	< 0.001	0.243	0.012	0.273	1	0.024	< 0.001	< 0.001	< 0.001	0.001
	11	Growth	0.987	0.224	1	1	1	0.997	1	1	1	0.02	1	< 0.001	< 0.001	< 0.001	1
	12	Exit	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.009	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	1	1	1	0.003
	13	War	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.023	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	1	1	1	0.008
	14	Invasion	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.013	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	1	1	1	0.004
	15	Multiple	0.579	0.014	1	1	0.999	1	0.923	1	0.902	0	1	0.003	0.008	0.004	1

Report Section: 4.5 Geographic Differences

ANOVA comparing impacts among south and north Metro Vancouver and the Fraser Valley

Impact	Variation test	Sum of squares	df	Mean square	F	p
Food unavailability	Between groups	0.43	2	0.21	0.15	0.864
	Within groups	295.9	204	1.45		
Cultural foods	Between groups	2.92	2	1.46	0.96	0.384
	Within groups	308.28	203	1.52		
Loss employment	Between groups	5.91	2	2.96	1.57	0.211
	Within groups	388.49	206	1.89		
Inability access markets	Between groups	1.95	2	0.98	0.6	0.548
	Within groups	336.24	208	1.62		
Challenges with delivery	Between groups	5.31	2	2.66	1.55	0.214
	Within groups	355.82	208	1.71		
Inability grow food	Between groups	3.89	2	1.94	1.04	0.354
	Within groups	381.94	205	1.86		
Highly processed foods	Between groups	0.75	2	0.38	0.23	0.793
	Within groups	338.96	209	1.62		
Livelihood and supply chain	Between groups	2.62	2	1.31	0.72	0.488
	Within groups	371.38	204	1.82		
Livelihood and employees	Between groups	5.02	2	2.51	1.43	0.241
	Within groups	357.07	204	1.75		
Demand charitable services	Between groups	2.8	2	1.4	0.77	0.463
	Within groups	371.08	205	1.81		
Physical health	Between groups	5.85	2	2.92	1.61	0.202
	Within groups	370.42	204	1.82		
Mental health	Between groups	3.27	2	1.63	0.96	0.386
	Within groups	349.09	204	1.71		

ANOVA comparing concerns among south and north Metro Vancouver and the Fraser Valley

Period	Hazard	Variation test	Sum of squares	df	Mean square	F	p
Short-term	Wildfire	Between groups	4.64	2	2.32	1.79	0.169
		Within groups	268.02	207	1.29		
	Flooding	Between groups	10.56	2	5.28	4.31	0.015
		Within groups	253.93	207	1.23		
	Drought	Between groups	3.82	2	1.91	1.16	0.317
		Within groups	339.91	206	1.65		
	Air	Between groups	0.44	2	0.22	0.16	0.85
		Within groups	283.82	207	1.37		
	Wildlife	Between groups	2.84	2	1.42	1.08	0.341
		Within groups	273.34	208	1.31		
	Soil	Between groups	3	2	1.5	1.1	0.334
		Within groups	282.79	208	1.36		
	Water	Between groups	0.95	2	0.47	0.37	0.691
		Within groups	264.75	207	1.28		
	Pandemic	Between groups	9.81	2	4.91	3.91	0.022
		Within groups	255.91	204	1.25		
	Economic	Between groups	6.16	2	3.08	3.24	0.041
		Within groups	196.96	207	0.95		
	Cost	Between groups	3.39	2	1.69	1.74	0.178
		Within groups	201.4	207	0.97		
	Growth	Between groups	0.46	2	0.23	0.21	0.809
		Within groups	223.87	208	1.08		
	Exit	Between groups	1.43	2	0.71	0.52	0.595
		Within groups	283.04	206	1.37		
	War	Between groups	8.25	2	4.13	2.27	0.106
		Within groups	372.83	205	1.82		
	Invasion	Between groups	2.44	2	1.22	0.61	0.542
		Within groups	409.07	206	1.99		
	Multiple	Between groups	8.36	2	4.18	2.78	0.064
		Within groups	311.34	207	1.5		
Long-term	Wildfire	Between groups	2.29	2	1.15	0.78	0.461
		Within groups	300.36	204	1.47		
	Flooding	Between groups	2.69	2	1.35	1.15	0.32
		Within groups	244.46	208	1.18		
	Drought	Between groups	1.44	2	0.72	0.47	0.628
		Within groups	318.76	207	1.54		
	Air	Between groups	0.11	2	0.05	0.04	0.962
		Within groups	288.35	207	1.39		
	Wildlife	Between groups	2.45	2	1.22	0.98	0.378
		Within groups	260.29	208	1.25		
	Soil	Between groups	1.42	2	0.71	0.52	0.597
		Within groups	284.5	207	1.37		
	Water	Between groups	0.91	2	0.46	0.39	0.681
		Within groups	246.39	208	1.18		
	Pandemic	Between groups	13.15	2	6.57	4.86	0.009
		Within groups	278.9	206	1.35		
	Economic	Between groups	7.82	2	3.91	3.59	0.029
		Within groups	227.48	209	1.09		
	Cost	Between groups	4.64	2	2.32	2.14	0.12
		Within groups	225.46	208	1.08		
	Growth	Between groups	0.77	2	0.38	0.27	0.763
		Within groups	291.45	206	1.41		
	Exit	Between groups	0.45	2	0.22	0.15	0.864
		Within groups	314.44	206	1.53		
	War	Between groups	8.73	2	4.37	2.33	0.1
		Within groups	382.03	204	1.87		
	Invasion	Between groups	6.23	2	3.12	1.58	0.209
		Within groups	406.66	206	1.97		
	Multiple	Between groups	6.25	2	3.12	1.92	0.15
		Within groups	337.27	207	1.63		

Tukey's post-hoc test on statistical significant comparisons among regions

Period	Hazard	Region A	Region B	Mean difference (A - B)	Std. error	p	95% confidence interval bounds	
							Lower	Upper
Short-term	Flooding	South MV	Fraser V.	-0.52	0.18	0.014	-0.95	-0.09
			North MV	-0.36	0.19	0.138	-0.8	0.08
		Fraser V.	South MV	0.52	0.18	0.014	0.09	0.95
			North MV	0.16	0.2	0.702	-0.31	0.63
		North MV	South MV	0.36	0.19	0.138	-0.08	0.8
			Fraser V.	-0.16	0.2	0.702	-0.63	0.31
Short-term	Pandemics	South MV	Fraser V.	0.01	0.19	0.998	-0.43	0.45
			North MV	-0.47	0.19	0.035	-0.92	-0.03
		Fraser V.	South MV	-0.01	0.19	0.998	-0.45	0.43
			North MV	-0.48	0.2	0.045	-0.96	-0.01
		North MV	South MV	0.47	0.19	0.035	0.03	0.92
			Fraser V.	0.48	0.2	0.045	0.01	0.96
Long-term	Pandemics	South MV	Fraser V.	-0.16	0.19	0.687	-0.61	0.3
			North MV	-0.6	0.2	0.007	-1.07	-0.14
		Fraser V.	South MV	0.16	0.19	0.687	-0.3	0.61
			North MV	-0.44	0.21	0.088	-0.94	0.05
		North MV	South MV	0.6	0.2	0.007	0.14	1.07
			Fraser V.	0.44	0.21	0.088	-0.05	0.94
Long-term	Economic downturn	South MV	Fraser V.	-0.13	0.17	0.738	-0.53	0.28
			North MV	-0.46	0.18	0.024	-0.88	-0.05
		Fraser V.	South MV	0.13	0.17	0.738	-0.28	0.53
			North MV	-0.34	0.19	0.167	-0.78	0.1
		North MV	South MV	0.46	0.18	0.024	0.05	0.88
			Fraser V.	0.34	0.19	0.167	-0.1	0.78

Report Section: 4.6 Underlying Factors

Factor analysis on food systems impacts data (bold indicates a factor association)

	Factor		
Impact	**1**	**2**	**3**
General food unavailability	**0.76**	0.34	0.46
Preferred/cultural foods unavailability	**0.86**	0.26	0.47
Loss of employment	0.61	0.31	**0.9**
Inability to get to food markets/stores	**0.85**	0.43	0.49
Challenges of using food delivery services	**0.88**	0.49	0.29
Inability to grow and produce food	**0.97**	0.48	0.38
Increased consumption of highly processed foods	**0.66**	0.3	0.36
Loss of livelihood due to food supply chain disruption	0.56	0.61	**0.92**
Loss of livelihood due to loss of employees	0.53	0.64	**0.76**
Increased demand on charitable food services	**0.7**	0.61	0.49
Diminished physical health from ongoing lack of food	0.49	**1.23**	0.35
Diminished mental health from ongoing lack of food	0.46	**0.8**	0.58

Factor analysis on short-term impacts concerns data (bold indicates a factor association)

	Factor			
Hazard	**1**	**2**	**3**	**4**
Wildfires	**0.85**	0.13	0.3	0.18
Flooding	**0.57**	0.07	0.46	0.38
Drought	**0.64**	0.24	0.27	0.57
Air pollution	**0.72**	0.41	0.2	0.32
Loss of ecosystems	**0.72**	0.27	0.14	0.42
Soil contamination	0.45	0.18	0.21	**0.86**
Water pollution	0.39	0.22	0.23	**0.87**
Future pandemics	**0.45**	**0.44**	0.4	0.2
Economic downturn	0.25	0.19	**0.63**	0.19
Cost of living increase	0.18	0.09	**0.77**	0.12
Population growth	0.11	0.3	**0.45**	0.39
Population decline	0.1	**0.7**	0.16	0.39
Civil war	0.28	**1.14**	0.18	0.1
Invasion	0.25	**1.25**	0.2	0.17
Multiple shocks	0.28	**0.6**	**0.6**	0.07

Factor analysis on long-term impacts concerns data (bold indicates a factor association)

	Factor		
Hazard	**1**	**2**	**3**
Wildfires	**0.8**	0.13	0.39
Flooding	**0.77**	0.09	0.38
Drought	**0.84**	0.19	0.22
Air pollution	**0.87**	0.23	0.25
Loss of ecosystems	**0.83**	0.26	0.27
Soil contamination	**0.9**	0.29	0.23
Water pollution	**0.82**	0.35	0.17
Future pandemics	0.45	0.27	**0.5**
Economic downturn	0.27	0.17	**0.8**
Cost of living increase	0.21	0.09	**0.82**
Population growth	0.38	0.35	**0.66**
Population decline	0.18	**0.79**	0.24
Civil war	0.33	**1.18**	0.21
Invasion	0.32	**1.28**	0.18
Multiple shocks	0.4	0.57	**0.63**