Building Climate Literacy Through a Climate Communication Platform for the Lower Fraser Basin

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

In the age of social media, people are increasingly relying on digital tools as a means of information, education, and participation[1]. There has been growing recognition and discussion regarding the use of social networks to engage communities in climate actions[2]. Many campaigns and initiatives have emerged in recent years which aim to involve individuals closely in the education of this problem[3]. Amid the ongoing climate crisis, the role of climate communication takes centre stage, particularly in the Lower Fraser Basin of British Columbia.

Currently, the Lower Fraser Basin lacks an effective comprehensive platform for public engagement and emergency mapping. The urgency of this matter becomes evident as climate change poses a substantial threat to the southern coastal communities of Canada[4].

Despite proven scientific research pointing to the anthropogenic influence on climate change, misinformation and politicisation has contributed to a divide in the public lens[5]. Surveys indicate that a majority of people are willing to take action on climate change[6]. There has been a growing use of social networks to engage communities in government actions; however, despite increasing awareness of social networks, there are limited applications in relation to climate policy[7].

This research aims to study climate change communication platforms and its impacts on the dissemination of information, with the aim of building climate literacy. The study will cumulate into a digital communication platform, in which users are able to engage with a spatial toolkit of various infrastructural, meteorological, and community resources in the Lower Fraser Basin through the development of a design framework. Promoting awareness of these strategies will facilitate education on the anthropogenic impacts on our ecosystem, ensuring that communities can continue to enjoy life by the water[8].

Considering the importance of digital platforms in climate communication, this thesis asks: How can synthesizing data on climate causes, risks, and adaptations with meteorological, infrastructural, and ecological information in a climate communication platform enhance climate literacy among residents of the Lower Fraser Basin, particularly in understanding and preparing for region-specific climate challenges?

1 Szombathelyi, Waldbuesser, and Tench, “Digital Age.”

2 Cunningham et al., “Engaging Communities in Climate Adaptation.”

3 Fernandez et al., “Talking Climate Change via Social Media.”

4 Intergovernmental Panel on Climate Change, “AR4 Climate Change 2007.”

5 Intergovernmental Panel On Climate Change (IPCC), *Climate Change 2022 – Impacts, Adaptation and Vulnerability.*

6 Intergovernmental Panel on Climate Change (IPCC).

7 Cunningham et al., “Engaging Communities in Climate Adaptation.”

8 McHarg, *Design With Nature.*

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Figure 1. The Lower Fraser Basin, image by author, base map adapted from ArcGIS.

1. Introduction

In the age of social media, people are increasingly relying on digital tools as a means of information, education, and participation[9]. Social media and digital networking have been increasingly used in recent years to engage communities in climate actions[10]. Many campaigns and initiatives have emerged, aiming to build climate literacy and involve individuals closely in the education of climate change[11]. Climate literacy refers to the understanding of one's influence on climate and the reciprocal influence that the climate has one society. One of the most common ways of news consumption has now been through web-based digital platforms, as 97% of Canadian households in British Columbia have access to high-speed internet[12]. Amid the ongoing climate crisis, the role of climate communication takes centre stage, particularly in the Lower Fraser Basin.

The Lower Fraser Basin, along with many Canadian communities, are vulnerable to the adverse effects of flooding[13]. The Lower Fraser Basin is Canada's third largest urban region, containing one-half of the population of British Columbia[14]. This region includes the estuary, lowlands, and mountain ranges surrounding the Fraser River prior to its discharge into the Strait of Georgia in southwest British Columbia[15]. This natural region, located approximately 1,400 kilometers downstream from the headwaters of the Fraser River, includes Metro Vancouver and the communities of the Fraser Valley. Known as the Mighty Fraser, the river is the tenth longest river in the world[16]. As one of the most extensive and productive ecosystems in Canada, the basin drains about one-quarter of British Columbia[17].

The Lower Fraser Basin is a confluence of the ecosystem and people. The region has a variety of conditions, with a diverse population of freshwater, marine, upland, and floodplain environments[18]. The complex makeup of ecosystems found here play a vital role in the development of aquatic life[19]. With over 2.3 million people, it consists of a myriad of cultures, values, interests, and activities that interact with, and are often dependent on, the river[20].

9 Szombathelyi, Waldbuesser, and Tench, "Digital Age."

10 Cunningham et al., "Engaging Communities in Climate Adaptation."

11 Fernandez et al., "Talking Climate Change via Social Media."

12 Innovation Science and Economic Development Canada, "Backgrounder."

13 *Building Resilience: Practical Guidelines for the Sustainable Rehabilitation of Buildings in Canada.*

14 Minister of Supply and Services Canada, "A State of the Environment Synopsis: The Lower Fraser Basin."

15 Minister of Supply and Services Canada.

16 Fraser Valley Regional District and Province of British Columbia, "Experience the Fraser: Lower Fraser River Corridor Project Concept Plan."

17 Minister of Supply and Services Canada, "A State of the Environment Synopsis: The Lower Fraser Basin."

18 Minister of Supply and Services Canada.

19 Maxwell, "Vision For A Restored Lower Fraser: Visualizing the Opportunity to Improve Community Resilience and Ecological Health at Sturgeon Bank."

20 Fraser Valley Regional District and Province of British Columbia, "Experience the Fraser: Lower Fraser River Corridor Project Concept Plan."

Climate change in the Lower Fraser Basin is causing significant impacts, resulting in warmer and drier summers, reduced snowfall, and increased risk of flooding and wildfires[21]. The Pacific Northwest floods of 2021 greatly impacted the province, and in British Columbia this resulted in the evacuation of 17,000 people, along with significant economic and environmental damage[22]. After the devastating flooding, sediment buildup in the channels of the Fraser River became an urgent safety issue[23]. For many people, the floods of 2021 increased the urgency of creating a climate change adaptation plan, with an emphasis on the Lower Fraser Basin[24]. This event exposed severe communication and coordination challenges, particularly in rural communities such as Clayburn Village and the town of Hope. These areas faced difficulties due to a lack of cohesive communication between local authorities, emergency services, and residents. The floods damaged critical infrastructure, such as the dikes and flood barriers, which had already been deemed inadequate by prior assessments. Despite ongoing efforts, many communities remain vulnerable, and the flood exposed gaps in climate communication for disaster preparedness[25]. Due to the site's physical geography, the Lower Fraser Basin, as well as other coastal communities, are particularly vulnerable to changing climatic conditions, as sea level rise and extreme weather events become more powerful and frequent[26].

In the past 20 years, tclimate change in Canada have become more frequent, intense, and impact more of the population. Despite proven scientific research pointing to the anthropogenic drivers of climate change, misinformation and politicisation has contributed to a divide in the public lens[27]. Surveys indicate that a majority of people are willing to take action on climate change[28]. There has been a growing use of social networks to engage communities in government actions through networks such as Facebook and Twitter; however, despite the increasing awareness of social networks, there is limited engagement in relation to climate policy[29]. This can be seen through the lack of urgency and sharing on EmergencyInfoBC's social media feed[30].

21 Austen and Isai, "Vancouver Is Marooned by Flooding and Besieged Again by Climate Change."

22 Dave, "Feasibility of Nature-Based Solutions to Enhance Stó:Lō Flood Resiliency in the Lower Fraser Valley."

23 Hoekstra, "Lower Fraser River Communities Call for Long-Term Dredging Plan and Federal Funding."

24 Dave, "Feasibility of Nature-Based Solutions to Enhance Stó:Lō Flood Resiliency in the Lower Fraser Valley."

25 Olsen, "Two Years after the Storm."

26 Nicholls et al., "Constructing Sea-Level Scenarios for Impact and Adaptation Assessment of Coastal Areas."

27 Intergovernmental Panel On Climate Change (IPCC), *Climate Change 2022 – Impacts, Adaptation and Vulnerability.*

28 Intergovernmental Panel on Climate Change (IPCC).

29 Cunningham et al., "Engaging Communities in Climate Adaptation."

30 "Emergency Info BC (@ EmergencyInfoBC) / X."

1.1. Existing Climate Communication in the Region

Currently, the Lower Fraser Basin lacks an all-inclusive digital platform for public engagement and emergency mapping. The urgency of this matter becomes evident as climate change poses a substantial threat to the southern coastal communities of Canada[31].

If people wish to access updated, specific information regarding severe climate events such as floods or wildfires, they are currently required to access a number of different resources. Some of these resources published by governmental agencies include the British Columbia Wildfire Service Map[32], EmergencyInfoBC[33], the British Columbia Flood Warning and Advisory Warning Map[34], and Severe Weather Alerts published by the Government of Canada[35]. All of these platforms currently have the goal of communicating extreme weather events such as wildfire, flood, heat, and snowstorm warnings. The current resources available vary greatly in textual details, terminology, and temporal resolution.

In addition to governmental agencies, there are a variety of other sources that are actively involved in the communication of climate change. One of the major agencies working within the region of the Lower Fraser Basin is the Fraser Basin Council, which is a non-profit organization which aims to bring people together across British Columbia to find shared solutions which advance sustainability[36].

As a non-profit organization, the Fraser Basin Council facilitates and coordinates a collaborative process in British Columbia's Lower Mainland to implement a regional-scale flood management strategy[37]. This initiative focuses on flood risks associated with the Lower Fraser River as well as coastal storm surge, highlighting the severity of climate change[38]. In this collective effort, there are more than 50 stakeholders involved, including local, First Nations, provincial, and federal governments, in addition to members from the private sector and civil society[39]. Currently, the organization hosts an information portal called FloodWise which focuses on flood risk management[40]. This website is an informational portal that provides public audiences with strategic plans and climate protection resources, as well as essential flood information such as definitions, impacts, and management responsibilities. While this resource may be beneficial, it does not provide live information, lacking as source of information for severe weather events.

31 Intergovernmental Panel on Climate Change, "AR4 Climate Change 2007."

32 "BC Wildfire Service."

33 "EmergencyInfoBC Home - EmergencyInfoBC."

34 Ministry of Environment and Climate Change, "Flood Warnings and Advisories."

35 Environment and Climate Change Canada, "Severe Weather."

36 Fraser Basin Council, "Fraser Basin Council: Strategic Plan 2021-2026."

37 Litke, "Flood Modelling and Mitigation Planning in BC's Lower Fraser River and Southcoast."

38 Litke.

39 Litke.

40 Fraser Basin Council, "FloodWise: BC Lower Mainland Flood Information."

The current climate communication resources in the Lower Fraser Basin spark concern, as the plethora of data is scattered across different agencies and stakeholders. As it currently stands, this unconsolidated network of resources is concerning, especially with the growing risk of climate change.

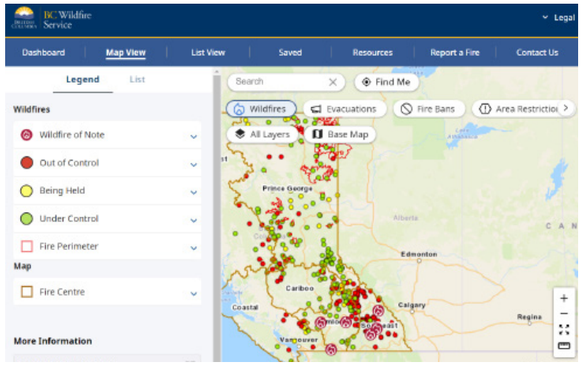


Figure 2. British Columbia Wildfire Service, retrieved from https://wildfiresituation.nrs.gov.bc.ca/map.



Figure 3. EmergencyInfoBC, retrieved from https://www.emergencyinfobc.gov.bc.ca/.

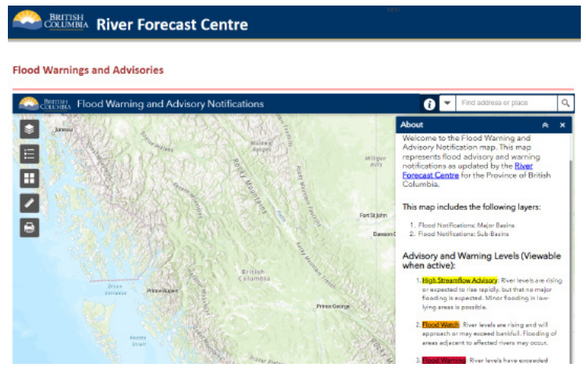


Figure 4. British Columbia Flood Warning and Advisory Warning Map, retrieved from http://bcrfc.env.gov.bc.ca/warnings/index.htm.

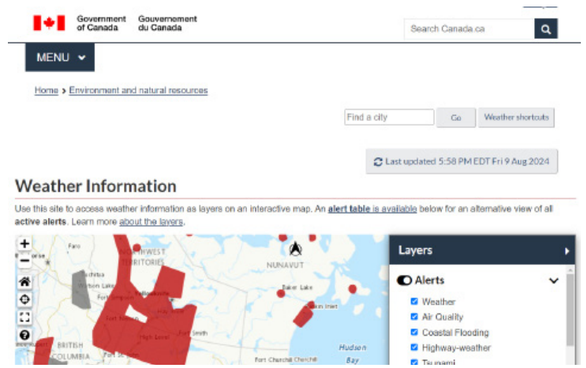


Figure 5. Severe Weather Alerts, retrieved from https://weather.gc.ca/index_e.html?layers=alert.

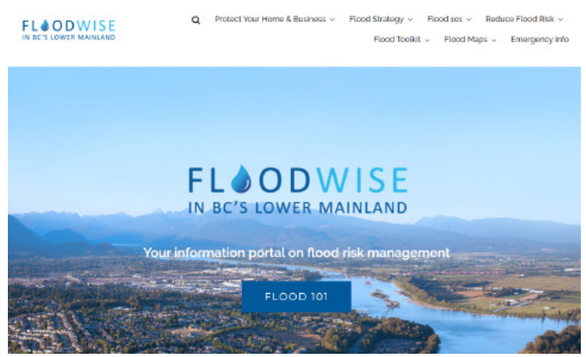


Figure 6. Floodwise, retrieved from https://floodwise.ca/.

1.2. Questions, Objectives, Methods of Study

This research aims to study climate change communication platforms and how the synthesis of specific types of data may contribute to supporting climate literacy. The study will cumulate into a digital communication platform, in which users are able to engage with a spatial toolkit of various infrastructural, meteorological, and community resources in the Lower Fraser Basin for the aim of building climate literacy.

The basis of this design will be based on the existing resources, integrating a typical weather application interface with information from a variety of non-governmental agencies along with local and regional governments, which serve as sources for flood mitigation management. By investigating the various elements, such as specific data about climate risks, time periods, and agencies, the project will re-imagine existing resources, following communication design theories and ensuring that it serves as a collaborative tool for resilience. Promoting awareness of flooding will facilitate extensive education, ensuring that communities can continue to enjoy life by the water[41].

Considering the importance of digital platforms in climate communication, this thesis asks: How can synthesizing climate causes, risks, adaptations, along with meteorological, infrastructural, and ecological information in a climate communication platform for the Lower Fraser Basin help build climate literacy?

The objectives of this research are the following:

1. To develop a digital prototype of a climate communication platform, where synthesized climate information from different agencies, currently distributed across many platforms, can be accessed by users.
2. To develop geographic representations through mapping, presenting vulnerabilities, weather, climate, infrastructure, and other key information in a collective manner for the Lower Fraser Basin with the ability to visualize spatially and temporally.
3. To identify benefits and constraints to support the development of a platform for local climate adaptation.

41 McHarg, *Design With Nature.*



Figure 7. Wildfire between Spences Bridge and Ashcroft, image by BC Wildfire Service, retrieved from https://bc.ctvnews.ca/b-c-braces-for-more-wildfire-activity-with-thunderstorms-in-the-forecast-1.6967726.

2. Climate Change Communication

Climate change is widely recognized as a global threat to ecosystems, human populations, and economies[42]. Global climate change has been greatly impacted by anthropogenic activities. The human influence on the climate is evident from the increased greenhouse gas emissions, observed climate warming, and in our physical understanding of the climate system[43]. The Intergovernmental Panel on Climate Change has stated that it is extremely likely that the observed increase in global mean temperature from 1951 to 2010 was caused by human influence[44].

Initial widespread communication on climate change began upon the establishment of the Intergovernmental Panel on Climate Change in 1988, focused on mitigation efforts, such as interventions to decrease sources and increase the sinks of greenhouse gas emissions[45]. However, by the 2000s, policymakers and researchers began to more heavily promote adaptation efforts, as it became clear that the impacts of climate change were already being felt, particularly in vulnerable regions and marginalized communities[46]. Climate change adaptation refers to strategies in response to realized or expected climate changes that aim to reduce vulnerability[47].

Adaptation is fundamentally different from mitigation because adaptation involves acceptance that climate change is presently occurring[48]. Climate change adaptation focuses on tangible issues, which can have immediate benefits. Increasing awareness of our current ecological crises offers an opportunity to reshape societal value systems[49]. Working on adaptation strategies does not involve agreeing on the cause of climate change, and therefore, has not been as politicized as mitigation efforts[50]. Many international, national, and regional organizations have created adaptation plans, typically driven by top-down decisions and analysis[51]. This includes the Government of Canada's Adaptation Action Plan, which is driven by perspectives of different orders of government to implement 73 federal actions across 22 departments and agencies[52].

Community-based adaptations to climate change have also been created, often using a bottom-up approach to craft adaptations that might be more suitable for implementation in specific contexts[53]. An example present in British Columbia includes the CONEXT program led by the Fraser Basin Council, a new climate preparedness framework to empower community leaders and staff in small, rural and remote

42 Cunningham et al., "Engaging Communities in Climate Adaptation."

43 Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2021 – The Physical Science Basis.*

44 Intergovernmental Panel on Climate Change (IPCC).

45 Plate et al., "Recommendations for Early Phases of Engaging Communities in Climate Change Adaptation."

46 Plate et al.

47 Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2022 – Impacts, Adaptation and Vulnerability.*

48 Plate et al., "Recommendations for Early Phases of Engaging Communities in Climate Change Adaptation."

49 Fernández Galeote et al., "Gamification for Climate Change Engagement."

50 Plate et al., "Recommendations for Early Phases of Engaging Communities in Climate Change Adaptation."

51 Plate et al.

52 Government of Canada, "Government of Canada Adaptation Action Plan."

53 Plate et al.

communities in adapting to climate change and building resilience[54]. Engaging community members, residents, and stakeholders within a local community can increase support, feasibility, and relevance for adaptation strategies[55]. These community-based programs to generate adaptation plans have become more common to address vulnerabilities to climate change in both rural and urban settings[56]. As climate change impacts are felt in the world's most vulnerable regions, community-based processes for climate change adaptations are essential to increasing resilience[57].

While there have been successful climate change adaptation strategies developed from both top-down and bottom-up approaches, implementation requires the acceptance of adaptation plans and policies by local communities, which is currently a significant challenge in adaptation planning and policy development[58]. Despite strong scientific research, there has been a lack of robust policies to address climate change[59]. This points to a clear challenge, in which policymakers cannot address climate change without the public acceptance and trust of the science behind climate change[60]. The urgency of this situation has been reflected in calls to increase climate literacy, in which an understanding of one's influence on climate change is presented[61]. Climate literacy involves the understanding of how our climate system functions in equilibrium. It introduces the fundamentals of climate science, the roles of feedback systems, and the impact of anthropogenic emissions on climate change. Building climate literacy involves fostering awareness of climate impacts, mitigation, and adaptation solutions. It recognizes Indigenous knowledge and leadership, explores governance and justice, and emphasizes shared responsibility for addressing climate change. Having a climate-literate population will allow for critical understanding when approaching scientific arguments about climate[62], using the knowledge to support and advocate for policy.

Despite the clear implications of the individual and household influence on climate change and the urgent need for a societal response, public engagement is currently limited[63]. Many people do not understand the correlation between their individual behaviour and its impacts on the climate, underestimating one's own power to influence climate change[64]. In particular, the lack of self-efficacy is one of the key reasons that prevent people from taking part in efforts regarding the climate change battle[65]. Many people see climate change as an abstract problem with

54 Fraser Basin Council, "CONEXT."

55 Plate et al.

56 Murphy et al., "Engaging Communities and Climate Change Futures with Multi-Scale, Iterative Scenario Building (MISB) in the Western United States."

57 Plate et al., "Recommendations for Early Phases of Engaging Communities in Climate Change Adaptation."

58 Moser and Dilling, "Toward the Social Tipping Point."

59 Cooper, "Media Literacy as a Key Strategy toward Improving Public Acceptance of Climate Change Science."

60 Cooper.

61 National Oceanic and Atmospheric Administration (NOAA) and American Association for the Advancement of Science (AAAS), *Climate Literacy: The Essential Principles of Climate Science.*

62 National Oceanic and Atmospheric Administration (NOAA) and American Association for the Advancement of Science (AAAS).

63 Fernandez et al., "Talking Climate Change via Social Media."

64 Fernandez et al.

65 Fernandez et al.

distant consequences, in which one's own actions and advocacy will not matter at an individual level. There needs to be a shift in climate change communication strategies to highlight how a person's actions can make a great impact[66].

66 Fernandez et al.

There has been growing recognition and discussion regarding the use of social networks to engage communities in climate actions[67]. Many campaigns and initiatives have emerged in recent years which aim to involve individuals closely in the education of this problem[68].

67 Cunningham et al., "Engaging Communities in Climate Adaptation."

68 Fernandez et al., "Talking Climate Change via Social Media."

In Canada, the lack of coordination between the federal government and major organizational clusters such as environmental groups, forestry, provincial governments, and research organizations cause future of climate change action to be uncertain, where efforts are delayed or underfunded, hindering the collective progress towards addressing climate change[69]. Studies have also shown that there is a widening gap between the public awareness of action that is needed and action that is being taken[70]. Additionally, there is a hesitancy to the climate information that one may have access to[71]. This makes the potential options to overcome these barriers more appealing, as engaging local communities in climate action will be critical to the success of climate adaptation[72].

69 Wellstead and Stedman, "Coordinating Future Adaptation Policies across Canadian Natural Resources."

70 Cunningham et al., "Engaging Communities in Climate Adaptation."

71 Cunningham et al.

72 Sherman and Ford, "Stakeholder Engagement in Adaptation Interventions."

Climate change and political polarization are two of the most critical issues in the twenty-first century[73]. Political opinions on climate change often turns into a partisan issue, with different political groups adopting contrasting views on its causes, risks, and solutions. This leads to the undermining or resistance of climate literacy efforts, making it harder to achieve consensus on climate policies. This division can stifle delay collective action to address the climate crisis.

73 Falkenberg et al., "Growing Polarization around Climate Change on Social Media."

Strong social networks, such as Facebook, have been shown to improve collaborative governance processes, as they facilitate the acquisition and diffusion of information[74]. Raising awareness for climate change using social networks has been shown to prompt individual and collective action[75]. A highlighted recommendation is the ability to not only make users aware of the subject, but to also be aware of the various options available for them to act upon[76]. In the case of campaigns for climate change, this may be complex as it is a broad subject that represents various narratives, which are connected to multiple actions that one may take[77]. Creating an engaging campaign involves following the six principles of contagiousness, known as STEPPS. This involves social currency, triggers, emotional resonance, public, practical value, and storytelling[78]. Environmental campaigns not only aim to promote awareness, but also to instigate changes in one's behaviour. Different scientific fields, including psychology, anthropology, sociology, and philosophy have attempted to understand the forces that influence one's behaviour regarding environmental protection[79]. The 5 Doors Theory focuses on five conditions that must be present in a cycle of behavioural changes, which include desirability, enabling context, can do, positive buzz, and invitation[80]. Intervention strategies are used to incite changes in behaviour. Based on prior research on climate change campaigns on social platforms, there are a set of interventions that prove to be effective, such as providing information, encouraging discussion, public commitment, and social feedback[81].

74 Cunningham et al., "Engaging Communities in Climate Adaptation."

75 Fernandez et al., "Talking Climate Change via Social Media."

76 Fernandez et al.

77 Fernandez et al.

78 Fernandez et al.

79 Fernandez et al.

80 Fernandez et al.

81 Fernandez et al.

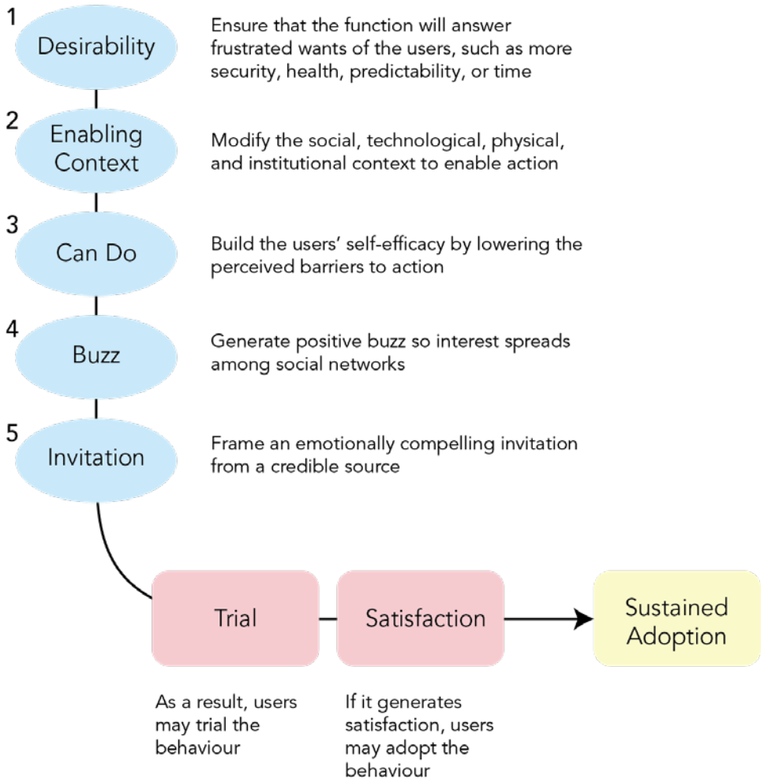


Figure 8. Five Doors Theory, image by author, 2024.

Using digital platforms to engage communities in climate change adaptations can be advantageous, as the information being shared is likely to be trusted through existing social networks[82]. When extreme weather events occur, it has been shown that there is an influx of people turning to social media platforms to share information, opinions, and experiences[83].

The use of crowdsourced data platforms in diverse communities can address marginalization in managing climate change adaptation[84]. By providing a digital platform where participants can contribute to climate change policy, residents from marginalized communities will have the opportunity to participate in governance[85].

82 Cunningham et al., "Engaging Communities in Climate Adaptation."

83 Roxburgh et al., "Characterising Climate Change Discourse on Social Media during Extreme Weather Events."

84 Dixon, Johns, and Fernandez, "The Role of Crowdsourced Data, Participatory Decision-Making and Mapping of Flood Related Events."

85 Dixon, Johns, and Fernandez.

2.1. Literature Review of Communication Design

Effective communication is widely known as the exchange of ideas that garners mutual understanding[86]. In the realm of spatial representation, climate change communication plays a crucial role in the understanding of climate change. By studying communication design, the key takeaways will clarify and provide a deeper understanding of climate change communication strategies. In climate-responsive spatial projects, visual design guidelines can help to better understand the complexity of climate change, translating it into legible visual information. In recent years, visual communication in climate-responsive design has been a topic of discussion, as well as the need to develop visual design guidelines to inform urban design and landscape architecture communication[87].

The current research covers the presence of User-Centered Design (UCD) and Climate-Focused User Experience (UX) design. By synthesizing principles from the diverse range of topics, a set of design principles will be identified to address the needs for a climate communication platform in the Lower Fraser Basin.

86 Fletcher, *Visual Communication for Architects and Designers.*

87 Cortesão et al., "Visual Guidelines for Climate-Responsive Urban Design."

2.1.1. User-Centered Design

To successfully communicate the complexity of climate change impacts, there must be a high level of knowledge, data, and information sharing between scientific disciplines and researchers, policy makers, and practitioners[88]. The production of tailored visuals developed for a specific user group is increasingly being promoted to enhance knowledge sharing, especially within the field of environmental management[89].

A software-developed platform is a prescriptive model that can exist to coordinate people involved in the communication of climate change[90]. User-Centered Design (UCD) is a design methodology that prioritizes usability requirements, using them to drive the features and technical development of digital platforms[91]. It is a software design methodology for designers and developers, helping them to create applications that meet the needs of their users[92]. UCD initially emerged from Human-Computer Interaction (HCI), which focuses on how humans relate to computing products[93]. Akin to how design fitting a human body is known as an ergonomic fit, design fitting one's senses, deductive ability, and memory is known as a cognitive fit[94].

UCD is evident in many digital projects that people interact with on a daily basis. An example of this design theory is present in Duolingo, an application designed for learning languages[95]. The developers created a simple design interface to address a range of users since people of any age and from any country can learn a new language. The designers studied methods in order to encourage engagement, including accessible graphics and the gamification of the content. Having interactive elements and an accessible interface for users from diverse backgrounds represents the need to have a customized experience to satisfy the intended users.

The UCD approach also allows for an opportunity to study the design's effectiveness with its intended users through various steps. This involves identifying the user needs, designing solutions to those needs, evaluating the solutions, and iterating through prototypes of interface design. In software development, prototyping refers to the creation of multiple software iterations, which are normally in progress, that allow developers to test different versions of the product with users throughout the various stages of development[96]. Prototypes allow users to evaluate the proposed interface design by actual testing, rather than having to interpret the design based on descriptions[97]. This allows for dialogue between the users and the developers, ensuring that a highly user-friendly platform is generated in an iterative design process. The UCD approach works by challenging subjective assumptions about user behaviour, requiring proof that the designer's design decisions are effective[98]. By relying on data to support the design decisions, assumptions can be removed, and the usability can be statistically proven[99].

User Experience (UX) is one of the products that has emerged out of UCD, including the user's entire experience with the product, as well as any physical and emotional reactions[100]. Visual products that are designed with explicit user consideration are perceived to be more interesting, clear, and useful than products designed without consideration of their representative group[101]. UCD is relevant when building a climate communication platform for the Lower Fraser Basin due to the intention to cater towards a specific geography and demographic. Implementing a human-centered design offers a streamlined pathway to building climate literacy.

88 Verweij, Marinova, and Lokers, "User Centered Design: Tools for Encouraging Climate Change Adaptation."

89 Grainger et al., "Tailoring Infographics on Water Resources Through Iterative, User-Centered Design."

90 Verweij, Marinova, and Lokers, "User Centered Design: Tools for Encouraging Climate Change Adaptation."

91 Verweij, Marinova, and Lokers.

92 Lowdermilk, *User-Centered Design.*

93 Lowdermilk.

94 Pratt and Nunes, *Interactive Design.*

95 "Duolingo."

96 Schach, *Object-Oriented and Classical Software Engineering.*

97 Verweij, Marinova, and Lokers, "User Centered Design: Tools for Encouraging Climate Change Adaptation."

98 Lowdermilk, *User-Centered Design.*

99 Lowdermilk.

100 Lowdermilk.

101 Grainger et al., "Tailoring Infographics on Water Resources Through Iterative, User-Centered Design."

2.1.2. Climate-Focused User Experience Design

User Experience (UX) design emphasizes triggering perception via several senses, creating pleasant anticipation, meeting psychological needs, allowing a learning process, ensuring usability, and generating a technical advance[102]. The idea of UX design is to achieve a positive emotional reaction of users, typically on product interaction to create selling proposition[103]. However, this application may also be used in climate change communication, where the emotional reception received will inform and encourage users to take action. In recent years, there has been an emergence of climate-focused user experience design, which represents a key approach to addressing climate concerns in an increasingly digitally connected world[104]. This can be seen in several examples, including in navigational applications such as Google Maps or Uber. The design implementation of bringing a more sustainable option to the forefront can nudge users in a climate-conscious direction.

By integrating climate-related information with engaging interfaces and behavioural design, Climate-Focused UX design seeks to create a connection between users and environmental issues. By incorporating persuasive design elements, these features can motivate users to act and foster a collective movement towards a more sustainable future. There are several key principles that are essential to Climate-Focused UX design, which inspire meaningful engagement and positive action, which include clarity, compelling visuals, interactive elements, personalization, and transitions from awareness to action[105].

In Climate-Focused UX design, it is important to prioritize clarity in conveying complex environmental information by making it understandable to a broad audience of people with various degrees of knowledge. It is also important to incorporate compelling visuals such as real-world imagery to evoke an emotional response that will resonate with the users' values. Having interactive elements will encourage explorational and experiential learning, which results in the understanding different environmental challenges. Short animated visualizations gather more interest in the realm of climate communication, and can be a key part of the design experience[106]. By personalizing the site to the proposed end-user, including tailored content will ensure that information will be relevant to individual interests. To facilitate transitions from climate awareness to action, there must be ways to easily access resources and feedback mechanisms to empower the users.

102 Saucken et al., "Principles for User Experience Design."

103 Saucken et al.

104 Piduru, "Climate-Focused User Experience (UX) Design: Leveraging Adobe Experience Cloud for Sustainable Engagement."

105 Piduru.

106 Cortesão et al., "Visual Guidelines for Climate-Responsive Urban Design."

Literature regarding climate change communication, specifically in Climate-Focused UX, states that visual clarity, trust, and interest are core theoretical ideas for the successful visual communication of information[107]. Visual clarity consists of balancing the level of detail, components and balance between site-specificity and abstraction. To effectively convey the core principle of trust, it is essential to make microclimatic processes visible without distorting them. In weather applications such as Apple Weather, straightforward icons of different meteorological conditions play a key role in the understanding of data. The use of icons allows for the graphical interpretation of forecasted weather without excessive information that may not be relevant.

A key component of UX design is the implementation of user groups and personas to design for a specific audience. This information may include characteristics such as wants and needs, or for a site-specific project, information like location and demographics can be beneficial for development. Personas represent archetypal users and play an important role in facilitating the understanding of user behaviours, needs, motivations, characteristics, and limitations[108]. Creating a small set of personas can make real users more tangible and facilitate empathy from the development team[109]. These personas allow for the user research and data to be humanized, enabling the creation of understandable representations for the targeted audience.

It is also important to note that climate communication is not a one-size-fits-all. Culture can be one of the most important aspects that communication designers should take into consideration when developing materials for an audience[110]. As designers, we cannot assume a single acceptable way to communicate, nor can we assume that communication is universal and works with all cultures[111]. There must be an understanding of the local ways of communication for an effective climate communication platform to exist, which makes a varied set of user personas beneficial. By taking this into account and setting a clear correspondence between theoretical concepts, representation objectives, and options, visual design guidelines for climate change communication can be beneficial[112]. Climate-Focused UX is relevant when building a climate communication platform for the Lower Fraser Basin due to the development of user personas and visual imagery specifically designed for the target audience.

107 Cortesão et al.

108 Bradley et al., "A New Perspective on Personas and Customer Journey Maps.

109 Bradley et al.

110 St. Amant, "Introduction to the Special Issue."

111 St. Amant.

112 Cortesão et al., "Visual Guidelines for Climate-Responsive Urban Design."

2.2. Key Examples of Climate Change Communication Platforms

Climate change impacts can cause detrimental damage to human populations through various means depending on one's geography, culture, governance structures, and demographics[113]. These impacts can vary, from rising sea levels, wildfires, increases in precipitation and temperature, along with other hazards to the environment[114]. Based on the context of this research, the following review of climate change communication platforms has been selected due to their representation of climate change impacts in today's digital landscape. The specific platforms studied are PetaBencana.id, the Ontario Climate Change Data Portal, Apple Weather, Surging Seas, U.S. Climate Resilience Toolkit, Waterfront Justice Project, Louisiana's 2023 Coastal Master Plan, and Fluxland. These platforms include meteorology sites, community mapping platforms, as well as mapping tools that inform users about urban infrastructure and flood risk. The design of the project will form as a hybrid of the above platforms. This range of platforms have emerged in recent years for the visualization of extreme weather scenarios and provide insight to the capabilities of current tools.

113 Smit and Wandel, "Adaptation, Adaptive Capacity and Vulnerability."

114 Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2022 – Impacts, Adaptation and Vulnerability.*

Name	Location	Purpose	Data Source	Platform	Category
PetaBencana.id	Indonesia	To collect insights from various channels into one interface, presenting a platform of disaster scenarios, empowering residents, humanitarian organizations, and authorities to make well-informed decisions during critical situations.	Government Agencies, NGOs, Crowdsourcing	Website	Community Disaster Mapping
Ontario Climate Change Data Portal	Ontario, Canada	To provide easy and intuitive access to the latest climate data in the Province of Ontario with both technical and non-technical end users at various temporal resolutions.	PRECIS Model	Website	Projected Data Mapping
Waterfront Justice Project	New York and New Jersey, United States	To draw attention to climate vulnerabilities through mapping, while calling for local policy changes. The maps document land use, environmental hazards, and demographic and socio-economic indicators in relation to Significant Maritime Industrial Areas (SMIAs) and hurricane storm surge zones.	New York City Environmental Justice Alliance (NYC-EJA) and the Scientist Action and Advocacy Network (ScAAN)	Website	Flood Risk Mapping
Louisiana's 2023 Coastal Master Plan	Louisiana, United States	To educate users regarding the land changes in Louisiana over time, with different parameters and scenarios.	Louisiana Coastal Protection and Restoration Authority	Website	Flood Risk Mapping
Surging Seas: Risk Zone Map	United States	To show areas vulnerable to near-term flooding from different combinations of sea level rise, storm surge, tides, and tsunamis, or to permanent submersion by long-term sea level rise.	Climate Central and US National Oceanic and Atmospheric Administration	Website	Flood Risk Mapping
Fluxland	Broward County, Florida, United States	To increase awareness and bridge the gap between different stakeholders of urban development by showing various datasets in relation to climate change.	Urban Risk Lab at Massachusetts Institute of Technology and the Center for Landscape Research at the University of Toronto, supported by Broward County	Website	Urban Development Mapping Platform
U.S. Climate Resilience Toolkit	United States	To improve users' ability to understand and manage climate-related risks and opportunities, and to help users make their communities and businesses more resilient to extreme events through a number of resources and spatial representations.	US National Oceanic and Atmospheric Administration (Climate Program Office)	Website	Climate Risk Data Portal
Apple Weather	Global	To check the weather in the users' current location, view upcoming hourly and 10-day forecasts, severe weather information, news, air quality, precipitation, and additional weather information.	Apple Data and Government Agencies	Application	Weather Forecast and Alerts

Figure 9. Key Examples of Climate Communication Platforms, image by author, 2024.

2.2.1. PetaBencana.id

PetaBencana.id is an online platform that generates real-time disaster maps by combining reports from both the public and government agencies[115]. Using social media and instant messaging during crises, the platform collects verified updates directly from residents on the ground, eliminating the need for costly and time-consuming data processing. These authenticated user accounts are presented with emergency information sourced from local and governmental entities. Through amalgamating insights from various channels into one interface, PetaBencana.id presents a platform of disaster scenarios, empowering residents, humanitarian organizations, and authorities to make well-informed decisions during critical situations[116].

PetaBencana.id was first launched in Indonesia in 2016 and has since grown to serve other regions. Indonesia suffers hundreds of extreme weather events each year, and in 2004, an Indian Ocean tsunami killed over 167,000 people[117]. Indonesia is home to over 257 million residents, with 112 million active internet users, who access the internet from both urban and rural areas[118]. As a country, its residents have become accustomed to social media networks, having the highest number of Facebook active users worldwide and the highest number of active Instagram users in the Asia Pacific region[119]. Due to Indonesians' active social media usage as a form of self-actualization and socialization, formal institutions and humanitarian agencies regularly monitor social media in order to respond to emergency situations through the users' status updates[120]. During the monsoon season, immediate response and evacuation efforts are coordinated at a neighbourhood level, working as a mutual support network[121]. Residents and community groups have made it clear that there is a distrust of data-collection projects, especially due to Indonesia's colonial history, where extracted knowledge from the local residents result in little benefits for the community[122]. In addition to this, political corruption and social inequality have created a culture of distrust between the government and its citizens[123]. Therefore, it is no surprise that studies show that in event of disaster, residents do not rely on help from government agencies or NGOs, instead using social media to self-organize, avoid danger, and collectively reduce risk[124].

With the penetration of social media in Indonesia, mutual support networks are able to operate on digital landscapes. The easy access of smartphones and social media have become an essential part of localized mutual support networks that work to prevent and, when necessary, respond to emergencies[125]. By harnessing the power of social media as a form of humanitarian response, PetaBencana.id gathers, sorts, and visualizes disaster information from a variety of social media and instant messaging platforms, triggered by listening for specific keywords. By providing open data and access to information, users are no longer limited to daily disaster updates from the top level of government agencies, but instead can share and receive information laterally and in real-time[126]. The platform can streamline the existing flows of visualized flood data, while also collecting new resident reports which inform the collective mapping of extreme weather events[127].

115 Hidayat, "Petabencana.Id in Flood Disaster Management."

116 Hidayat.

117 Taylor, "Saving Indonesians from Climate Disasters, One Social Media Post at a Time."

118 Fadmastuti, "Selfies Save Lives (Digital Strategies for Flood Response in Indonesia)."

119 Fadmastuti.

120 Fadmastuti.

121 Mahtani and Holderness, "Multiperspectival Cartographies for Democratic Climate Adaptation."

122 Mahtani and Holderness.

123 Mahtani and Holderness.

124 Fadmastuti, "Selfies Save Lives (Digital Strategies for Flood Response in Indonesia)."

125 Fadmastuti.

126 Fadmastuti.

127 Fadmastuti.



Figure 10. PetaBencana Flood Report Cards, image by Mahardika Fadmastuti, accessed from "Selfies Save Lives (Digital Strategies for Flood Response in Indonesia)." IOP Conference Series: Earth and Environmental Science 338 (November 24, 2019): 012040. https://doi.org/10.1088/1755-1315/338/1/012040.

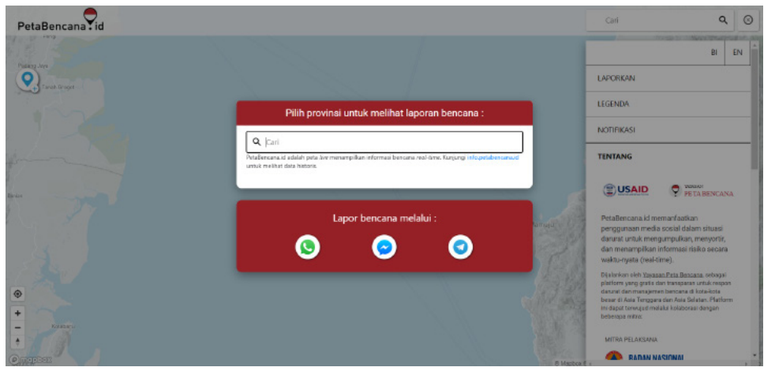


Figure 11. PetaBencana.id Disaster Map Landing Page, retrieved from https://petabencana.id/.

Using a developed bot, PetaBencana.id is able to listen to specific keywords during an emergency event from a variety of sources, such a social media platforms, local apps, and instant messaging services[128]. It is designed so that users can simply do what they had been doing prior, which is posting on social media and spreading the news with their contacts. Research has shown that during emergencies, residents are less likely to adopt new applications, and they tend to use their existing resources with increased frequency to stay up to date with information[129]. The ability of the software to gather information across a variety of sources eliminates the roadblocks that may occur when training users to use new apps for emergency reporting. By having a chat bot integrated into the social media and messaging platforms, PetaBencana.id can simplify the process of emergency reporting and produces a form of AI-assisted civic co-management[130]. The platform has been able to serve as a coordinated source of information for both agencies and residents, bypassing the traditional centralized model in favour of a decentralized one.

A key feature of this tool is the ability to define the location of individual users, with the integration of live mapping. Thus, these elements allow for real-time data to be disseminated, resulting in an experiential experience for users to interact with. As a crowdsourced mapping platform, different users are able to access live information submitted by those in the region, allowing for a collective experiential emergency mapping platform to be established. The integration with existing social infrastructure, visual clarity, and live mapping features are key elements that can be used to inform a climate communication tool.

128 Fadmastuti.

129 Fadmastuti.

130 Fadmastuti.

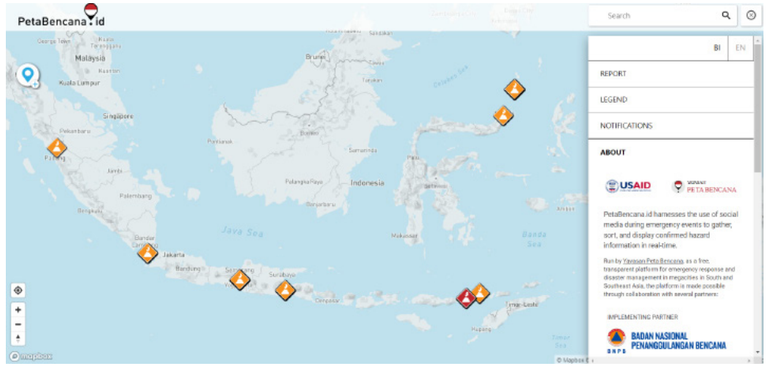


Figure 12. PetaBencana.id Disaster Map, retrieved from https://petabencana.id/.

2.2.2. Ontario Climate Change Data Portal

The Ontario Climate Change Data Portal is a climate change communication platform which presents scientifically projected climate information. The site was launched in January 2014 by Dr. Xander Wang, who had aimed to provide easy and intuitive access to the latest climate data in the Province of Ontario with both technical and non-technical end users[131]. The platform allows for visual representation through geospatial maps and data downloading for a variety of climate variables at different temporal resolutions. This includes looking at temperature, precipitation, relative humidity, solar radiation in annual, seasonal, monthly, daily, and hourly increments[132]. The Ontario Climate Change Data Portal has received more than 17,200 downloading requests from over 180 registered users as of January 2016. The users requesting this information included academics, municipal and provincial agencies, non-government agencies, and private sectors[133].

Climate models are essential when projecting future climatic changes under different scenarios[134]. In the Ontario Climate Change Data Portal, high-resolution regional climate simulations were produced using the PRECIS model, which considers both the atmosphere and land surface components of the climate system[135]. The PRECIS model has been shown to performs very well in simulating the observed annual precipitation[136]. Using the model can provide helpful information for assessing the potential effects of climate change in the context of Ontario[137].

131 Wang et al., "GIS-Based Data Portal for Climate Change Impact Assessment."

132 Wang et al.

133 Wang et al.

134 Wang et al., "Probabilistic Projections of Regional Climatic Changes over the Great Lakes Basin."

135 Wang et al.

136 Wang, Huang, and Liu, "Twenty-First Century Probabilistic Projections of Precipitation over Ontario, Canada through a Regional Climate Model Ensemble."

137 Wang, Huang, and Liu.



Figure 13. Ontario Climate Change Data Portal: Mean Temperature, retrieved from http://ontarioccdp.ca/.

The use of projected, scientifically backed information for public viewing provides an insight to future climate projections, which will evoke an emotional response. These elements, with the ability to engages users with explorational and experiential learning will allow users gain an understanding of environmental challenges through temperature changes in their community. The high level of visual engagement that is present in this platform allows users to connect with others through the crowd-sharing element, which in turn provides visuals that will evoke an emotional response, therefore leading to user empowerment.

This platform succeeds in its goal of representing climate changes in a future time period, backed by scientific research. The presentation of projected data in a climate communication platform is beneficial as it provides a future temporal scope for users to envision the lasting effects of climate change, and is a key element that can be carried forward in this thesis.

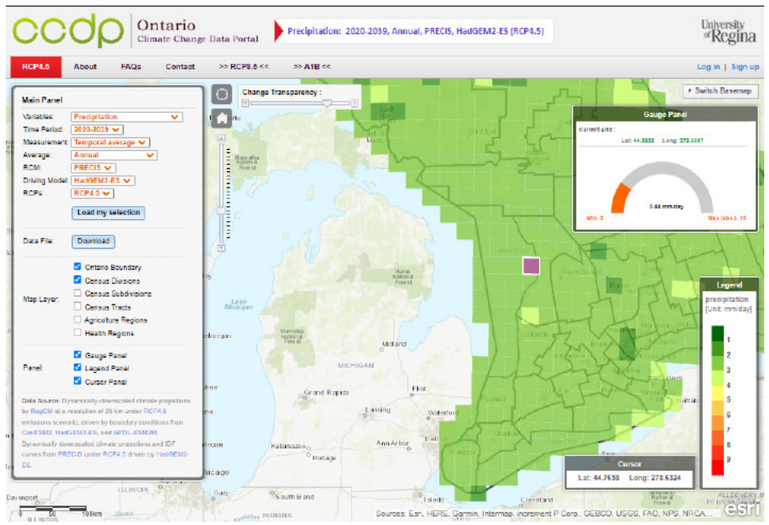


Figure 14. Ontario Climate Change Data Portal: Precipitation, retrieved from http://ontarioccdp.ca/.

2.2.3. Waterfront Justice Project

The Waterfront Justice Project is a collaborative effort between the New York City Environmental Justice Alliance (NYC-EJA) and the Scientist Action and Advocacy Network (ScAAN). This project includes a website, in which users can access a waterfront map that showcases a variety of sites which are vulnerable to severe impacts due to climate change. The site aims to identify points of community vulnerability in and around significant maritime and industrial areas[138].The goal of this project is to create a framework for climate-resilient industrial waterfronts, hoping to reproduce these strategies across the United States[139].

The platform consists of a series of thematic narratives across a multitude of sites, representing various parameters and temporal resolutions. The highlighted areas shown on the website uncover concerns such as toxic hazards, highlighting how these waterfront spaces disproportionately impact people of colour. The site has an interactive interface which is also coupled with a series of slides that moves in conjunction with the scaling of the map. This allows the data to be presented in a clear way, while still allowing the user the flexibility to interact with the platform freely.

The platform's feature of being able to view more information about each highlighted zone is informative to users and creates an accessible way of understanding data from various agencies, making it a key agenda to include in the design of a climate communication platform.

138 "Scientist Action and Advocacy Network | ScAAN."

139 Bautista, Osorio, and Dwyer, "Building Climate Justice and Reducing Industrial Waterfront Vulnerability."

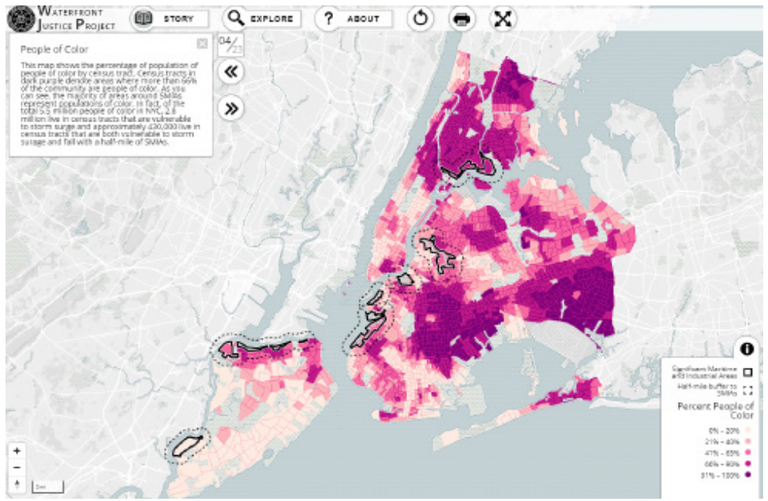


Figure 15. Waterfront Justice Project, retrieved from https://scaan.net/waterfrontmap/.

2.2.4. Louisiana's 2023 Coastal Master Plan

Over 2000 square miles of land in Louisiana has succumbed to the Gulf of Mexico since the 1930s, due to anthropogenic and environmental factors. This presents a devastating loss, which has been exacerbated by climate change and extreme weather events. After Hurricanes Katrina and Rita devastated coastal Louisiana in 2005, the Louisiana Legislature created the Coastal Protection and Restoration Authority (CPRA), who acts as a coordinator between federal, state, and local restoration efforts[140]. The CPRA has developed a series of Coastal Master Plans over nearly two decades, with the goal of evaluating and planning the wide variety of projects along the coast of Louisiana[141].

To preserve its rich history, culture, ecosystems, and natural resources that are at risk due to climate change, the Coastal Protection and Restoration Authority published its 2023 Coastal Master Plan to communicate its evaluation and adaptation goals[142]. There is an interactive online companion to the plan, which is a data viewer which presents projections of coastal change over 50 years, along with the potential impacts of restoration and risk reduction projects to address the challenges of land loss and coastal flood risk[143].

140 SCAPE, "2023 Coastal Master Plan."

141 SCAPE.

142 "2023 Coastal Master Plan."

143 "Louisiana's 2023 Coastal Master Plan Data Viewer."

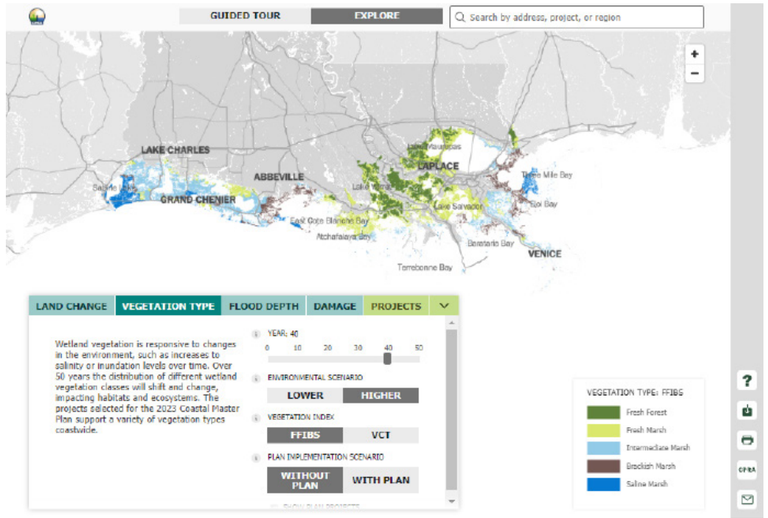


Figure 16. Louisiana's 2023 Coastal Master Plan, retrieved from https://mpdv.coastal.la.gov/.

The online companion allows for users to visualize the data, without having to manually adjust parameters, streamlining the process of understanding complex data. Rather than focusing on specific layers, the platform focuses on cause and effect, which can evoke an emotional response in users due to their ability to explore the platform with variables of their own choosing. The website states the outcomes of the region with and without the proposed plan in place, allowing users to gain an understanding of the different scenarios that the region could face in the future based on current decisions.

Louisiana's 2023 Coastal Master Plan is particularly relevant when building a climate communication platform for the Lower Fraser Basin due to the simplicity of the presented information. Rather than offering a number of different parameters for the users, which may be overwhelming, the platform focuses on the bigger picture of climate change. This form of communication is impactful and accessible, allowing users with varied levels of knowledge to be able to understand the consequences of our present actions.

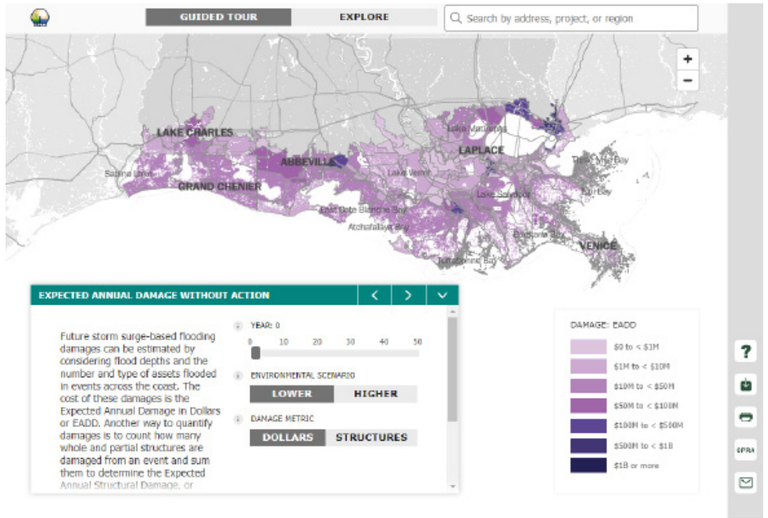


Figure 17. Louisiana's 2023 Coastal Master Plan Tour, retrieved from https://mpdv.coastal.la.gov/.

2.2.5. Surging Seas: Risk Zone Map

Surging Seas was initially launched in 2012 by Climate Central as the first interactive map which presented sea level and coastal flood risk information across the contiguous United States. Backed by peer-reviewed scientific sources, the website strives to provide accurate and clear information about sea level rise and coastal flood hazards at various temporal resolutions[144].

144 "About | Surging Seas."

The Surging Seas: Risk Zone map shows areas vulnerable to near-term flooding from different combinations of sea level rise, storm surge, tides, and tsunamis, or permanent submersion by long-term sea level rise. In the United States, it incorporates the latest, high-resolution elevation data supplied by the National Oceanic and Atmospheric Information. It has the capability to display points of interest, containing layers displaying social vulnerability, population density, and property value. It provides the ability to search by location name or postal code[145].

145 "Surging Seas."

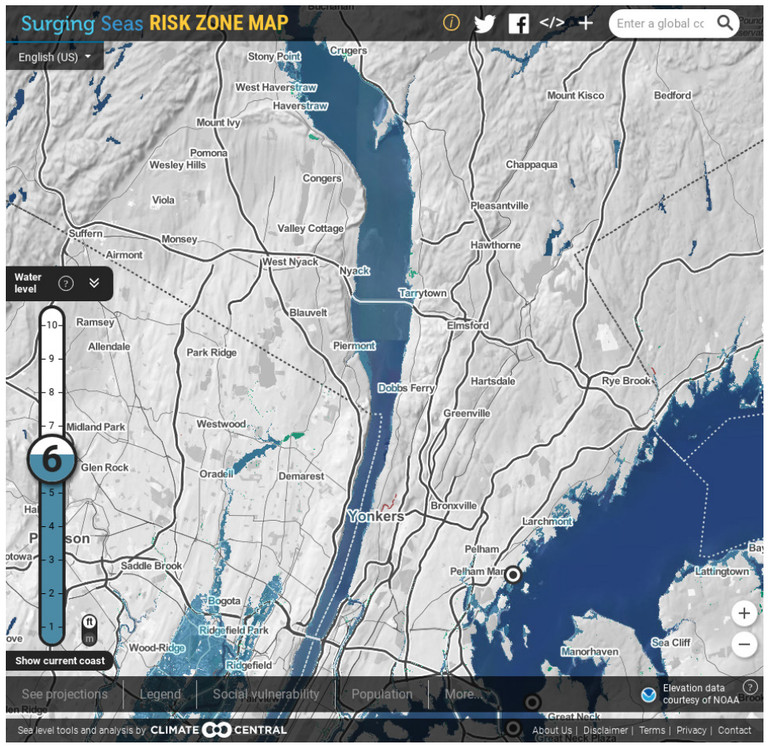


Figure 18. Surging Seas Risk Zone Map, retrieved from https://sealevel.climatecentral.org/.

This platform is able to consolidate information across the United States into one platform. The ability for the user to adjust various parameters for the visualization of sea level rise is critical to the platform, as it allows users to view visual data in relation to one's geographical location. In addition, the ability for the website to provide further, detailed information regarding a specified location is a form of effective data representation.

This communication tool encourages user interactivity, which is a notable feature that allows users to customize their experience on the platform, providing a personalized experience through the ability to visualize data. Having a tailored experience for the user allows one to access resources that are relevant to individual interests. This form of climate change communication is successful in conveying complex data and prioritizing a human-centered design approach, which is a beneficial takeaway that can be applied to a communication tool for the Lower Fraser Basin.

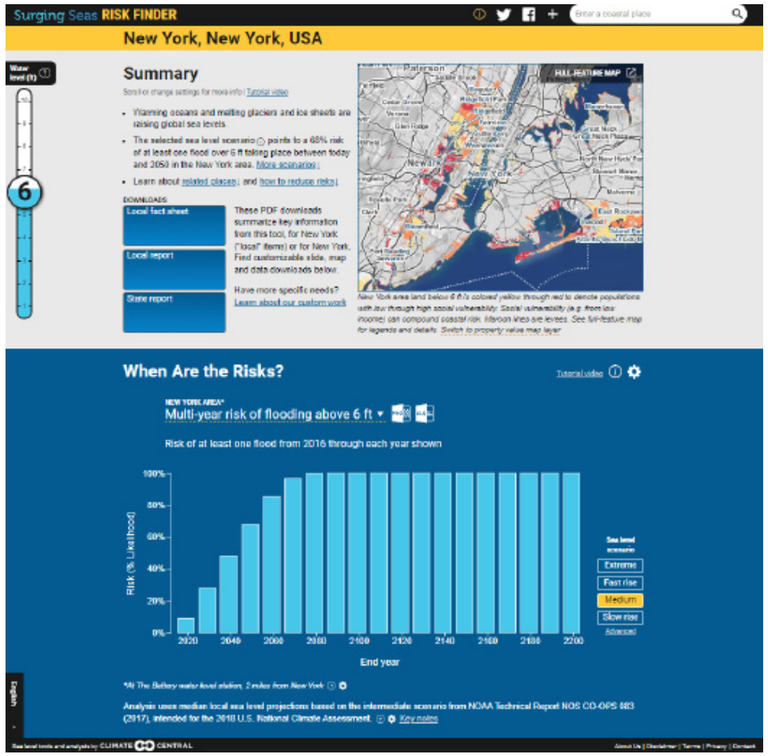


Figure 19. Surging Seas Risk Finder, retrieved from https://sealevel.climatecentral.org/.

2.2.6. Fluxland

Fluxland is an interactive geo-socio-spatial platform designed by the Urban Risk Lab at Massachusetts Institute of Technology and the Center for Landscape Research at the University of Toronto. The platform was designed to increase awareness and bridge the gap between different stakeholders of urban development through a data-driven, collaborative, web-based toolkit for decision making across different scales and stakeholders[146].

The platform was designed to communicate the growing risk of climate change in Florida, where three-fourths of the population resides in coastal areas[147]. Climate change poses a great threat to the region, impacting the saltwater intrusion levels and therefore threatening infrastructure[148]. In order to address the potential adaptability of the urban fabric to the vulnerabilities of climate change, the team worked with the County Office of Environmental Licensing in Broward County, Florida[149]. With the goal of connecting planning and policy-level data with citizens, the platform presents opportunities of cross-departmental decision making, participatory planning, and civic engagement[150]. Having an interactive platform allows for users to explore the various impacts that sea level rise may have on the county's stormwater management, infrastructure, and development potential.

The platform's essential information is clearly displayed to ensure easily interpretable data. In addition, the consolidation of information that is available allows for users to engage in data outside of typically defined political boundaries, which is an important takeaway for the design of a tool in the Lower Fraser Basin.

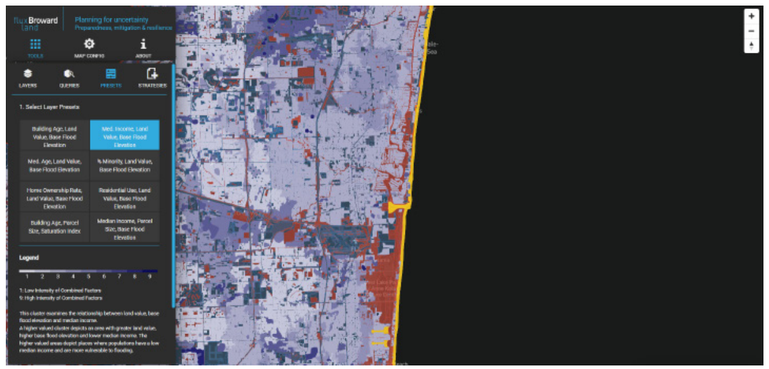


Figure 20. Fluxland, retrieved from https://broward.flux.land/.

146 MIT Urban Risk Lab, "FluxLand."

147 MIT Urban Risk Lab.

148 MIT Urban Risk Lab.

149 MIT Urban Risk Lab.

150 MIT Urban Risk Lab.

2.2.7. U.S. Climate Resilience Toolkit

The U.S. Climate Resilience Toolkit is a federal website which was launched in 2014 for state and local policymakers to improve the capacity of resilience to climate-related hazards[151]. It is the first of its kind to bring together data from multiple federal agencies into a decision support platform, focusing on framing climate adaptation and resilience. The online toolkit focuses on various subcategories, allowing users to access different resources when building climate resilience. This toolkit is a website which is designed to help people find and use tools, information, and subject matter expertise in order to promote climate literacy[152]. The site provides data and information throughout the United States government in one location.

It is an innovative platform which connects different stakeholders which may vary in their motivation, expertise, agency, and level of technical capability[153]. The toolkit is able to bridge the knowledge gap between scientific data, decision-support tool, and emerging best practices that are central to the adaptive capacity of the public, private, and civic sectors that are present in the United States[154]. The toolkit was created to integrate, contextualize, and design the information in ways that would make it accessible to varying audiences to find and use[155].

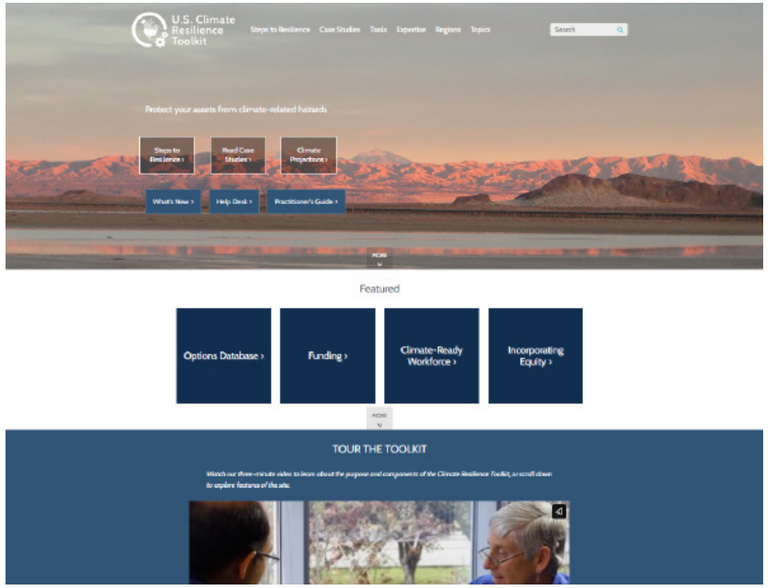


Figure 21. U.S. Climate Resilience Toolkit Home Page, retrieved from https://toolkit.climate.gov/.

151 Gardiner, Herring, and Fox, "The U.S. Climate Resilience Toolkit."

152 "About | U.S. Climate Resilience Toolkit."

153 Marshall et al., "Helping Communities Build Climate Resilience with a Toolkit of Scientific and Local Knowledge."

154 Marshall et al.

155 Marshall et al.

The purpose of the site is to improve users' ability to become climate literate through understanding and managing their climate-related risks and opportunities. By doing so, this allows users to make their communities and businesses more resilient to extreme weather events[156]. The platform has been able to provide data and tools into context for decision makers, framing climate resilience within risk management, focusing on end user's stories, and direct engagement with users[157]. This has been evident in adaptation plans brought out by the governmental agencies for the cities of Houston and Oklahoma City.

Using a blend of literature review and real-world consultations with communities, the U.S. Climate Resilience Toolkit developed a Steps to Resilience framework which identified risks and exposure due to climate-related hazards. The development of the toolkit emphasized audience engagement, which provided mutual benefits for users and developers of the Climate Resilience Tool. This method serves as a replicable model for other toolkit developments, as researchers have pointed out that there is evidence of progress using this method of development[158].

While there is no single method of measuring the success of the toolkit, one way of determining the success of the site is to monitor visitor statistics, identifying the number of return visitors to the website. From 2016 to 2017, the website experienced a 76% increase in visitors[159]. Through a UCD approach, there has been user feedback and engagement with communities, hearing and observing users within the target audience expressing the value for the site's usefulness and user-friendliness[160].

This tool outlines resources that are beneficial to ensure that knowledge can be shared with different regions across the United States. By outlining clear steps to resilience, the platform makes the concept of climate communication clear and concise, streamlining the experience for users. In this tool, the importance of accessibility is paramount, especially when designing for a large, varied population with different geographical contexts. The consolidation of different data sources allows for a simplified experience, becoming a one-stop-shop. By providing easy access to data and resources, the interface allows for users to access a number of resources dependent on the location of interest, which is essential to transitioning awareness to action, and is a beneficial takeaway for the development of a climate communication platform.

156 "About | U.S. Climate Resilience Toolkit."

157 Gardiner, Herring, and Fox, "The U.S. Climate Resilience Toolkit."

158 Gardiner, Herring, and Fox.

159 Marshall et al., "Helping Communities Build Climate Resilience with a Toolkit of Scientific and Local Knowledge."

160 Marshall et al.

2.2.8. Apple Weather

The rapid development of technology in recent years has enabled users to access weather information on smartphone apps more than on other information sources[16161]. Statistics have revealed that smartphone weather apps had 91% smartphone reach in the United States as of 2018[162]. In the second quarter of 2011, the second most used apps, after games, were weather apps[16363].

Prior to the widespread adoption of smartphone apps, the distribution of real-time weather information was difficult and often unfeasible through the traditional means of television, newspaper, and radio broadcasting[16464]. The communication of weather information has become easier with smartphones and their ability to host web-based applications, which are able to reach many people due to portability and ubiquity[16565]. The connectivity of weather applications to the internet allows users to receive specific information and/or notifications to always reach updated information, accessing the immediate data stream[16666]. In addition, smartphones can disseminate alerts and updated weather warnings in a timely manner through push notifications[16767]. These features, while paired with location-enabled systems, allow mobile phones to provide punctual, location specific, and time-sensitive weather forecast[16868].

161 Khamaj, Kang, and Argyle, "Users' Perceptions of Smartphone Weather Applications' Usability."

162 Khamaj, Kang, and Argyle.

163 Zabini, "Mobile Weather Apps or the Illusion of Certainty."

164 Zabini.

165 Zabini.

166 Zabini.

167 Zabini.

168 Zabini.



Figure 22. Apple Weather Home Page, retrieved from Apple Inc., "Weather," 2024.

Mobile weather apps also harness the ability to crowdsource data from individuals. Local weather observations from users can be used to improve weather information, and several studies have shown the importance of this data for a better understanding of meteorological phenomena[16969]. By using weather apps, users can have a personalized experience with tailored content, allowing adaptability and changing the user perception of giving and receiving weather information[17070]. Furthermore, mobile weather apps have been proven to have increased usage during extreme weather events, shaping user reviews and the topics they talk about, highlighting the communal reliance of these apps[17171].

Using the Apple Weather app, available on iOS platforms, one can check the weather for their current location, along with viewing upcoming hourly and 10-day forecasts. In addition, there is an option to see severe weather information, news, air quality, precipitation, and additional weather information[17272].

A main feature of Apple's Weather app is the hourly forecast, where one can see the hourly temperature forecast, chance of precipitation, high and low temperatures, and more. The interface allows for easy accessibility, through its intuitive swiping motion to left or right to show the temporal scale at hourly intervals. In addition to the hourly forecast, there is a 10-day forecast option, where one may view the weather conditions, chance of precipitation, and the high and low temperatures for the days ahead. In certain regions, there is also a next-hour precipitation forecast, where notifications are provided through data from national weather services. This service is currently only available in Australia, Ireland, Japan, the United Kingdom, and the United States[17373].

This platform integrates severe weather alerts, allowing one to view updates for weather events such as winter storms and flash floods. This feature works in partnership with government-issued alerts, allowing users to tap on the alert to view more information from their local governance. Currently, the severe weather information is only available in specific regions, which include Australia, Brazil, Canada, India, Japan, Mexico, Thailand, and the United States, in addition to most countries and regions in Europe. In Canada, Apple Weather sources its data from Environment and Climate Change Canada[17474]. As of 2024, Apple provides its own temperature, wind map, and precipitation map data. Apple outsources its data for air quality maps.

169 Zabini.

170 Zabini.

171 "User Perceptions Towards Mobile Weather Apps: An NLP-Based Content and Reviews Analysis Study | IEEE Conference Publication | IEEE Xplore."

172 "Check the Weather on iPhone."

173 "Feature Availability and Data Sources in the Weather App - Apple Support (CA)."

174 "Feature Availability and Data Sources in the Weather App - Apple Support (CA)."

Another key feature that exists on the Weather app is the presence of maps. The map feature allows users to view a as the temperature, precipitation, air quality, or wind conditions in their local area. By tapping the map within the widget, one can view it in full screen and change the map view between the different conditions[17575]. The user interface of this platform allows for access to customization of the weather units for temperature, wind, precipitation, pressure, and distance. It also allows for users to send weather reports, when the weather conditions in the user's location does not match what is shown in the Weather app. This allows for Apple to continuously develop and improve the platform and its services, allowing the end user to easily file reports.

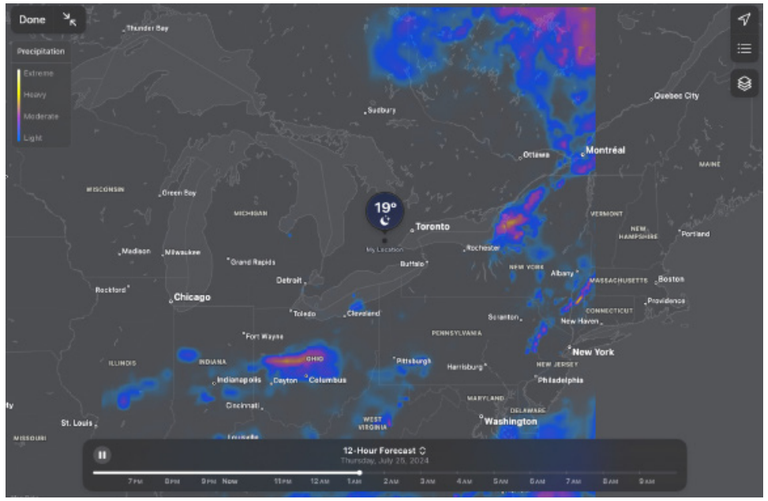


Figure 23. Apple Weather Map, retrieved from Apple Inc., "Weather," 2024.

The widespread implementation of this application has allowed for a large number of people to access live meteorological information, integrated with live severe weather warnings. This allows users to access personalized information that is essential, without the need for another platform to access official government-issued warnings. The design of the platform prioritizes the visual clarity of climate information, ensuring that data is displayed without visual clutter within individual widgets. Any unnecessary data has been removed, with the focus being on essential features to convey the messaging in a succinct manner. The versatility of this application in reference to climate communication makes it a notable platform for the dissemination of data, warnings, and risks.

175 "Check the Weather on iPhone."

3. Synthesizing an Iterative Climate Communication Platform

Learning from the attributes and limitations of the platforms previously analyzed, this chapter presents the development of a design prototype for a climate communication platform in the Lower Fraser Basin. Grounded in research on existing climate communication platforms, visual communication strategies, and the unique environmental context of the region, this project seeks to bridge critical gaps in how climate information is accessed and shared.

The development of this platform was guided by several key research agendas and components. These research agendas define the central goals of the platform's user experience and inform the critical design choices needed to create an effective communication tool. The research components focus on the specific climate elements that will be featured on the platform, ensuring that the most relevant and actionable data is presented to users. The research components will focus on each of the different climate elements, outlining the data that will be presented in the platform.

This design iteration and process will result in an outline for a design framework, intended for the future development of climate communication platforms. By offering a set of design principles that can be used to build accessible and user-centered platforms, this project aims to generate an early set of guidelines for the next steps of this project.

3.1. Research Agendas

The following research agendas are key aspects integrated into the platform that will inform the user experience. Informed by the prior literature review, the elements included in this category will showcase important features that climate communication tools should include. This includes scalability, temporality, multi-agency collaboration, and accessibility.

3.1.1. Scalability

An important agenda item that must be noted for a climate communication platform is the ability to access various scales of information through mapping and visual communication. Currently there is an enormous need across the world to segment climate change audiences at global, national, and local scales[176]. Research has shown that climate change communication narratives are failing to communicate the scale of climate change, and by allowing users to visualize the scope of the area of study the information will be presented with a point of reference familiar to the user. By including compelling visuals, including clear photographs and diagrams of projects happening in specific regions, it will allow users to understand the role of the platform in their lives.

176 Leiserowitz et al., "Global Warming's Six Americas."

Scalability is essential to the key principle of having interactive experiences, as it will allow for users to explore while learning about various climate change initiatives and challenges. This refers to having elements, such as maps, being able to reveal different resolutions of information by zooming in and out. This can be prompted manually, through user action, or automatically, through a programmed animation across different scales. Having interactive experiences encourages explorational and experiential learning. By providing a frame of reference for the user that is location-specific, the information will ensure relevance to individual interests and will facilitate user engagement.

3.1.2. Temporality

Temporality refers to the state of existing within or having a relationship with time. This can be exemplified in climate change communication through the inclusion of various temporal resolutions, which can range from seconds to centuries. It is commonly seen in timeline bars that span across webpages, or the depiction the before and after scenarios of a particular change. Including a temporal element to the digital communication platform will allow for the user to engage with data through historic, present, and future means, allowing the scale and urgency of climate change issues to be highlighted.

Temporality will address engagement through its visuals that highlight changes in the environment which will resonate with the values of the users. In addition, temporality is able to be used in conjunction with scalability, allowing for users to inspect their geographical location and the changes that have occurred over time. By providing both engaging and interactive experiences, temporality will provide contextual information that will allow for engagement with the audience.

This temporal engagement may include incorporating visuals that evoke emotional messages to facilitate user empowerment. By incorporating persuasive design elements including short animations and clear graphics, these features can motivate users to engage in climate action. Having striking imagery will also impact user behaviour, creating a lasting impact through emotional resonance.

3.1.3. Multi-Agency

Multi-agency representation is vital to the success of a climate communication platform. One of the existing challenges of the platforms that are currently on the market is the lack of cohesion from different agencies regarding a comprehensive public-facing platform. By including various stakeholders into this platform, a database of different information which can range from climate risks to infrastructural projects will be combined into one platform. This will address the current gap with information currently being shared across different platforms.

By amalgamating the different agencies that are involved in the narrative, such as the federal, provincial, and municipal governments, as well as non-governmental organizations, meteorological data, and crowdsourced data from the community, the accessibility of data will be

greatly enhanced, allowing for easy access to resources. By combining all of the data into one database, the cohesion will also ensure clarity and simplicity in the information. This will lead to effective data representation, eliminating any excessive or repetitive information that overlaps across agencies.

3.1.4. Accessibility

One of the key barriers to successful climate change communication is public accessibility. This refers to the ease of use, ease of access, and ability for a platform to communicate ideas without assuming the users' skill or knowledge level. Research on climate information websites has shown that barriers may include navigational challenges, minimal guidance, and inferred information without context[177].

177 Hewitson et al., "Climate Information Websites."

To address accessibility, prioritizing effective data representation is essential. One of the common critiques in current climate change communication platforms is the presence of excessive data, which may not all be relevant[178]. By filtering out relevant information, the data-ink ratio can be maximized, ensuring that every element serves a purpose in representing data. By highlighting key information using annotations, contextual information will be provided. In addition, addressing public accessibility can be done through the inclusion of design interfaces that can provide easy access to climate resources to motivate individual action.

178 Hewitson et al.

Having personalized content for each user will ensure relevance to individual interests. This includes the element of storytelling, allowing users to engage in immersive narratives that allow for experiential learning. Interactive experiences also translate to having user-defined personal experiences when using the platform. Providing a function to share and report severe weather events encourages user discussion, which is essential to a successful climate communication campaign[179].

179 Fernandez et al., "Talking Climate Change via Social Media."

Accessibility also refers to the clarity of the content for users from different backgrounds, ensuring that visual and textual communication is clear and easily interpretable. Excessive data and information will be eliminated, focusing only on essential features to convey the data in a succinct manner. One way of generating clarity is to create multiple iterations, allowing for users to evaluate the proposed interface design based on their own understanding of clarity[180]. Encouraging social feedback will further facilitate the clarity of the graphic data.

180 Verweij, Marinova, and Lokers, "User Centered Design: Tools for Encouraging Climate Change Adaptation."

Accessibility is essential to transitioning awareness to action. By designing for a wide range of users with different knowledge levels, having easy access to resources and feedback mechanisms is vital. This may mean having clear visuals for those with visual impairments or language options for those who are not familiar with English.

3.2. Key Components of Climate Communication

There are various components that can provide benefits to a climate communication platform. These components can be broken down into climate risks and infrastructure, as well as the impacts of urbanization. These two major categories are deeply interconnected, yet represent complementary elements of climate communication.

Climate risks refer to the immediate and long-term threats posed by changing environmental conditions, such as flooding, heatwaves, and rising sea levels. These are issues that are particularly significant for vulnerable areas like the Lower Fraser Basin. These risks are dynamic and constantly evolving, requiring live data and clear communication strategies to keep users informed and prepared.

On the other hand, infrastructure and the impacts of urbanization focus on how built environments respond to the aforementioned climate risks. Urbanization intensifies the vulnerability of regions through increased population density, expansion into floodplains, and the strain on essential networks. However, infrastructure also provides resilience against these threats by incorporating flood defenses, green spaces, and sustainable design principles.

While climate risks often deal with the natural environment's unpredictability, the infrastructure and urbanization category revolves around anthropogenic responses and preparations. The relationship between the two categories is symbiotic, as understanding climate risks is essential for designing effective infrastructure, and the quality of urban planning directly influences the community's capacity to withstand and adapt to these risks. From this, we can deduce that a robust climate communication platform must recognize both categories and communicate how they interrelate, so that users can both grasp the severity of climate risks and understand how infrastructure developments play a key role in managing these risks.

3.2.1. Climate Risks

This platform aims to compile the various climate risks that are associated with the Lower Fraser Basin, often coming from different sources. This includes the meteorological relationships that are present in the region, the flood events, wildfire risks, as well as seismic hazards and activity.

Understanding meteorological relationships is crucial for developing a comprehensive climate communication platform for the Lower Fraser Basin. Meteorological relationships refer to the interactions and connections between different atmospheric processes that influence weather and climate. These relationships are how various factors, such as temperature, humidity, wind, pressure, and precipitation interact with one another to create weather patterns or climatic trends.

This region experiences complex weather patterns that significantly impact its hydrological systems and, consequently, the lives of its inhabitants. Communicating these meteorological relationships can help local communities prepare for weather-related extreme events. Meteorological communication is one of the leading categories of broadcasting and distribution. The ongoing development of communication strategies possesses a great influence on the way weather forecasts are communicated to, and used by, people.

Representing this component can be achieved through detailed visualizations and data representation of precipitation patterns, temperature changes, and storm frequencies. By overlaying this information with the other components of the platform, it can allow one to see how these meteorological phenomena interact and contribute to broader climate change dynamics. By showing historical data and trends, the platform can highlight meteorological changes over time, allowing users to understand the severity of climate change. This understanding can lead to more informed decision-making at both individual and policy levels, encouraging proactive measures to mitigate adverse effects. Emphasizing meteorological relationships enhances the platform's educational value, empowering users with the knowledge needed to adapt to and mitigate the impacts of climate change.

Flood events are a major concern in the Lower Fraser Basin, making their inclusion in a climate communication platform vital. This region is particularly susceptible to flooding due to its geographic and hydrological characteristics, including the convergence of multiple waterways and the influence of tides. Communicating the risks and historical occurrences of flood events can significantly enhance community preparedness and resilience.

The platform will provide dynamic maps and data on past flood events, showing areas most affected and the frequency and severity of these occurrences. In addition to historical data, real-time monitoring and representation can alert residents and authorities to imminent flood risks, allowing for timely evacuation and other protective measures. By understanding the factors contributing to flooding, such as snowmelt, heavy rainfall, and tidal influences, users can grasp the interconnected nature of these events. By illustrating the impact of land use changes and urbanization on flood risks, the platform can also promote sustainable practices and informed urban planning. Showing flood events can empower users to take proactive steps in order to protect their livelihoods.



Figure 24. Waves push up on the shoreline in White Rock, B.C., during a storm in March 2016. Image by Bill Hawke, retrieved from https://www.cbc.ca/news/canada/british-columbia/coastal-flooding-risk-data-1.7166103.

In conjunction with the increasing flood risks, the Lower Fraser Basin has been subject to abrupt increases in wildfires due to compounding effects of climate-induced moisture changes[181]. British Columbia has experienced its four most severe wildfire seasons of the last fifty years during the past seven years[182]. This has been attributed to meteorological and anthropogenic factors, causing destruction and hardship to both human and ecological communities. There is currently no indication that this upward trend in climate-induced wildfire activity will stabilize in the near future[183], causing additional concern for the urgency of communicating these risks. The rapid onset of increased wildfire activities calls for a philosophical change in the way we think about wildfires, where people's roles in proactively managing fire-prone landscapes is essential. It is important to share updated wildfire information in order for users to recognize and accept that there is a new and uncertain age of wildfires.

181 Parisien et al., "Abrupt, Climate-Induced Increase in Wildfires in British Columbia since the Mid-2000s.

182 Parisien et al.

183 Parisien et al.

Seismic hazards and activity are critical components of a climate communication platform for the Lower Fraser Basin, a region prone to earthquakes due to its location near major tectonic boundaries. Understanding these risks are vital for enhancing public safety and preparedness. By providing clear and accessible information about the Lower Fraser Basin's seismic history, fault lines, and potential impacts, users may understand the risks they face. With compelling visuals, one may be able to see the intensity of seismic hazards and the potential impacts that earthquakes may have on local infrastructure. Real-time monitoring and early warning systems can be integrated to provide immediate alerts, giving residents crucial time to take protective actions. Including educational resources on how to prepare for and respond to earthquakes can foster a culture of preparedness.

3.2.2. Urbanization

Including the impacts of urbanization in the climate communication platform for the Lower Fraser Basin is crucial for through representation. Urbanization significantly alters natural landscapes, which contributes to exacerbating flood risks and ultimately being a part of climate change. Infrastructure often lies in vulnerable areas, and understanding their interactions with climate risks is essential for resilience planning. Highlighting the effects of urbanization, such as reduced permeability and increased heat islands, can inform sustainable development practices.

Additionally, visualizing the condition and distribution of critical infrastructure will help identify vulnerabilities and prioritize mitigation efforts. By integrating data on infrastructure and urbanization impacts, the platform can facilitate informed decision-making, promote adaptive urban planning, and enhance public awareness of how development choices influence climate resilience.

3.2.2.1. Hard Infrastructure

Hard infrastructure, also commonly referred to as grey infrastructure, is crucial for climate communication as it helps visualize and manage urban resilience. By including hard infrastructure projects in the platform, it allows users to understand its role in flood mitigation, seismic safety, and adaptation to the impacts of urbanization. Users will be able to interact with the information about hard infrastructure, and understand both the positive and negative impacts that it may have on the landscape. The hard infrastructure projects in the region included are dikes and dams.

One of the oldest forms of coastal resiliency in British Columbia is the practice of diking, which started as early as 1864[184]. The Dike Maintenance Act states that a dike is an embankment, wall, fill piling, pump, gate, pipe, sluice, culvert, canal, ditch, drain, or any other thing that is constructed, assembled, or installed to prevent the flooding of land[185]. In 1894, the greatest flood on record occurred, which resulted in devastating losses for the Lower Mainland and the Lower Fraser Basin[186]. As floodplain development continued, dikes were increasingly relied upon to protect these areas[187].

184 Ministry of Environment and Climate Change, "Dike Management: Province of British Columbia."

185 Ministry of Environment and Climate Change.

186 Ministry of Environment and Climate Change.

187 Ministry of Environment and Climate Change.



Figure 25. Dikes in the Lower Fraser Basin, image by author, base map adapted from ArcGIS.

While diking in British Columbia was once a reliable form of flood management, it has been found that the infrastructure, policies, and practices in the Lower Mainland need upgrading[188]. In 2015, an assessment revealed that 71% of the assessed dikes are vulnerable to failure by overtopping during either a major Fraser River or coastal flood[189]. Only 4% of assessed dike segments meet current provincial standards for dike crest height[190]. "A key reason why so many of these dikes are considered vulnerable to failure is because most were reconstructed in the 1970s and 1980s according to the standard of the time, which has since been recognized as too low[191]. Many communities in the Lower Fraser Basin rely on dikes for flood protection, but often lack dedicated funding for major upgrades and rehabilitation[192]. In addition to this, some communities, including First Nations, are not presently protected by diking systems at all[193].

In addition to dikes, the Lower Fraser Basin has erected many dams. The purpose of a dam is to store water, wastewater, or other liquid borne materials for any of several reasons, which may include flood control[194]. Currently, there are more than 1,900 active dams in British Columbia which are regulated under the Water Sustainability Act[195].

188 Fraser Basin Council, "Lower Mainland Flood Management Strategy: Phase 1 Report."

189 Fraser Basin Council.

190 Fraser Basin Council.

191 Fraser Basin Council.

192 Fraser Basin Council.

193 Fraser Basin Council.

194 Association of State Dam Safety, "Dams 101."

195 Ministry of Environment and Climate Change, "Dam Safety."

3.2.2.2. Ecosystem-based Adaptations

Ecosystem-based Adaptations (EbA), also commonly referred to as green infrastructure, refers to an umbrella term for a variety of ecosystem-based approaches to address climate mitigation and adaptation while preserving biodiversity and promoting societal benefits[196]. These strategies are commonly used in climate change planning for their potential to reduce emissions and vulnerabilities in a coordinated manner, while advancing co-benefits that improve community livability and can be tailored to meet a myriad of unique community goals[197]. Restoring coasts, rivers and wetlands to reduce flood risk are likely to have seen the largest investment in EbA and it is becoming an increasingly accepted approach, despite the remainder of significant social, economic and technical barriers[198].

In British Columbia, Ecosystem-based Adaptations are an underutilized opportunity as there is no policy, standards, or regulations for implementation[199]. Thus, EbA are rarely seen in provincial commitments against climate change. Throughout British Columbia's flood management and climate adaptation there is a lack of acknowledgment

196 Lappage, "Weathering the Storm."

197 Seddon et al., "Understanding the Value and Limits of Nature-Based Solutions to Climate Change and Other Global Challenges."

198 Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2022 – Impacts, Adaptation and Vulnerability.*

199 Lappage, "Weathering the Storm."

towards using nature as a means to reduce climate risk and flood risks[200]. Currently, the only program recommending the use of EbA is the Stewardship Centre for BC's Green Shores program. This program encourages shoreline projects to use nature-based erosion protection and restoration in sites where erosion protection is needed[201].

Including ecosystem-based adaptations in the climate communication platform will illustrate how natural processes mitigate climate impacts, showcasing projects for coastal management. These strategies enhance community understanding of sustainable practices and empower proactive involvement for resilience in the Lower Fraser Basin. Some common examples of EbA in the Lower Fraser Basin include coastal management, stormwater management, and re-naturalization efforts.

Coastal management refers to strategies and actions which are aimed at protecting coastal ecosystems and communities. In the Lower Fraser Basin, coastal management is crucial due to the region's vulnerability to sea level rise, storm surges, and erosion. This category includes practices such as wetland restorations, living shorelines, and sediment-related mitigation efforts. These measures not only protect against erosion and flooding but also enhance habitat for wildlife and improve water quality.

The Lower Fraser Basin is an area where industrial development and private land ownership have accumulated a significant percentage of the waterfront land. Farming, mining, and industrial manufacturing are just some of the human-centered operations that impact the sediment from any given watershed, therefore it is deemed necessary to integrate the sediment processes into the conversation surrounding coastal management[202]. The role of sediment is an integral part of the economy and culture in the region. The Fraser River Port Authority currently dredges the river for navigation purposes. While dredging is recognized to be a necessity for the region, every year the Fraser River Port Authority disposes an average of 841,000 m^3 of sediment in the ocean, representing nearly one third of all ocean disposal in Canada[203].

Incorporating coastal management into a climate communication platform helps residents and policymakers understand the importance of natural coastal defenses and encourages the adoption of sustainable practices. By visualizing the benefits and effectiveness of these strategies, the platform can foster community engagement and support for coastal resilience projects.

200 Lappage.

201 The Stewardship Centre for BC, "Greenshores Guide to Expedited Permit Process for Nature-Based Shoreline Projects in BC."

202 Burkholder, "Designing Dredge."

203 Bros, "Sustainable Dredging Program on the Lower Fraser River."

Stormwater management involves controlling and using rainwater runoff to reduce flooding, erosion, and water pollution. In the Lower Fraser Basin, effective stormwater management is essential due to the region's heavy rainfall and urban development. Ecosystem-based stormwater management techniques, such as green roofs, bioswales, and rain gardens, mimic natural hydrological processes to absorb and filter rainwater. Incorporating stormwater management into the climate communication platform highlights the importance of these practices in reducing urban flooding and improving water quality. According to the Stewardship Centre for BC, nature-based shoreline projects can be designed to be resilient to sea level rise and other climate change impacts[204]. Techniques such as permeable paving, rainwater harvesting systems, and constructed wetlands are becoming common strategies to slow down and treat stormwater runoff.

These approaches help to mitigate flooding, reduce strain on municipal sewer systems, and protect water bodies from contamination by filtering pollutants before they reach rivers and oceans. The implementation of Ecosytem-based Adaptations in stormwater management work not only manage stormwater, but also to enhance urban green spaces, providing benefits to the entire ecosystem such as improved air quality and increased urban biodiversity.

By providing interactive maps and visualizations of stormwater management projects, the platform can educate the public on how these systems work and their benefits. This can lead to greater community support and implementation of green infrastructure solutions.

Re-naturalization efforts focus on restoring natural landscapes that have been altered by human activity. In the Lower Fraser Basin, these efforts are vital for enhancing ecological resilience and providing critical ecosystem services. Re-naturalization may include the removal of hard infrastructure, reforestation of degraded land, and the re-establishment of natural waterways. These efforts are often aimed at reversing the effects of industrialization, urban sprawl, and intensive agriculture, which have led to habitat loss, pollution, and altered hydrological cycles.
In the Lower Fraser Basin, many re-naturalization strategies focus on rehabilitating wetlands and estuaries to support biodiversity and restore fish habitats, especially for species like salmon that are critical to both local ecosystems and Indigenous cultures. Across North America, there are a number of initiatives that include the use of native plants

204 The Stewardship Centre for BC.

to stabilize soils, improve water quality, and provide wildlife corridors, enabling species migration and adaptation in the face of climate change.

By showcasing case studies, the platform can demonstrate the tangible benefits of these efforts, such as improved habitat connectivity and increased resilience to climate extremities. This can motivate community involvement and support for re-naturalization projects.



Figure 26. The second round of sediment addition at Sturgeon Bank in February 2024, image retrieved from https://storymaps.arcgis.com/stories/3e1c0693a8174e62abcee482bde4d906.

3.3. Design Process

This design aspect of this thesis focuses on using previously conducted research in order to develop a digital communication platform for the Lower Fraser Basin. In development, a platform refers to the integration of several tasks, whereas a tool is designed for a specific function. This platform will consist of a multitude of functions, including accessing updated severe weather data, infrastructure projects, crowdsourced information, and the ability to share and make reports.

A significant barrier to current successful climate communication platforms is the accessibility of the platform. Based on the climate communication platforms that were studied previously, many of them lack integration with existing social media platforms, with majority of the usage being web-based access through an internet address. This poses a significant barrier to many, as the act of accessing a new webpage, downloading a new app, or using new technology can be an unnecessary hurdle for receiving climate information. Due to this aspect, the platform focuses heavily on the integration of a climate communication system into an existing interface that is widely used and accepted.

By using Apple Weather as the basis for this prototype, it will allow existing users the option to access a comprehensive climate communication tool. Nearly 1.5 billion people are active iPhone users across the globe, with Apple Weather being a pre-installed application[205]. Instead of requesting users to access a new platform, this design proposes an integration with existing software for a streamlined approach.

205 "U.S. iPhone User Share 2014-2022."

The design process for this climate communication tool initially began with a study of the outlined user personas and overall user group analysis. In this research, there are a set of defined user personas that have been designed as potential users of this software. These users vary in age and lifestyle, but all reside in the Lower Fraser Basin. The three personas are designed to represent the diverse audience that may use the platform, with each of them having different navigational experiences during usage. Based on each persona, a personified in-app circulation will be generated, allowing for viewers to understand the navigational journey from a persona's point of view.

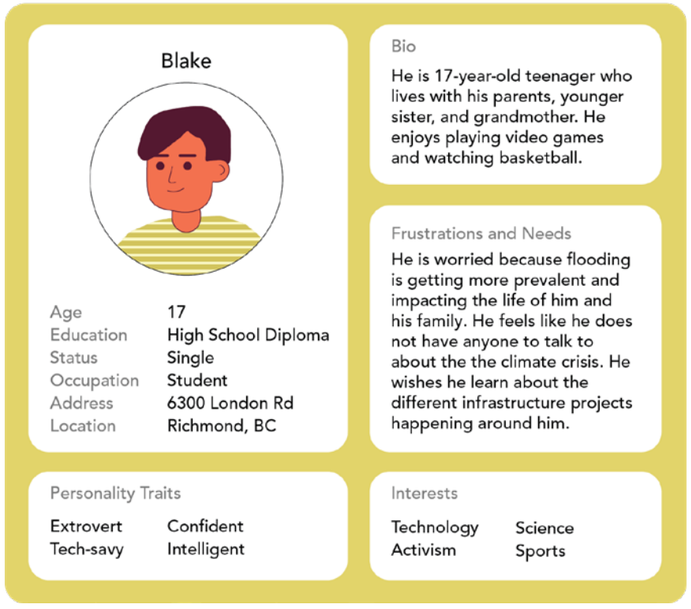


Figure 27. User Persona 1: Blake, image by author.

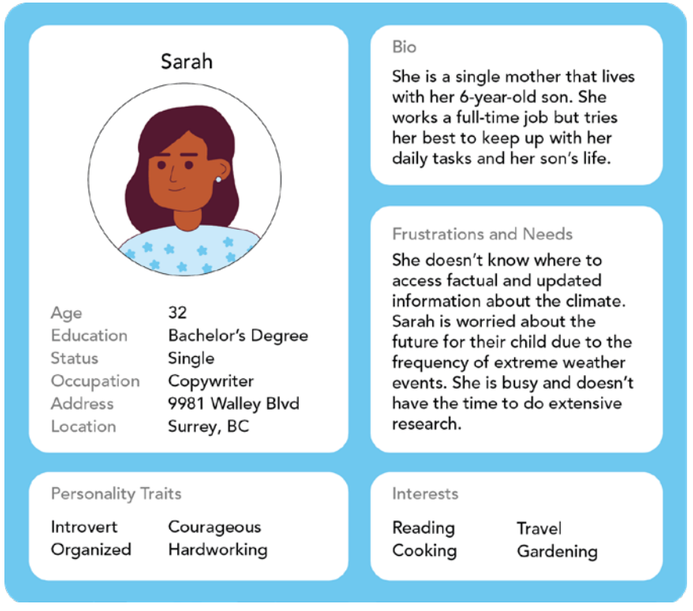


Figure 28. User Persona 2: Sarah, image by author.

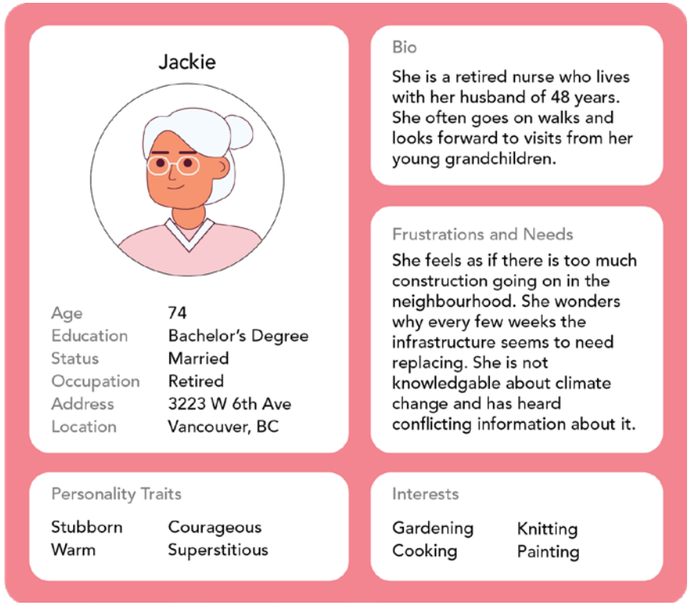


Figure 29. User Persona 3: Jackie, image by author.

From the research outlined, a prototype mapping exercise was conducted, producing the following sitemap. The development of a sitemap is critical for an iterative design approach, where website content can be organized and edited as the development continues. Using a sitemap allows for designers to visualize the navigational elements of the platform, with an emphasis on accessibility through ease of use.

The following site map focuses on building out the existing home page of the base design to include a beta mode, which then leads to five main pages. The Climate Adaptation Map then leads to additional options for users to access pages within the map.

The climate communication tool prototype was generated through Figma, where the software allowed for the development of this project. The home page of this platform has a layout intended to be the same as the current home page as Apple Weather. This layout is intended to allow existing users of Apple Weather to feel familiar with the inclusion of additional tools.

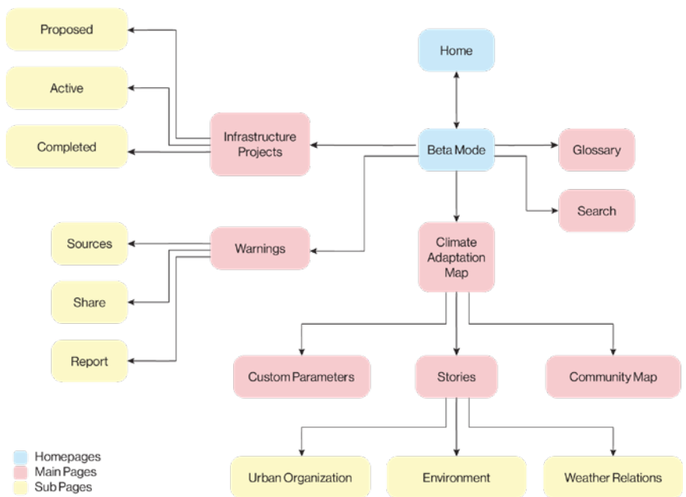


Figure 30. Site Map, image by author.

The platform had a number of selected widgets which were added in order to present a more comprehensive view of the weather conditions of the ecosystem. These widgets were selected to show data and spatially represent the area. All of the original widgets inherent to the current Apple Weather application were retained, with most of them keeping the inherent blue colour. The severe weather warning and adjacent precipitation map were adjusted to be a red shade, to convey a sense of urgency and emotional resonance with the user. A new category of widgets, shown in green, has been included, which include infrastructure notices, seismic risks, wildfire risks, and the mapping element.

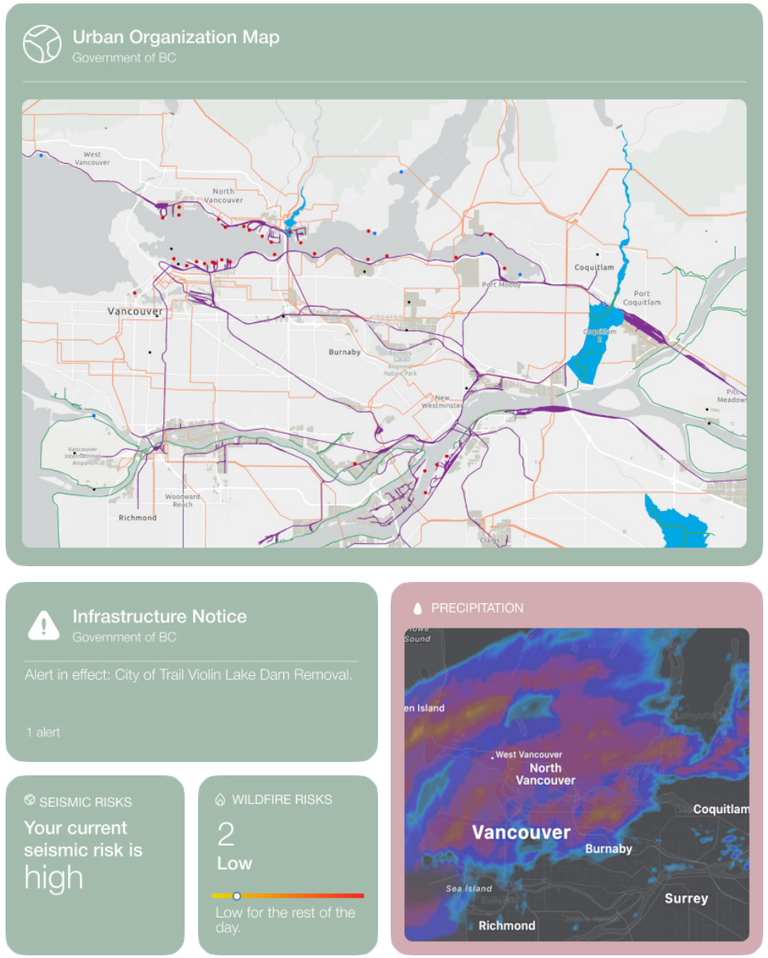


Figure 31. Selected Widgets, image by author.

3.3.1. Navigational Experiences

Through different navigational experiences based on user personas, we can investigate the typical usage of the application.

The platform's first navigational exploration will discover the platform through the eyes of Blake, a 17-year-old teenager. He is already a user of Apple Weather and is familiar with the usage of the existing platform.

The second navigational exploration follows Sarah, a busy working mom, who has used Apple Weather before, but does not typically have the time to browse through apps and explore slowly.

Lastly, we see the application through the lens of Jackie, a retiree who is not the most familiar with using Apple Weather.

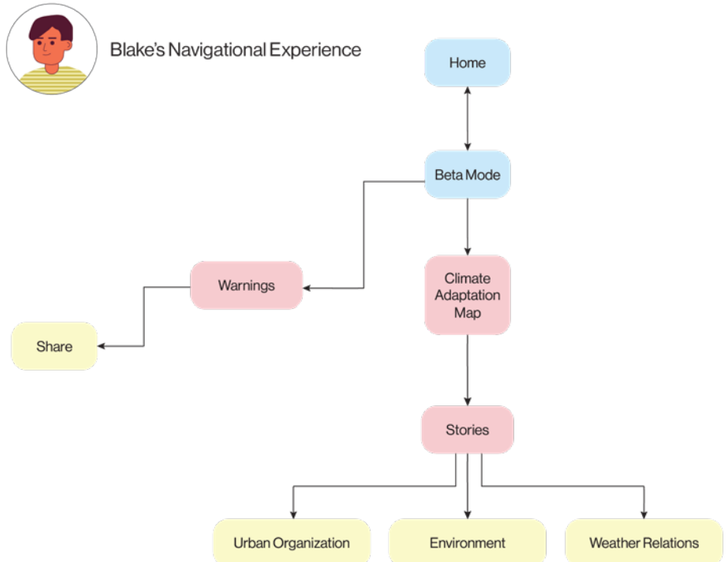


Figure 32. Blake's Navigational Experience Mapping, image by author.

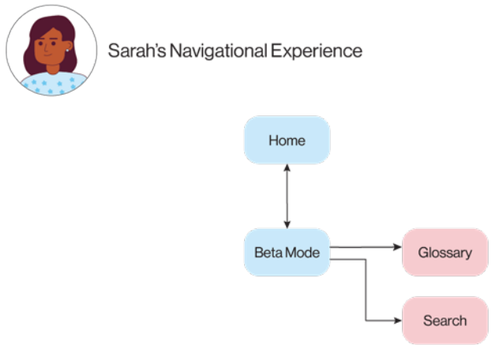


Figure 33. Sarah's Navigational Experience Mapping, image by author.

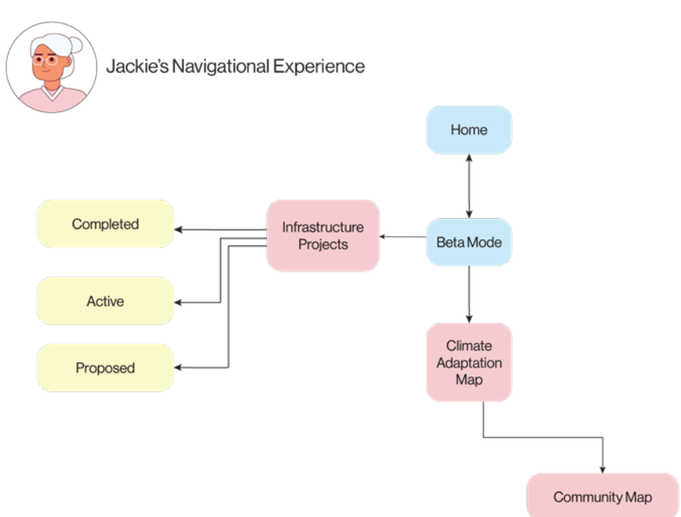


Figure 34. Jackie's Navigational Experience Mapping, image by author.



Blake

"I opened Apple Weather, like I do before school each morning, to check the forecast for the day. When I was opening the app, I noticed a small button in the top-right corner, called beta mode. I had no idea what this meant, but I was curious since using this app is part of my daily routine. I clicked on it, hoping to see what new features the app had implemented."



Figure 35. Home Page, image by author.



Blake

"Upon accessing the beta page, I was immediately greeted with a couple new widgets and a number of different colours for differentiation. The language options in the top-right corner are great, since my family is more comfortable accessing information in Spanish. The severe weather warning seems pretty intense right now, so I clicked on it to see more details!"

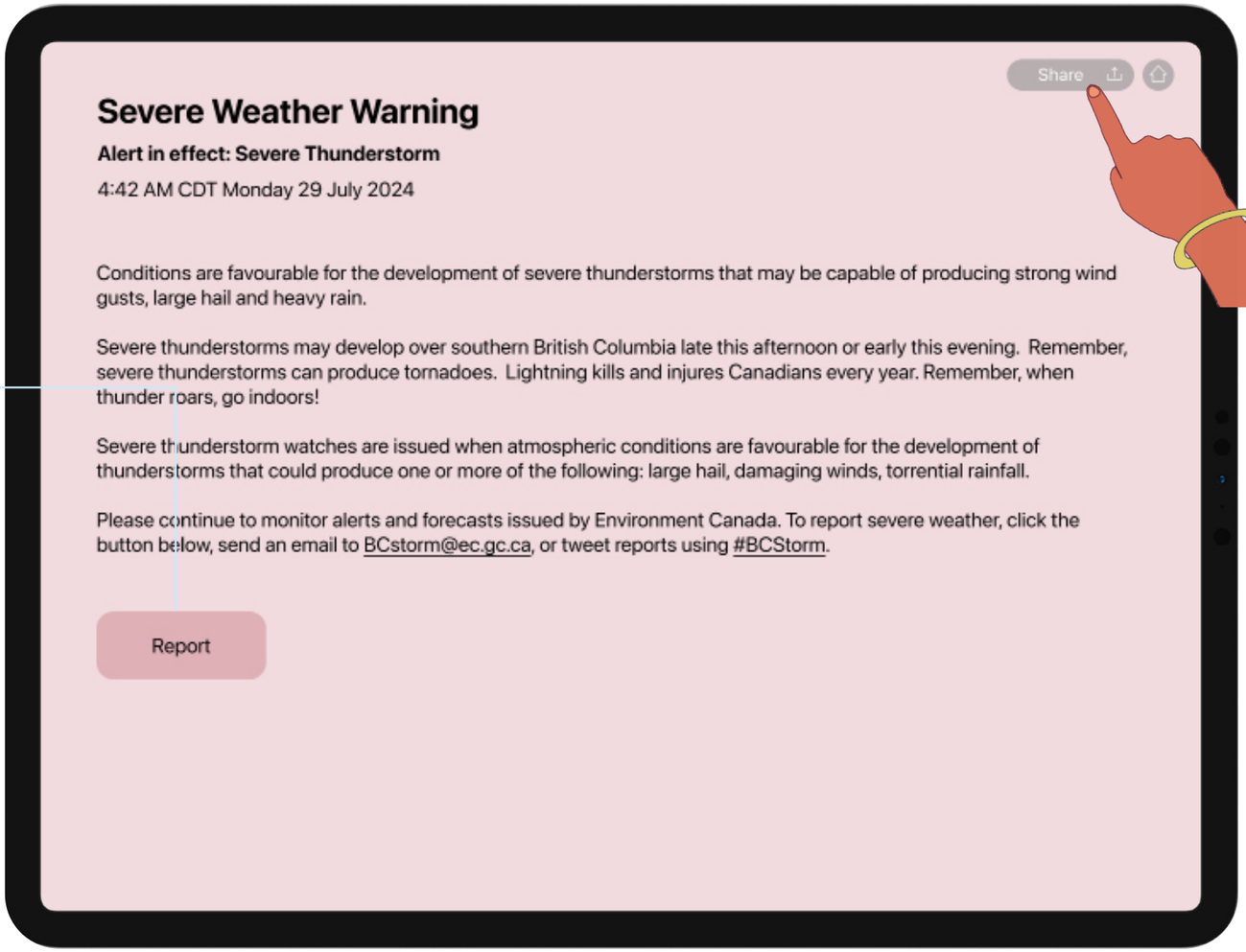


Figure 36. Beta Page, image by author.

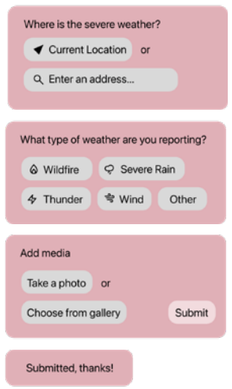


Blake

"Seems like a pretty big deal! I love that I can read all about the severe weather and even file a report if I see anything myself. Since there's a severe thunderstorm going on, I better warn my friends. We were planning on playing basketball outside, but since there's a storm going on, it may be better to stay indoors. I'll click this button in the top-right to share, then click the adjacent home button to head back to the beta page."



The report button, shown on the page above, leads to the prompts shown below.



As a further exploration of Apple Weather's severe weather warnings, the updated widget will allow users to access information from Environment and Climate Canada directly from the application, rather than being taken to an external webpage. This widget allows users to see the most updated information from a reputable governmental source, as well as simple descriptions and recommendations.

Figure 37. Warnings Page, image by author.



Blake

"Back on the beta page, I scrolled down the page to reveal the additional widgets and options. Upon seeing the big map displayed, I was curious and decided to click on it based on the different colours I could see highlighting various rail lines in my community."



Scrolling down on the beta page, more widgets can be visible, including a large widget which has a map displayed on it. This widget will lead users to access the climate adaptation map, which encompasses a number of different experiences.

The widget will rotate through different map imagery dependent on the user's location and usage history. This will allow the most relevant option to be displayed to the user.

Figure 38. Beta Page (continued), image by author.



Blake

"Upon clicking on the widget, I was brought to the climate adaptation map. This page includes a number of different options for me to access, including different stories, layers, and a community map. There is also a timeline at the bottom, which I can drag or play to visually interpret the changes in my community over time. Since I was very interested in the different stories available, I decided to click on the options to browse through the options."

This series of buttons in the top-left corner showcases the various options available for the user to choose from. This includes selecting from a number of stories, adjusting the layers, and accessing the community map embedded within this page.

The community map button allows users to see contributions from other users through the platform's in-app reporting function.

The interactive map allows for users to zoom, scroll, and adjust the timeline at the bottom of the screen to access the temporal changes in the data shown.

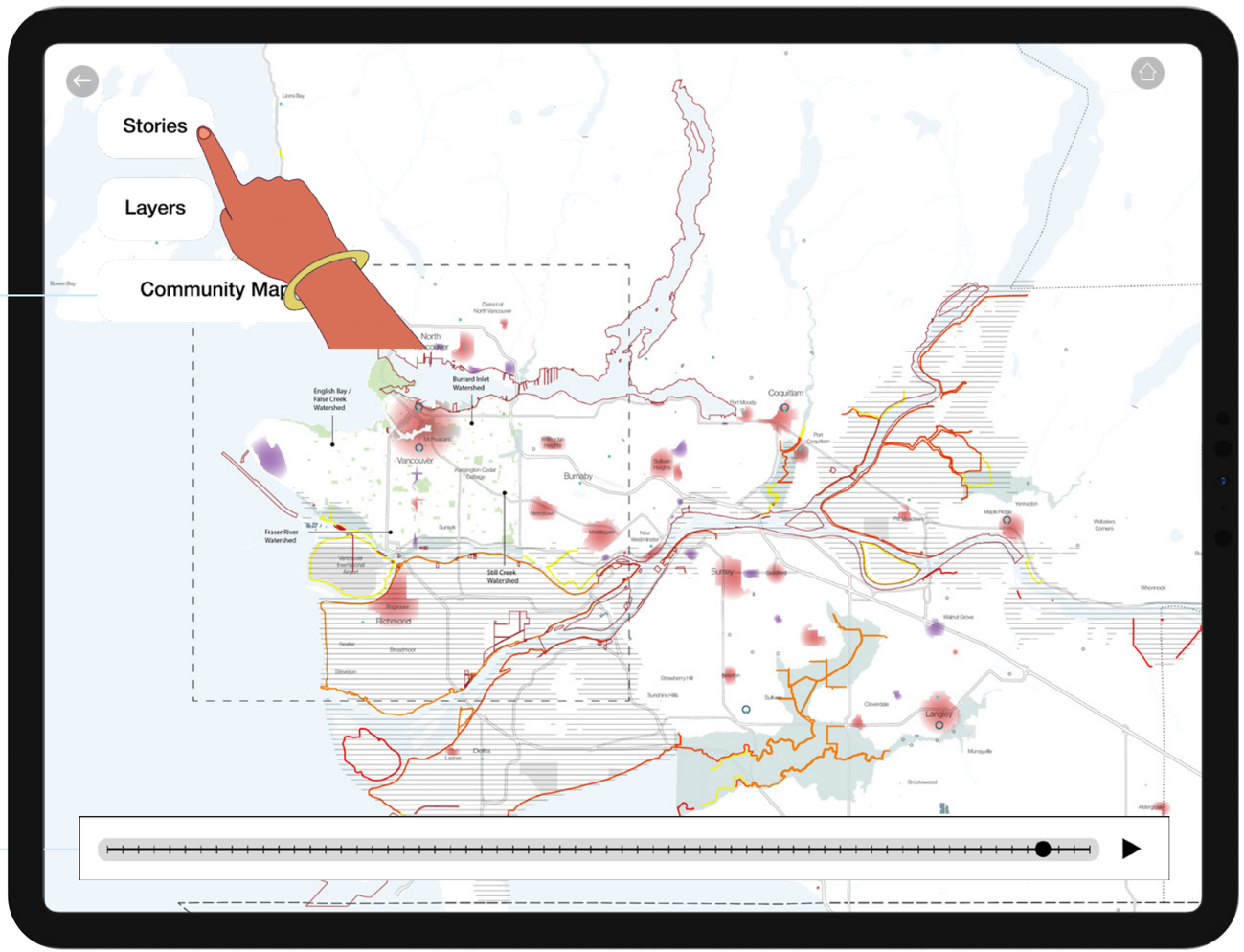


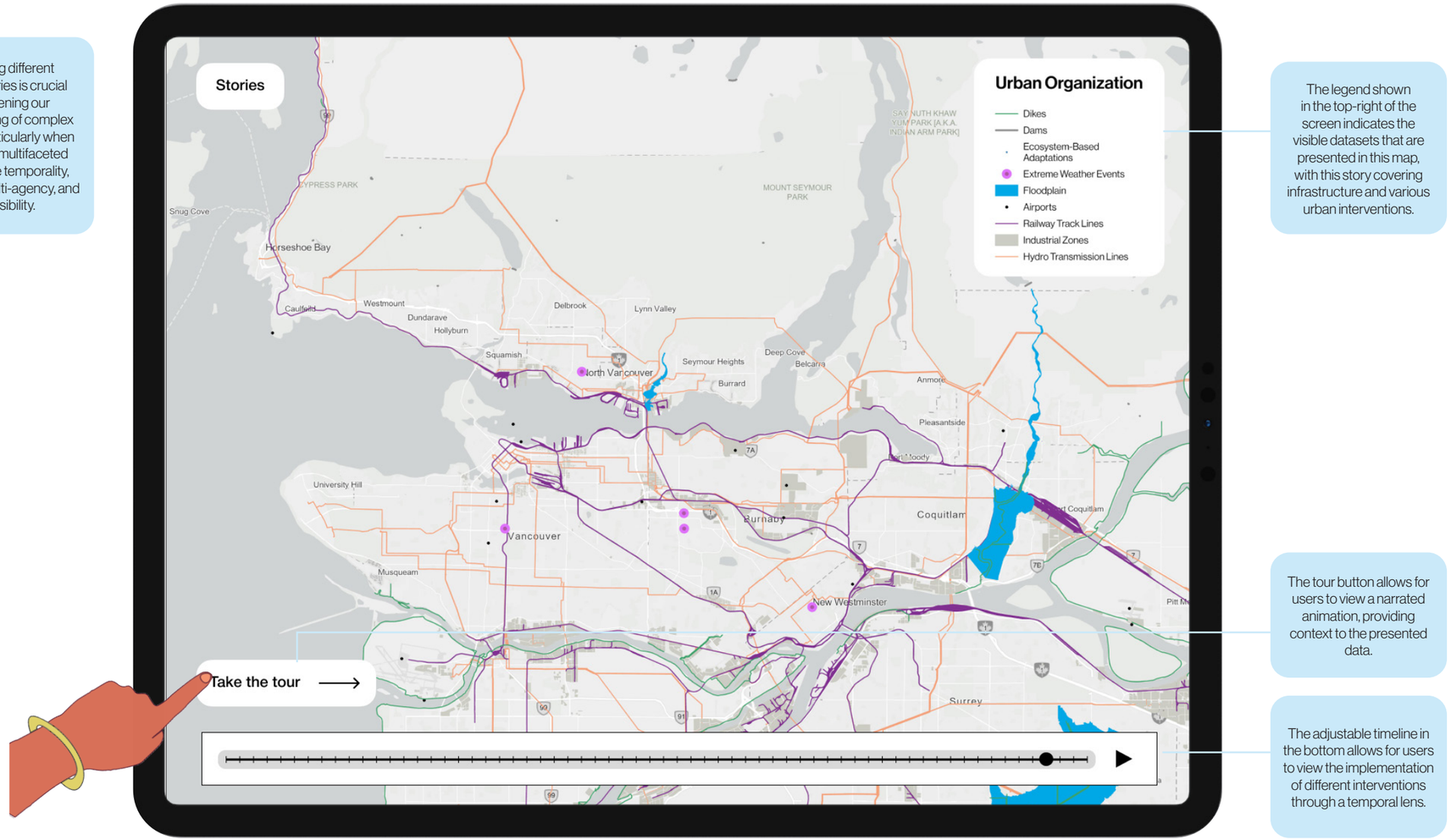
Figure 39. Climate Adaptation Map Page, image by author.



Blake

"The first story I clicked on, Urban Organization, shows the different infrastructural changes and urban interventions in my neighbourhood superimposed on coastal adaptations and floodplain information. I found this to be super interesting, particularly because I was able to zoom in and out of the map to see some of the projects in the region. I am interested in the tour button in the bottom-left, so I clicked it to see what would come up."

Accessing different curated stories is crucial for deepening our understanding of complex systems, particularly when addressing multifaceted agendas like temporality, scalability, multi-agency, and accessibility.



The legend shown in the top-right of the screen indicates the visible datasets that are presented in this map, with this story covering infrastructure and various urban interventions.

The tour button allows for users to view a narrated animation, providing context to the presented data.

The adjustable timeline in the bottom allows for users to view the implementation of different interventions through a temporal lens.

Figure 40. Urban Organization Map Page, image by author.



Blake

"The tour displayed a flyover animation of the region, where areas of interest were pointed out. I was able to see the different infrastructural projects in relation to my location."



Figure 41. Urban Organization Map Tour, image by author.



Blake

"After the tour, the tour explorer allowed me to explore different elements of the map, which included different rail infrastructure. Since many of these train tracks have industrial uses, I never even realized they were there! It was especially interesting to see how coastal adaptations like dikes have integrated into our complex web of urbanization."

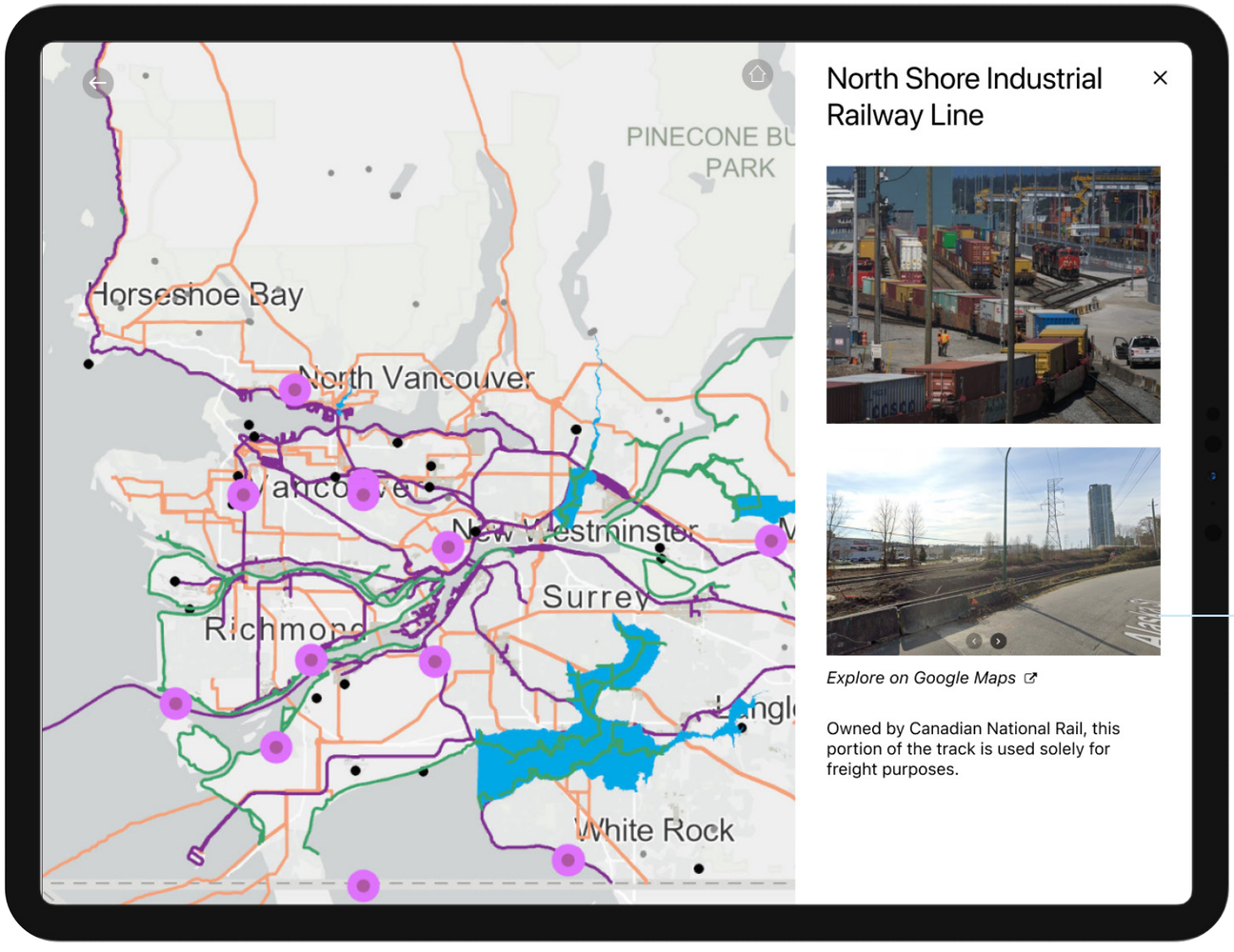


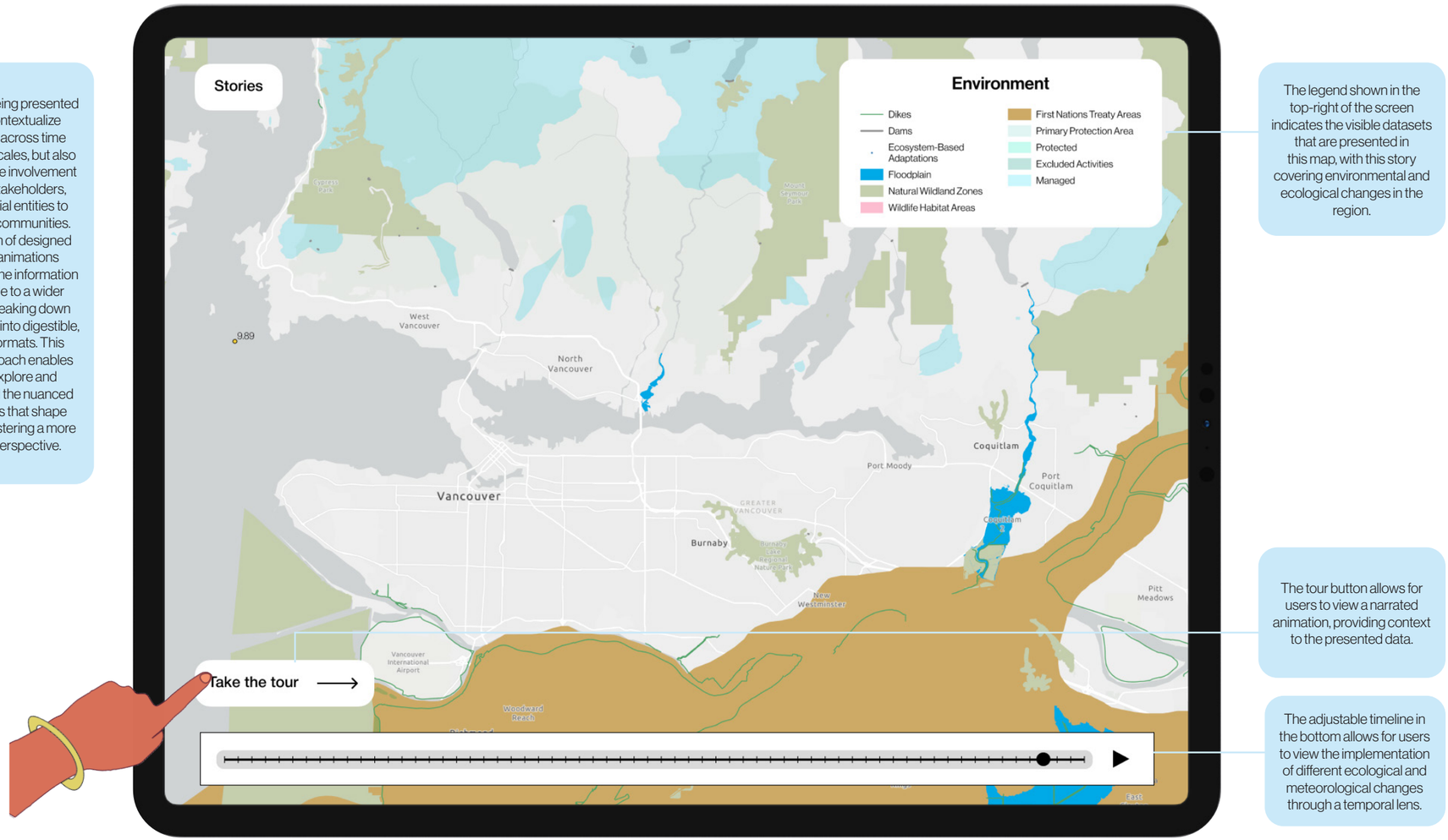
Figure 42. Urban Organization Map Tour Explorer, image by author.



Blake

"The next story I accessed was the Environment story. This displayed coastal adaptations and floodplains, pairing them with information about our natural and protected zones. I found it quite interesting seeing the different regions, and I was quite surprised to see Richmond as one of the First Nations Treaty Areas. I was super curious about this map, so I clicked the tour button."

The stories being presented not only contextualize information across time frames and scales, but also emphasize the involvement of various stakeholders, from industrial entities to Indigenous communities. The inclusion of designed tours and animations ensures that the information is accessible to a wider audience, breaking down complex data into digestible, engaging formats. This layered approach enables users to explore and comprehend the nuanced relationships that shape the region, fostering a more informed perspective.



The legend shown in the top-right of the screen indicates the visible datasets that are presented in this map, with this story covering environmental and ecological changes in the region.

The tour button allows for users to view a narrated animation, providing context to the presented data.

The adjustable timeline in the bottom allows for users to view the implementation of different ecological and meteorological changes through a temporal lens.

Figure 43. Environment Map Page, image by author.



Blake

"Seeing the Treaty Areas in addition to the coastal adaptation infrastructure is very fascinating. It is nice to see the progress of the Richmond South Dike and the different improvements they are planning on implementing. It makes me curious to learn more about the Indigenous influence of the area and the ecosystems present in our land."

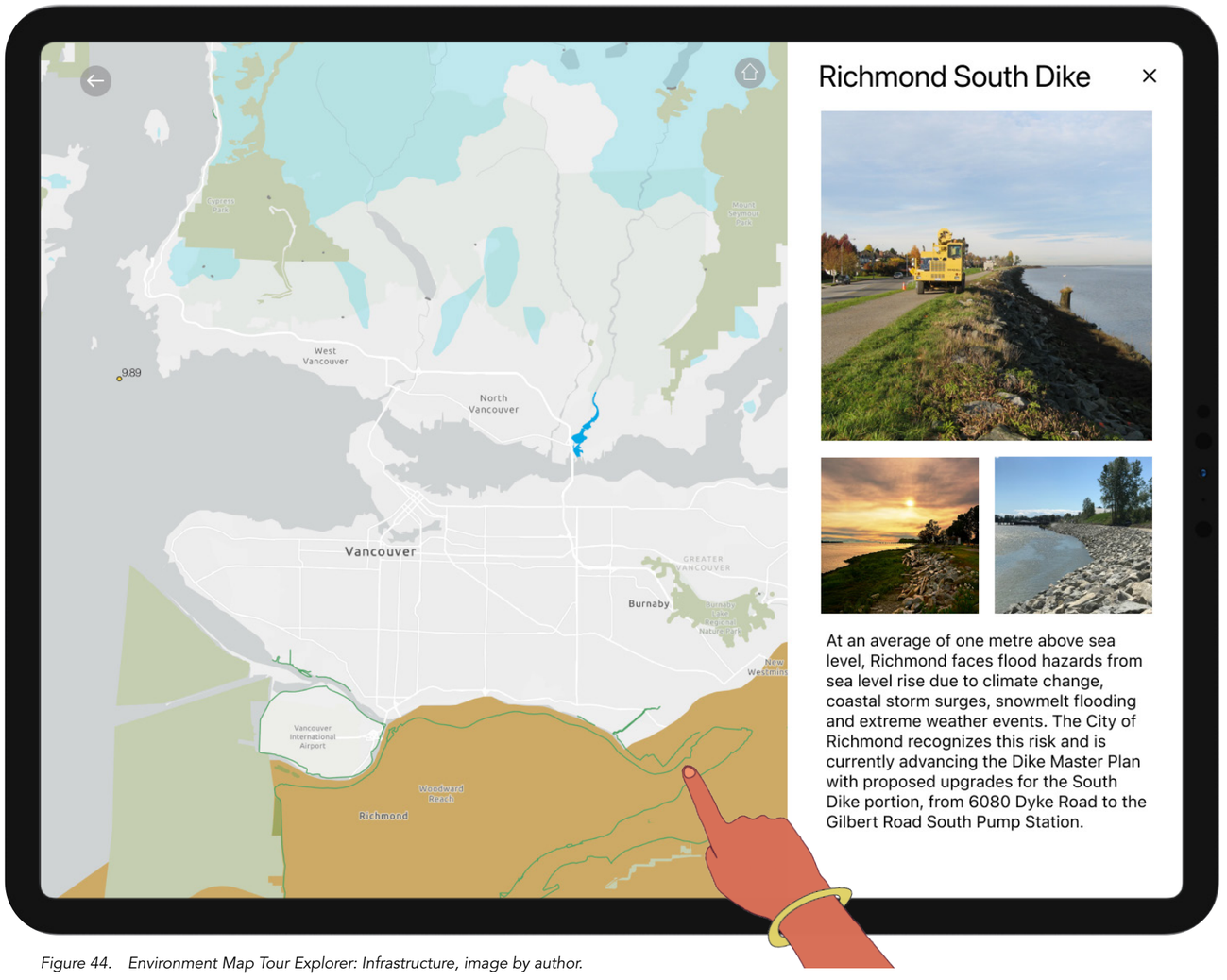


Figure 44. Environment Map Tour Explorer: Infrastructure, image by author.

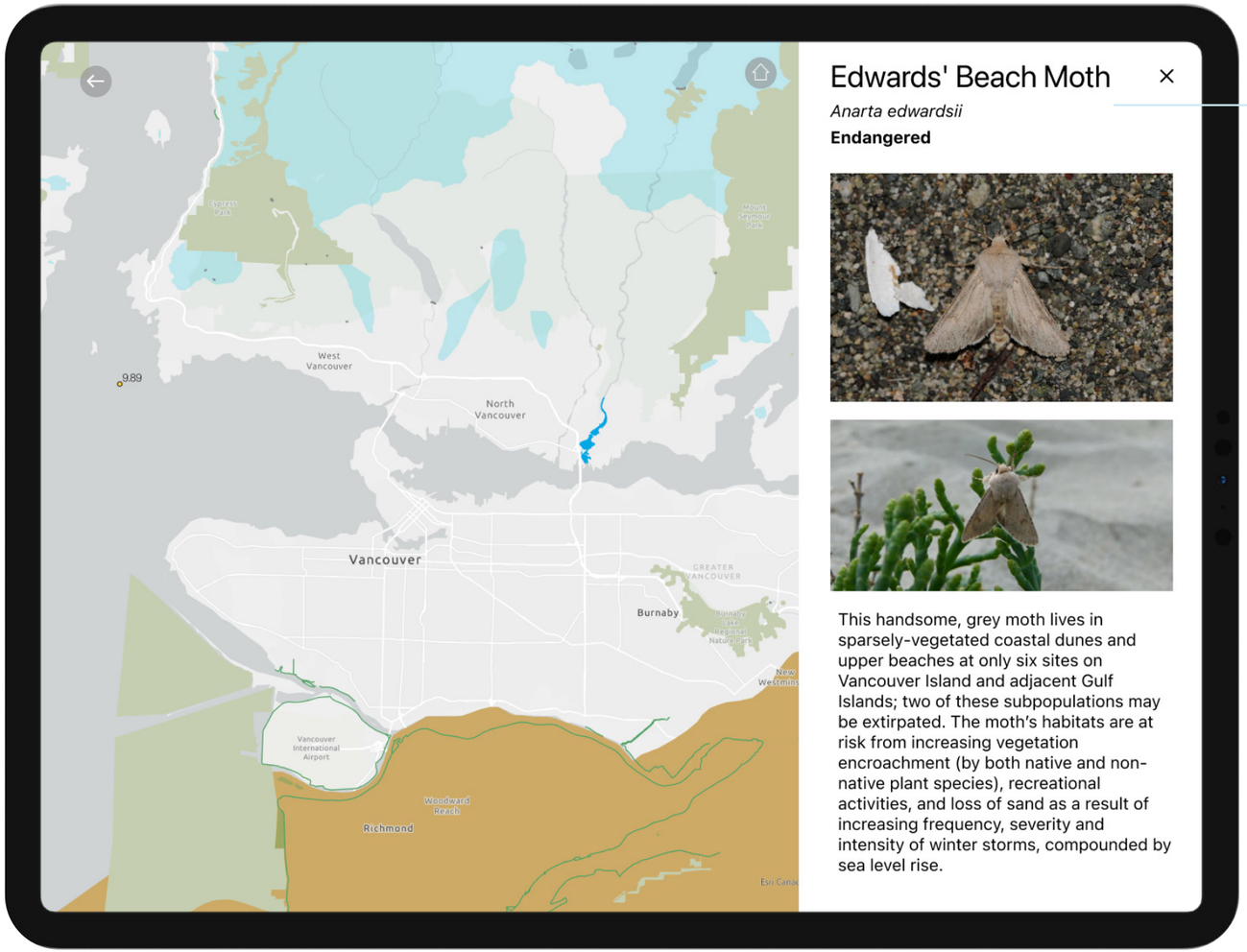
The tour explorer for this map allows for users to browse through various ecological and infrastructural phenomena in the region.

The explorer provides images and information regarding specific items, educating users about the climate risks associated with the specific element. For this selection, the description indicates the planned updates for the Richmond South Dike.



Blake

"The ecosystem is made up of many different species and biodiversity, and it is upsetting when I see species at risk of going extinct. I think that looking and browsing through these different species and seeing their status really keeps me aware of the impacts that human actions can have on wildlife."



The page displays the name of the species in both English and scientific names, and shows the current status of the species.

In addition to showing infrastructural projects visually, the tour explorer also allows for users to browse through ecological species in the region.

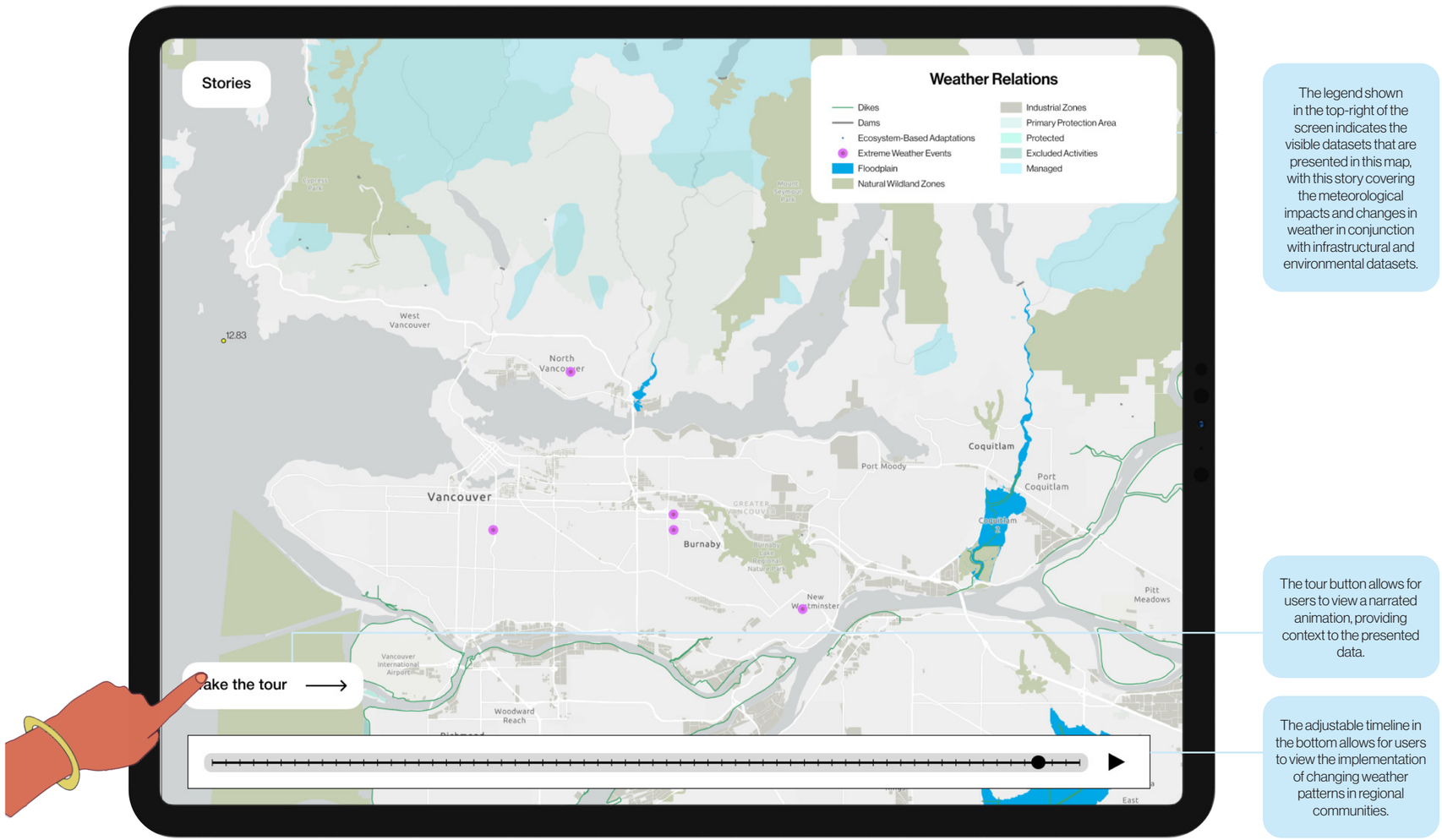
The explorer provides images and information about species that live in the area, allowing users to have an understanding of the ecosystem around them.

Figure 45. Environment Map Tour Explorer: Species, image by author.



Blake

"The last story I accessed was the Weather Relations story. This map allowed me to visualize the projected mean temperatures of the region, which highlighted the urgency of climate change. I found it extremely concerning that mean temperatures in the Greater Vancouver Area would increase so significantly in the next few decades. I wonder how much things will change once I'm older... We better act soon."



The legend shown in the top-right of the screen indicates the visible datasets that are presented in this map, with this story covering the meteorological impacts and changes in weather in conjunction with infrastructural and environmental datasets.

The tour button allows for users to view a narrated animation, providing context to the presented data.

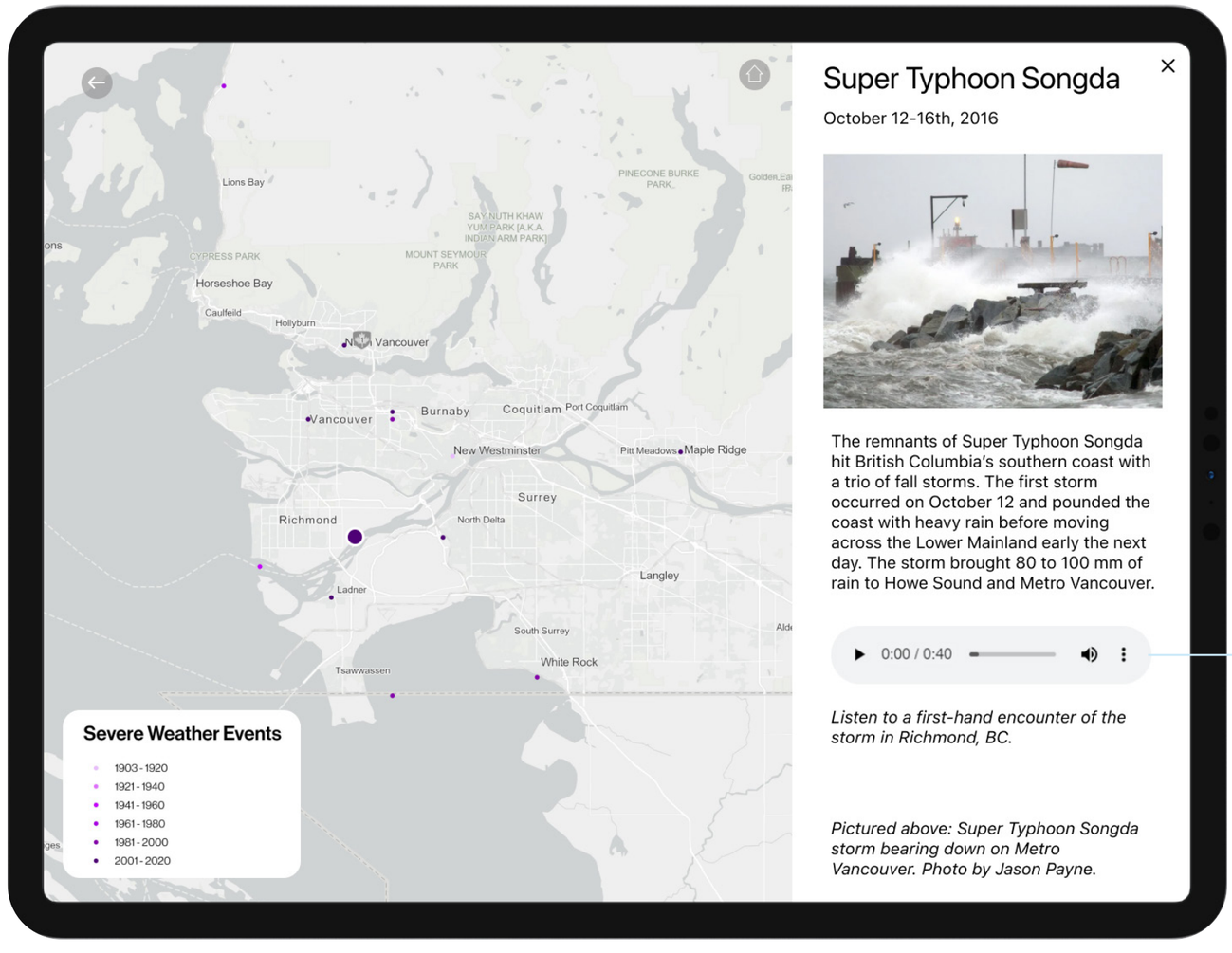
The adjustable timeline in the bottom allows for users to view the implementation of changing weather patterns in regional communities.

Figure 46. Weather Relations Map Page, image by author.



Blake

"The tour explorer for Weather Relations allows me to see the different extreme weather events that have happened in the region. I am super intrigued to learn of all this, since many of these occurred before I was born or when I was too young to remember. I really like that I can interact with historical artifacts and various media from the event - it makes me feel like I'm living through it myself. After browsing this page, I clicked back to the beta page."



This tour explorer allows for users to visually see the various severe weather disasters that have occurred in the region over time.

Each event is noted with its name and date, along with its location being highlighted on the map itself.

The explorer focuses on providing accurate historical sources along with varied media types in order to facilitate an interactive experience where users can feel immersed in the event.

Figure 47. Weather Relations Map Tour Explorer, image by author.



Blake

"After exploring the platform, I found it to be super cool and nice to be able to interact with the different features that it has to offer. One of the most useful widgets in the platform is the severe weather warning widget. This is super helpful, since it means I can instantly know about any severe weather events that may be occurring near me. Before I exited the app, I decided to pin the widget to my home screen."

Clicking and holding the selected widget prompts a selection menu where users have the option to add the widget to their home screen, allowing for the widget to be visible event when not in-app.



Figure 48. Beta Page, image by author.



Sarah

"Since I am typically a busy person, I usually don't have much time to browse the weather app other than to look at the forecast for the day. I was curious about the beta mode, so I decided to click on it to browse quickly before work one morning."



Figure 49. Home Page, image by author.



Sarah

"When arriving at the beta page, I noticed the icons in the top right. I really appreciated the inclusion of the search bar, so now I am able to look for the specific communities and locations where severe weather events are happening. I'm curious about the status of the wildfires up in Frank Creek, so I decided to search for it."



Figure 50. Beta Page, image by author.



Sarah

"Next to the search bar was the glossary page, where I was able to access definitions and examples of terms that I was not familiar with. Having this page is super helpful, as it explains a lot of the words that I had previously misunderstood. I thought that my coworkers would also find this resource helpful, so I also shared it with them, before returning to the beta page."

The glossary provides clear definitions of specialized terms, which is especially important for users who may not be familiar with technical language.

The glossary includes terms that were selected based on existing toolkits, namely the U.S. Climate Resilience Toolkit and Floodwise. Both of these existing tools include a page where a glossary is included, providing users with important information pertaining to climate terminology and clear, concise definitions.

This aids in comprehension and ensures that all users can access the information they need without confusion.

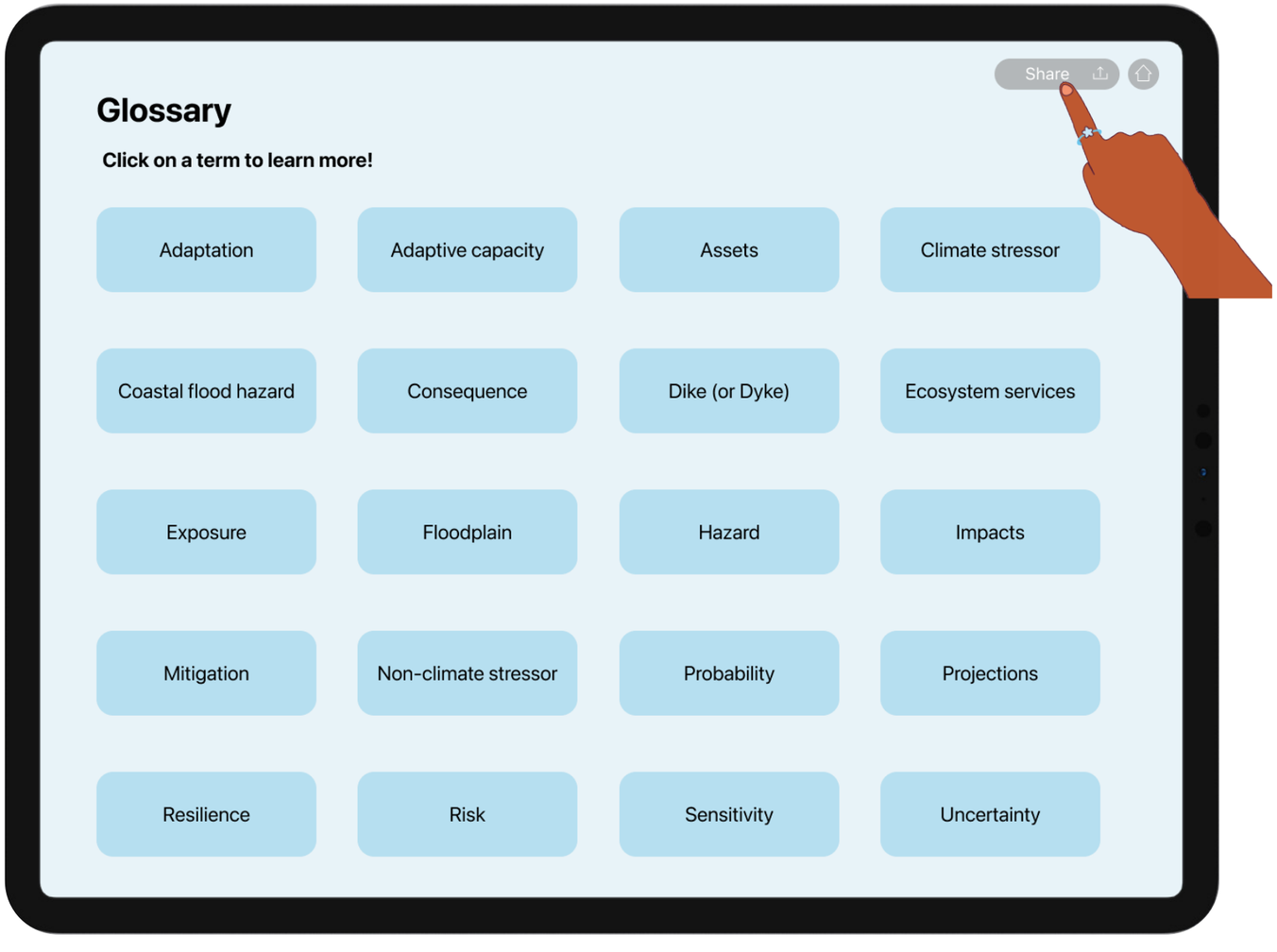


Figure 51. Glossary, image by author.



Sarah

"While I don't have a keen interest in environmental issues, I was intrigued by the wildfire risk widget as I scrolled down on the beta page. Since there have been escalating wildfires in my region recently, so I have been on alert, but I just don't have the time to constantly monitor the news or go on the Government of BC's individual websites, so seeing it here is helpful. I decided to add it to my home screen."

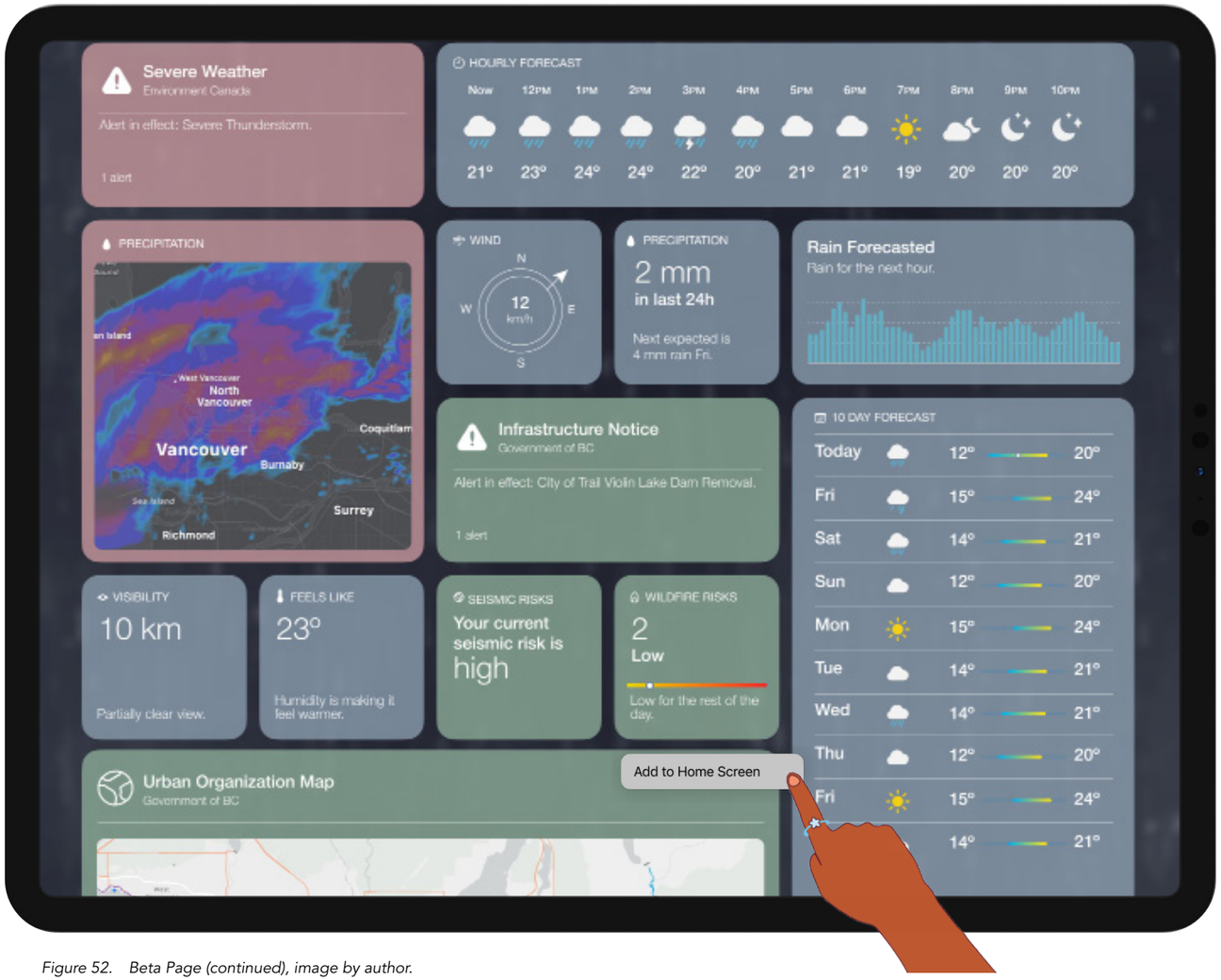


Figure 52. Beta Page (continued), image by author.



Jackie

"I usually watch the weather forecast on TV, since it is what I'm used to. However, this past Christmas, I was gifted an iPad, and started exploring the different features that it has to offer. One of the pre-installed applications was Apple Weather, and upon discovering the beta mode button, I decided to click on it out of curiosity."



Figure 53. Home Page, image by author.



Jackie

"I was happy to see the additional widgets in this beta mode. Particularly, I was intrigued by the infrastructure notice. This is interesting to see, as there has been a lot of construction in the area recently and I have been wanting to keep up with it. I don't know how to browse the internet super well, so I am glad that there is something I can click to see the status of projects near me."



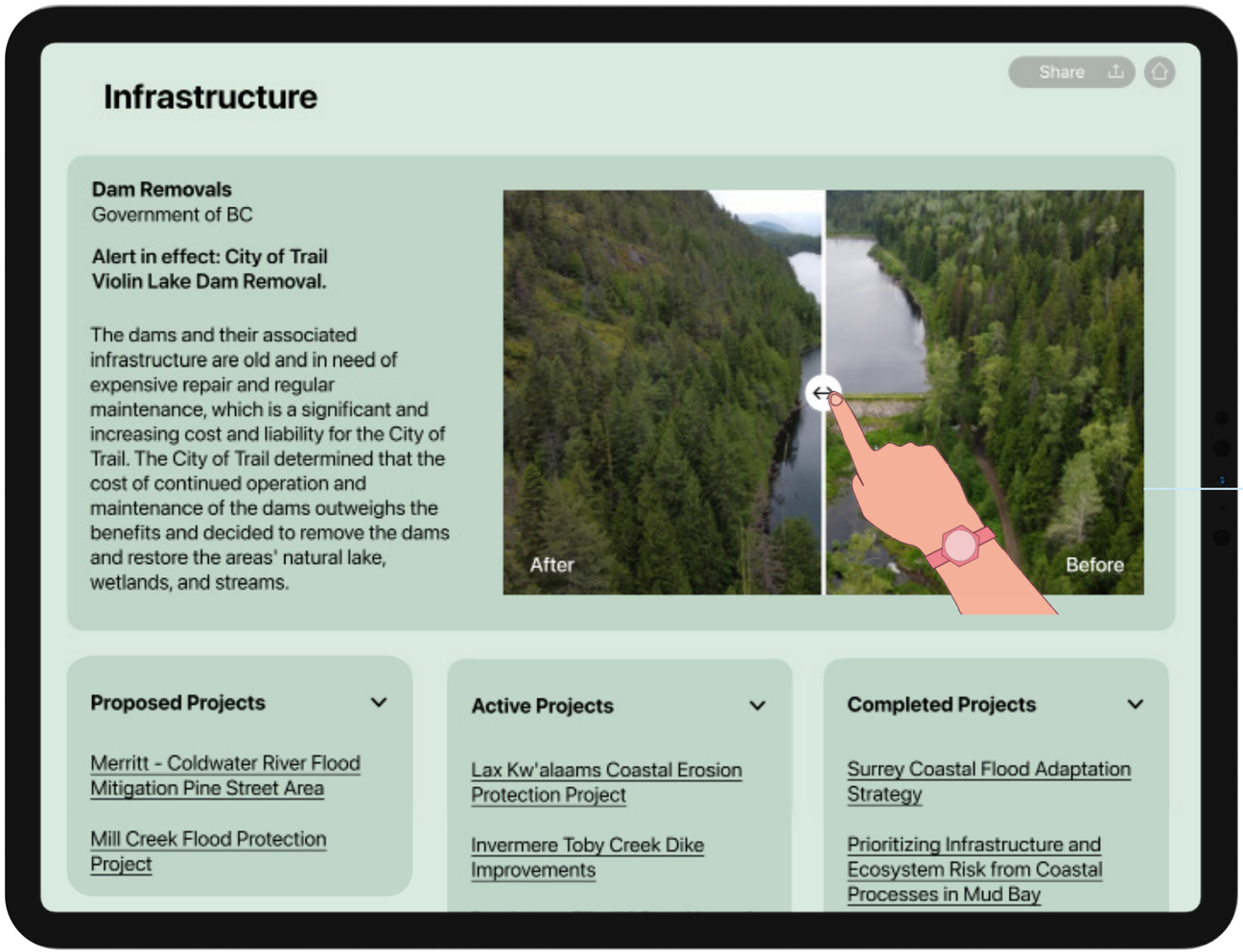
Figure 54. Beta Page, image by author.



Jackie

"This page helped explain a lot of the work that they have been doing in the region. I really like seeing the highlighted project, and being able to interact with the visual material in the page. I also really enjoy how I can click the different categories of projects down below."

Clicking on the application's infrastructure widget will allow for the user to access the infrastructure page. This page includes a description and images of a featured infrastructure project as a personalized outcome of a user's location.



The interactive slider allows for users to visualize the changes of the featured project.

The buttons across the bottom of the page show the different projects that are currently proposed, active, or completed. It allows for users to click on individual projects to learn more about them and interact with media.

Figure 55. Infrastructure Page, image by author.



Jackie

"I scrolled down back in the beta page, and I was captivated by this community map. Unlike the other widgets, which seem to collect data from governmental and non-profit organizations, it was nice to see real information being shared by my neighbours. I clicked on the map in order to view more of the comments and media that have been contributed by the community."

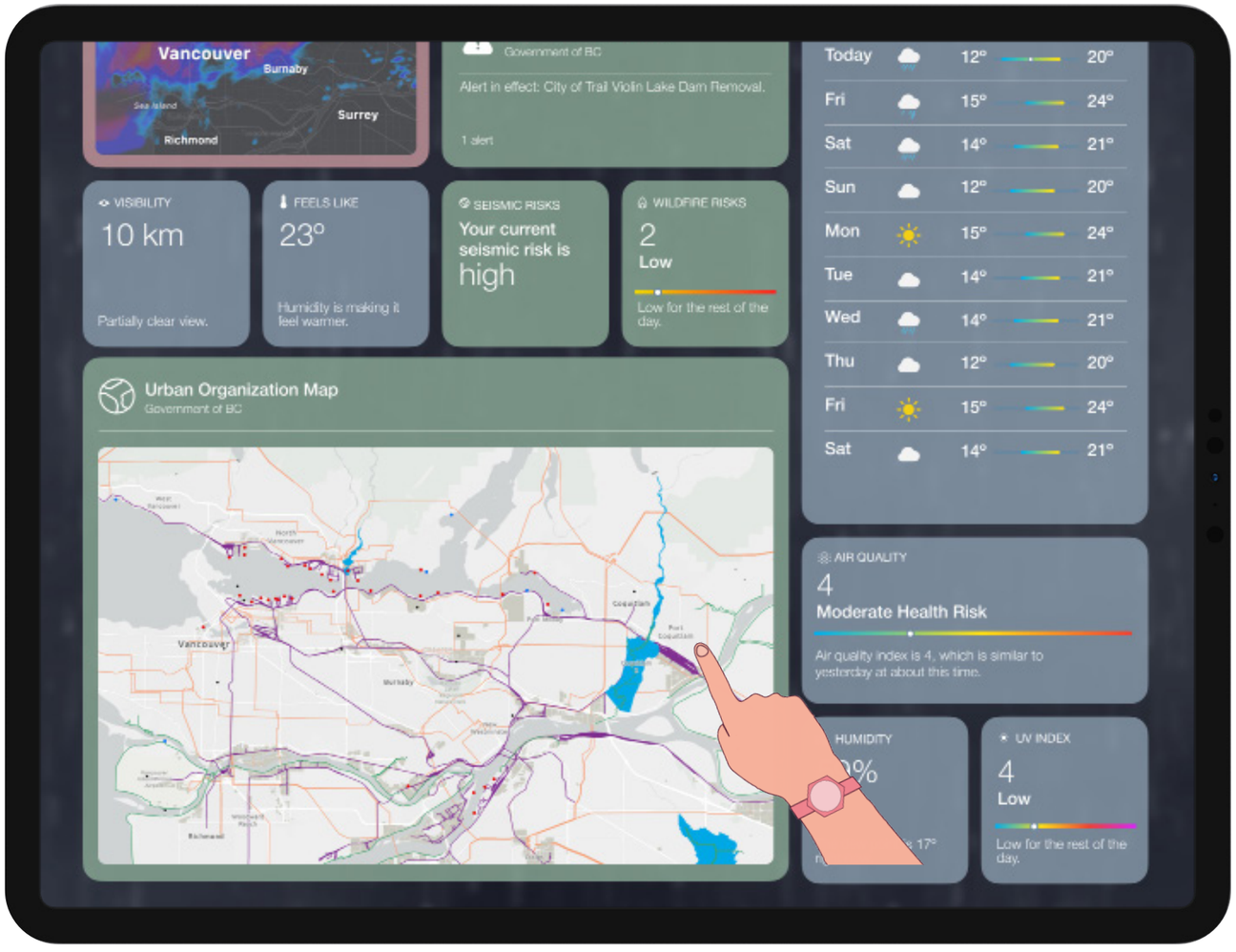


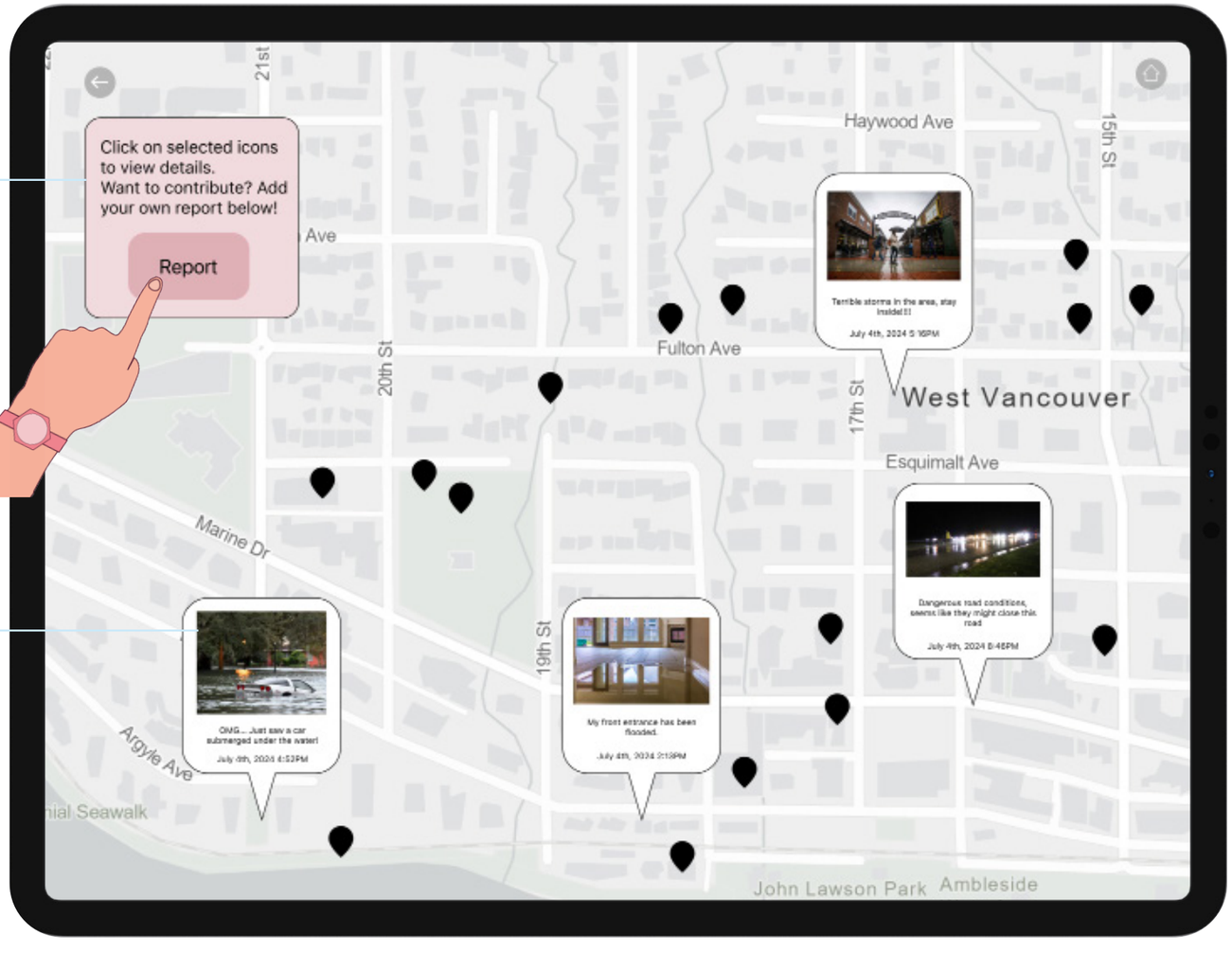
Figure 56. Beta Page (continued), image by author.



Jackie

"This tool is quite nice to explore! Since I don't have direct relationships with many of my neighbours, I find it quite interesting that we can all share images and testimonies on this page. This way we can all see and share our experiences in real time. I feel like I can trust this community map because I can see that it is powered by contributions from people who actually live in the area. I decided to file a report since there is some heavy rain outside."

This is linked to the report function of the platform, with clear steps for reporting the location, type of severe weather, and the option to add an image.



To facilitate a community-based learning experience, the community map is a page where users can contribute to.

The consolidated images will then appear on a community map, in which images will pop up of different flooding scenarios across the region. The images, by default, will stay visible for a 24-hour period, but will also feature an element where users can adjust the visibility period of the images.

Figure 57. Community Map, image by author.

3.4. Findings, Evaluation, and Next Steps

The current iteration of the platform has a number of successes and shortcomings. By revisiting the platform's original requirements and goals, we can critique the outcome of the design. The initial thesis question explored how synthesizing climate causes, risks, and adaptations, along with meteorological, infrastructural, and ecological information in a climate communication platform can help build climate literacy in the Lower Fraser Basin. This was the initial design goal of the project, and steps were generated in order to produce the platform's design.

The platform was successful in gathering various sources and information, consolidating various climate change resources into a single communication platform. The widgets successfully work together in clusters, with additional information and links to actionable items within easy access. Creating the mapping feature allows for the tool to convey narratives of the region, while allowing the user to have the freedom to contribute or edit the visibility of certain features. The platform is able to effectively communicate information that was previously presented separately. Having access to this information can allow users to interact with educational resources and reputable data sources.

While the platform has successfully gathered information, the efficacy of building climate literacy is not necessarily proven. The platform has gone through its first iteration, where information has been clearly displayed, but there has not been a developed metric in order to evaluate whether the presentation of this information leads to climate literacy. Therefore, the platform cannot definitively conclude whether the goal of building climate literacy through these sources is successful.

In addition to this, the platform has been designed with UCD principles in mind, however a key part of that includes receiving feedback from the targeted user base as a component of the development. Missing this key part of the process in this iteration of the design leads to design decisions that may have bias or may not work as intended.

The aforementioned platform layout is designed to be accommodating for various types of users. By returning to the proposed user personas, we can visualize various pathways that these users may navigate through the tool. By performing a cognitive walkthrough of the project, we can see the platform from the user's perspective. This also acts as an audit of the platform's design, evaluating navigation, clarity of information, and the flow of each user's journey. The interactivity of the different widgets and buttons will also be evaluated, indicating the usability of these features.

These cognitive walkthroughs allow for the development to be critiqued and act as a good source of information to continue developing the flow of the platform. By identifying common navigational procedures, the development can streamline some of the processes to accommodate a simplified user interface.

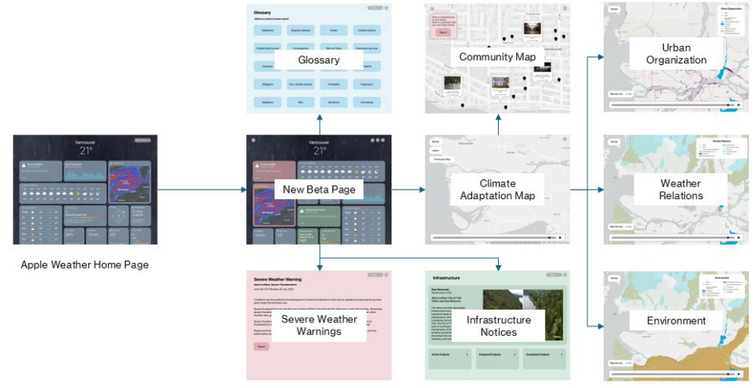


Figure 58. Site Navigation, image by author.

In future iterations of this project, a target user base will be invited to test the tool, with feedback contributing to further development. This is critical as there are cultural nuances that need to be taken into account at this phase of the process. The Lower Fraser Basin is a vast region with a number of different cultures and practices, and having an in-depth understanding of users' social media usage, platforms of choice, and different media channels for consuming information is critical.

There is also discussion regarding the different features of the platform in its current state. It aims to be an informational portal, a space for reporting severe weather, a social networking site, in addition to its inherent weather forecasting. This poses important discussion regarding whether this is too many features for a single platform, and questions whether some of its uses can be outsourced to already existing tools.

One of the most critical features of the platform is its ability to consolidate information from different agencies. As an information portal and news site, there is potential for integration with widespread weather forecasting platforms. This can already be seen in Apple Weather's existing ability to access governmental weather alerts. By expanding this aspect of the platform further, users can gain a more holistic understanding of weather patterns, climate change, and the impact that anthropogenic actions may have on our ecosystem.

Some of the current features that are present in the platform can be linked, with reciprocal feedback, to existing tools. This may include the severe weather reports in the platform having a relationship with governmental agencies, news networks, and weather forecasts. Features such as the community map can be integrated with existing mapping tools, like Google Maps, which will allow the platform to be streamlined. Reducing the platform's number of features and linking it to other tools will be beneficial, as it allows for increased accessibility and reduced likeliness of technological errors. With location-based features being a part of different apps and platforms, outsourcing this feature may allow further integration with social media networks like Instagram.

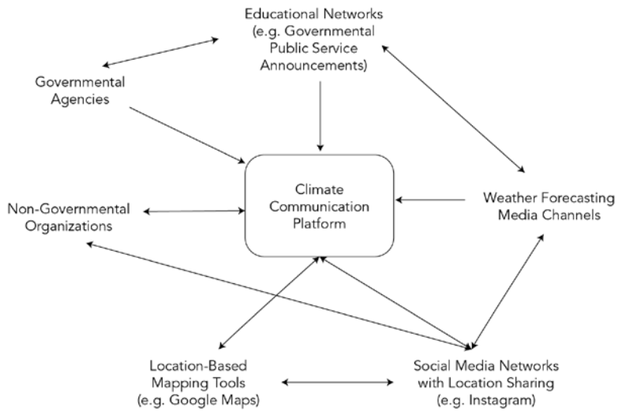


Figure 59. Network Relationships, image by author.

As a first step towards a comprehensive design tool for the Lower Fraser Basin, this design prototype is an initial exploration of climate communication. As the platform continues to evolve, focusing on user-centered evaluation methods and establishing measurable outcomes for climate literacy will be essential to fully realizing its potential in fostering informed, climate-conscious users.

From the previous evaluation, it has been determined that the platform has achieved its goal of presenting a synthesized source of information that displays data following accessible design strategies. However, the information determining the success of building climate literacy is inconclusive. By reducing redundancy and collaborating with established platforms, the project can streamline the user experience and minimize potential technological challenges. Continued feedback from a diverse user base, along with attention to cultural and regional nuances, will be crucial in ensuring the platform's effectiveness in building climate literacy and fostering a broader understanding of climate impacts in the Lower Fraser Basin.

3.5. Benefits and Constraints

The development of this platform has uncovered a number of benefits and constraints that may support the development of this platform for local climate adaptation in the Lower Fraser Basin and elsewhere.

Some of the benefits of having a platform such as this one include the ease of integration into an existing tool, multi-functionality, the ability to reach a large population of people, as well as having a personalized user experience.

One of the primary benefits of this climate communication platform is its ability to seamlessly integrate into Apple Weather. By embedding the platform within an interface that people already use, users can access critical climate information without needing to install a new app or visit a separate website. This reduces friction, encourages more frequent use, and allows for quick access to relevant data, fostering a smoother user experience.

This platform's flexibility to support multiple functions offers a comprehensive solution to climate adaptation. Users can access real-time data, alerts, resources for personal action, community updates, and interactive features all in a single application. This approach saves time for users and provides them with a variety of tools, empowering them to make more informed decisions on climate resilience.

Leveraging a popular application like Apple Weather allows this climate communication tool to potentially reach a vast audience. By tapping into this platform with large user bases, this initiative can distribute climate information to a broad spectrum of people across the Lower Fraser Basin. The widespread reach makes it easier to educate and engage the public on climate adaptation efforts, increasing awareness and fostering community resilience.

The last, and perhaps most significant benefit identified through this research is the ability to personalize climate information based on user location, interests, and preferences. Tailored alerts and data to specific communities or individuals allows enhanced engagement and relevancy.

Constraints of this platform include the fact that this may only reach a subset of the population, external ownership, as well as additional cultural barriers that scaling this project beyond the Lower Fraser Basin may entail.

One of the major constraints of the platform is that it may only reach a subset of the population, particularly those who can afford and prefer to use iOS devices. This limits accessibility to individuals who rely on other operating systems, access weather forecasting through other forms of media, or cannot afford high-end smartphones or devices. As a result, the platform may not be equitable in its outreach, excluding vulnerable or lower-income populations who are often disproportionately impacted by climate change.

Another constraint that is present is the platform's reliance on Apple's ecosystem. This introduces a constraint in that it is not independently owned. Apple retains control over the application, its distribution, and its policies. This dependency can create challenges if Apple introduces changes to its terms or features that limit functionality, disrupt service, or raise costs for the developers or users. The platform's autonomy and long-term sustainability may be affected by this external control.

Expanding this platform beyond the Lower Fraser Basin may present cultural and regional challenges. Even when designing this tool to fit a specific user audience in the Lower Fraser Basin, there were many differences in culture that had to be accounted for. With this in mind, it is clear that climate communication strategies that resonate with one region may not be effective in another due to differing cultural norms, languages, or priorities. Climate risks and responses also vary by region, so the platform would need significant customization to be relevant and accepted in different areas, making the further scalability of this platform a challenge.

4. Conclusion

The reason for developing this thesis was to explore the idea of the consolidation of various resources to create a more effective way of climate change communication. The growing challenges that anthropogenic influences have imposed on our landscapes have irreversible consequences, and are constantly evolving by the second. It is critical that we act now – which is the main inspiration and driving force behind this thesis.

Initially, this thesis was started as an exploration of the various coastal adaptations that were present in the Lower Fraser Basin, but this research has evolved into an unveiling of a much larger picture. The interconnected networks and relationships between human and non-human influence on the region is difficult to pinpoint, and with growing tensions, climate literacy has become a headline in the topic of climate change. With this in mind, the project evolved into the iterative development of a climate communication platform which would address the agendas of temporality, scalability, multi-agency, and accessibility.

This research highlights the benefits that an effective climate communication platform can bring to address specific challenges of the Lower Fraser Basin. As climate change continues to pose significant threats, the role of social media and digital tools in disseminating accurate, actionable information becomes increasingly vital. The design iteration of the comprehensive digital platform integrates climate data, infrastructural resources, and community engagement to bridge the gap between awareness and action. The platform not only addresses the current deficiencies in public engagement and emergency response, but also fosters climate literacy by making complex information accessible and understandable. This approach could serve as a model for other regions facing similar environmental challenges, empowering communities to take informed action in the face of a rapidly changing climate.

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