Supporting UBC Campus Landscapes and Food Systems during Extreme Weather Events

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SEEDS Sustainability Program

Land Acknowledgement

We are deeply grateful to work, play and learn at the University of British Columbia Vancouver Campus, located on the traditional, ancestral and unceded territories of the xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish), and səlilwətaɬ (Tsleil-Waututh) Nations. We raise our hands in thanks to the many people who have stewarded this land since time immemorial and acknowledge our shared positions as visitors on this land from diverse backgrounds.

The field work, research and interviews presented in this project were conducted on these lands. The results from our project include suggestions and practices that were introduced to this land through the ongoing process of colonialism. It is important to acknowledge the historical and ongoing impacts of agriculture on Indigenous communities and foodways and its role as a tool of colonization. The land that UBCV occupies was and continues to be significant to the Musqueam, Squamish and Tsleil-Waututh Nations and remains an integral part of their food system. We hope that our project can support UBC SEEDS, the UBC Botanical Garden and the University Neighborhood Association's ongoing reconciliation efforts.

Practitioners' Summary

UBC Foodscapes During Extreme Weather Events

Research Background

- Extreme weather events continue to increase due to climate change. It is essential to examine effective management strategies for mitigating the negative impacts of these events on gardens and share this information with food growers across campus
- Our local gardens and food landscapes are crucial components in fostering sustainable food systems and strengthening local community connections and resilience

Project Purpose

- Improving local food system resilience against extreme weather by enhancing community gardens' climate adaptation at UBC

Project Goals

1. Enrich our understanding of how to build resilience to extreme weather events
2. Develop community-based resources and practical tools for use by gardeners
3. Enhance the collaboration and communication between garden sites

Project Objectives

- Conduct a literature review of the primary extreme weather events
- Collect field data on microclimate conditions at UBC Vancouver Campus gardens
- Gain insight into challenges faced by extreme weather events from campus food growers and garden owners
- Create a guide to support gardeners in increasing preparedness and resilience in the case of extreme weather events

Methods

Literature Review
On the policies and practices of climate resilience

Focus-Group Interview
with gardner managers and gardners

Data Collection
On site surveying throughout a two-week period

Deliverables

UBC Climate Ready Plan/Toolkit

- Audit of four garden microclimates.
- List of extreme weather events that UBC food systems are at risk of and their potential impacts on their food systems.
- Management plan for building resilience to and managing the impacts of extreme weather events

Key Findings

- Knowledge Sharing
- Institutional Support
- Site-Specifc Climate Info
- Community Resilience

Executive Summary

Unsustainable human activities are intensifying the effects of global warming through the emission of greenhouse gasses (GHG). These GHG emissions have caused the global surface temperature to increase by 1.1°C between 2011-2020 compared to the temperature between 1850-1900 (IPCC, 2023). The Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) emphasizes with high confidence that human-caused climate change greatly influences extreme climate and weather across the globe. Extreme weather events cause losses and damage to nature and people, leading to consequences such as decreased food and water security (IPCC, 2023). With a growing global population placing increasing pressure on agricultural systems to maximize production, measures must be taken to reduce the risk imposed by extreme climate and weather. We need to prioritize mitigation and adaptation strategies (Fróna et.al., 2019; City of Vancouver, 2012; 2020).

Localizing food production can help support community food security and literacy (Ziervogel & Ericksen, 2010). Consequently, the purpose of our research was to identify strategies to increase the climate resiliency of food systems and landscapes at the UBC Vancouver Campus. This was accomplished through a literature review, field research on the microclimates of four garden sites and group interviews with gardeners and garden managers. The previous iteration of this project identified climate-resilient food plants suitable for growth to support climate-ready food gardens at the UBC Vancouver campus (McLeod et al., 2023). We expanded on this project by addressing the knowledge gap regarding management strategies focused on the impacts of extreme weather events. Specifically, we addressed the events of heat domes, cold snaps, high winds and flooding. Our research expanded past food-plant production to include the broader ecosystem, microclimate, and community aspects.

Our literature review focused on how extreme weather events affected food availability in Metro Vancouver, British Columbia, with emphasis on the significance of food sovereignty. Gillett and colleagues (2022) define food sovereignty as a concept that stresses the importance of everyone having the right to healthy and locally suitable food that is produced in an environmentally friendly way. The review of policy documents and peer-reviewed sources revealed significant gaps in policy, in particular that UBC is lacking a specific strategy to address extreme weather events for campus food growing activities. It was suggested that bringing communities together and allowing them to be more involved in planning and managing local gardens, will help improve resilience to extreme weather and reduce food insecurity (Drolet, 2011). Sohail and Chen (2022) emphasize the importance of gathering detailed climate data to improve the current understanding of extreme weather to better overcome challenges presented by them.

Using the principles of Community-Based Action Research (CBAR), our research and recommendations prioritized the inclusion of key stakeholders and community members in every stage of the research process focusing on identifying and bolstering the existing strengths within the community (Gullion & Tilton, 2020). We recommend that UBC Campus and Community Planning along with our clients, the UNA and Botanical garden, distribute our toolkit to campus food growers. We also propose the development of an in-person campus food garden networking opportunity through workshops to improve communication and share knowledge between campus food growers to increase community resilience to managing the impacts of extreme weather events. We recommend that future SEEDS delves deeper into prolonged microclimate assessments of more campus locations, looking into plant breeding to breed more climate-ready crops, and extending research regarding our campus food gardens and their future regarding managing more severe and often extreme weather events.

A UBC Climate-Ready Toolkit (Appendix D) was developed based on findings from our research in addition to a publication of this report to the UBC SEEDS library. This UBC Climate Ready Toolkit contains an audit of four garden site microclimates and a framework on how to collect microclimate data, information on the potential impacts of extreme weather events on UBC gardens and a management plan to build local resilience to extreme weather events.

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List of Abbreviations

AG - Agronomy Garden
BC - British Columbia
BG - UBC Botanical Garden
CAP 2030 - Climate Action Plan 2030
CBAR - Climate-Based Action Research
GHG - Greenhouse gasses
IPCC - Intergovernmental Panel on Climate Change
ROTR - Roots on the Roof
SEEDS - Social Ecological Economic Development Studies
SRI - Sustainable Region Initiative
TF - Totem Field
UBC - University of British Columbia
UNA - University Neighborhoods Association garden

1. Introduction

1.1 Research Topic

Human activity is the main driver of global climate change which is a direct cause of meeting demands from the human population's need for energy, food, infrastructure, services, and waste disposal areas (Owrangi et al., 2014). Climate change has increased vulnerability in many low-lying coastal, river delta megacities, already stressed by rapid population growth and other economic, social, and health factors (Owrangi et. al., 2014). Metro Vancouver where UBC lies fits this description and has been impacted quite severely and randomly by extreme weather events (Gillet et al., 2022). The threat of rising sea levels (Arkema et al., 2013) as well as more intense and less predictable extreme storm surges makes the coastal city of Metro Vancouver more vulnerable to these adverse conditions (Owrangi et al., 2014). Additionally, the IPCC identifies in their Sixth Assessment Report that climate change has reduced food security due to the greater frequency and intensity of climate extreme events (IPCC, 2023). UBC's 2030 Climate Action Plan explicitly recognizes the unsustainable nature of UBC's food systems, highlighting the need to mitigate greenhouse gas emissions linked to the campus food system (UBC Campus and Community Planning, 2021). Extreme weather events can have specific effects on food systems ranging from direct impacts on crop production (e.g., changes in rainfall resulting in drought or flooding, and/or heat domes and cold spells resulting in changes in the length of the growing season) to food price and supply chain infrastructure changes (Rahman et al., 2022).

Our research focuses on developing strategies to increase the climate resiliency of food systems and landscapes from extreme weather events at the UBC Campus and the broader Vancouver region. The extreme weather events of interest are heat domes, cold spells, extreme winds, and flooding. Food sovereignty, which encompasses prioritizing local agricultural production to feed people and allowing populations to take part in agricultural policy choices, is identified as an important consideration when developing agricultural land-use and management policies that are more resilient to the impacts of climate change (Grey & Patel, 2015; Taylor, 2013; Morrison, 2011). This research will draw concepts of food sovereignty and food security when looking at the roles of current and future local food gardens, as well as highlighting their importance in our campus communities, emphasizing the need to build resilience towards extreme weather events in a changing climate.

Thus, this paper aims to identify the most prominent issues from extreme weather events faced by campus gardens to determine their potential to grow into more resilient, adaptable, sovereign, and sustainable food systems that can withstand unpredictable extreme weather events.

1.2 Research Relevance

With a rapidly growing population and the uncertain threats from climate change, adapting our current agricultural systems to feed the global community is of utmost importance. In recent years, we have seen increasing urbanization and development of arable lands as well as the degradation of agricultural landscapes due to unsustainable agricultural practices (Eigenbrod & Gruda, 2015). It is estimated that by 2030, around 70% of the world's population will live in cities which will increase demand for urban infrastructure development and sources of food within urban centres. It is also estimated that agricultural practices and overgrazing account for over 60% of global soil erosion and loss of arable land (Eigenbrod & Gruda, 2015).

In addition to these challenges, instances of extreme weather events, amplified by the effects of climate change impact agricultural production, cause supply chain disruptions and decrease productivity (Barclays, 2023). Notably, the economic costs caused by extreme weather events such as unusual temperatures, droughts, high precipitation and snow have increased nearly eight times globally since 1970 (Barclays, 2023). There is increasing concern surrounding how to feed our growing global population in the face of unpredictable and volatile climate events (Fróna et al., 2019). Agricultural production is increasingly distanced from local food systems which can contribute to food insecurity, with disproportionate impacts on poorer communities or developing countries (Ziervogel & Ericksen, 2010). Ziervogel and Ericksen (2010) highlight that these impacts extend beyond agricultural output to affect food accessibility, utilization, and stability; they can damage infrastructure, limiting access to food, especially in rapidly urbanizing areas.

In acknowledgement of the urgency to update current practices, leading institutions, like UBC, have taken the initiative toward creating goals within their campus that increase sustainability practices that align with their policies related to campus planning, resource usage, and emergency response (UBC Campus & Community Planning, 2023). Specifically, action plans such as Climate Action Plan 2030, Zero Waste Action

Plan, Neighborhood Action Plan, etc., have been created with the overall goal of significantly reducing greenhouse gas emissions on campus and in our neighborhoods (UBC Campus & Community Planning, 2023). Additionally, Metro Vancouver has formally centralized the concept of sustainability towards the city's operation and land-use planning philosophy known as the Sustainable Region Initiative (SRI) (Metro Vancouver, 2023). Within this endeavour, their vision included focusing on food systems, ecological health, and climate change (Metro Vancouver, 2023).

Our project at the UBC Vancouver campus will aid campus community gardens in becoming more climate resilient in the face of challenges such as heat domes, cold snaps, flooding or high winds. By studying the microclimates of different garden sites and the effects of extreme weather on UBC's community gardens, our project will address some of UBC's CAP 2030 targets, focus areas, and actions, specifically in the realm of food systems which is considered a main theme to be addressed in their report. CAP 2030 aims to achieve a 50% GHG emission reduction of food systems, and our research can help advance research amd improve strategies on resource management and community preparedness against climate challenges (UBC Sustainability, 2023).

Our research outcomes provide UBC's gardens and food landscapes on the UBC Vancouver campus with improved and refined solutions to cope with the impacts of extreme weather events. Moreover, our research can be beneficial to gardens across Vancouver that face similar challenges from extreme weather events and that have similar microclimates. Our research will allow the campus community and beyond to gain insight into implementing effective methods of dealing with extreme weather events such as heat domes, cold snaps, floods, and extreme winds. It is anticipated that the long-term benefits from our research will be that campus gardens, which serve as the core local produce providers to many campus residents and campus food institutions, will be better equipped to protect sustainable food spaces and continue to help reduce food insecurity and increase food sovereignty.

1.3 Project context

Our project took place at the UBC Vancouver campus in collaboration with student-led community gardens, the UBC Botanical Garden, the University Neighborhood Association (UNA) gardens, and the UBC SEEDS team. The UNA is an organization which oversees the major residential neighbourhoods on UBC Vancouver's campus and is responsible for managing infrastructure, public concerns and resident access to UBC facilities (University Neighborhoods Association, 2023). Furthermore, the UBC Botanical Garden was founded with the goal of research into native British Columbia (BC) flora, but has since expanded to include focuses on education, conservation, community outreach and public display of non-native plants (UBC Botanical Garden, 2019). All of these gardens are situated on lands which have been stewarded by the xʷməθkʷəy̓əm (Musqueam) First Nation since time immemorial.

UBC has fifteen campus garden landscapes (Obedkoff, 2020). Our research focused on Roots on the Roof, Agronomy Garden, UNA Greenway South, and Botanical Garden. The student-led Roots on the Roof and Agronomy Garden are both variable in their goals, production levels, locations and management. These gardens utilize a communal-plot garden model where individuals do not own certain plots and the community cares for the garden as a collective (UBC Sustainability, n. d.). The food grown in these student gardens have been imperative in assisting campus food security initiatives such as UBC Sprouts, Agora Café, and even the UBC food bank (Obedkoff, 2020). Next, the UNA has five garden sites: Hawthorn Garden, Rhodo Garden, Nobel Garden, and the two Greenway Gardens. These five sites count for 230 plots cumulatively (University Neighborhoods Association, 2023). UNA garden plots are managed using a rental system where individual residents are assigned a single plot for their care (University Neighborhoods Association, 2023). Finally, the UBC Botanical Garden has a food garden where they grow an array of produce and harvest throughout June to October known as the Healthy Harvest program (UBC Botanical Garden, 2019). This produce is delivered to food groups on campus like the Alma Mater Society (AMS) Food Bank (UBC Botanical Garden, 2019). Hired gardeners and horticulturalists, student work-learns, and volunteers take care of the botanical food garden (UBC Botanical Garden, 2019).

In recent years, the UBC Vancouver community has endured the recurring impacts of unpredictable extreme weather events, including heat domes, cold snaps, flooding, and extreme wind, causing disruptions to class and work schedules, the health and well-being of local people, and physical damages (Government of Canada, 2022; Ruttle, 2024). These weather events are unusual for our region, making navigating the negative impacts of these events difficult due to under-preparedness or lack of resource access. However, it is also valuable to consider that while unusual, at the same time extreme weather events in the region are becoming more frequent and more normalized.

In 2023, a project was conducted on investigating and developing strategies that ensure campus gardens can become more "climate-ready". Specifically, they aimed to determine climate-resilient food plants suitable for growth at the UBC Vancouver campus and generated a climate-ready food garden management plan and a research report on supporting climate-ready food gardens (McLeod et al., 2023). The project focused on navigating food production challenges regarding crop yield and growth in a changing climate while promoting community resilience (McLeod et al., 2023). We identified that the previous project lacked recommendations for management strategies in extreme weather events, thus our project explores this knowledge gap and will further build up this work. This focus was decided on with the clients and SEEDS team, both of whom were heavily consulted during our research timeline. Through our secondary research and primary data collection, we identified challenges faced by UBC growers related to extreme weather events, and expanded beyond food-plant production to the broader ecosystem, microclimate and community.

1.4 Project Purpose, Goals & Objectives

The purpose of our project was to develop strategies that can increase the climate resiliency of food systems and landscapes at the UBC Campus and the broader Vancouver region. Our three primary goals were to enrich our understanding of how to build resilience to extreme weather events through increased knowledge of microclimates and growing practices at the UBC Vancouver campus, to develop community-based resources and practical tools for use by gardeners to increase the climate resiliency of garden sites during extreme weather events, and to enhance the collaboration and communication between different garden sites to foster

community resilience and effective resource sharing. To address our research goals successfully, we created the following four objectives:

(1) Conduct a literature review of the primary extreme weather events (flood, cold spell, heat dome, and extreme winds) at the UBC Vancouver Campus;

(2) Collect field data on microclimate conditions at UBC Vancouver Campus gardens to study the land, water, soil, and climate management and provide recommendations to increase resilience to extreme weather events;

(3) Gain insight into challenges faced by extreme weather events from campus food growers and garden owners through a focus group; and

(4) Triangulate data and research to create a guide to support gardeners in increasing preparedness and resilience in the case of extreme weather events and in turn, strengthen the communication network between campus-wide gardens and food security initiatives.

2. Methodology and Methods

2.1 Research Methodology

The research performed in this project was informed by and adhered to the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (Panel on Research Ethics, 2022), and a signed consent form was acquired from each interview participant (Appendix B.1). The research methodology used in this study is the Community-Based Action Research (CBAR). CBAR refers to collaborative research on a specific problem or issue that is grounded within a geographically bounded community to develop interventions and assess outcomes (Gullion & Tilton, 2020). This type of research prioritizes including key stakeholders and community members in every stage of the research process (Pain et al, 2019). We applied this approach by directly collaborating with affected community members by extreme weather events and centering our research and work around their concerns expressed through our interviews. The methodology aims to encourage active participation from all stakeholders throughout the research process. This way, practical community concerns can be addressed through the process of conducting experiments and analyzing data to

obtain knowledge, as well as reflecting on one's own experiences and actions. CBAR likewise facilitates the use of local knowledge and practices in the development of effective, context-specific adaptation and mitigation strategies for urban agriculture under climate challenges. While conducting our research, we practiced CBAR methods by prioritizing interactions with and feedback from food growers and garden managers at the UBC Vancouver campus gardens. We aim to amplify their voices and concerns through our project and highlight the areas in which the community's strengths can be utilized to their fullest. Through our research, we hope to combine empirical data collection with community feedback and shared knowledge to co-create solutions that will improve resilience and sustainability in urban garden settings.

2.2 Research Methods

Research was conducted through various methods of primary and secondary data collections. Primary data was gathered through group interviews and field data collection. Secondary data was collected through literature reviews and historical microclimate data from Totem Field.

Our secondary data from literature reviews focused on climate and weather challenges within Metro Vancouver, gaps in policy related to food systems and local food production, and promising areas where policy can be created and implemented using the CBAR method to emphasize the strengths of active community members and centers Indigenous voices. The historical microclimate data from the Totem Field at UBC was used as a comparison for our microclimate data and to identify trends in microclimate changes. This data is crucial to understanding the ecosystem behaviour and health in these gardens and how they've changed over time which is key when looking into increasing climate resilience.

For primary data collection, the group interviews aimed to gather information on how extreme weather events have affected UBC campus gardens, to learn about management strategies currently being used to mitigate their negative impacts, and to gain feedback on what resources gardeners need going forward. Next, the field data collected helped us understand how the four gardens' microclimates varied and how the effects of extreme weather events might be impacting them in a quantitative way. We used this data and analyzed it with our control data from Totem Field. This data is important to the garden environment when it comes to sustainability management and resilience to climate change and extreme weather events.

2.2.1 Secondary Data Collection Research Methods:

Our secondary data includes microclimate data to cross-reference as needed from the Totem Field on UBC Campus which was retrieved from the Totem Field Micrometeorology Group's ongoing project data set. This data has been measuring meteorological observations including air temperature, humidity, precipitation, soil temperatures, solar irradiance, and wind since 1957 (Department of Geography, UBC, 2024). Secondary data was also sourced through review of literature and policy on climate change, urban gardening, and adaptation to extreme weather events in Canada and British Columbia. Our literature review began with larger context on climate change, extreme weather events and the role of community gardens in local food systems. Information was sourced from scholarly journal publications and government publications using the UBC library and Google Scholar databases. The research approach involved a search on the UBC Library and Google Scholar using keywords such as "flooding," "climate change," "agricultural practices," "food sovereignty," and "Indigenous knowledge" to find relevant academic journals and government policy reports.

This review helped establish a theoretical framework for the study, identify gaps in current research, and understand the broader policy environment that is impacting urban gardens. Further, a special attention was given to local environmental policies and historical climate challenges and promising practices grown from these challenges in Vancouver to strongly match the project within the regulatory landscape.

2.2.2 Primary Data Collection Research Methods:

Microclimate Surveys

Field data was collected at 11:00 am on six different days across two weeks (March 13th, 2024 - March 26th, 2024). Soil samples were collected the first four of the six days. Data was collected from four garden sites: the Agronomy Garden (AG), Roots on the Roof (ROTR), the UBC Botanical Garden (BG), and the UNA Greenway South garden (UNA). Data collected from these gardens included soil and air temperature, along with wind speed. Each group member was assigned one garden site and collected all data from that site.

Before conducting microclimate surveys, qualitative data was collected on the gardens' topography, canopy cover, garden bed type and surrounding environment. Soil samples were collected at 10 cm of depth, and stored in sealed plastic bags that were kept in a dark and cool room until they were analyzed for moisture

and pH in the lab (Appendix C.1; C.2). Samples were taken at each garden site from different areas of the same garden bed. Soil temperature was collected using thermometers which were fully inserted into the soil and left until the temperature remained consistent. Air temperatures and wind speeds were collected by imputing the coordinates of our current location on our Iphones to track air temperature and wind speed.

Interviews

The sample group of participants selected for these interviews included managers and long-term volunteers from the four garden sites used for microclimate assessments. These participants were selected due to their high level of experience and knowledge of these garden sites to ensure that the data points that we collected were relevant and significant insights from the community gardeners around campus. We interviewed 5 gardeners across three interview sessions. Our interview data collection was guided using scripted questions on the gardeners' experience with extreme weather events, garden management strategies and required resources. Questions created were open-ended yet directed and provided an opportunity for participants to share their personal insights to the discussion (Appendix B.3). The interview script was developed to guide discussions and ensure consistency across sessions. All interview data was recorded via typed notes (Appendix B.4).

This mixed-methods approach was chosen to facilitate the integration of objective microclimate data with subjective experiential insights from managers and gardeners. This way, the understanding of how environmental conditions and community responses interact can be much improved. All research activities were conducted following ethical guidelines of the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans, with approval obtained from the garden managers (Panel on Research Ethics, 2022). Participants provided informed consent to ensure that they were fully aware of the study's scope and their rights within it.

2.3 Methods of Administration

Interviews

Interviews were conducted in March. The interviews were scheduled at convenient times for participants over Zoom for better accessibility. We hosted three group interviews with five total gardeners and garden managers from the four surveyed garden sites. The selection aimed to represent diverse experiences with varying garden microclimates and management practices. The managers from Agronomy Garden and Roots on the Roof were interviewed together, one manager and one participant from UNA Gardens were interviewed together and one manager from the UBC Botanical Garden was interviewed separately. While guided by a script, we asked follow-up questions depending on gardener responses where we felt we needed more explanation or information. We also endeavoured to create a space where the participants felt safe to speak freely on any topic without judgement. The interviews were conducted over Zoom and lasted approximately an hour. We asked questions that fell into three broad categories: (1) Context on what extreme weather events were relevant to each garden site, (2) Current management practices and (3) What resources gardeners need to improve their gardens' climate resiliency (Appendix B.3). Interview data was analyzed by grouping similar data from the aforementioned categories into more easily understandable figures.

3. Results

3.1 Primary Data

3.1.1 Garden Site Observations

Through our garden site observations, we identified four key categories of information to gather on the garden sites. These categories are as follows: (1) Topography, (2) Canopy cover, (3) Garden bed style and (4) Surrounding environment (Table 1). These categories were chosen as they have strong implications on the microclimate of the garden and influence factors such as water drainage, shade coverage and wind protection. The qualitative observations revealed nuanced, but also distinct characteristics. Similar trends can be observed amongst the four gardens regarding topography and garden bed style (Table 1). They are all on relatively flat to flat landscapes with a raised bed gardening style, with the exception of the Botanical garden that also uses ground beds. In contrast, UNA Greenway South has distinctly higher canopy coverage at 45% compared to the

other three gardens. The surrounding environment was quite consistent amongst all but Roots on the Roof that was notably unique in its location on a concrete roof with few surrounding juvenile trees.

Table 1. Qualitative observations from the four sampled garden sites at UBC, Vancouver sampled on March 14th, 2024 at 11:00 am.

Garden	Topography	Canopy cover (%)	Garden bed style	Surrounding environment
Agronomy Garden	Relatively flat	5%	Raised beds	Large trees, buildings, shrubbery, road, sidewalk
Roots on the Roof	Flat	2%	Raised beds	Concrete roof, some juvenile trees
Botanical Garden	Relatively flat, in a dip	0%	Raised beds, ground beds	Large trees and built structures, walking paths
UNA Greenway South	Relatively flat	45%	Raised beds	Large trees, buildings, road

3.1.2 Field Data

Through our microclimate assessments, we collected six data points per garden site on air and soil temperature, wind speed, and four data points per garden site on soil moisture and soil pH. Data analysis on wind speed revealed that Roots on the Roof garden experienced the highest average wind speeds of 9.57 km/hr while the other gardens averaged around 7.5 km/hr (Fig. 1). Furthermore, comparison of average air temperature to soil temperature suggests that air temperature strongly influences soil temperature (Fig. 2). The soil temperatures that we sampled are presented in comparison to soil temperatures at UBC's Totem Field which were collected by the Totem Field Micrometeorology Group. Lab analysis of the four soil samples per garden revealed that the Botanical Garden had the highest average soil moisture at 77.85%, and the Agronomy garden had the lowest at 39.94% (Fig. 3a). In terms of pH (Fig.3b), it ranged from acidic to more neutral across the garden sites with Agronomy having the most acidic soil at a pH of 5.6 and the Botanical and UNA gardens having almost neutral soil at a pH of 6.9.

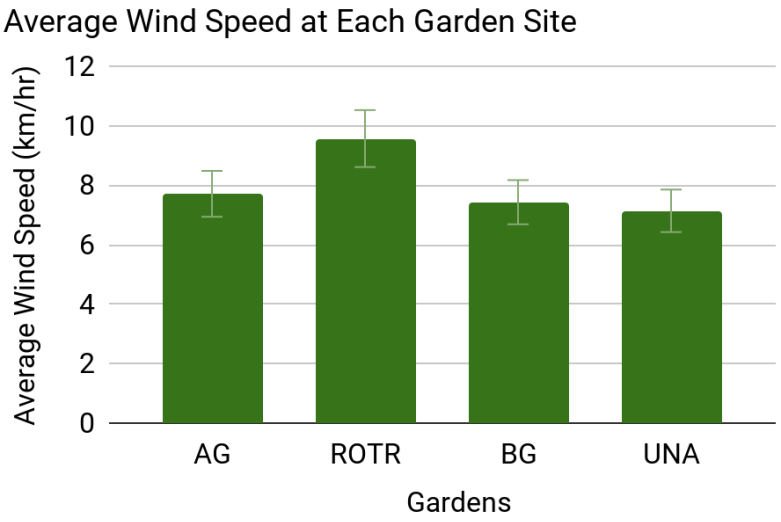

Figure 1. Comparison of the average wind speed in km/hr recorded at each garden site. The average values are plotted with standard error (n=6). AG: Agronomy Garden, ROTR: Roots on the Roof, BG: UBC Botanical Garden, UNA: University Neighborhoods Association Greenway South garden.

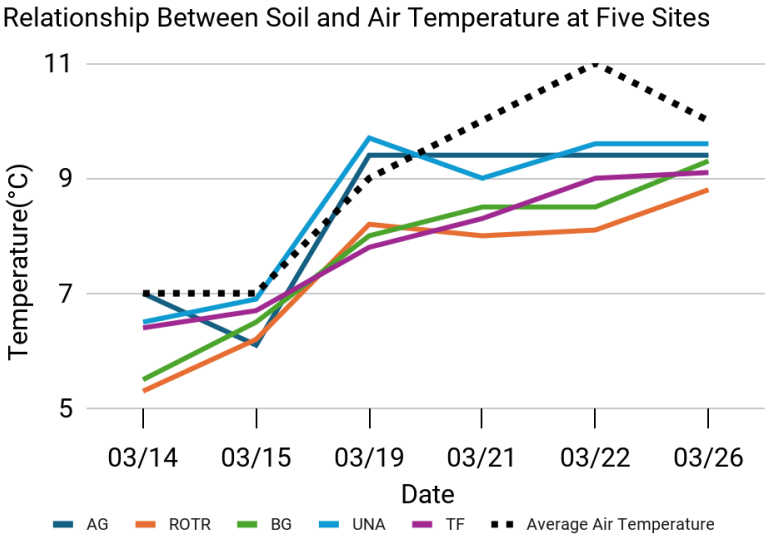

Figure 2. Comparison of average soil temperatures at each UBC garden site to Totem Field soil temperature data and average air temperature across all five sites. TF: Totem Field.

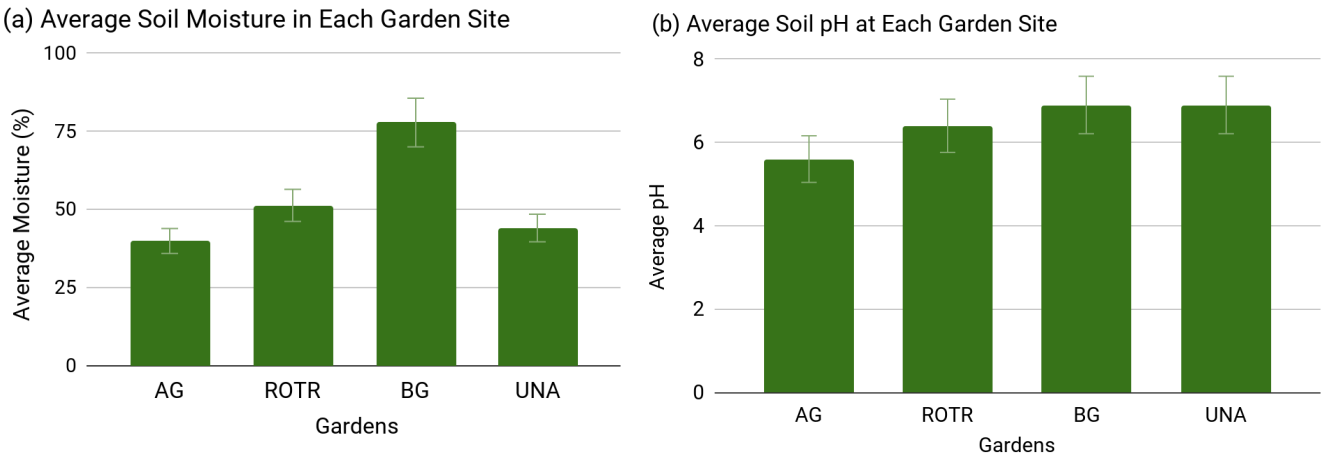

Figure 3. 3(a) The average percent soil moisture at each UBC garden site. The average values are plotted with standard error (n=4). 3(b) The average soil pH at each UBC garden site. The average values are plotted with standard error (n=4).

3.1.3 Interview Findings

Gardener Concerns

In our analysis of interview data, we found that all gardens experienced heat domes, three out of four gardens experienced cold snaps, one out of four gardens experienced high winds and no gardens experienced flooding (Table 2). The most frequent and pressing concerns expressed during the later spring and summer were about the impacts of heat domes. Frequently discussed challenges within the heat domes category were soil moisture retention, sun damage to plants, lack of access to automated irrigation and subsequent potential harm to gardeners in extreme heat. Under the category of cold snaps, shifting seasonality was a prominent concern, especially for gardens lacking access to an indoor growing space.

Table 2. Gardener reported experiences with extreme weather events at the surveyed garden sites over the last year

Garden	Extreme Weather Event			
	Heat domes	Cold snaps	High winds	Flooding
Agronomy Garden	✓	✓		
Roots on the Roof	✓	✓	✓	
Botanical Garden	✓	✓		
UNA Greenway South	✓			

Current Garden Management Practices

Through our interviews, the participants identified many different management practices being utilized across the gardens which we have grouped into 3 distinct categories (Fig. 4) based on our data analysis. The categories are as follows: (1) Physical weather protection, (2) Crop selection and (3) Knowledge acquisition and transfer. Knowledge acquisition and transfer refers to the process of gardeners increasing their knowledge on how to manage their garden well through either experience or learning via an outside source. This included knowledge transfer and acquisition on the topics of crop selection and physical weather protection.

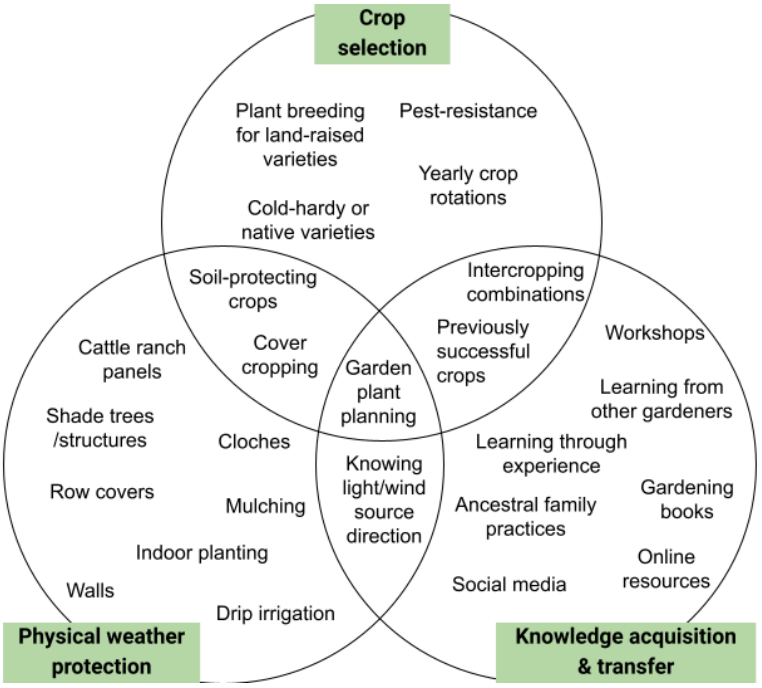

Figure 4. Garden management practices identified in interviews currently used by gardeners.

Gardener Needs

The participants identified two primary sources that gardeners requested aid from: (1) The gardening community and (2) The university (Table 3). Gardeners overall expressed a lack of support from or a connection to the gardening community and the student-run gardens, Roots on the Roof and Agronomy Garden expressed lacking support from the university. Gardeners universally expressed interest in sharing their own resources and knowledge with other gardens but felt that they lacked the ability to do so.

Table 3. Resources and sources identified in interviews that could increase garden resilience to extreme weather events.

Source	Resource
Gardening Community	➔ Enhanced community connection ➔ Seed/plant sharing ➔ Documentation on how to start and run a garden ➔ Sharing tools or equipment ➔ Knowledge sharing ◆ Plant knowledge ◆ Management recommendations ◆ Sourcing grants/funding ◆ Sourcing physical resources ◆ Workshops ◆ Online information sources
University	➔ Funding to purchase resources to build resiliency ➔ Paid/credited position for garden managers ➔ Facilitation of campus garden connection ➔ Indoor growing space access ➔ Advertisement of these garden spaces

3.2 Secondary Data - Literature Review

The literature reviews, which serve as a secondary source for this research, focus primarily on the challenges related to climate resilience and food systems in Canada and British Columbia, specifically in Metro Vancouver. The objective of our review was to identify current challenges, policy gaps, and promising practices in regards to current food systems and building extreme weather resilience.

The main challenges relevant to our research were (1) that Metro Vancouver has a complex climate which makes it challenging to increase resiliency and decrease vulnerability (Owrangi et. al., 2014; Gillett et al., 2022), and (2) extreme weather can cause physical damage to crops and farm infrastructure, and supply chain disruptions (Barclays, 2023). Furthermore, in terms of policy, key gaps were observed between policy creation and effective implementation (Owrangi et. al., 2014). Despite valuable policy creation towards supporting food landscapes, the notable disparity regarding the implementation of them suggested a systemic issue within government frameworks. There is also a significant gap present on local food production policies. Despite a large focus on large-scale food production, there is very little focus placed on small-scale production and its benefits towards local scale food security (Drolet, 2011). Large-scale can theoretically feed more people, but

the reviews questioned - at what cost? In addition, while Canada and Vancouver both have food plans that outline challenges to food systems such as the Agriculture and Agri-Food Canada Food Policy Report (2019) and Vancouver's Local Food Systems Action Plan (2021), UBC is lacking a specific plan target towards food policy. Finally, the key promising practice highlighted was that policy can be created and implemented using a community-based action research (CBAR) method which emphasizes the strengths of active community members and centers for Indigenous voices (Dell, 2009; Drolet, 2011; Taylor, 2013). This can help create more intentional and effective approaches to local food system challenges such as extreme weather events.

4. Discussion

Results from our data collection provided insight into the role of community gardens in local food systems alongside the potential and historical impacts that extreme weather events have on them. Key findings from our collected data indicate that, in order to increase campus community garden resilience to extreme weather events, it is essential to increase knowledge on extreme weather events and climate change, create strong community connections between garden sites and have support from larger institutions such as UBC.

4.2 Microclimate Assessments

The results from our primary data collection through field work and interviews provided valuable insights into the microclimate and management practice of the four UBC gardens sites studied. It offered a thorough understanding of how various environmental factors influence gardening practices, highlighting the challenges faced by these community gardeners in managing their plots effectively. The initial qualitative garden site observations made before collecting microclimate data revealed similar, but also distinct variations in topography, canopy cover, garden bed style, and surrounding environment amongst the 4 sites (Table 1). These factors play important roles in shaping the microclimate of each garden by influencing variables such as soil temperature, soil water content, shade coverage, wind protection, and water draining (Luo and Zhou, 2006; Lin et. al., 2018). For example, canopy coverage was mostly similar across sites (~5%) with the exception

of UNA Greenway South with significantly higher coverage (~45%) which may affect light availability for plants and overall moisture retention (Table 1) (Dormann et al., 2020). The environments surrounding the gardens were quite similar between sites, with ROTR as the exception as it is located on a concrete roof with minimal surrounding trees (Fig. 1).

Soil is a largely non-renewable resource and a key component in food growth (Blum, 2005). The microclimate data results on soil moisture and pH are key indicators of soil health and can aid in identifying sustainable management practices to maintain soil health. There were some variations in soil moisture between garden sites, indicating a need for tailored management strategies to optimize growing conditions and increase or decrease moisture as needed. For example, the Botanical Garden had significantly higher soil moisture than the other sites (Fig. 3a). Increased moisture is associated with reduced oxygen and nitrogen diffusion in the soil (Borowik and Wyszkowska, 2016) which can negatively impact plant health and make crops more prone to the effects of extreme weather. Conversely, lower soil moisture, as observed in the Agronomy Garden, Roots on the Roof and Greenway South results can increase the effects of droughts from the heat domes resulting in reduced growth rates, increased stress on vegetation, and alterations or transformations to the entire ecosystem (Borowik and Wyszkowska, 2016). Soil samples from each garden site fell within or slightly above this range which indicates that pH is not a likely concern for gardeners at these sites. The optimal soil pH range for plant health, growth and microbial activity is 5.5 to 6.5 (Brady and Weil, 2002). Soil pH levels can indicate soil fertility and nutrient availability, enabling them to make informed decisions about soil amendments and fertilization (Brady and Weil, 2002).

Soil temperature is fundamental for plant growth, health, and productivity. Although our microclimate assessment data only covered two weeks of soil temperature, it was still relevant as it revealed key findings. Our data indicates that the soil and air temperature are strongly positively correlated (Fig. 2), which highlights the importance of soil thermal dynamics in gardening practices. We found that the four garden sites had very similar soil temperatures to Totem Field data (Fig. 2). This means that the Totem Field data can be an extremely valuable resource to gardeners at the UBC campus as it is automatically collected every day throughout the day and can be used as a proxy measurement for garden soil temperatures. This would enable gardeners to

make informed decisions about planting, water management, and climate change adaptation (Blum, 2005). Many plants have temperature requirements for periods in their growth cycle such as germination, growth, flowering, and fruiting. Extreme weather events such as cold snaps can make it difficult for gardeners to predict when the last frost will be and can significantly shorten the growing season (Interview - Agronomy Garden gardener, 2024). Thus, our microclimate assessment on soil and air temperature revealed the necessity for gardeners to take advantage of the availability of this data through the Totem Field Meteorology Group and use it when timing seed planting and seed selection.

The results from our wind speed assessments revealed that ROTR experiences significantly higher wind speeds than the other three gardens (Fig. 1) which is supported by our qualitative observations that the site is located on the roof where it has little protection from wind by buildings or large trees. This puts the garden crops at a higher risk of the winds shredding their leaves, tearing off flowers, breaking of branches, and the uprooting of shrubs and trees, which leaves the plants more susceptible to further damages from insects and disease (University of California, 2024).

4.2 Interview Findings

Our interviews with gardeners and garden managers from each site enabled us to get first hand information on the impacts of extreme weather events on their respective gardens, their management strategies and what resources would benefit gardeners. From the interviews, it was identified that heat domes are the primary concern among gardeners because they strongly affect soil moisture retention, plant health, and gardener well-being. Cold snaps also posed challenges, particularly for gardens lacking indoor growing spaces, emphasizing the importance of adaptive strategies and availability of resources in response to shifting seasonality.

Current garden management practices highlighted from interviews encompassed a range of strategies, including physical weather protection, crop selection, and knowledge acquisition. The management strategies utilized at each garden site were highly dependent on the resources available to each garden. For example, the Botanical Garden uses drip irrigation which is costly and requires private water access to implement. This method is not available to the Agronomy Garden due to cost and water access limitations. Gardeners

prioritized acquiring knowledge on crop selection and weather protection techniques, highlighting the role of continuous learning and knowledge exchange in optimizing garden productivity and resilience. It was reported that gardeners primarily gained knowledge through experience or from in-person interactions with other gardeners.

Gardeners identified that the resources which may help them in increasing their garden's climate resiliency can be primarily sourced from either community support or institutional assistance. The types of resources that gardeners desired from the community were ones that they expressed willingness to share themselves. These resources included place-based knowledge, resources and labor. Resources requested from the institution were often things that gardeners were lacking and unable to share themselves, such as funding or indoor growing space access. Gardeners expressed a strong desire for enhanced community connections and knowledge sharing platforms which could be facilitated by the university. Gardeners also expressed how difficult it is to build and maintain community between gardens because garden managers often have more important garden tasks to prioritize and do not have extra time or resources to develop community. In addition, many garden managers and volunteers are students who plan to leave the gardens post-graduation which breaks the continuity in community and contacts.

While the microclimate assessments were helpful for gaining information on the garden environment, most gardeners relied on environmental information that they have personally gathered over multiple growing seasons through experiential trial and error to inform their management strategies. This highlights the importance of sharing place-based knowledge within garden communities. Microclimate assessments may be primarily helpful in adding to or corroborating experienced gardeners' findings and informing newer gardeners who don't have multiple seasons of experience at a particular garden site.

4.3 Literature Review

The results from our secondary data stress the importance of local food systems as a sustainable, community-oriented practice that can reduce both food insecurity and GHG emissions (IPCC, 2023). Local food production reduces the economic costs and GHG emissions released from the transportation of food. The existing state of climate change, inducing extreme weather events, has heavily impacted areas like Metro

Vancouver. The first key challenge identified by literature is that Metro Vancouver has a complex climate, making it challenging to increase resilience and decrease vulnerability (Owrangi et al., 2014; Gillett et al., 2022). Practices to increase resilience should be targeted very specifically to local gardens. The use of techniques such as direct drilling, cover crops, and soil mulches is very successful in protecting crops against extreme weather but is very dependent on soil type and must be tailored accordingly, which proves the importance of our conducted microclimate assessments in determining which management strategy to implement that will be the most effective (O'Connell et al., 2007). Furthermore, another advantage our literature review confirmed with respect to microclimate assessments is, for example, knowing its percent canopy coverage, which can help with measures like increased tree planting to provide shade to protect crops from extreme heat and strong winds, as well as reducing potential flood peaks due to the drainage abilities of trees (Dell 2009; O'Connell et al., 2007).

Furthermore, our reviews heavily discussed and emphasized the importance of integrating Indigenous perspectives and prioritizing food sovereignty are essential strategies for developing resilient food systems. This is extremely important when looking at decolonizing the land and straying away from colonial approaches of managing our land as their practices and policies as discussed have not necessarily aided in climate change and thereby extreme weather, yet instead exacerbated the effects. A common and powerful tool of oppression used by colonial systems is the removal of control over food systems from a community, followed by charitable responses to problems such as food insecurity. This model is reproduced today in subtle ways such as the enforcement of Western ideas of nutrition, the exclusion of minority groups from decision making spaces and the privatization of land which may have once been a source of food (Dennis & Robin, 2020). In *"Our hands at work: Indigenous food sovereignty in Western Canada"* (2019), author Tabitha Robin discusses the ongoing impacts of colonialism on Indigenous food security and sovereignty. The violent displacement of Indigenous peoples across Canada physically separated many people from their traditional food systems and forced reliance upon Western food systems. For many Indigenous people, food sovereignty involves reclaiming traditional ways of life which are inextricably tied to the land. Thus, the opportunity to be on the land in places such as community gardens can be essential for food sovereignty for urban Indigenous populations. While

gardening in the Western/colonial methods such as heavy tillage and gardening for productivity and reward are not necessarily traditional for many Indigenous cultures, gardening can facilitate the practice of cultivating food and sharing knowledge in a community setting. This further stresses the importance of building resilience to extreme weather and developing community-driven solutions that not only address immediate needs during extreme weather events but also build long-term sustainability into our food systems. Centering Indigenous knowledge and science is essential for this and will be crucial in our mindset towards food production and deconstruct the structural inequalities especially between the producers and consumers, and marginalized groups - these factors underlie and create barriers to accessing food. By implementing practices identified in the literature reviews, such as community gardening and inclusive policy-making, we can improve local food security and resilience. This approach will ensure that our project utilizes community strengths in order to promote garden climate resiliency and food security.

4.4 Unexpected Findings

Some key unexpected findings came from the results of our interviews. Notably, not one garden mentioned flooding as an extreme weather concern, which was surprising given that past research emphasized Vancouver areas being at major flood risk largely by extreme rainfall and storm surges (Owrangi et. al., 2014; Gillett et al., 2022). Another unexpected result were cold snaps being of little concern. In the past couple of years, UBC campus and the Vancouver area has experienced prolonged cold snaps to temperatures of around -20°C which is unusual for the area, thus we were expecting more reaction from the interviews regarding the issues from these extreme cold weather. Instead, many gardeners only planted to cover crops during the winter growing season and thus the damages incurred from cold snaps were not too costly to their gardens.

4.5 Limitations

Key research limitations include the amount of time we had to collect microclimate data. Due to our project timeline and limited number of months to complete the research, we could only conduct the microclimate assessments for two weeks which is not enough data for significant long-term results. This microclimate data is also limited by being collected for one season of the year, thus limiting the scalability of

the results to other seasons. Additionally, our scope of the UBC campus food gardens was limited as we only visited and interviewed food growers from four of the fifteen campus community gardens (UBC, 2020) and collecting for field data and interviews from more gardens could have provided us with more significant findings that are representative of more food growing spaces. Finally, although brief mentions towards food security is given throughout the report, given the project's capacity, we were not able to take it a step further and delve into more research into food security initiatives on campus and how the presence of these community gardens are and can play bigger roles into decreasing food insecurity on UBC campus.

5. Recommendations

Future Research

Future Research Recommendations to continue to expand our knowledge and to help gardeners create more climate resilient gardens that can better withstand extreme weather events.

1) **Mapping Climate Resilient Gardens to Better Withstand Extreme Weather Events (Within 1-2 years)**

We recommend the next group of students to work together with the clients of these gardens to help map out and plan the ideal garden that will be best protected throughout extreme weather events. This would entail students going to map and survey the different community gardens around campus. They would map out the area by looking at topography, how much shade the garden gets, how the beds are built, and how much protection and shade there is from various elements. They should use the data we collected this term as well as the years before to aid them in this process. This could be by adding more shrubbery or trees, or having more protection over the garden beds from wind, sun, or cold snaps. This research would take more than one semester but with the work of the group before us and our the work we have done, the next group could begin this research to plan community gardens that can strongly survive through extreme weather events.

2) **Collection of Long-Term Microclimate Data in Community Gardens (Ongoing)**

Our recommendation is to continue on the microclimate research we have been doing, but collect more long-term data throughout the whole year. Although LFS 450 was one semester long, we believe if it

were offered as a two-semester course or if we were able to get gardeners to collaborate with UBC and the SEEDS organization to collect data year round both the research and data collected would be more significant. On top of this it would help strengthen the data and findings collected in secondary research if we have consistent year-round data.

3) Testing Various Plant Species that can Thrive in Different Microclimate Conditions (Ongoing)

We recommend that the next group of students study various plant species and test whether they can thrive in our local microclimate conditions surrounding UBC. The students would use the data we have collected along with the information from the project the year prior to help create this list of plants that can survive throughout the various extreme conditions. They would be able to work with SEEDS and the other community gardens to delve into the science of plant breeding and how breeding different seeds together can create different strains that are more climate resilient and can adapt to the ever changing climate around us. More research needs to be done into plant breeding as it could be the future for many community gardens around us as it could be the key to having a variety of plants that can truly thrive in these extreme weather events.

Future Action

Short Term Recommendations (to be implemented within the next year)

1) Facilitating Garden to Garden Connection Through In-Person Workshops

Our research strongly encourages the forming of in-person networks among gardeners to exchange knowledge and resources as it is essential to building resilience to extreme weather events. Our interviews highlighted that there is an existing resource containing all the community gardens and their contact information, yet there was a large wish amongst gardeners to be introduced in-person to facilitate the connections. We identified the Botanical Garden as a potential garden to host workshops to strengthen and facilitate these connections. The BG would be a good location due to its size, resource capacity, and more central location to the other gardens that could host workshops to strengthen and facilitate these connections. These workshops would be accessible to all campus gardeners and would serve as a start of a larger branch of

networking that can occur within certain groups of community gardens (i.e. student-led, UNA). The effectiveness of this recommendation can be measured by sending out a survey regarding the workshops and the face-to-face interaction helps and gather feedback to improve on based on their experience.

2) Distribution of Toolkit to Support Food Growers in Building Garden Resilience to Extreme Weather Events

We recommend and hope that our clients (UNA and BG) will take the toolkit that we created and share it with the other gardens and gardeners in this area to help share the research we did to increase climate resiliency in surrounding food systems. This toolkit in the form of a pamphlet could help these campus food growers to gain more insight into building resilience and managing the impacts of extreme weather events in a very accessible way. Our aim of creating a pamphlet was so that we could breakdown knowledge barriers and fears that may exist when trying to manage the impacts of extreme weather in a visually drawing, less intimidating and easy to carry method.

Long Term Recommendations (now-2050)

To be able to adequately support on-campus food gardens with their needs in building resilience to extreme weather, we recommend that campus planners and food growers continue conducting microclimate assessments periodically throughout the year to gain more specific insight into which parts of their garden need more attention such as soil is lacking moisture making the garden more prone to the effects of droughts, or increase wind speeds but not enough protective cattle ranch panels or canopy to shield the crops. To encourage collecting and using microclimate data, we have listed out in the toolkit how to collect preliminary level microclimate data. As time goes on, we hope to see intentional changes and improvements made to the food landscapes that make them more resilient and less vulnerable to extreme weather events.

Conclusion

The severity and occurrence of extreme weather events will persist given the direction of our world and its battles with anthropogenic climate change. Through our microclimate assessments, interviews with food growers, historical Totem Field data, and insight into challenges, policies, and promising practices from

literature reviews, we have enriched our understanding of how to build resilience to extreme weather events. We have also developed community-based resources and practical tools distributed by SEEDS and the gardens themselves for use by gardeners to increase the climate resiliency of garden sites during extreme weather events, and proposed ways to enhance the collaboration and communication between different garden sites to foster community resilience and effective resource sharing. These campus gardens are aware and experiencing the impacts from extreme weather, especially heat domes, yet at their current states, not all gardens are prepared to withstand future impacts with a dichotomy existing between the available resources from student and non-student led gardens. However, our research demonstrates that referring to microclimate data, building and increasing community and ecological resilience, improving policies, and Indigenous knowledge and values are key amongst all climate-ready food gardens.

The findings of our study indicate that community gardens, food growers across campus, and SEEDS can help gardeners mitigate impacts of extreme weather by 1) sharing our garden management toolkit to mitigating and responding to the impacts of extreme weather events, and 2) collaborate with one another to build a network to share knowledge and create climate resilience through workshops and meetings. Some limitations faced during our research occurred due to not being able to collect the most significant data as we only had two weeks to collect microclimate data. Another limitation faced was only being able to survey four out of the fifteen gardens across campus. If we were able to survey more sites and collect data for a longer period of time our findings would be more significant. That being said, we believe that the data collected and results from our findings help provide this like-minded community the building blocks for more research to build on in the future. In addition, we believe these results may help to create more climate resilience among more than just local garden communities, but to the wider community of Vancouver. Overall, our project demonstrates the importance and need for community resilience, institutional support when it comes to policy, more microclimate data, and knowledge sharing between one another to create a resilient and promising foodscape in and around UBC that can withstand the impact of climate change which correlates to the increase of extreme weather events.

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Appendices

Appendix A: Additional Figures

***Table A.1 Soil Temperature Collected During 6 Days at* °C at AG: Agronomy Garden, ROTR: Roots on the Roof, BG: UBC Botanical Garden, UNA: University Neighborhoods Association Greenway South garden**

Sites	14/03/24	15/03/24	19/03/24	21/03/24	22/03/24	26/03/24
AG	7°C	6.1°C	9.4°C	9.4°C	9.4°C	9.4°C
ROTR	5.3°C	6.2°C	8.2°C	8°C	8.1°C	8.8°C
BG	5.5°C	6.5°C	8°C	8.5°C	8.5°C	9.33°C
UNA	6.5°C	6.9°C	9.7°C	9°C	9.6°C	9.6°C

***Table A.2 Air Temperature Collected During 6 Days at* °C at AG: Agronomy Garden, ROTR: Roots on the Roof, BG: UBC Botanical Garden, UNA: University Neighborhoods Association Greenway South garden**

Sites	14/03/24	15/03/24	19/03/24	21/03/24	22/03/24	26/03/24
AG	8°C	7°C	9°C	9°C	9°C	7°C
ROTR	8°C	9°C	11°C	10°C	10°C	10°C
BG	7°C	8°C	10°C	8°C	10°C	8°C
UNA	7°C	9°C	9°C	10°C	11°C	9°C

***Table A.3 Air Speed Collected During 6 Days at* km/h at AG: Agronomy Garden, ROTR: Roots on the Roof, BG: UBC Botanical Garden, UNA: University Neighborhoods Association Greenway South garden**

Sites	14/03/24	15/03/24	19/03/24	21/03/24	22/03/24	26/03/24
AG	7km/h	-	10km/h	5km/h	11km/h	5km/h
ROTR	8km/h	10km/h	11km/h	16km/h	8km/h	5km/h
BG	7km/h	9km/h	7km/h	16km/h	5km/h	6km/h
UNA	9 km/h	10 km/h	7km/h	5km/h	10km/h	6km/h

Table A.4 Raw Data of Prepared Soil Samples for Measuring Percent Moisture Content

Sites	Tin Wieight (g)	Tin+Wet Soil (g)	Tin+Dry Soil (g)	Wet Soil Weight (g)	Dry Soil Weight (g)	Soil Moisture (%)
BG1	1	11.02	6.78	10.02	5.78	73.35640138
BG2	1.25	11.73	7.17	10.48	5.92	77.02702703
BG3	0.98	11.9	7.11	10.92	6.13	78.14029364
BG4	0.99	12.11	7.07	11.12	6.08	82.89473684
UNA1	1	11.69	8.28	10.69	7.28	46.84065934
UNA2	1	11.96	8.89	10.96	7.89	38.91001267
UNA3	1.58	11.38	8.27	9.8	6.69	46.48729447
UNA4	1.51	11.36	8.34	9.85	6.83	44.21669107
ROTR1	1.57	12.41	8.6	10.84	7.03	54.19630156
ROTR2	1.59	12.18	8.92	10.59	7.33	44.47476126
ROTR3	0.99	11.98	8.18	10.99	7.19	52.8511822
ROTR4	1.57	12.22	8.49	10.65	6.92	53.9017341
AG1	0.98	11.96	8.77	10.98	7.79	40.94993582
AG2	0.99	12.57	9.25	11.58	8.26	40.1937046
AG3	1.58	11.9	9.45	10.32	7.87	31.13087675
AG4	1.56	12.96	9.29	11.4	7.73	47.47736093

Table A.5 Soil pH **at AG: Agronomy Garden, ROTR: Roots on the Roof, BG: UBC Botanical Garden, UNA: University Neighborhoods Association Greenway South garden**

Sites	Sample #1	Sample #2	Sample #3	Sample #4
AG	5.58	5.83	5.37	5.81
ROTR	5.93	6.27	7.06	6.43
BG	7.11	6.94	6.57	7.07
UNA	7.12	6.90	6.70	7.04

Appendix B: Data Collection Tools

B.1 Focus Group and Interview Availability Form

Focus Group Survey

Please pick a time and format that works best for you. We are opting to use Zoom rather than in-person so it is more accessible for more people.

Switch account

Not shared

* Indicates required question

What is your name? *

Your answer

What time works best for you **on zoom**? *

- [ ] Friday, March 22nd, 1:30-2:30 pm
- [ ] Monday, March 25th, 11:00-12:00 pm
- [ ] Tuesday, March 26th 6:00-7:00 pm
- [ ] Thursday, March 28 6:00-7:00 pm

B.2 Focus Group and Interview Consent Form

THE UNIVERSITY OF BRITISH COLUMBIA

Liska Richer
Faculty of Land and Food Systems
221-2357 Main Mall
Vancouver, BC, Canada V6T 1Z4
Tel: 604-822-3270 | Email: liska.richer@ubc.ca

Campus Food System Sustainability Project: INFORMED CONSENT

STUDY TEAM: Hannah Tahami, Kat Seow, Farbod Ali Rezaee, Liliana Henriksson

Principal Investigator:
Liska Richer, Instructor, Land & Food Systems (LFS) 450 class, Faculty of Land & Food Systems
Email: liska.richer@ubc.ca |Tel: 604.822.3270

INVITATION & STUDY PURPOSE
You are being invited to take part in this research study because you are affiliated with the UBC food system. We want to learn more about the sustainability of the campus of the food system and this study will help advance our knowledge and learn more about ways to enhance its sustainability.

STUDY PROCEDURES: *How is the study done?*
This study is being carried out by students within their course on "Land, Food and Community III" (LFS 450) in the Faculty of Land and Food Systems. If you agree to participate, you are being asked to participate in an in-person focus group. It is estimated that your time commitment will be 60-90 minutes. You will be verbally asked a set of questions in-person.

STUDY RESULTS
The results of this study will be reported in course based undergraduate reports and will be published in the SEEDS Sustainability Library and UBC cIRcle Digital repository.

SAFETY & RISK PROTOCOLS FOR IN-PERSON RESEARCH
Researchers in this study will follow UBC's Communicable Disease Prevention Framework and take precautions against infectious diseases. Precautions that will be taken are outlined below:

Health Checks:
On the day of any in-person research activity, the researcher(s) will do health checks and ask participants do health checks. If they answer in a matter that appears to demonstrate symptoms of a communicable disease, the research event will be postponed and rescheduled at a later date, or alternatively the format will be changed to a remote event (online or phone).

Behavioural Considerations:
Masks and hand sanitizers will be made available to use by researchers and for use by research participants.

Duty to Accommodate:
All researchers will accommodate participant requests for increased infectious disease protections. Please let the researcher know if you require modifications to the research procedures to enable your participation. The researcher is obligated to accommodate reasonable requests and can discuss your situation with you. Examples of reasonable changes include increasing infectious disease protections by providing masks or improving ventilation, changing a meeting location to improve access and navigation, or providing the services of an interpreter.

Other Risks:
Some of the questions asked may seem sensitive or personal. Please let one of the research staff know if you have any concerns. You do not have to answer any question if you do not want to.

THE UNIVERSITY OF BRITISH COLUMBIA

Liska Richer
Faculty of Land and Food Systems
221-2357 Main Mall
Vancouver, BC, Canada V6T 1Z4
Tel: 604-822-3270 | Email: liska.richer@ubc.ca

POTENTIAL BENEFITS OF THE STUDY
You may be helped in this study by findings contributing to the advancement of a more sustainable food system. In the future, others may benefit from what we learn in this study.

CONFIDENTIALITY
Your answers will remain anonymous unless you provide written permission (below) to the UBC student conducting the interview or survey, to disclose your name, working position or any other information revealing your identity in any possible future use of the information you provide. If you are participating in a focus group, please note that only limited confidentiality can be offered and we encourage participants not to discuss the content of the focus group to people outside the group; however, we can't control what participants do with the information discussed. All documents will be identified only by code number and kept in a locked cabinet. Participants will not be identified by name in any reports of the completed study.

PAYMENT
We will not pay you for the time you take to be in this study.

CONTACT FOR INFORMATION ABOUT THE STUDY
If you have any questions or concerns about the study, please contact the Principal Investigator.

Principal Investigator:
Liska Richer, Instructor, Land and Food Systems 450 class, Faculty of Land and Food Systems
E-mail: liska.richer@ubc.ca Tel: 604.822.3270

L Richer

Liska Richer
Principal Investigator, January 2024

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

PARTICIPANT CONSENT AND SIGNATURE PAGE
Taking part in this study is entirely up to you. You have the right to refuse to participate in this study. If you decide to take part, you may choose to pull out of the study at any time without giving a reason and without any negative impact on your employment, or class standing. Your signature below indicates that you have received a copy of this consent form and that you consent to participate in this study.

Participant Signature Date

Printed Name of the Participant signing above

B.3 Focus Group and Interview Questions

1. What kind of weather has caused the most challenge in your garden?
2. What kinds of impacts have these events had on your plants? (yield,management, etc.)
3. What methods have you implemented to combat the impacts of extreme weather events?
4. Where did you learn/source these strategies?
5. How have these methods changed over time? How have you adapted?
6. What resources would be helpful in increasing your garden's resilience to extreme weather events? (ex. information, financial support, management recommendations, network, supplies, etc.)
7. Do you think that increasing the connection between gardens would improve the resiliency of your garden to extreme weather events? How might increased connection between gardens look?

B.4 Interview Notes

Focus Group Notes

March 25th 2024 11:00 am-12:00 pm on Zoom

March 26th 2024 6:00 pm-7:00 pm on Zoom

April 4 2023 10:00am-11:00am on Zoom

Preface

Hello! *do individual introductions (order: Hannah, Kat, Farbod, Liliana)* We are a group of undergraduate students in the class LFS 450: Land, Food and Community. We are conducting research on the impacts of extreme weather events such as heat domes, cold snaps, extreme winds and flooding on the UBC Vancouver Campus food system. We are interested in learning about your experience as gardeners at the UBC location in the face of these weather events. The information that you provide us today will serve as a foundation for our research and help us to identify key issues that are relevant to you. At the end of this project, we will produce a formal report on the wider context of climate change and extreme weather events, the microclimates of specific garden sites around UBC Campus and potentially applicable agroecosystem management strategies. We will also provide a recommendation handbook available for gardeners with practical advice on increasing the climate resiliency of your garden site.

Intros

Tell us about your garden: goals, management, what do you grow, where does the produce go, what other species does your garden support, etc.

Name	Garden	Notes
[redacted]	AG	Located at the intersection of Agronomy Road and Main Mall - community-run - No formal hiring to run the garden for accessibility purposes, low pressure commitment - Started as a SEEDS project - visibility of food growing on campus (very approachable) - Grow lots of veggies, berry plants, and produce grown distributed to club member - extra produce has been donated to Sprouts

		community fridge and Agora - Hub for birds and tons of squirrels, lots of pollinators, earthworms, woody insects, big compost bins host worms, wood bugs, and other insects, vermicompost

[redacted]	ROTR	- 192 square meter garden, 5.2x more productive than UBC farm
		- Food aggregation system (?)
		- 1600 pounds of food grown for sprouts and food hub
		  - 1300 lbs of it is donated - 300 lbs distributed among the food growers
		  - Run many workshops
		  - Hub for birds, raven mom nesting on the roof, house finch breeding pairs (11 birds specifically?) Lots of bird drama?
		  - "Sugar daddy" garden - ability to receive a lot of money from grants

[redacted]	UNA	[redacted]- oversees 5 community gardens 3 Hawthorn and 2 Wesbrook - Plots are overseen by one individual gardener, but some communal or pollinator plots, in contract that you cannot sell the produce so the produce is used by gardener, support pollinators through different plants, mason bee homes, coyotes [redacted]- working here for 4 years at Bean Around the World garden- children's garden, there are kids that come, blueberries, raspberries, strawberries, blueberries like to live with strawberries, kids can come and walk through garden and pick and taste everything, unique because it doesn't belong to anyone specific but everyone takes care of it, lady who has been there for 15 years or longer, most gardeners are young moms with young kids, had to learn a lot about vegetable gardening, belong to volunteer group with the UBC Botanical Gardens, workshop every week have someone to talk to them, christina cheung the layered edible garden, people can come and taste, it's a sharing garden
[redacted]	BG	Position is ([redacted] is gardener and she reports to garden supervisor who happens to be former food garden horticulturist, they report to Douglas) responsible for horticulture in BG and collections, all the people who work outside in the gardener report to Douglas About the food garden: first opened in 1983 and reason for opening was to promote educaiton, research, public engagement, conservation of food plants. Primarily a demonstration garden, show the public a range ofedible plants and different ways to grow them, management style that relies on sustainable techniquest, no pesticides, non-edible plants to support o=pollinators and other beneficial organissm Has extensive raised beds, open beds where they grow trees nad shrubs that produce food, make use of walls to create microcliates

		which can extent the season, garden is fairly large (½ acre), max sun exposure, have experienced cold weather, cold snaps in jan, heat domes, somewhat protected from winds with trees, trees that they grow are mostly aspaliard - trained 2d to create fences, grow cane and bush fruits and vegetables They dont eat it - healthy harvest program in 2017, before that food was harvested nad distributed to soup kitchen on DTES, since 2017 all the produce (which is considered organic but no cert), goes to support food security in UBC community, harvest with the help of volunteers, friends of the garden volleys, students, garden staff, gather weight and clean produce, foes to AMS food bank and other food security groups on campus, program provided 950 kg of produce over 60 varieties of fresh produce, engaged about 356 volies from community

Have you experienced:

Heavy winds?	[redacted] says yes - cattle ranch panel over a meter to help with the winds (sturdy metal structure) [redacted]- no [redacted]-no [redacted]- no
Heat domes?	Yes (both [redacted] and [redacted]) - especially on ROTR because the Nest roof is built to reflect sunlight [redacted]- yes one of the biggest challenges they face [redacted]- yes
Flooding?	[redacted] and [redacted]- No [redacted]- no [redacted]-no [redacted]- when it was built, builders paid attention to drainage so raised beds and open beds actually dont accumulate much water
Cold snaps?	[redacted]-yes [redacted]- yes (lost an entire crop of brassicas at ROTR) [redacted]- not really [redacted]-yes, but no impact on the garden

**eutrophication at ROTR - when the landscape sprays the graywater gets algae in soil (less susceptible to droughts) but heat combined with pesticide/fertilizers from surrounding areas worsens eutrophication.
UNA- said they dealt with a lot of droughts, problem with irrigation system, best times of day to water, the lack of rain, cant get out every day to water, last summer they needed someone to water everyday more water=shallower roots, only water every other day heavily. Wanting to Creating a better drip irrigation system

[redacted]- They only got water twice a week in botanical garden to encourage roots to grow deeper

[redacted]- drought - if something happens to irrigation, as uni gets more interested in water conservation, will have to be and have become more water conserving in the BG

- Prolonged cold in spring which delays planting, late summer or autumn rains can be a source of promotes disease, reduces productivity of garden

[redacted] - extreme cold snaps -> loss winter vegtables such as winter broccoli

Cold snap in Jan -> made them loss crops

They use covers to protect their products??

They have walls in ceratin part of the gardens -> the wall is for sound and accumulating heat

The warmth in the sun gets trapped in the garden because of the walls around -> old technique

Becasue they have good infrustructure, driught is not a big deal, but sudden cold snaps really affect them

The garden functions to be an example for the community

Always produce food for ams food bank -> unless UBC cancels the fundings

Road covers -> it breaths and the humidity can pass through and rain to some degrees and doesnt let the heat from skipping -> they use it to keep the heat and protect the food from pest -> have to use rocks when its windy because they can get moved when its rainging

They are serius about sustainability -> sometimes have to adjust however

The garden is one of the most sustabnle gardens, everything is compsted -> they are concenrted about native insects -> they include lots of plants that are good for the insects -> friendly plants and the ones that are beneficial to the insects -> they try to be as bio diverse as possible -> they label their produce -> so that sometimes ppl dont eat the beneficial plants

Moulches and crop rotations and companion planinting, catch croping, green manours

Gardenes are very responsive and addabtive -> when something doesnt work -> ppl mostly new -> it is difficult to pass along the information -> they have a library on food plants and have outreach where ppl like Lind and gardeners come and speak -> david tarent (used to work here) also did a talk -> Internet is a great source but it is not local

Climate change is affecting different areas differently, thus learning locally is much better and is recommended to talk to people like Linda about gardens -> they're all very proud of her

The library is more of a reading room

There are many BG are across north america -> they all talk

There has been a slow warming -> been helpful for growing better

What they do in gardening now -> they do plants and techniques to give them the widest options

They are doing a much better job in maintaining a biodoverse system

What would be beneficial -> networking, sharing information, technology transfer -> also when an infrustutice breaks down they need money and resources to maintain they functionality of the gradne such as fences -> it would be useful to have the ability to raise money -> they have a person to raise money for the garden since they get a certain amount of money from UBC. They are doing renovations and posts this year -> these cost money so thay had to go raise money -> all in all, you need someone to help you raise money

They differ from community gardens because they have established gardensc-> it would be useful to identify ppl who hae skills to find money and resources (do the jobs thayt are different from gardening)

Sometimes gardeners blame themselves for the wrong produces -> but maybe the soil is not good enough

Issue of the rodens are very big -> they eat the plants

They think having workshops in person and go to the garden to learn -> they are willing to do it -> thye need ppl ask themn to do it -> if they advertise it -> this will make them overwhelm with ppl from other gardens -> the great thing about a workshop os that ppl can communicate to eachother.

Questions

Question	Notes
What kind of weather has caused the most challenge in your garden?	**ROTR -** heat is primarily caused by the way the nest is constructed - all built to reflect heat on the garden. Planted trees to help create shade however very little canopy coverage. Weather is changing faster than they can keep up with. **AG -** the heat is very difficult, harder to keep water in the soil. Hard to upkeep the garden in the summer due to lack of staffing - reduce crop yield. **UNA-** [redacted]- Need more sun because the trees are getting taller and creating too much shade for their garden. She said plant what works for that area not what you want [redacted]- Having to be more aware of what they can and can't grow instead of growing large tomatoes they have to grow cherry tomatoes. Droughts/ heat domes have been the challenge for them **BG-** because we have a pretty solid in tact infrastructure of irrigation, drought isnt much of an issue, cold snap is bad but they can always restart, they have a nursery, problems that might affect a smaller community garden arent as
	much of an issue, they have professional staff who know what theyre doing, university comes and fixes big issues, built in so that they can be a demonstration garden that functions for the public, always going to have produce for the AMS food bank, not worried about it unless the uni cut off the funding or water
What kinds of impacts have these events had on your plants? (yield,management, etc.)	**ROTR-** Usually just means not being in the garden as much - garden is a quarter of what we do. Run a summer mentorship program to teach people how to garden. Can't go outside because it is too hot or too cold. AMS building ops locked them out for two months which hurt the roof. We have hydroponic farms in engineering. The plants I have bred are good enough - 3 fully land raised variety, send seeds to UBC farm to make enough seeds. Test breeding for resilience and taste. Plant a row in the living conditions she wants them to survive them in - to have the plants adapt to the weather changes. Bred crops to grow in the winter and in the snow in unusual sprouts weathers. **AG-** managing for cold snaps or unseasonable cold - can't plant inside, no indoor growing time so we couldn't start plants until mid April which significantly shortens the growing season, really on top of forecasts, can't trust "last frost dates", changing plans often, can be difficult to have something to club members to do when its too cold to plant, hard to retain members in winter, continuation of members, coming up with little workshops and stuff instead **UNA-** [redacted]-one big compost soil delivery at the beginning of the year but trying to do it twice a year and make the soil last longer. As they have been having struggles with droughts [redacted]- Use something to cover the soil better. Being made aware from other people that one of the soil layers needs to be done to protect your garden. Leave the soil more as is, if you till the soil too much you dry it out. You adapt little by little
What methods have you implemented to combat the impacts of extreme weather events?	**ROTR-** trees and shade, trying to get as much coverage as possible (trees were just planted last year) thus canopy coverage is still low. Planted on the north-south axis to maximize shade. **AG-** used small cloches Plastic dome covering to sow seeds and have the sprouts survive and help with watering

	- condenses onto plastic - assures for seed germination (moist but not too wet). Decent amount of shade from a big witch hazel seed - plant varieties most susceptible to struggles with heat are in shade, and plants that love the heat are more in the sun. **UNA-** [redacted]- can use drip irrigation system to make it easier for gardners and helps during droughts. Trying to send out more resources on cover cropping during the winter. Send otu what things to grow according to the weather, especially during the droughts and cold. **BG**- cold snaps - cloches and row covers (spun bonded polyester materials like interfacing but thinner, floats, humidity can pass through but it stops the heat from escaping, put on beds where they planted early to help retain the heat and provide some protection from pest insects, they have to be pegged down because the wind will be blown away, they move with the growing crop so they dont weigh them down, they are also made of plastic which is a bummer ig), very serious about sustainability issues but certain compromises they feel they have to take like plastic containers and row covers but generally speaking, the garden is among the most sustainable gardens we have, trash is composted, concerned about native insects and beneficial insects and include a lot of plants that are good for overwintering nesting and pollinator friendl plants nad plants that beneficials can feed on, try to be as biuodierse as possible, label everything - Use mulches and no-till options for some areas, use crop rotation (ealthy plants are more resilient), companion planting, catch cropping (filling in spaces where thighs are slow to come on), green manure - Easy when its with an institution and have a lot of history and knowledge is passed down, gardeners are very responsive and collaborative, difficult to pass on information in smaller community garden, have a library with lots of information, invite people in to talk, do outreach, have speakers nad workshops, emphasizig local knowledge, climate change affecting different areas differently, people who have been working in this environment for years are probalmt best placed to ehlp out

	, walls in certain parts of garden for sound abatement because its loud when people are driving by but also they help accm=uulate heat (south facing walls) radiates heat into the night
Where did you learn/source these strategies?	**ROTR-** family, ancestral farming practices **AG-** picked up or learned from working with other gardeners **UNA-** [redacted]-Working together with other gardners to adapt to the changing climate systems. Being connected with the botanical garden . Up to 70 people in this group “an amazing group”. Hearing these people every week, large variety of topics are covered, they have seeds and ideas of having to do things. “The outside book never closes, ever learning”. [redacted]- Mostly use online, Richmond group → Urban bounty has really great published resources how to start a garden and manage it. The city of vancouver has some resources they have used. Were able to use people on UBC to do pH tests/ soil tests **BG-** reading room, people are welcome to come and read, BG community is very well connected to botanical gardens across the world and esp across BC, forums where you can talk about the issues, notwithstanding the importance of local knowledge, ltos of accumulated knowledg ein institutions that are botanical garens, information is potentially available to all of them, unis have food gardens and experience, can tap into that wen they want, other person who we might want to talk with is Tara lol she oversees harvest and volunteers
How have these methods changed over time? How have you adapted?	**ROTR-** practicing over time and adapting to what practices are most relevant and applicable, relationship building to the land and what is there **AG-** learning where to plant things over a few seasons based on shade coverage **UNA-** [redacted]- pretty consistent in that time, people who are just starting... helping them be successful with their plot [redacted]- “to seed and when to seed, it takes a bit of

	where and what to plant, and what goes well together". A lot more planning involved. Where there has been change **BG-** in some ways, therse been a slow warming which has been prob helpful in terms of what we can grw, hopwfully weve gotten smarter, historicallty garden used synthetic agrochemicals, been the big change, represented the paradigm shift froma reactive to a proactive mode, nowthey try to head off potential problems bt introducing plants and techniquest hta give the widest range of options instead of reacting to a particular problem an trying to control - that is the wrong approach, we can mostly live without catastrophic pest infestations or diseases if we learn to put up with a little and devode resources to other Productivity prob reduced bUT biodiversity increased nad that allows us to reduce number of resources that have to apply to pest management and increased susntaibility of system , look at food gardening as a system, doing a much better job of maintaining the system rather thna creating a system that is unrealistic and unsistabilty.
What resources would be helpful in increasing your garden's resilience to extreme weather events? (ex. information, financial support, management recommendations, network, supplies, etc.)	**ROTR-** permanently promised money by faculty - first year of carly running it, but hopefully it will help so that I can help other garden too in the summer (taking care of the space), struggle building up connections. Definitely have the resources on campus but feel like we do not have the sources to connect the areas together and the resources to help each other. There have been attempts by the UBC farm to connect gardens, but it hasn't done much **AG-** Information is definitely helpful. Natural sources has been one of the biggest struggles. Information on how to get said funding/ grants would help and make things easier especially when it is a smaller organization to help kickstart - difficult to find the resources for funding when you don't know where to find them. Management recommendations would be super helpful - especially regarding knowing your land/knowing your garden. The thing that helped me the most (can't remember where it came from), map your garden (i.e. where sun comes from), sit and observe garden to understand what is going on. Sit through rainy season - which areas get water, which areas might flood, etc. Network - last year/before. Idea to try and connect with the other community gardens on campus. There are so many little gardens, but really difficult to find out who runs them

	and collaborate together - it is a serious hurdle when running gardens at ubc **UNA-** [redacted]- more information (was mentioning Mediterranean rosemary did really bad). Was told to plant white rosemary which can withstand the cold better [redacted]- PDFS/ good workshops people have attended, be able to share soil delivery from a management perspective. UNA has good funding. Just finding ways to work together with other gardens to be able to share some of the resources they have. BEeing able to connect with other gardens around the area. **BG-** networking is always shring of information esp technology transfer likes someone discovered that something is beneficial, then sharing that information, we all need to share the information so that we can all do a better job, indfradtructure breaks down and they need money and resources to maintain the functionality of the garden, thinking about community gardens if theres wooden thing, they will often need to be replaced and a useful thing to have is the ability to raise money or to find resouvres , BG has resources thru Uni, have a development officer whos job it is to raise money, only get a certain cut from uni, have to find money elsewhere to make the BG function, if the food garden needs money, have to go and fundraise for that, that might be a gigantic task for a community garden, important to have people help find funding and materials, differ in community gardens in that they have a budget thru the uni, need to add to it and have someone to help with that, most communit gardens are reactive because they dont have a reserved of money, might be useful to identify in another garden people who have those skills who can help out finding money or resources or doing jobs that arent really related to gardening
Do you think that increasing the connection between gardens would improve the resiliency of your garden to extreme weather events? How might increased connection between gardens look?	**ROTR-** Yes, it would improve the garden in every aspect **AG-** Yes, if we know each - are you on campus can you check it out, can you water. Super happy to share tools, resources to help cope with extreme events. The more connected, the more resources and knowledge **UNA-**

	[redacted]- YES, Wants to meet in person and have real face to face communication, be able to connect and visit each others gardens and find ways they can learn from other gardens/ gardeners. The connection is important and needed to learn more and create more resiliency [redacted]- YES! Be able to do some sort of open gardens and go visit, sort of like a show and tell **BG**- connection is great, in terms of weather events, sometimes people who are interested in gardening are not very knowledgeable about like soil hydrology, so the siteing of a comm garden might be bad ad might need to build higher raised beds or not enough water and so the raised beds might be too high (new phenomenon), when you get more people around to discuss those thins, this can make a difference, not sure how much people listen to eachother casually, there might meed to be more of a formal structure like a shared SWOT analysis, not relly a process person, but those processes are often very effective when there are problems, msot of the time problems are not perceived, people blame themselves or a lousy harvest like theyre a bad gardener but it might be the other circumstances. Go back to first principles of soil, annula additions, where do we find the righ material o include, should we be composting, how do we avoid rodents, etc. issue of rodents is very big in ters of what is harvestable and healthy, rats are not a weathr related event but still a significant issue Hands-on workshop approaches are best, people are busy and when youre busy a zoom seminar or reading online is fine but theres nothing like actually doing things in person and doing a workshop, willing to do that kind of thing, they just need someone to ask for it, if they advertise that they avhe a food garden workshop, theyll be overwhelmed by people not in the communit gardening community, theyre happy to do it! Brings people together
Anything else?	**ROTR-** I would love to get everyone in a room in person. Tried groupchats - almost never use it. Tried email chain have not used it. Until we meet and know each other in person, no one is going to reach out. I understand there is no quick way to build relationships **(BOTH ROTR & AG)** Building resources for continuity-making resources for the next leader of the garden to do the thing since were all students and will be eventually

	graduating and leaving LFS 496 position **AG-** If you run a garden or want to run a garden show up to some in person meeting. Long term connection - facebook groups can be quite helpful in my experience because you can make posts in addition to chats. You can also post events. Another big hurdle is we have a lot of ideas and motivation but not a lot of time given that we are full-time students and staff. Resource pool to pay garden managers - if I was getting paid, it would allow me to put more work into it. **Capacity** is such an issue. **UNA-** [redacted]- educating people in the garden adding informational signs within gardens [redacted]- UBC seed library is hard to access and having better ways to access and connect. Being able to sustain biodiversity within this library **BG-**

Thank you so much for your time in sharing this information.

Appendix C: Procedure

C.1 How the Soil Samples pH was Measured

1. In a "Dixie Cup" place:
a. For inorganic soils: 20 gm of soil and 20 ml of distilled water
b. For organic soils: 10 gm of soil and 20 ml of distilled water or, if necessary, 5 gm of soil and 20 ml of distilled water.
3. Prepare some duplicates.
4 . Stir the suspension several times during the next 30 minutes.
5. Let stand for about an hour to allow most of the suspended clay to settle.
6. Measure the pH by carefully immersing the combination electrode into the clear supernatant solution.
*The soil samples were dried out for a week before being measured and used for pH testing

C.2 How the Soil Samples Moisture was Measured

1. Weighed 10g sample of wet soil
2. Dried the sample in the oven
3. Weighted the Dried sample soil
4. Calculated the moisture:
a: % Moisture = (Wet Soil Weight (g) - Dry Soil Wright (g)) / Dri Soil Weight (g)

Appendix D: Deliverable (Toolkit)

GARDEN MANAGEMENT DURING EXTREME WEATHER EVENTS

WHAT IS A MICROCLIMATE?

A microclimate is the specific climatic conditions of an area. These conditions are influenced by environmental surroundings.

Microclimate influences factors such as soil moisture, site temperature and wind exposure.

COLLECTING MICROCLIMATE DATA

Collect data over >2 weeks at the same time(s) and location(s) every day.

Materials: Thermometer, trowel, Ziplock bags, phone

Procedure:

1. Record air temperature and wind speed from a reliable weather information source.
2. Measure soil temperature using thermometer
3. Take soil samples from ~10 cm below the soil surface
   a. Weigh moist soil samples, then fully oven dry samples. Find soil moisture using this formula:

$$\frac{\text{(wt. moist soil) - (wt. dry soil)}}{\text{(wt. dry soil)}}$$

WHY EXTREME WEATHER EVENTS?

Extreme weather events such as **heat domes, cold snaps, high winds or flooding** can cause **physical damage** to gardens or pose **health threats** to gardeners.

These events are becoming **more prevalent** due to climate change. They are **unpredictable** in nature and have different impacts based on a garden's **microclimate**.

Collecting and mobilizing **community based research** and knowledge can help increase **community resilience** to climate change.

A food grower's guide to mitigating and responding to the impacts of extreme weather events

Hannah Tahami, Liliana Henrikkson, Kat Seow & Farbod Alirezaee
In collaboration with the UBC Botanical Garden & the University Neighborhoods Association

HEAT DOMES

are periods of unusually high heat which can cause drought, scorch plants and harm the health of gardeners.

Priority: Retain soil moisture and cool the garden area

Plant trees to provide shade and reduce garden temperature

Use cloches to retain soil moisture

Install drip irrigation to water remotely

Mulch to protect soil from direct sunlight and retain moisture

Cultivate plants that cover and protect the soil

Avoid excess tilling

COLD SNAPS

are periods of unusual cold and frost which can kill plants, especially early spring seedlings, and shorten the growing season.

Priority: Protect plant leaves and roots from frost damage

Use cloches or row covers to hold in heat and protect from frost

Mulch soil to protect soil

Start seedlings indoors

Plant cold-hardy varieties or land-raise plants for cold weather

Start seeds in the sunniest areas of your garden first

Use walls around your garden to reflect heat back inward

EXTREME WINDS

can cause soil loss or physical damage to plants

Priority: Shield plants from wind

Plant trees/hedges or build structures to provide protection

Plant in shielded areas

Keep soil covered or cropped year-round to retain soil

FLOODING

occurs when there is high precipitation and can wash away both plants and soil.

Priority: Encourage drainage and retain soil

Use raised beds for good drainage

Plant on flat areas or at the top of a slope

Use sandy soil encourage high water infiltration and drainage

Keep garden cropped year-round to retain soil