An Unfair Share

Exploring the Disproportionate Risks from Climate Change Facing Washington State Communities

A report by the University of Washington Climate Impacts Group, Front and Centered, Urban@UW and the University of Washington Department of Environmental & Occupational Health Sciences

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Cover photos: Community members at listening sessions held across Washington State for this report.

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EXECUTIVE SUMMARY

Climate impacts or hazards, stemming from events like heat waves, floods and drought pose challenges for all Washington communities, now and in the future. However, the degree to which communities will experience these climate change-related hazards, described here as *exposure,* is not the same. Similarly, the extent to which communities can cope with the impacts of climate change-related hazards, described here as *vulnerability,* varies across communities, and even among individuals. Both exposure and vulnerability ultimately determine an individual's or community's level of *risk*. This hazard-vulnerability-exposure framework is used in this report for exploring the impacts on communities from climate change-related hazards in Washington state.

The aim of this report is to support ongoing discussions regarding the climate change-related hazards facing communities in Washington, with a special emphasis on communities of color, indigenous peoples and communities with lower incomes. For climate policies and programs to effectively address existing or future inequities, there needs to be credible information about who is at risk in Washington state from climate impacts, and why. This information should clarify how communities may be exposed differently and how factors like race/ethnicity, wealth, income, level of education and health status affect the ability to cope with the impacts, or related harms. It should also highlight the types of community strengths, assets and processes that can build resilience to climate impacts.

In this report, our research team has identified factors that contribute to disparities in how communities in Washington state experience and cope with the climate change-related hazards with a specific focus on where people live and work. This report does not address 'second order' impacts from climate hazards experienced elsewhere, such as impacts on global food systems and trade. This work draws upon two key inputs: 1) comments made by diverse community members during eleven statewide Listening Sessions, convened with community-based organizations in 2017, and 2) a review of published research related to Pacific Northwest climate impacts, public health and disaster planning and response. Key findings include:

> **Local social, economic, demographic and geographic factors ultimately determine how severe climate change-related risks will likely be.** Climate change-related risk often has more to do with population characteristics such as race/ethnicity, wealth, educational attainment, occupation, political voice and the strength of community organizations than with the pace or magnitude of a changing climate. Therefore, communities of color, indigenous peoples and communities with lower incomes tend to face the greatest climate risks.

> **Where you live and where you work are important factors that contribute to exposure and vulnerability to climate change-related impacts.** A range of climate change-related hazards will affect key industries across Washington state, but the impacts will be unevenly felt. The agricultural workforce in Washington state is roughly 53% non-white and 40% Hispanic/Latinx (U.S. Census Bureau, 2017). Most agricultural workers in Washington state are male, foreign-born, work long hours, rotate to different employers, have little formal education, and are more likely to suffer from chronic health problems (Bethel et al., 2017). In the agricultural sector, upwards of 79% of outdoor farm workers experience a heat-related illness during the summer harvest season (Bethel et al., 2017; Spector et al., 2014). *See Chapter 5*.

> **Efforts to build community resilience to climate change in Washington state are more likely to be effective if they are inclusive and reinforce existing social structures that promote cohesion.** Social cohesion, which is the result of strong social networks, trusted relationships and shared cultural experiences, can help communities access and share resources in the face of disasters and emergencies. Shared spaces and community groups that act as hubs for exchanging information and sharing resources play a critical role in bolstering resilience. Displacement and division can undermine this social cohesion.

Several extreme weather events in the U.S., which are projected to worsen with climate change, have demonstrated that social cohesion, or the ability for communities to communicate, cooperate, access and share resources, can reduce negative consequences of such events. During a 1995 heat wave in Chicago, Latinx neighborhoods experienced substantially lower mortality rates than other neighborhoods. The higher resilience of that community has been ascribed to greater social cohesion within these neighborhoods (Klinenberg, 2002). *See Chapter 4.*

Given the placed-based nature of climate change-related risks, community members are likely to be the experts in developing and deploying solutions that enhance social cohesion, prevent displacement and bolster community resilience to climate change.

> **There are several research gaps where future work is needed to improve our understanding of the climate change-related risks facing Washington communities.** Climate change-related hazards such as increasing air temperature, flood risk and wildfire can all negatively impact human health and livelihoods. Unfortunately, there is limited understanding of which communities across the state are most likely to be exposed and vulnerable to these hazards. A few examples of existing research gaps, which are explored in Chapter 7, include:

- Understanding the extent to which climate change-related hazards exacerbate threats to health, including mental health conditions, is needed. Emerging research indicates that mental health can be affected by extreme heat. Many communities of color, indigenous peoples and communities with lower incomes already experience health disparities and tend to have more limited access to healthcare. Understanding the extent to which climate hazards may exacerbate threats to health conditions, like mental health, would be valuable for public health professionals, emergency managers and hazard planners.

- Examination of community experiences during, and after, specific climate-related events like extreme rainfall and flooding would help to deepen our understanding of the responses and consequences of such events in Washington state. To go beyond the anecdotes collected for this report, more systematic investigation is needed of community experiences surrounding extreme events. This type of work would identify the relative importance of specific factors that affect community vulnerability among Washington state's different racial/ethnic groups.

- Understanding how climate impacts are being managed for port infrastructure and surrounding neighborhoods is needed. Ports in Washington state will experience more frequent flooding and inundation from sea-level rise. Neighborhoods surrounding ports are characteristically non-white and lower-income; the confluence of these factors makes ports potentially important locations for thinking about greenhouse gas reductions, climate resilience and equity issues.

- Better understanding the different risks facing urban and rural populations in Washington state is needed. How do factors like housing quality, affordability, and availability of services in these different contexts contribute to exposure and vulnerability to climate change-related hazards?

Understanding how climate impacts intersect with issues of equity and environmental justice requires using participatory, community-centered research. As a beginning in this work for Washington state, our project team intentionally brought university students and researchers together with community groups, creating the occasion and stimulus for shared learning and exploration of new questions. We hope this contribution is followed by many more efforts to build closer connections between academic spaces and the communities in our state. It has never been more critical to combine perspectives and resources to craft inclusive responses to the emerging risks of climate change.

CHAPTER 1. INTRODUCTION

This report highlights the disproportionate climate climate-related hazards facing communities in the state of Washington, with a focus on communities of color, indigenous peoples and communities with lower incomes. The content of the report is drawn from on-the-ground experiences and perspectives of community members, as well as available published research. The report also identifies knowledge gaps in our collective understanding of the disproportionate risks facing these frontline communities, as well as examples of inclusive planning processes that are being pursued to build climate resilience.

> **"Climate change affects all, but not all are affected equally."**
>
> - Yuen et al., 2017

WHAT IS THE PURPOSE OF THIS REPORT?

> **To stimulate more, and deeper, discussion of the human dimensions of climate impacts, specifically in Washington state.** There are several sources of information about the implications of climate change for Washington state (e.g. Snover et al., 2013; Mauger et al., 2015) and the Northwest (e.g. Dalton et al., 2013; Mote et al., 2014). However, these synthesis reports focus heavily on the physical and ecological dimensions of climate change, and less attention is paid to the demographics, identities, socioeconomic status, and cultural values of potentially-affected individuals and communities. Also, there is limited information about the distribution of risk among individuals and communities with differing demographics, identities, socioeconomic status, and cultural values. This report is not a comprehensive review of the human dimensions of climate impacts in Washington state. We hope this report will catalyze interest in and support for future work focused on better understanding of the human dimensions of climate impacts in Washington state, and on ways to enhance the resilience of at-risk individuals and communities.

> **To better highlight community voices and integrate their knowledge with the existing body of research.** This report recognizes and promotes the idea that "inclusive community driven planning processes can maximize the benefits of climate preparedness action" (Yuen et al., 2017). The report's organization and topics draw heavily on a series of Listening Sessions conducted by community organizations in various parts of Washington state. These sessions served as an important distillation of the climate concerns from individuals and communities and reflect how these concerns intersect with other economic,

social, cultural and environmental challenges. The perspectives of the participants provide a compelling illustration and validation of existing research. In some cases, where the participants' comments did not include information about specific climate risks, it raises valuable questions about risk framing, communication and different sets of world views.

WHY NOW?

Equity is emerging as a guiding principle for climate preparedness planning and for actions on environmental issues more generally (e.g., King County, 2015; Willimas-Rajee and Evans, 2016; City of Seattle, 2018a,b). Recently-proposed legislation for a carbon pollution tax in the Washington Legislature included language to direct a portion of the revenue to support communities of color, indigenous peoples and communities with lower incomes, to support the transition away from fossil fuel use and to mitigate the harm from climate impacts (WA Senate Bill 6203, 2018). Also, Initiative 1631, a proposed ballot Initiative for the November 2018 elections in Washington state, has similar language regarding the use of revenues from a carbon pollution fee to benefit "vulnerable" populations facing health and socio-economic barriers that are potentially exacerbated by climate impacts (WA Initiative 1631, 2018).

For climate policies and programs to effectively address existing or future inequities faced by communities of color, indigenous peoples and communities with lower incomes in Washington state, there needs to be credible information about *who is at risk in Washington state from climate impacts, and why*. This information should clarify how communities may be exposed differently and how factors like race/ethnicity, wealth, income, level of education and health status affect the ability to cope with climate change-related impacts. It should also highlight the types of community strengths, assets, and processes that can be supported to build resilience to climate impacts.

By synthesizing current knowledge and identifying where further research might be valuable, ***this report aims to support ongoing discussions regarding the climate risks facing communities in Washington state, with a special emphasis on risks faced by communities of color, indigenous peoples and communities with lower incomes.***

WHO IS THIS REPORT FOR?

There are four primary audiences for this report:

1. **Those involved in formulating and overseeing local and state programs that address greenhouse gas emissions and climate preparedness.** The report is intended to point to resources that might provide more detailed information on specific topics and highlight areas of community and point to knowledge gaps that warrant future focus.

2. **Community-based organizations and environmental justice groups that are raising awareness about the climate concerns and issues facing communities of color, indigenous peoples and communities with lower incomes**. The combination of first-hand experiences of participants in the Listening Sessions with existing research may be a useful tool for groups as they work with the general public or with specific state, tribal, or local agencies.

3. **Researchers in search of opportunities to build needed knowledge** related to the distribution of climate risk across Washington state and beyond. The research needs that have been identified will likely require an interdisciplinary approach and may be of interest to diverse natural and social science research communities, as well as stakeholders in the community that are willing to lead, partner, and participate.

4. **Funders** who financially support research and climate justice efforts across Washington state.

REPORT OVERVIEW

> **Chapter 2** outlines the approach used to develop this report, describes the community listening sessions and introduces the conceptual framework for climate risk used in this report.

> **Chapter 3** provides a brief introduction to the climate change-related hazards facing Washington state.

> **Chapters 4 and 5** both focus on climate risks: *Climate Risks That Affect People Where They Live* (Chapter 4) and *Climate Risks That Affect People Based on Their Livelihood* (Chapter 5). The choice to organize the risk information into these chapters was made

based on comments from the Listening Sessions, where issues related to "home" or "work" were often the focus of discussion.

Each risk chapter has two main sections:

1. A section on risk *Exposure* describes how climate risks depend on the geography of where people live (floodplains, wildland-urban interface, urban centers) and the demographic characteristics of communities in these areas (Chapter 4), as well as the sector in which they work (agriculture, fisheries, construction; Chapter 5).
2. A section on individual and community *Vulnerability* describes how a host of socioeconomic factors, race/ethnicity, level of education, wealth and income, and community infrastructure act to amplify or mitigate climate risks (Table 1).

TABLE 1: Selected areas and industries that are exposed to climate impacts and the factors that affect vulnerability discussed in this report.

Exposure based on Where People Live (Chapter 4) > Floodplains > Wildland-Urban Interface > Urban areas	**Factors that Affect Vulnerability (Chapters 4 & 5)** > Race and Ethnicity > Wealth & Income > Linguistic Isolation > Social Cohesion > Age and Health Status > Perception of Risk > Community Infrastructure > Cultural Value/Importance > Education and Job Mobility > Existing Environmental Stressors > Immigration Status > Water Rights
Exposure based on Livelihood (Chapter 5) > Agriculture > Fisheries > Construction	

> **Chapter 6**, *Community-Responsive Approaches to Building Climate Resilience,* is solutions-oriented and provides resources for preparing for future climate impacts and examples of inclusive processes driven by community members. It discusses linkages between policies and programs designed to manage climate risk and those aimed at reducing greenhouse gas emissions.

> **Chapter 7** identifies several *Research Gaps*. Further research involving community members in these areas could support progress in addressing the disproportionate climate risks across Washington.

Excerpts or summaries from the Listening Sessions appear throughout the report. The excerpts are used to emphasize the perspectives of the Listening Session participants, and to frame the discussion of the literature around their statements. In some instances, quotations are taken from other reports, rather than the Listening Sessions. Citations are provided for these excerpts.

It is critical to emphasize that this report is intended as a starting point to catalyze further discussion, engagement, and research. The material presented here is not an exhaustive review of affected communities or the available literature. For example, the Listening Sessions were conducted by organizations that were self-selected through a proposal process. These sessions were intended to be geographically and demographically diverse, but not a proportional sub-sample of communities across the state. In a similar vein, the literature review largely reflects the authors' collective expertise in regional climate science and public health. Given the complexity of the issue, future work would benefit from inclusion of a wider range of disciplinary backgrounds, with particular emphasis on economics, demography, and social justice. In addition, this work presents a snapshot in time (mid-2018). The experiences of individuals and communities are constantly evolving, as is the research that draws from or illustrates these experiences.

CHAPTER 2. REPORT APPROACH

WRITING TEAM

The writing team consisted of an interdisciplinary group of researchers from University of Washington, including the Climate Impacts Group, Urban@UW and the Department of Occupational and Environmental Health Sciences in the School of Public Health.

During the preparation of this report, input was solicited about the approach, content, and format with the Front and Centered Steering Committee as well as an external group of researchers from the University of Washington. Their feedback was invaluable for improving this report; the research team is appreciative of their contributions and insights.

COMMUNITY LISTENING SESSIONS

Community listening sessions helped identify the ways that community members perceive climate risks, providing critical input to the structure and content of this report. This section provides a summary of the format for the sessions; greater detail can be found in Front and Centered's Listening Session Report (2017).

Listening sessions were conducted by various community-based organizations that work in collaboration with Front and Centered. These organizations work in, and with, communities who have been identified as disproportionately vulnerable to environmental harm, including: communities of color, indigenous peoples, communities with lower incomes, immigrants and refugees, and linguistically isolated groups.

To conduct the listening sessions, Front and Centered issued a request-for-proposals to community-based organizations across the state to host listening sessions. Community-based organizations that were selected received a facilitator's guide and accompanying materials, including a note-taking template, a summary template for facilitators and a request for photos following the listening sessions.

Community leaders from host organizations facilitated the listening sessions, took individual notes and summarized each of their meetings. Where possible, Front and Centered staff and affiliates attended the listening sessions. Food, beverages and childcare were available when needed. When needed, an interpreter was also available for translation. Eleven two-hour community listening sessions were hosted between July and November 2017.

FIGURE 1: Map of locations of community listening sessions across Washington state.
From: Front and Centered (2017).

Community organizations that helped to conduct these listening sessions include:

1. *Asia Pacific Cultural Center (APCC)* serves as an interactive cultural crossroads between local and international communities in Tacoma, WA. The APCC hosted a listening session in both English and Korean.
2. *Chaplains on the Harbor,* is a faith-based center providing the community with resources and leadership development in Grays Harbor, Washington. Chaplains on the Harbor hosted a listening session with particular emphasis on participation of Quinault Tribal members.
3. *Community to Community Development (C2C)* is a women-led grassroots organization dedicated to food sovereignty and immigrant rights. C2C hosted a Spanish listening session in Bellingham, WA. Participants included Latinx young adults, parents, farm workers, and students from the community.
4. *Entre Hermanos* promotes the health and wellbeing of the Latino gay, lesbian, bisexual, transgender, and questioning community in a culturally appropriate environment through disease prevention, education, support services, advocacy and community building. Entre Hermanos hosted a listening session in both Spanish and English in Seattle, WA.
5. *Mother Africa* assists African refugee and immigrant women and their children to reach their highest potential. Mother Africa hosted a listening session in Kent, WA in both Arabic and English with women from North Africa/Arabic cultural backgrounds.

6. *The Snohomish County Branch (SCB) NAACP* currently serves all communities between South Snohomish County and the Canadian Border. They hosted a community listening session that took place in Everett, with additional participants from Edmonds and Lynnwood. Participants represented various backgrounds and ethnicities.
7. *The Latino Community Fund (LCF), Central Washington,* cultivates new leaders, supports cultural and community based non-profit organizations, and improves the quality of life for all Washingtonians. LCF engaged Latinx youth in a listening session hosted in both English and Spanish in Ellensburg, WA.
8. *OneAmerica, Vancouver* is Washington's largest immigrant and refugee organizing, advocacy and civic engagement organization. OneAmerica hosted a listening session in Vancouver, WA in both English and Spanish. Community members, mainly Latinx, participated in the meeting.
9. *Na'ah Illahee Fund, Yakama Nation, and Olympic Peninsula* supports and promotes the leadership of indigenous women and girls in the ongoing regeneration of indigenous communities. Na'ah Illahee Fund hosted two listening sessions as part of the tribal community meetings: one within Yakama Nation, with tribal member representation from the Snake and Columbia Rivers, with a focus on the Wanapum and another listening session in Lower Elwha Klallam.

CONCEPTUAL FRAMEWORK FOR CLIMATE RISK

Following a global assessment of climate risk, this report defines risk as *"the potential for consequences when something of value is at stake and the outcome is uncertain…*" (IPCC, 2014a). Risk emerges at the intersection of hazards, exposure and vulnerability, where:

> **Hazard** is defined as a climate change-related event or trend that causes loss of life, injury, or other health impacts, as well as damage to property, infrastructure, livelihoods or ecosystems. This report focuses on events that occur in the current climate and are expected to increase in frequency and/or magnitude as a consequence of climate change (e.g. flood, wildfire, heatwaves).

> **Exposure** is the extent to which people, ecosystems, infrastructure or cultural resources experience hazards. Exposure is often related to geography (e.g., people living near the coast will be exposed to coastal flooding and sea-level rise, whereas those living farther inland will not be exposed). However, other factors can influence exposure. For example, individuals who work outside during heat waves or during smoke events

typically face greater exposure to heat stress and poor air quality, relative to people who can remain indoors.

> **Vulnerability** is the extent to which an individual or community will be adversely affected when experiencing a climate-related hazard. Considerable research has identified the various social, cultural and economic factors that contribute to vulnerability (Cutter et al., 2003; Donner and Rodríguez, 2008; Balica et al., 2012). These factors include wealth, race/ethnicity, health status, age and linguistic isolation. Since most of the existing work on vulnerability to climate impacts is focused on broad scales (e.g., national or international), or for specific communities and events (e.g., African-American communities in the wake of Hurricane Katrina), this report attempts to identify ways in which prior work is applicable to communities in Washington state.

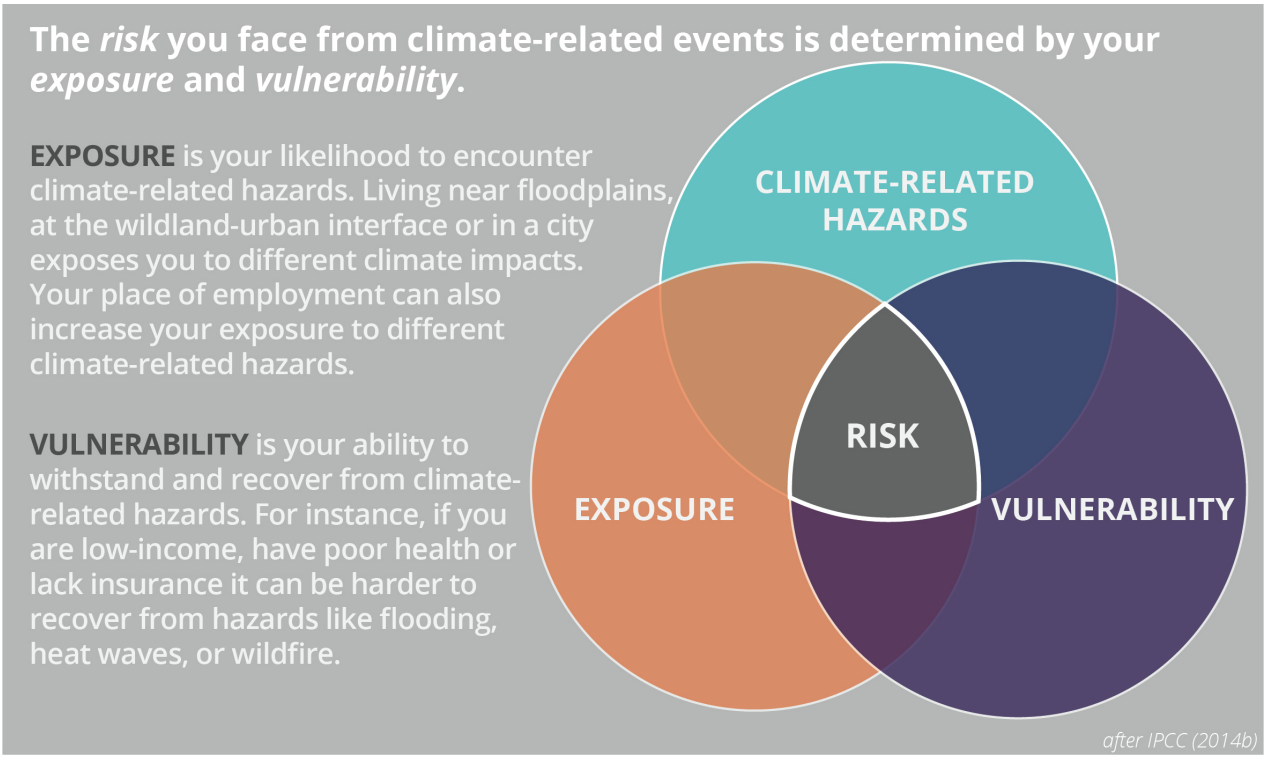

FIGURE 2: Hazard-Exposure-Vulnerability conceptual framework used in this report for exploring the community-based impacts of climate change-related hazards in Washington state. Modified after IPCC (2014b).

The hazard-exposure-vulnerability conceptual framework is a useful lens for examining potential policies or programs intended to boost climate preparedness. For example, building flood protection structures would help reduce the impacts of flooding and lower risks for communities near those structures. Policies or programs that would remove incentives or add disincentives associated with settling in a floodplain minimize exposure,

as fewer individuals would be in harm's way. Efforts to reduce vulnerability might aim to improve the housing stock of residents in the floodplain, or improve their access to insurance, thereby allowing faster recovery following future flooding.

RACIAL AND ETHNIC DIVERSITY IN WASHINGTON STATE

Race and ethnicity play a central role in conversations about disproportionate climate risks. To ground the discussion that follows in this report, it is useful to understand the demographic characteristics of Washington communities, both now, and in the future.

Currently, a little more than 7 million people live in the state of Washington. Although the current population is seventy percent white, the state's racial/ethnic diversity is growing and is projected to continue to grow in the coming decades. By 2050, it's possible that over half the state's population will identify as Black, Latino, Asian Pacific Islander, Native American, or Mixed race (Figure 3; classifications used are those defined by National Equity Atlas, 2018). These trends are similar to those observed and expected for many other parts of the country.

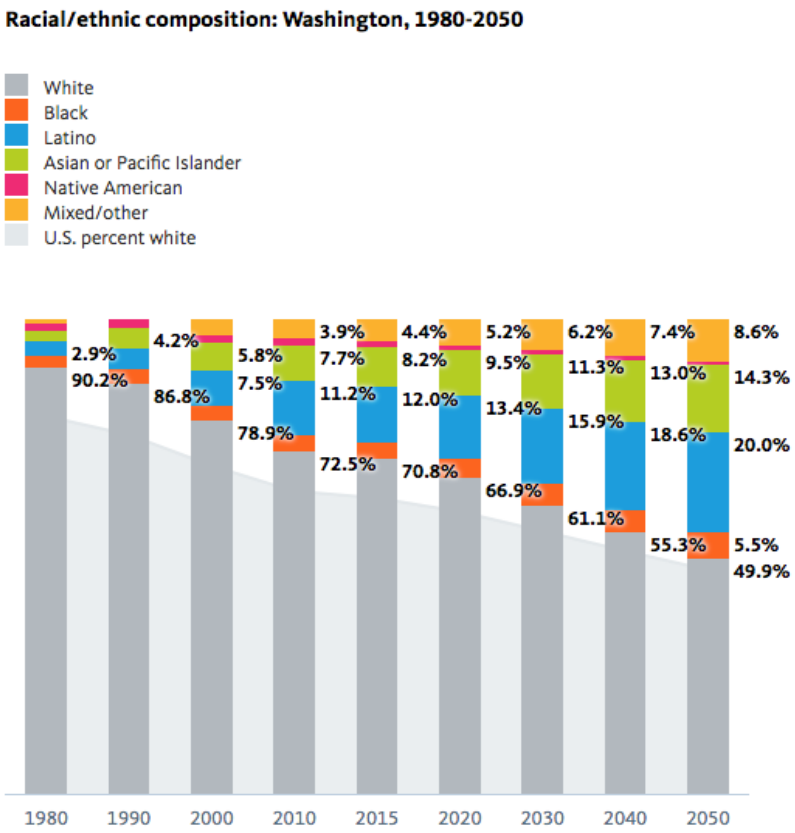

FIGURE 3: The proportion of Washington's non-white population has grown substantially in the past several decades and is projected to continue to grow. By 2050, projections show that half of Washington's population might be people of color. From: National Equity Atlas (2018).

Across the state, several areas have relatively greater diversity: Central Washington, including portions of Yakima, Benton, Kittitas, Grant, and Douglas counties; areas along the Interstate-5 corridor, especially south of Seattle, near Tacoma and in Snohomish County; and the areas near Willapa Bay and Grays Harbor (Figure 4).

While these maps can provide a useful snapshot of diversity across the state, caution should be used when interpreting them. Summarizing population data by census-tract can obscure the importance of densely populated areas where tracts are geographically small. Also, the characteristics of minority groups with relatively small proportions of the population are potentially lost in the spatial aggregation. For example, for tribal communities, which represent a small proportion of the state population (~1%), these maps are unlikely to capture areas that are culturally important. Additionally, the census categories for race/ethnicity are coarse, and do not necessarily reflect the diverse needs, assets and challenges that are present in different communities across the state.

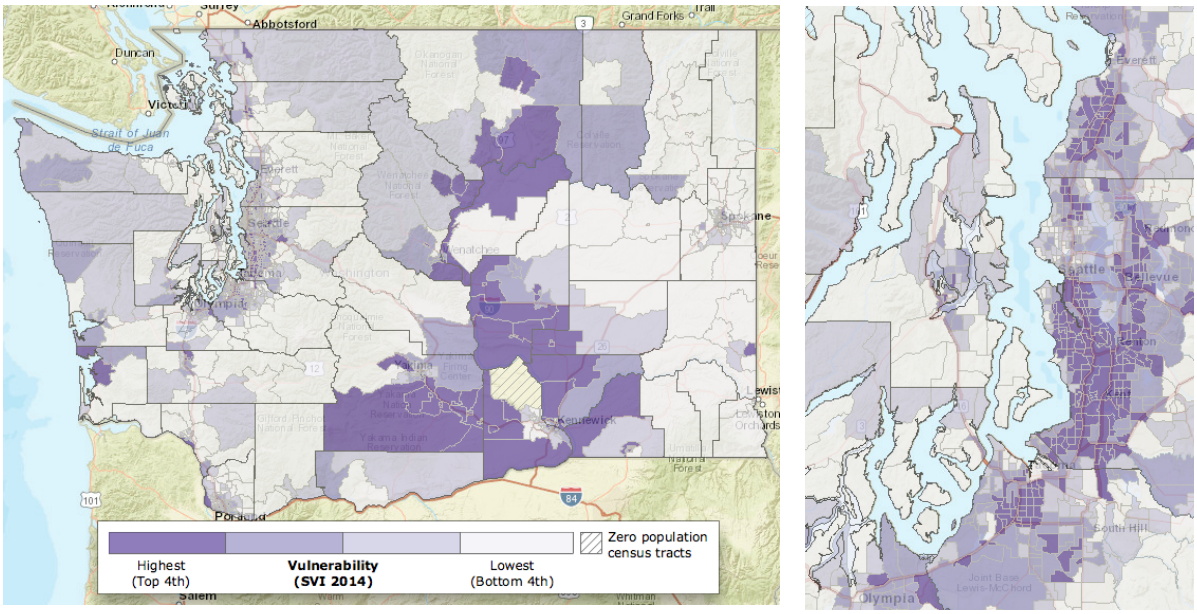

FIGURE 4: 'Social Vulnerability Index' (SVI) maps likes these are used to indicate the relative vulnerability of given area (drawn by U.S. census tracts) due to specific socioeconomic and demographic variables. Here, darker shading (or a higher SVI) indicates greater proportions of non-white residents and less English proficiency in Washington (left) and in Puget Sound (right). From: CDC (2018).

CHAPTER 3. CLIMATE CHANGE-RELATED HAZARDS

Weather and climate-related hazards, such as heat waves, droughts, wildfire and floods pose challenges for all Washingtonians. In this section, we provide an overview of Washington-specific climate-related hazards and explain how we expect human-caused climate change to affect these hazards. For more in-depth discussion of climate change in Washington state, please consult the State of Knowledge Reports for a) the Puget Sound (Mauger et al., 2015), and b) Washington state (Snover et al., 2013). The technical information presented in this section draws primarily from those synthesis documents.

Key points about hazards include:

> **Climate-related hazards occur in the current climate.** Future climate change is anticipated to make many of these climate events more frequent or more intense.

> **Past experiences with climate-related hazards provide an important guide for understanding the ways in which communities are at risk, their ability to cope, and the resources that can enhance the ability to cope under future climate change.**

> **Climate-related hazards mean different things in different places.** The frequency, intensity, and consequences of different climate-related hazards will vary for different communities in different locations. For example, a heat wave in Seattle might have negative consequences when temperatures exceed 85°F, whereas the same temperatures in parts of Eastern Washington are more common and might be considered "normal."

This report focuses on climate-related hazards specific to Washington state, with a focus on the climate-related hazards that are expected to become more frequent or intense with anthropogenic climate change. Although climate-related hazards in other parts of the country and world will undoubtedly have important consequences for communities and business in Washington (e.g., changes in global agriculture markets affect the prices and export opportunities for food produced and consumed in Washington, thereby affecting both consumers and agricultural workers), predicting the direction, timing, and magnitude of these changes is beyond the scope of this report.

WARMING TEMPERATURES

Washington state, and the Pacific Northwest more broadly, has warmed since the late 1800's. Average annual temperatures in Washington have increased almost 1.8°F for the period 1895-2017 (OWSC, 2018). The region has also experienced a number of notably warm years in the recent decade—2015 was the warmest year on record (going back to 1895); 2016 was the fourth warmest; 2014 was the seventh warmest (NOAA, 2018). Substantial warming is expected in the coming decades, which will make some of the recent notably warm or record-setting years more like an average year in the future.

Warmer average temperatures raise the risk of extreme heat events, which threaten human health. For example, by the 2020s the number of days that exceed a health heat alert threshold in King County is projected to more than double, from about four days per year to over nine days per year. By the mid-21st century, the number of days is projected to more than triple, to about thirteen days per year (Isaksen et al., 2014)

Warmer air temperature also translates into warmer water temperature. As air temperatures warm, water temperatures increase in streams, lakes, the Puget Sound and the Pacific Ocean. Warmer temperatures threaten fish, make it more likely for harmful algae to bloom and create conditions conducive for diseases that affect shellfish. Recent closures of fisheries in 2015, both in Washington and along the entire West Coast, were largely driven by warm temperatures (NOAA, 2016).

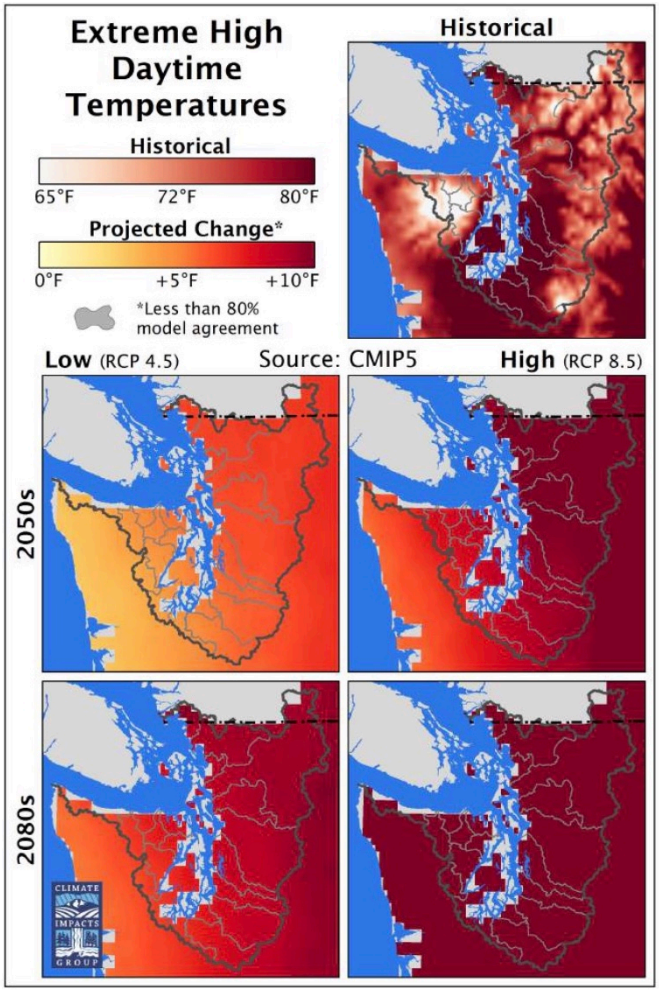

FIGURE 5: High temperatures on our hottest days in the Puget Sound could be as much as 10°F warmer by the end of the 21st century (compared to the historical period 1970-1999) From: Mauger et al., 2015.

While not always a hazard, warming air temperatures alter conditions important for agriculture. On average, growing seasons (as measured by the absence of frost) have lengthened in the Pacific Northwest by over 30 days and will continue to lengthen with future warming. Longer growing seasons can help some crops; however, warming may pose challenges for crops that rely on cold temperatures as part of their development process.

It should be noted that warming reduces the frequency and intensity of cold conditions in the winter. However, recent work on cities around the world suggests that health benefits of milder winters are likely to be outweighed by the negative impacts from more intense summer heat (Kinney et al., 2015; Staddon et al., 2014).

WATER STRESS AND DROUGHT

In the coming decades, the typical spring snowpack in Washington state is expected to be less than in the past, as warming pushes snowlines to higher elevations. The region will be left with less snowmelt in the summer, and many rivers will experience more frequent low flow events, and potentially lower low flows (Figure 6; projected streamflow for major Puget Sound watersheds is available in Mauger et al. (2015) Appendix D and for eastern Washington in Hamlet et al. (2013). Combined with warmer summer temperatures that drive up water demand, the stage is set for more frequent and severe droughts for areas that rely on snowmelt. Reductions in streamflow also exacerbate warming of streams, making it more difficult for cold-water fish, such as salmon, to thrive.

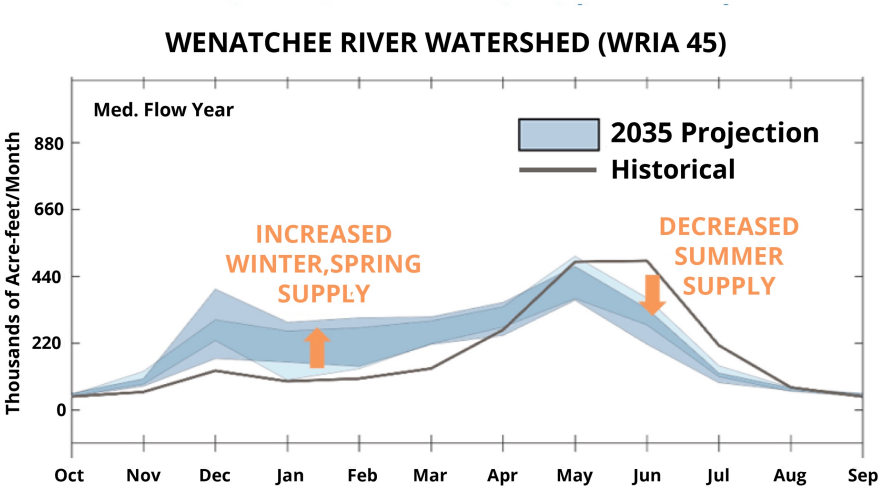

FIGURE 6: Projections of future water supply for the Wenatchee River show an anticipated increase in natural winter water supply and a decrease in natural summer supply. While this is not the case for all Washington watersheds, many watersheds will be facing changes in the timing and amount of water supply and demand. Modified from: Washington Department of Ecology (WA ECY, 2016a).

In 2015, Washington state experienced low snowpack conditions arising from warmer-than-average temperatures, which led to significant water stress for irrigators, managers of small water systems, fisheries, and forests. These conditions are analogous to what is expected in the future as a result of climate change. Specifically, the temperatures experienced during the winter of 2015 are similar to the average conditions projected for the middle of the 21st century. In many locations, the snow in 2015 resembled the average conditions projected to occur at the end of the 21st century.

FLOODING

Flooding is influenced by many weather and climate factors, including the intensity of rainfall (e.g., the amount of rain falling in periods of a few hours or a day), antecedent rainfall that saturates soils and enhances runoff (e.g., the amount of rainfall that would fall over a number of weeks or months), or the temperature at which precipitation falls (e.g., in colder storms, more precipitation will fall as snow reducing the immediate flood risk by retaining water in the snowpack rather than contributing to streamflow). There are also many non-climatic factors that contribute to flooding, such as the presence of impervious surfaces or stormwater infrastructure.

While it remains a challenge to project how future flooding may change at local scales, we have relatively high confidence of how future climate change will increase flood risk through changes in heavy precipitation, snowpack, and sea level.

> **Heavy rainfall is anticipated to get heavier**. The heaviest rainfall events on the West Coast of the United States are delivered by 'atmospheric rivers' (also known as 'pineapple express' events), which are expected to produce more rain in the future. One study suggests that these extreme precipitation events would yield 15-39% more precipitation (based on a 24-hour period) by the end of the 21stcentury (relative to 1970-1999; Warner et al., 2015).

> **With higher snowlines, storms can generate higher streamflow**. With warmer temperatures, a greater portion of precipitation will fall as rain instead of snow, increasing streamflow and raising flood risks along rivers and streams.

> **Sea-level rise increases risk of coastal flooding.** As sea level rises along the coasts, including in Puget Sound, future coastal river floods, and local coastal saltwater flooding, will be more severe, both in terms of water depth and the geographic area of flooding.

These three factors (increasingly heavy rainfall, higher streamflow because of warmer temperatures and sea-level rise) create the so-called "triple whammy" of flooding facing many western Washington watersheds. In parts of eastern Washington where snowmelt has typically been an important component of streamflow, the anticipated loss of snowpack would raise flood risks in the fall and early winter and cause snowmelt-related flooding to occur earlier in the spring. In areas where the geology sets the stage for landslides, projected increases in heavy rainfall and the shift from winter snow to rain can also raise landslide risk.

WILDFIRE

In recent years, and especially in 2014 and 2015 (and to a lesser extent 2017), Washington experienced active wildfire seasons that caused significant damage and disruption across the state. The fires led to numerous evacuations. Smoke spread across large areas of the state, sometimes originating from fires burning outside of Washington state, leading to unhealthy air quality conditions.

Although forest management practices, historical fire suppression, and development into fire-prone areas (the 'wildland-urban interface') have all contributed to fire risk, human-caused warming has increased wildfires across the Western United States (Abatzoglou and Williams, 2016). As warming continues, we expect wildfire potential to increase, as warmer temperatures and drier conditions dry out live and dead vegetation that is the fuel for wildfires. Many future climate projections indicate less rain falling in the summer across Washington. Although summers are already relatively dry, this future drying exacerbates fire risk.

Although eastern Washington is more accustomed to wildfire, western Washington is also susceptible to wildfires and has experienced large wildfires in the past. It is projected that future fires in western Washington could burn more area, due to increased drying of these dense forests. Given the proximity to most of the state's population, the consequences of a large fire in western Washington could be significant.

AIR QUALITY

Use of fossil fuels, which is the key driver of global climate change, also contributes to poor air quality. Fossil fuel combustion creates pollution that leads to smog and ground-level ozone, which can have adverse health impacts. In addition, fossil fuel combustion generates small particulate matter that can cause respiratory problems. Reducing use of fossil fuels brings about the co-benefit of reducing these air pollutants.

Warmer summers may also contribute to decreased air quality, especially in urban areas where air pollution is relatively high. Warmer conditions facilitate the formation of ground-level ozone (Jackson et al., 2010). Although progress to improve air quality has been made in many areas of Washington State, future warming could work against these accomplishments.

OCEAN ACIDIFICATION

Strong evidence has emerged that the acidity of the near-shore ocean and the Puget Sound are increasing as a result of higher carbon dioxide concentrations in the atmosphere (Feely et al., 2012). Greater acidity harms zooplankton, with potentially significant consequences for the marine food web and can inhibit shellfish from forming their calcium shells, affecting important fisheries in the state. Researchers across the state, in universities and federal agencies, are working to better understand the specific consequences for Washington state (e.g. Washington Marine Resources Advisory Council, 2017).

CHANGES IN THE SPREAD OF INFECTIOUS DISEASE

Across continents and around the world, climate change is affecting and will continue to alter the spread of diseases (USGCRP, 2016). Climate change can affect the 'vectors,' like mosquitoes, that spread disease (e.g. West Nile virus); it can permit new pathogens to thrive in new places (e.g. *Cryptococcus gattii,* a tropical and subtropical fungus recently found in British Columbia); and it can affect the presence of food-borne diseases (e.g. *vibrio* bacterial outbreaks in shellfish). Understanding how these disease pathways will change in Washington is an active area of research and public health monitoring.

CHAPTER 4. RISK BASED ON PLACE OF RESIDENCE

Where people live is one of the most important determinants of their exposure to climate change-related hazards. In this section, we focus on several geographic areas in Washington that are exposed to climate change-related impacts including floodplains, the wildland-urban interface, and urban areas. Then, we discuss the socioeconomic and cultural factors that contribute to vulnerability, both within, and beyond, these exposed areas.

> **“[Climate change] really affects our morale and our feelings, how we interact and communicate with each other. We are off-balanced. Are we resting like we should be resting? It is hard to live together with all the climate change. It is affecting us mentally and spiritually.”**
>
> - Lower Elwha Listening Session, 2017

EXPOSURE

Exposure in Floodplains

A floodplain refers to areas near coasts or rivers that experience periodic flooding. More technical definitions (e.g. FEMA, 2018) tend to focus on areas that have a 1% chance of experiencing flooding in any given year, i.e., areas that would be exposed to the “100-year flood.” Large portions of Western Washington are considered to be within a floodplain.

As discussed in the previous chapter, flood risks are expected to increase in the future, owing to heavier rainfall events, more winter precipitation falling as rain instead of snow, and sea level rise (for coastal areas). Consequently, many existing floodplains are likely to become more risky places to live in the future, and larger areas are likely to be susceptible to flooding. These changes in flood risk are expected to be most apparent in Western Washington (e.g. Hamlet et al., 2013).

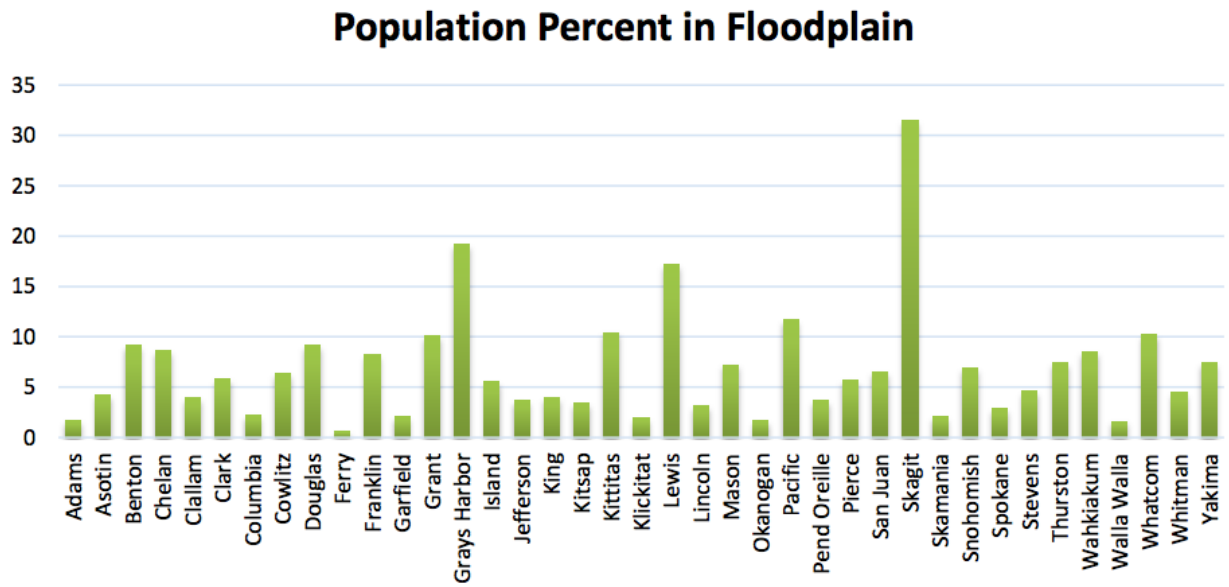

FIGURE 7: A relatively large proportion of the population in western Washington lives in floodplains. The greatest exposure is in Skagit, Grays Harbor, and Lewis Counties. From: Washington Department of Ecology, RiskMAP Business Plan (WA ECY, 2016b).

Floods pose direct threats to individuals and their property. Flooding can also impair water quality, introducing contaminants into water supplies. Disruption to transportation networks during floods can prevent people from getting to work or accessing critical health services. Following floods, damaged homes can experience mold, which poses health risks to residents.

An important knowledge gap exists in identifying the characteristics (e.g., race/ethnicity, wealth, age, type of housing) of individuals and communities that live in the current floodplain, as well as those likely to live in floodplains in the future. Studies have suggested that a disproportionately high percentage of the population residing in floodplains across the nation is composed of racial and ethnic minorities (Donner and Rodríguez, 2008). This is also reflected in analyses of specific, local flooding events along the U.S. Gulf Coast (e.g., Adeola, 2003). However, such an analysis has not been conducted for Washington state. There are specific watersheds where Native American populations are highly exposed to flood risks (See 'Tribes and Flood Risks' text box), and certain areas where relatively large floodplains and sizeable racial and ethnic enclaves intersect, including the Yakima Valley and portions of the I-5 corridor south of Seattle.

TRIBES AND FLOOD RISKS

Many tribal communities in western Washington, including the Swinomish Indian Tribal Community (2010), the Jamestown S'Klallam Tribe (2013), and the Port Gamble S'Klallam Tribe (2017), have identified flooding and sea level rise as important issues in their climate change vulnerability assessments and adaptation plans. Some of these communities' lands are highly exposed to flooding. At the Hoh Indian Reservation, 90 percent of the reservation land is in a 100-year floodplain (Papiez, 2009). For the Swinomish Tribe, 15 percent of land is at risk from sea level rise, including the community's economic zone at the north end of Fidalgo Island (Snover et al., 2013).

The Quinault Indian Nation is taking steps to relocate the village of Taholah to higher elevation, following damaging floods in 2014 and 2015 (Quinault Indian Nation Business Committee, 2017; US Climate Resilience Toolkit, 2017). These events demonstrated the village's vulnerability to catastrophic flood damage from future tsunamis, or from sea level rise. While relocation may be an extreme option for most communities, the experience of the Quinault provides insight into how a coastal tribe is planning for future flood risks.

Exposure in the Wildland-Urban Interface

The "wildland-urban interface" is the area of transition between developed lands and less-developed natural areas. In areas around the I-5 corridor, the interface may be relatively sharp as one moves eastward toward the Cascade Mountains; in other parts of the state, like Kittitas County, any of the unincorporated parts of the county are considered to be part of the interface (Kittitas County Community Development Services, 2018).

Wildfire is of high concern in these areas, as the presence of people and structures introduce wildfire-related risks to human health, homes, businesses and transportation systems. Similar to the floodplains, there is no census information that identifies precisely who lives in the wildland-urban interface. However, there has been substantial population growth in these areas. Between 1990 and 2010, over 300,000 homes were added to the wildland-urban interface in Washington state, an increase of over 50% (Martinuzzi et al., 2015). Census tract data demonstrates some of the wealth disparities that exist between different portions of the wildland-urban interface in Washington. Many of the regions on the eastern slopes of the Cascade Mountains are relatively poor; nearly all the tracts fall in bottom half of the poverty index (Figure 8). Some of the areas around the Olympic National Park and Olympic National Forest also exhibit relatively high rates of poverty. It is the opposite case for the western slopes of the Cascades.

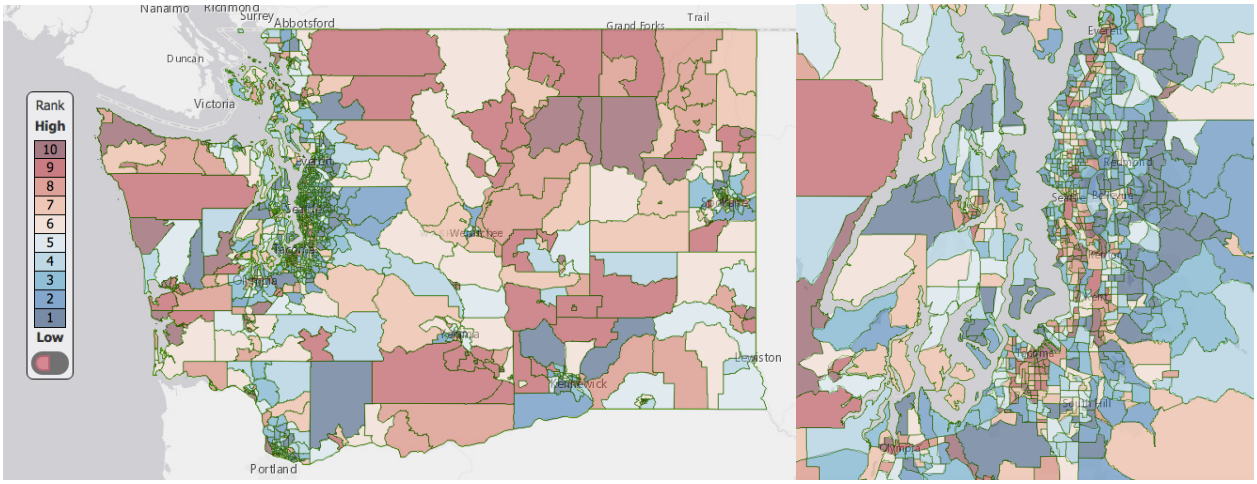

FIGURE 8: Relative rankings for the percentage of people in poverty. Except for Wenatchee, Spokane, and the Tri-Cities, most of the census tracts in eastern Washington, including those areas in the wildland-urban interface, are in the bottom half of the state's poverty rankings. From: Washington Tracking Network, 2018.

While the direct exposure to fire itself may be limited primarily to those living at the wildland-urban interface, the health threats from wildfire smoke can spread much further. For example, most of the state was faced with smoke impacts during large wildfire events in the summer of 2017 (Figure 9). Of particular note, the August 2017 fires were taking place in British Columbia, demonstrating how wildfire threats beyond the state's borders can still affect people in Washington. The smoke posed challenges for those with pre-existing respiratory problems (e.g., asthma, chronic obstructive pulmonary disease (COPD), children, and the elderly; WA DOH, 2017; see Vulnerability, Age and Health Status section).

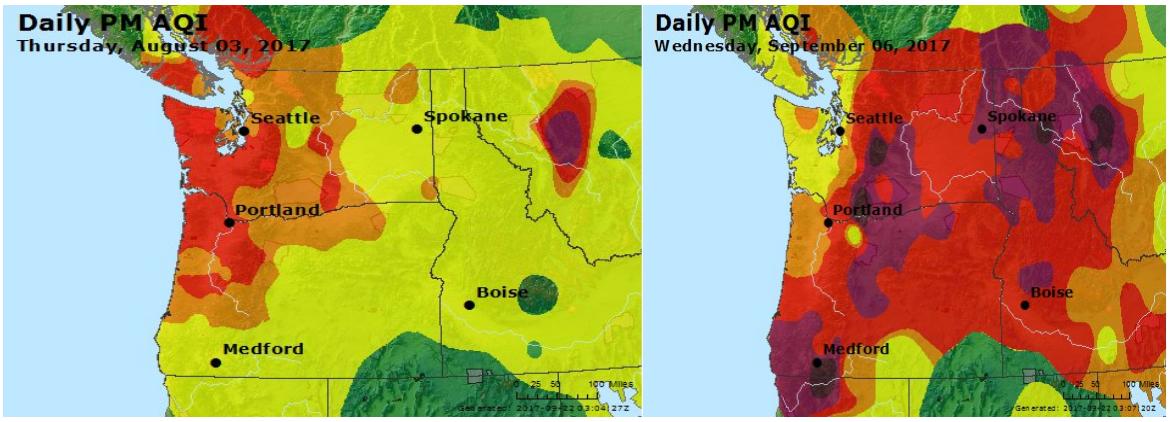

FIGURE 9: Air Quality index maps for Aug. 3, 2017 and Sept. 6, 2017. Both days show the large geographic range of poor air quality (black, purple, red) resulting from wildfire smoke. For the August case, the fires were in British Columbia; in September, the fires were primarily in eastern Washington. Red and purple shades correspond to hazardous air quality conditions, even for normally healthy individuals. Yellow corresponds to moderate air quality; green corresponds to good air quality. From: AirNow (2018).

Exposure in Urban Areas

Large land areas in urban environments covered with concrete and asphalt amplify the intensity of increased air temperatures (known as the urban heat island; e.g., Kenward et al, 2015; EPA, 2018). The large amount of paved surfaces, combined with the relatively smaller amount of vegetation, elevates daytime high temperatures and nighttime low temperatures and can increase the duration of heat events.

Paved, impervious surfaces also prevent rainfall from absorbing into soil, increasing stormwater runoff during heavy rain events, creating the conditions for flooding. Heavy rain and flooding can cause damage to water treatment systems or lead to contamination of water bodies (e.g., following combined-sewer overflows).

> **"Had a house flood due to stormwater. [I was] displaced for 9 months."**
>
> - NAACP Listening Session

Due to the density of vehicles and industry, urban areas (and areas downwind of urban centers) can experience issues with air quality, especially during warm summer days. Future warming may increase the chances of poor air quality by enhancing the formation of ground-level ozone, which can cause respiratory issues.

The large population of Washington's urban areas make them a priority for considering climate risk. Nearly 10% of the state's population lives in Seattle (704,352, as of 2016); and the combined metropolitan area of Seattle-Tacoma-Olympia includes almost two-thirds of the state's population (U.S. Census Bureau, 2016). In addition to the urban corridor along the Puget Sound, Spokane is the state's second largest city (215,973, as of 2016), and Vancouver, Yakima, and the Tri-Cities (Kennewick, Pasco and Richland, collectively) have populations exceeding 80,000.

Cities also include a relatively large proportion of people of color in Washington state. The population of Central Puget Sound, including seven of the state's ten largest cities (Seattle, Tacoma, Bellevue, Kent, Everett, Renton, and Federal Way), is approximately 65% white, 13% Asian Pacific Islander, 10% Hispanic, 5% Black, 1% Native American and 6% Mixed Race. Several cities in the region, including Bellevue, Kent, Renton, and Federal Way are majority non-white. Outside of the Puget Sound, the city of Yakima has a large proportion of people of color—just under 50% of the population is Hispanic.

It is important to note that exposure to climate change-related hazards is not uniform within a city. For example, some areas of cities have significant tree canopy, which can offset the urban heat island effect. However, in many cities, including Seattle, census tracts with high proportions of people of color or low-income individuals tend to have less tree canopy (City of Seattle, 2016a), creating a racial/ethnic and socioeconomic disparity in exposure to high temperatures that can be ameliorated by shade. Additionally, access to affordable housing, poor housing quality or homelessness can significantly contribute to an individual's exposure to climate change-related hazards.

FACTORS AFFECTING VULNERABILITY

There are a range of socioeconomic factors that contribute to the vulnerability of individuals and communities to climate impacts. The following sections describe these factors and discuss how they intersect with the demographics of Washington state in general, as well as the demographics of locations within the state that are highly exposed to climate-related hazards. The list of vulnerability factors below is not comprehensive, but introduces concepts found in the literature (e.g. Cutter, 2003, Cutter et al., 2009; Tierney 2006), as well as those mentioned in the Listening Sessions.

"Vulnerability is a multifaceted phenomenon. As such, solutions, too, must be multifaceted, addressing the range of social, cultural, demographic and economic conditions – often interacting in complex ways – that culminate in population vulnerability…Individual preparedness and response to disasters is generally influenced by factors that have little to do with the hazard agent or the disaster event itself, such as social class, education, gender, race/ethnicity, cultural background and language proficiency, among others."

- Donner and Rodriguez, 2008

It is important to note that the socioeconomic factors related to climate vulnerability are not independent from one another. For example, level of income often has a strong connection to displacement pressures, which in turn can force individuals to move out of their communities, diminishing social cohesion and potentially relocate individuals in areas with increased exposure to climate-related hazards.

Race and Ethnicity

Race and ethnicity have strong connections with vulnerability to climate-related hazards, in large part because of significant existing racial and ethnic disparities in socioeconomic status, health and education that can affect an individual's or a community's ability to cope with a climate hazard. These connections were often raised in Listening Sessions, and in discussions with the Front and Centered Steering Committee. Many of these disparities are discussed in greater detail in the subsequent sections.

It is critical to recognize that historical policies and practices that establish or reinforce racial/ethnic and economic disparities can influence current vulnerability (Got Green/Puget Sound Sage, 2016). Examples include redlining practices (e.g., Morill, 2013) which have often limited the areas in which people of color could purchase homes, resulting in increased exposure to environmental pollutants that compromise health (Morello-Frosch, 2011), or dispossession of land or non-fulfilment of treaty rights (Norton-Smith et al., 2016; Whyte, 2013). Although these actions may have occurred in the past, they often set the stage for where and how people live today, and the resources available to them in their communities.

It is also important to note that the connection between race/ethnicity and vulnerability is strongly modulated by place and context. There are many examples where racial and ethnic minorities have disproportionately suffered following a weather or climate-related hazard: disproportionate mortality and economic loss for Blacks following Hurricane Katrina (Brunkard et al., 2008; Zoraster, 2010); disproportionate health impacts on Hispanics following flooding in El Paso, Texas (Collins et al., 2013); disproportionate heat impacts on Blacks in California (Basu and Ostro, 2008). However, there are also examples where specific racial/ethnic groups exhibited relative resilience to impacts resulting from climate-related risks. These examples of resilience often point to aspects of social cohesion (see "Social Cohesion" subsection) that allowed community members to effectively communicate and access resources to facilitate recovery.

Wealth and Income

Access to financial resources (e.g., through income and wealth) plays an important role in determining vulnerability to a wide range of disasters, as it can determine people's ability to "absorb the losses" from hazard events (Cutter et al., 2009; Fothergill and Peek, 2004). People and communities with fewer financial resources have limited ability to rebuild and recover following hazard events, and less access to insurance (Zoraster, 2010). In cases where temporary or permanent relocation is required, they often have fewer options (Green et al., 2007). They may also have limited access to quality health care (USGCRP, 2016), which can be especially important for heat, air quality and flooding events where acute health impacts often occur.

For Washington in particular, access to fire insurance may become even more limited following recent fire events with some companies in the Northwest ceasing to offer coverage (Washington State Office of the Insurance Commissioner 2017). If other insurers follow suit, rates could increase, exacerbating the struggles that low-income individuals and communities face when managing their fire risk.

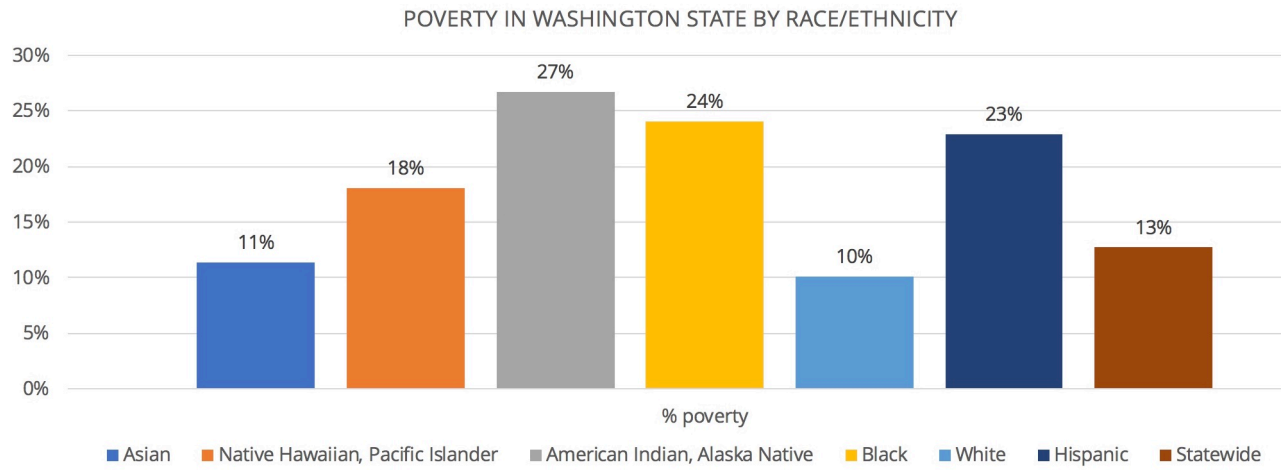

FIGURE 10: Poverty rates in Washington state composited by race/ethnicity (ACS, 2017).

Using measures of poverty to indicate a lack of financial resources, Figure 10 shows the substantial disparity in poverty among racial/ethnic groups in Washington. Except for Asians, all non-White groups exhibit higher poverty rates. The poverty rates for households identified as American Indian/Alaskan Native, Black, and Hispanic are between two and three times greater than the poverty rate for White households. Geographically, higher poverty rates are exhibited in rural areas in central and eastern Washington and on the

Olympic Peninsula, as well as along the Interstate-5 corridor, especially south of Seattle, around Tacoma, and around Everett (Figure 8).

Cities often exhibit significant disparities related to wealth and income among racial and ethnic lines. For example, within Seattle, the state's largest city, "recent estimates…show continued, deep disparities in the social and economic well-being of Seattle residents. Disparities by race and ethnicity are evident in every major indicator of well-being measured…In general, the largest disparities in Seattle, as well as in the nation as a whole, are for the Black population and the Hispanic/Latino population compared with the White, non-Hispanic population." (City of Seattle, 2018c)

Social Cohesion

> **"When asked about their physical environments, participants…identified displacement from their communities as the primary, external threat. And not just displacement of households, but erosion of cultural anchors like community centers, culturally relevant businesses, faith institutions and service providers. When communities lose these anchors or have to leave them behind as they disperse to the suburbs, we lose critical social cohesion to deal with all threats, including climate change."**
>
> - Got Green/ Puget Sound Sage, 2016

Several recent weather and climate-related hazards have demonstrated that the ability for communities to communicate, cooperate, access and share resources can reduce negative consequences. For example, during the 1995 heat wave in Chicago, Latino neighborhoods exhibited substantially lower mortality rates than other neighborhoods in the city. The differences have been ascribed to the relatively higher level of social cohesion in the Latino

neighborhoods, where more intact public spaces and communication among neighbors prevented elderly people (the primary victims of the heat wave) from becoming isolated in their homes (Klinenberg, 2002). Following Hurricane Katrina, the Vietnamese community in New Orleans East avoided some of the catastrophic outcomes that affected other groups in the city. This has been ascribed to pre-existing social networks, trusted relationships, and shared cultural experiences that helped the community access and share resources in the wake of the storm, and subsequently contributed to political empowerment (Leong et al., 2007; Chamlee-Wright and Storr, 2009)

In Seattle, community organizations have been identified as valuable assets in helping reduce and manage climate-related hazards, by reducing vulnerability (Got Green/Puget Sound Sage, 2016). These groups empower individuals and bring attention to shared concerns regarding climate change-related hazards. Several such groups have had success in attracting public-sector programs and investment to their constituents.

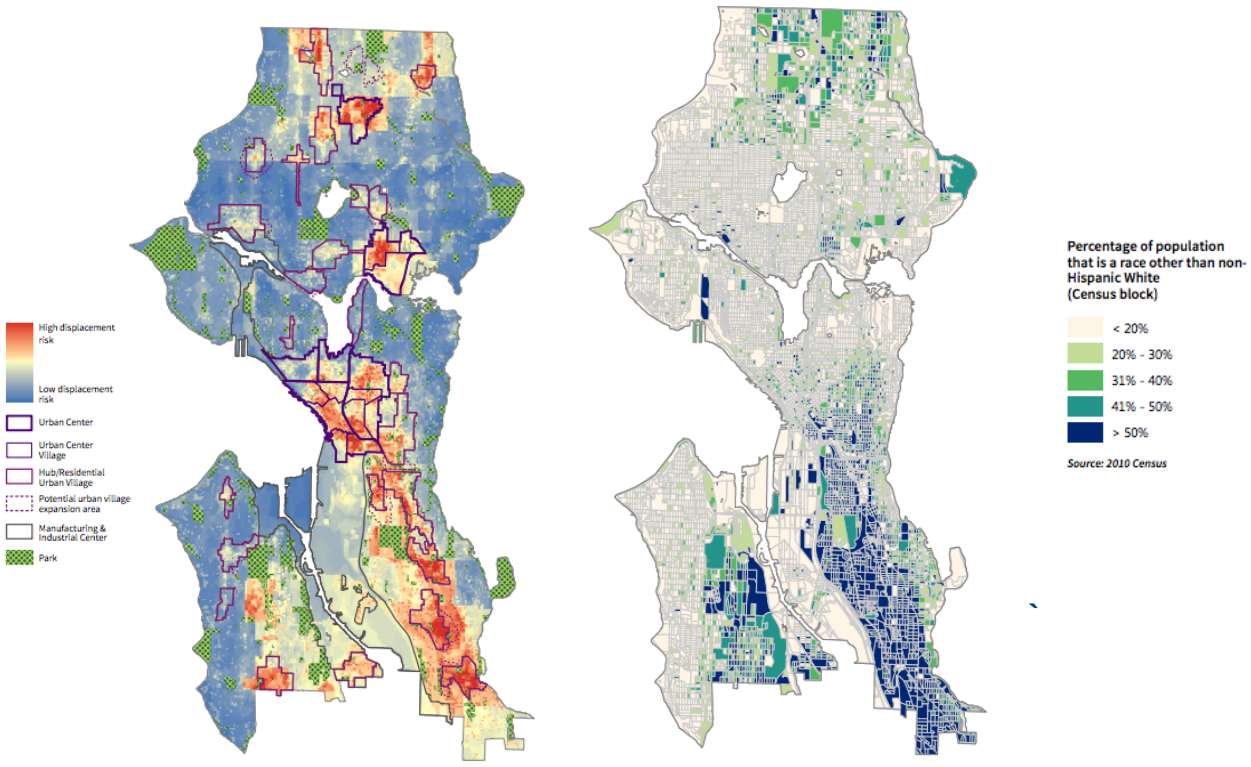

FIGURE 11: Displacement Risk (left) for neighborhoods in Seattle. Many of the areas with the highest risk of displacement are also where people of color reside (right). From: City of Seattle (2016b).

Even in less dense, rural communities, social cohesion can be an important factor when preparing for wildfire risk. Previous work found that communities were more effective in

preparing for wildfire when individuals engaged in local land-use and natural resource planning processes, had resided in the areas for a long time, had past experiences with fire and had the ability to coordinate and exchange information with neighbors (Bihari and Ryan, 2012).

Population growth and rising housing prices in the urbanized areas of the I-5 corridor have created displacement pressure on many individuals and families. In Seattle, race and ethnicity are closely connected to the risk of displacement (Figure 11). Displacement can erode the cultural and social connections that support strong social cohesion, which in turn, can increase an individual's vulnerability to climate-related hazards.

Linguistic Isolation

Lack of English proficiency can reduce the chance that warnings about extreme weather events or poor air quality are received by individuals or communities. This can be a challenge for immigrant communities, especially when translated information is not available or readily accessible. Even when warning information is received, many minority groups may not trust the source (Donner and Rodríguez, 2008), or options to evacuate may be limited or not known. Larger family size, which on average is more common for non-white families, may also inhibit evacuation (Donner and Rodríguez, 2008; Tierney, 2006).

Age and Health Status

Age, pre-existing health conditions and access to healthcare contribute to vulnerability. Children and the elderly tend to be more sensitive to climate hazards, especially episodes of extreme heat and poor air quality (Gamble et al., 2013; USGCRP, 2016). Those with pre-existing health conditions, such as cardiovascular disease, diabetes and asthma are more susceptible to illness and mortality when exposed to weather and climate hazards (USGCRP, 2016). Age, pre-existing health conditions and disabilities can make it more difficult or less likely for individuals to evacuate during flood or fire events (USGCRP, 2016).

Within Washington, considerable research has demonstrated the vulnerability of the elderly and those with pre-existing or chronic illness to episodes of extreme heat (Isaksen et al., 2015a,b; Calkins et al., 2016). Access to healthcare is a substantial barrier that can exacerbate the health risks faced by communities of color, indigenous peoples and in communities with lower incomes.

Perception of Risk

Perceiving and understanding risk can be a first step in enhancing preparedness and ultimately reducing vulnerability (Donner and Rodríguez, 2008). Although many of the risks discussed in this report reflect comments from community members in the Listening Sessions, the mention of flood risks was infrequent. Surprisingly, flooding was not raised during the Listening Sessions occurring around the Puget Sound; across all the sessions, flooding was not discussed as frequently as issues with heat, water supply, or water quality.

These results are consistent with those from a more focused set of surveys and interviews in South Seattle (Got Green/Puget Sound Sage, 2016), where flooding was noted as an "unseen impact" and scored lower in surveys than other climate impacts. It is possible that residents around the Puget Sound have a low perception of flood risk; however, the reasons for this perception are not known and warrant future investigation.

Cultural Importance

Climate change poses serious risks to Native American tribes' sovereignty, culture, health and economies (Norton-Smith et al., 2016). The identities and culture of tribes are intimately tied to the historical climate, landscape, waterways, plants and animals of the region. Access to traditional food sources and medicine are critical to cultural and community health (Lynn et al., 2013; Cozzetto et al., 2013). As climate change alters the timing of key planting, blooming and harvesting events or the locations where different species can thrive, it poses challenges for traditional cultural practices, as well as tribal conceptions of health and well-being (Donatuto et al., 2011).

> **"The ways we are supposed to exist die off as the water dies off. Our life is water."**
>
> - Lower Elwha Listening Session, 2017

Tribal communities have sacred connections to specific locations, which might include residences, trading routes, or meeting places. These too may be facing pressures from a changing climate, especially those in coastal or estuarine areas where sea-level is rising. At the same time, tribal spaces are often facing non-climate pressures from increases in

recreational or commercial uses or land development. The ability for tribes to accommodate these changes by focusing on resources in different locations is often complicated, as many of the institutional arrangements that secure their access (e.g., treaty rights) are geographically fixed to specific places as well.

Community Infrastructure

Climate-related hazards affect the built infrastructure that allow people to get to work, use electricity and heat, access water, go to school, shop and be part of a community. The health system, another type of infrastructure, provides critical services even in the absence of extreme weather events. The ways in which Washington state's built infrastructure and health system can be impacted by extreme weather and climate change are summarized in Table 2. This summary draws from available synthesis documents and vulnerability assessments focused on the state of Washington.

Impacts on built infrastructure and health systems affect everyone. However, there are several factors that make communities more vulnerable to damage or disruption to critical services, such as transportation, power, water and health care (Table 2). These factors are often tied to disparities in the access to services, the reliability or quality of the services or the reliance upon the services. These often include:

> **Limited access to or poor quality of infrastructure and health services.** In many cases, low-income communities, communities of color and indigenous peoples are currently relying on older infrastructure that is in a state of disrepair or that functions poorly. For example, in the Yakima Valley, it was found that approximately 25,000 low-income Hispanic residents relied on contaminated groundwater (VanDerslice, 2011). Stress on such water systems from climate hazards is likely to exacerbate these problems. A similar case can be made for health systems that are underfunded or struggling to serve the needs of populations with disproportionately high chronic disease or disability, or limited access to health insurance.

> **Existing issues with pollution and environmental contaminants.** Climate hazards, especially flooding, can be a mechanism for releasing hazardous or toxic materials from previously-polluted industrial or agricultural sites, amplifying the chances for people to encounter dangerous substances. Low-income individuals and people of color tend to reside near Superfund sites (Mohai and Saha, 2007), which can pose threats to air and water quality. Concerns about exposure to pollution and current air and water quality were repeatedly mentioned in Listening Sessions.

> **Lack of mobility options.** For many communities of color and communities with lower incomes in the Puget Sound, public transportation is vital for employment, education, child care and other daily activities. Disruptions to these systems can cause relatively greater consequences than for similar workers with greater flexibility in working schedules, such as telework, those who can afford access to multiple forms of private or public transportation or those who simply live closer to their work, school and child care.

> **Urban versus non-urban resources for infrastructure.** The utilities, transportation authorities and health systems in the large metropolitan areas tend to have more financial resources, larger staff, greater technical expertise and more formal preparedness plans that allow them to manage climate hazards. In more rural locations, institutions managing water, electricity, transportation and health are often less well equipped to deal with these hazards and may take longer to recover from disruptions. The difference may become more acute as the suburb and exurb areas grow in response to escalating costs of living in the urban core, potentially disadvantaging those that currently live in these communities, as well as those being forced out of nearby cities.

> **Ability to absorb regressive costs**. As infrastructure and health managers deal with climate hazards, there is the potential that repair and maintenance costs could grow. Should these costs be passed onto the consumer in a regressive manner (e.g., through increased utility base rates), that would have a disproportionate impact on low income individuals. For example, in 2007, flooding along the Chehalis River caused hundreds of millions of dollars in damage, including closure of Interstate 5 and significant costs to farmers, shellfish producers and utilities (Batker et al., 2010). Many of the areas within the Chehalis watershed have very low per capita incomes, and relatively high rates of poverty and unemployment (Batker et al., 2010). The damage to one water utility, Boistfort Valley Water, stopped water services to customers for three months. In an effort to recoup costs, the utility had to raise base rates by over 10% after resuming operations (Batker et al., 2010).

TABLE 2: Summary of the climate impacts on community infrastructure and factors that affect infrastructure vulnerability.

SYSTEM	PRIMARY HAZARD	FACTORS THAT CONTRIBUTE TO VULNERABLE INFRASTRUCTURE	REFERENCES
TRANSPORTATION	**Heat:** damage to pavement and rails; limits to construction or maintenance work **Flooding:** closure of roads and rail **Wildfire:** closure of roads and rail; evacuations	> Age > Poor state of repair > Design standard based on historical climate or less usage > Lack of system redundancy	*Mauger et al., 2015; WSDOT, 2011; Strauch et al., 2015*
WATER *(includes drinking water supply, water treatment, and stormwater management)*	**Drought:** reduced water supply or quality **Heat:** reduced water quality; increased costs for treatment **Flooding:** stormwater mobilization of contaminants; wastewater discharge into water bodies **Saltwater intrusion:** potential contamination of groundwater supplies	> Age > Poor state of repair > Design standard based on historical climate or smaller population > Lack of system redundancy or backup supplies	*Mauger et al., 2015; Anderson et al., 2016*
ELECTRICITY	**Heat:** decreases in winter demand, increases in summer demand; challenges in meeting water temperature requirements for fish **Wildfire:** damage to transmission/distribution systems; potential outages **Changes in hydrology:** higher winter flows and lower summer flows alter supplies	> Growing demand (e.g. greater load and more stress on system) > Increasing efficiency of buildings and appliances (can be an asset that reduces vulnerability)	*Mauger et al., 2015; Raymond, 2015*
HEALTH	**Heat:** increase emergency calls, heat related illness, and mortality **Water:** poor water quality (see water systems) can lead to illness **Vector borne diseases:** expansion of ranges, appearance of new diseases **Shellfish contamination:** algal blooms and high temperatures can make shellfish unsafe to eat	> Limited capacity of current facilities > Inadequate monitoring and warning systems	*Calkins et al., 2016; Isaksen et al., 2014, 2015a,b*

CHAPTER 5. RISKS BASED ON EMPLOYMENT AND LIVELIHOODS

The industry in which people work is another important determinant of exposure and vulnerability to the impacts of climate change. A range of climate-related hazards will impact key industries across Washington state, but the impacts will be unevenly distributed. Here we focus on agriculture, fisheries and construction. These sectors experience the direct consequences of a changing climate and have relatively large, exposed outdoor labor forces. This is not a comprehensive list of industries/livelihoods that will be affected by climate impacts. It is also not a comprehensive list of industries with important connections to communities of color, indigenous peoples or communities with lower incomes. However, these are the three industries or livelihoods where dis-proportionate exposure and vulnerability can be identified, and/or they were mentioned in the Listening Sessions.

> **"What job opportunities do we have compared to other communities? Right now, we have some less job opportunities and live in poorer conditions, like our buildings. This affects our health."**
>
> - Mother Africa Listening Session, 2017

EXPOSURE

Exposure in the Agriculture Sector

Washington state is an agriculturally rich state, with farming and food production accounting for 13% of the State's economy (Washington State Department of Commerce, 2018). Agriculture generates income and employs individuals in all 39 counties in the state and is an important source of employment in rural communities (Washington State Department of Commerce, 2018). The number of workers employed in the agricultural sector in Washington has grown by 29% between 2005-2015 (Washington State Employment Security Department, 2016). The central portion of the state, responsible for the majority of tree fruit production, employs 54% of the annual agricultural workforce and supports the greatest number of seasonal jobs. More than half of these jobs (64%) are at crop production worksites, in particular, fruit and tree nut farming (Washington State Employment Security Department, 2016).

During episodes of extreme heat, agricultural workers can face heat-related illness (HRI; e.g. Bethel et al., 2017; Spector et al., 2014; Bonauto et al., 2007). HRI's, like exertional heat stroke, can occur in young, healthy individuals. Agricultural workers are at a particularly high risk, as they conduct heavy physical labor, work outside and work during the summer (Gubernot et al., 2015). Risk can also be higher for workers that are required to wear personal protective equipment (e.g., when applying pesticides) that restricts evaporation. Finally, heat exposure and physical strain in these outdoor working populations may also increase the risk of accidents and traumatic injuries, brought on by increased physical fatigue, dehydration, impaired mental capacity and concentration, decreased postural stability and misuse of protective equipment (Spector et al., 2015).

Under current conditions, upwards of 79% of outdoor farm workers experience an HRI during the summer harvest season (Bethel et al., 2017; Spector et al., 2014). The actual number of workers affected is likely higher, since HRI is not well recognized and is likely underreported (Bonauto et al., 2007; Spector et al., 2014). Most farm laborers report not receiving heat-related illness training despite laws requiring employers to do so (Bethel et al., 2017). Most HRI incidence in outdoor workers occur in Central Washington, including Yakima, Grant, and Benton counties (Spector et al., 2014). Inadequate water supplies, long distance to water and/or a toilet, lack of shade and piece rate compared to hourly payment are all factors contributing to a higher risk of HRI within the agricultural workforce (Spector, et al., 2015).

"We are concerned about workers having to check out from work earlier during work days due to hot weather or during bad winter conditions. What happens when extreme weather becomes more frequent? Laborers will lose work hours due to this, a valuable source of income."

- Vancouver Listening Session, 2017

While extreme heat affects agricultural workers directly, drought events tend to affect agricultural workers through their impact on water supplies and crop yields. Recent statewide drought emergencies (2001, 2005 and 2015) typically had significant impacts on crop production and revenue. It was estimated that the 2015 drought caused $633-773 million in damages (McLain et al., 2017). Many growers noted increased costs for pest and

weed control, as well as the need to drill emergency drought wells. When drought is prolonged, significant damage to crops and pastures tends to increase; crop failures and losses can lead to larger changes in the agriculture industry, such as shifting of crop types or rotating land out of production.

Wildfire, which often coincides with droughts and periods of extreme heat, can impact agriculture workers' health directly through smoke. Exposure is exacerbated for workers with outdoor employment. Workers can also be indirectly impacted through wildfire damage to production areas and processing facilities. For example, wildfires in Central Washington during 2015 damaged agricultural worksites, including fruit packing houses, rangeland, pasture and orchards (McLain et al., 2017).

> **"Wildfires and air pollution are affecting the health of farmworkers."**
>
> - Whatcom Farmworkers Listening Session, 2017

An emerging concern for agricultural workers is the establishment of West Nile Virus (WNV) in Washington state. Although the number of cases of West Nile Virus in Washington is far below many oher states (CDC, 2016). Orchards are potentially highly active areas for WNV, as they provide essential plant nectar for mosquito survival and nesting and feeding sites for birds (Crowder et al., 2013). In eastern Washington, particularly the Yakima Valley, orchards are a major component of the agricultural landscape.

The agricultural workforce is roughly 53% non-white and 40% Hispanic/Latinx (U.S. Census Bureau, 2017). Most agricultural workers in Washington state are male, Latino, foreign-born, work long hours, rotate to different employers, have completed little education, and are more likely to suffer from chronic health problems (Bethel et al., 2017). Migrant and seasonal farmworkers are typically younger, less likely to speak English, and less likely to be United States citizens or have authorization to work (Culp et al., 2011). This may make many workers reluctant to report illness or stresses, as they are dependent on their employers for work and wages and fear questions that might lead to the disclosure of personal information.

Exposure of Fisheries

Fisheries are a large part of Washington's culture and economy (e.g. Hatten et al., 2014; Fontaine and Steinemann, 2015). Commercial and recreational fishing supported approximately 30,000 jobs in Washington state in 2015, ranking in the top-10 among states for the size of its fishery-supported workforce (National Marine Fisheries Service, 2017). This sector resulted in nearly $2.5 billion in sales in 2015 (National Marine Fisheries Service, 2017).

Warmer temperatures and drought both have negative consequence for many Washington fisheries, especially salmon. Warmer stream temperatures can enhance the spread of disease among fish, which can reduce fish populations. For example, during 2015, the U.S. Fish and Wildlife's Makah National Fish hatchery ended up euthanizing 80,000 young Coho salmon to prevent the spread of disease (Northwest Treaty Tribes, 2015). Drought, in reducing streamflow, can compound temperature problems, and has been implicated in declining runs of salmon and steelhead (Lynn et al., 2013). Several hatcheries, including the Makah and Lummi Skookum Creek Hatchery, have released juvenile salmon earlier than usual during drought years to compensate for declining river and stream flows (Northwest Treaty Tribes, 2015). Future projected losses of thermal refugia would exacerbate challenges for cold-water fish.

> **"The algae from warming waters is impacting the fishing industry and fishing jobs."**
>
> - Westport Listening Session, 2017

Warming ocean and freshwater temperatures causes increased growth rates and occurrence of harmful algal blooms (Mauger et al., 2015). The presence of toxigenic diatoms like *Alexandrium* and *Pseudo-nitzschia* already impacts the shellfish in the Puget Sound, threatening this roughly $108 million per year industry (Moore et al., 2015; Trainer and Hardy, 2015). Shellfish are frequently monitored for harmful bacteria and when levels exceed safe consumption limits, harvest areas can be closed for weeks, negatively impacting those fisheries and employees that rely on them.

Changes in water quality also threaten fishery health. Water quality in streams can suffer following wildfire. After a wildfire, the lack of groundcover and vegetation exposes previously vegetated slopes, allowing sediment to be mobilized and washed into the

stream. The increased sediment load can be harmful to fish and block fish passages (Meixner and Wolhgemuth, 2004; Murphy et al., 2015).

In the Puget Sound and Pacific Ocean, acidification poses a serious threat to water quality (Feely et al., 2012; Mauger et al., 2015). Increasing the acidity of marine waters stresses the organisms that create shells like oysters, clams, mussels and crabs, and is expected to directly threaten the fishery industry in the Pacific Northwest (Busch et al., 2013). In addition to the impacts on shellfish fisheries, ocean acidification can affect fish that are dependent upon shellfish for their diets (Kaplan et al., 2010). These include commercially important groundfish species like yellowtail rockfish and English sole. Acidification may also impact some types of salmon, impeding their growth rates and limiting their sense of smell, making them more susceptible to predators (Mauger et al., 2015).

Livelihoods in fisheries are important for many communities, including indigenous people (Front and Centered, 2017). Unfortunately, there was less information available on the demographics on the Washington fishing industry. Demographic information for the fisheries industry is typically aggregated with the agricultural and forestry sectors, making it difficult to determine the racial/ethnic and socio-economic characteristics of the workforce.

It is important to note that fisheries support a range livelihoods related to processing, packaging and transporting products. These positions may also be exposed to climate impacts on streams and oceans, but more work is needed to better understand exactly how the industry may reorganize to adapt to changing climate conditions, and how these decisions might affect employment.

Exposure for the Construction Sector

Construction is a moderately sized industry in Washington state. In 2017, construction accounted for over $22 billion of Washington's gross domestic product (~1.0% of GDP; U.S. Bureau of Economic Analysis, 2018). In 2017, construction employment averaged over 200,000 jobs, an increase in over 13,000 jobs from 2016 (based on change in annual average; U.S. Bureau of Labor Statistics, 2018). Construction employment in Washington can fluctuate from season to season by more than 15,000 jobs (U.S. Bureau of Labor Statistics, 2018). Roughly 22% of the workforce identifies as a race other than white, and nearly 13% as Hispanic/Latinx (U.S. Census Bureau, 2017).

By virtue of being outdoors, many construction employees are exposed to extreme heat events. In Washington state, heat related illness is most common among roofing

construction and highway/bridge construction workers (Bonauto et al., 2007; Spector et al., 2014). Similar to agriculture workers, these workers are outside performing heavy labor during the hottest time of the day, and frequently during the summer (Dutta et al., 2015). The use of personal protective equipment, often required for safety reasons, can exacerbate the risk of heat illness (Rowlinson and Jia, 2015). Heat stress often leads to accidents while on site, through fatigue, impaired mental capability, and misuse of personal protective equipment (Rowlinson and Jia, 2015).

Construction employees that work outdoors are often exposed to poor air quality, whether it be from vehicles or from an environmental source, like a wildfire. Most studies have shown that exposure to air pollutants in these jobs are typically below established levels of concern (Lewné et al., 2007)

FACTORS AFFECTING VULNERABILITY

There are a range of socioeconomic factors that make workers more susceptible to impacts, or less likely to bounce back from disruptive climate events. The list below is not comprehensive, but introduces concepts found in the literature, as well as those mentioned in the Listening Sessions. In many cases, race/ethnicity intersect with these factors, and the connections are identified where possible.

It is important to note that the factors affecting vulnerability are not independent from one another. For example, for some new immigrants, linguistic isolation, lack of citizenship, and limited educational attainment can all contribute to limited job mobility that results in vulnerability. For this reason, it can be challenging to isolate and measure the importance of individual factors. Acknowledging this barrier, the discussion below is largely descriptive rather than quantitative.

Race and Ethnicity

Race and ethnicity play an important role in employment opportunities, which in turn influence how individuals cope with and respond to climate-driven disruptions. Following weather and climate disasters, job losses can be disproportionately high for people of color (Zoraster, 2010). Since there are often strong connections among race/ethnicity and educational level, English language proficiency, and immigration status (see subsections that follow), the subsequent employment opportunities for people of color can be limited. This is especially true for those in lower wage and service sector jobs. And these jobs themselves may be in short supply following hazard events (Zoraster, 2010).

Education and Job Mobility

A limited education typically reduces the number of employment opportunities. This can be an acute problem in the wake of disruptive extreme weather events when workplaces may be recovering from damage. It is also exacerbated in portions of the state where a single industry is dominant. Damage or disruption to that industry (e.g., drought in a largely agricultural county) can leave residents without options to find work, or without the skill that enable relocation and entry into a new industry.

In Washington, the Latino population has a relatively lower educational attainment (Figure 12; 37% have less than a high school education). Geographically, many of the census tracts in central and eastern Washington exhibit low educational attainment (Figure 13). The local economies of most of these areas are dominated by agriculture.

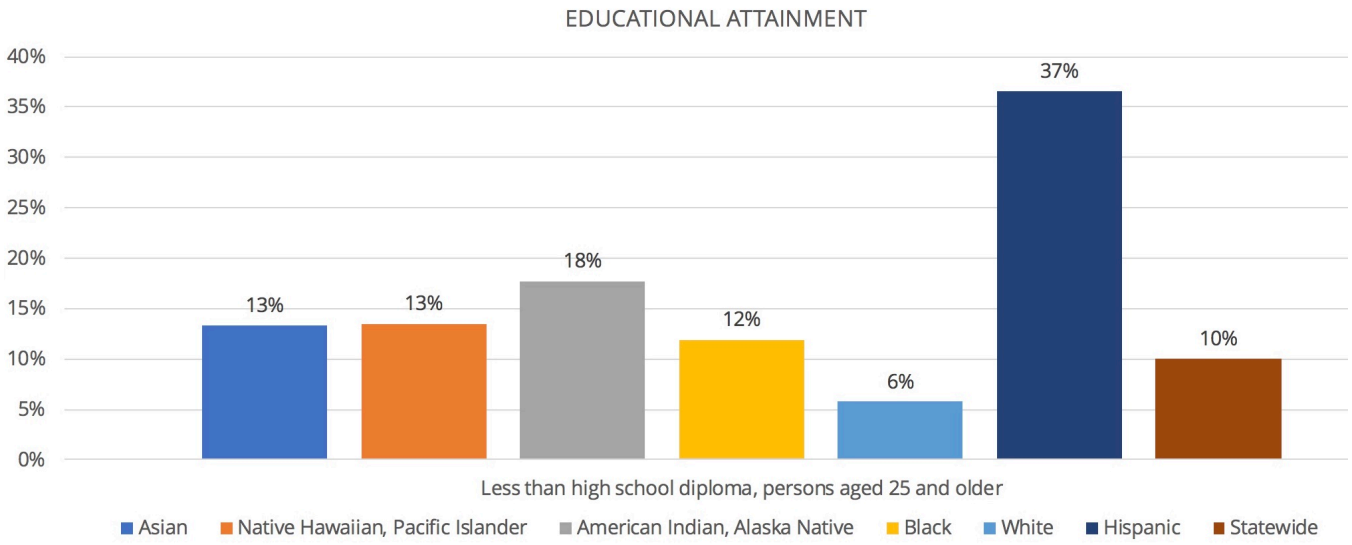

FIGURE 12: Poor educational attainment, composited by race/ethnicity for Washington state from the American Community Survey (ACS, 2017). The graph shows the relatively lower educational attainment by non-white Washingtonians.

For construction workers over the age of 25, educational attainment tends to be higher than for agriculture workers; in 2017, 16% of workers in construction lacked a high school degree, compared to 33% for agricultural workers (U.S. Census Bureau, 2018). However, there are still many individuals in the construction industry subject to limited job mobility because of limited educational attainment.

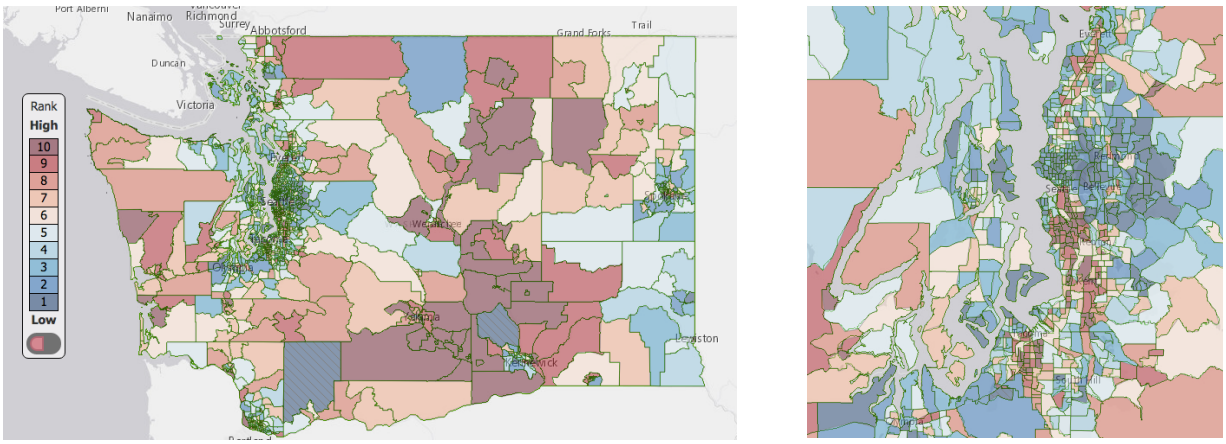

FIGURE 13: Lack of a high school diploma for census tracts in Washington. Red shading indicates relatively greater numbers of people without a high school diploma. From: Washington Tracking Network (2018).

Linguistic Isolation

When the workforce does not speak English, workers may not have sufficient access to emergency management information (e.g., warnings, evacuation instructions) or health-related job training (e.g., proper use of safety equipment, warning signs of heat related illness; Rowlinson and Jia, 2015).

> **“[We need] information about contamination in different languages and communities that are not normally reached out to.”**
>
> - Whatcom Listening Session, 2017

Workers with less English proficiency may be less likely to report health-related issues to managers, making it difficult pursue interventions that might minimize problems caused by heat or poor air quality. During Listening Sessions and a follow-up Equity Workshop, the research team heard anecdotal examples of migrant workers being unaware of smoke warnings during the 2017 fire events. Workers were also unsure of their options (i.e., did they need to work? where would they go?), or of the availability of emergency shelters during the smoke events.

> **“…as Koreans we do a lot of fishing on our own but we don’t know where the right place is, and some of us do it anyway.”**
>
> - Pierce Listening Session, 2017

Existing Environmental Stressors

Existing issues with environmental pollution or resource use can increase vulnerability to subsequent climate impacts. For example, for fisheries, modifications to natural streams and shorelines through dams and channelization have had significant impacts on fish populations throughout the region. Water pollution, which was a frequently raised topic in Listening Sessions, is also a stress on many fish, especially those passing near urban areas. For example, several fish populations in the Yakima River basin are currently among the 13 stocks of salmon listed as an endangered species (Hatten et al., 2014). Future climate-related changes in streamflow and stream temperature are likely to pose greater challenges for these fish.

Immigration Status

During feedback sessions with the Front and Centered Steering Committee, the issue of immigration status was raised as a factor contributing to vulnerability. Immigrants may not have authorization to work, severely reducing their options to work. Job opportunities may place them in a position of potential exploitation by an employer. Climate change-related hazards may exacerbate this lack of job security, especially in relatively lower-wage sectors (Zoraster, 2010). For many undocumented individuals, lack of access to health care (Ortega et al., 2007; Vargas Bustamante et al., 2012) may also raise their vulnerability.

In the agricultural sector, many seasonal workers are immigrants. For example, in 2015 in Washington state, over 12,000 H2A visas were approved for seasonal agriculture work (WAFLA, 2017). These workers have traditionally experienced less safe working conditions (Culp et al., 2011), which can heighten job-place health risks, especially related to heat illness and poor air quality.

Water Rights

The system of water rights creates disparity in vulnerability among water users. In addition to dryland farmers who do not irrigate, farmers with junior water rights are among some of the most vulnerable to drought impacts (Fontaine and Steinemann, 2009). Workers associated with these operations are more likely to experience disruptions in work during times of water stress. For junior water rights holders, it is often costly to deal with a reduction in their water allocations. Coping strategies might include drilling for emergency or new groundwater wells, purchasing water rights, or fallowing land. Costs can affect employment, typically through a reduction in labor opportunity (Howitt et al., 2015).

Fisheries are often reliant on in-stream flow targets being fulfilled. However, during times of water stress, the reliability of these flow targets is often lower than the reliability for other water uses, such as irrigation (Miles et al., 2000).

Cultural Importance

For many tribal communities, agriculture and fisheries are part of social, cultural, spiritual identity and health (Montag et al., 2014; see also Cultural Importance section in Chapter 4). Access to these resources often underpin livelihoods, providing direct sustenance and/or economic benefit through sales. Threats to tribal livelihoods that revolve around growing, gathering, and fishing may also invoke issues about fulfillment of tribal treaty rights, making these damages an issue of international and federal law. (Cozzetto et al., 2013; Lynn et al., 2013).

CHAPTER 6. COMMUNITY-RESPONSIVE APPROACHES TO BUILDING CLIMATE RESILIENCE

The need to build climate resilience was emphasized by multiple communities during the project Listening Sessions. Communities identified barriers that limit them from responding to and preparing for the impacts of climate change. Barriers included limited financial resources, inadequate access to relevant information, and the lack of community-responsive state and federal policies that support those most impacted by climate change (Front and Centered, 2017).

> **“There is a need to speak out for ourselves, our families, and friends. Especially helping those who cannot speak out because they cannot vote or for other reasons. Especially needed when the political climate attacks climate change and cuts funds to help environmental & climate change programs.”**

- Vancouver Listening Session, 2017

Even as community members and community organizations point out the barriers to preparing for climate impacts, it is important to note that their communities are coping with climate stress. The state has experienced drought, fire, heat waves, and floods in the past several years, and communities of color, indigenous peoples and those with lower incomes continue to persist and overcome. Their message is not one of despair or helplessness, but rather a request for more substantial and dedicated support. Many communities are prepared to engage in policy making and policy implementation that would serve to address the underlying factors that contribute to climate risk.

COMMUNITY-DRIVEN EFFORTS TO DOCUMENT CLIMATE IMPACTS AND ADVANCE CLIMATE PREPAREDNESS

> **"In community-driven climate preparedness planning processes, frontline community members most impacted by climate change share decision power with the lead government agency and help produce strategies focused on their priorities and concerns. Community partnership & collaboration are at the core of equitable climate resilience planning."**
>
> - Yuen et al., 2017

In this section, we explore some examples of community-responsive approaches to building climate resilience in and beyond Washington state. These examples offer potential models or resources for communities across the state:

- **City of Seattle Equity and Environment Initiative, Seattle, WA** – In 2015, the City of Seattle launched an effort to build trust and deepen the level of communication between communities and city agencies and staff. This work included the development of an Equity and Environment Agenda for the city that articulates goals and strategies to minimize inequities and "create opportunities for communities of color, refugees, people with low incomes and limited-English proficiency individuals to be leaders in Seattle's environmental movement." (City of Seattle, 2018b; Yuen et al., 2017).

- **Multnomah County, OR** – Multnomah County has integrated equity considerations into its Climate Action Plan (Willimas-Rajee and Evans, 2016). To establish its equity lens, the County engaged a diverse mix of community groups representing communities of color and low-income communities. The participants formed an Equity Working Group that helped develop a set of principles against which to test proposed climate actions. These include: addressing disproportionate impacts, providing shared benefits, being accessible, promoting engagement, building capacity, fostering partnership that aligns with community priorities, building relationships, expanding economic opportunity and staff diversity, and remaining accountable. The Climate Action Plan establishes three

levels of equity objectives: equitable processes (e.g., transparent, fair, and inclusive engagement activities and decision-making processes), equitable distribution (e.g., funding and resources are prioritized to support those that are most at risk), and equitable structures (e.g., actions address the underlying institutions and systems that act to reinforce racism and classism).

- **WE ACT, New York: Designing Equitable and Culturally Vibrant Planning Processes:** Using the community driven resilience planning framework (NACRP, 2017), WE ACT activated community knowledge and perspectives to co-identify the solutions and approaches needed to build community resilience to climate change in New York City. With an ultimate goal of protecting the city's most vulnerable communities from climate-related impacts, WE ACT initiated a community-driven climate resilience planning process. This resulted in the Northern Manhattan Climate Action Plan (NMCA, 2016) and the Upper Manhattan Climate Action Manual (Khawarzad, 2017). These plans, grounded in community needs, offer concrete actions that will enable the community to leverage economic resources and build programming to support action and awareness of community vulnerabilities and exposure to relevant climate hazards (NACRP, 2017).

- **Our Power Richmond, Richmond, CA** – In a community surrounded by the largest oil refinery in California, a group of local community organizations successfully, through "persistent and coordinated" action, mobilized to ensure community voices and needs were represented in the city's 2012 General Plan. "Owing to the depth of community organizing efforts, Richmond is one of the first cities in the country to address the links between public health and the environment in its General Plan" (NACRP, 2017). This multi-stakeholder coalition ultimately built political power, influencing City Council elections, and continues to use their collaboration to make sure the implementation of the General Plan reflects their needs and priorities across city projects, programs and laws.

EFFORTS TO MAINTAIN TRADITIONAL CULTURAL PRACTICES & RESOURCES

In this section, we share two examples of community-responsive approaches to building climate resilience specifically within Pacific Northwest Tribes. These examples offer potential models or resources for other tribal communities and highlight the role that traditional knowledge can play in shaping efforts to build climate resilience.

- **Preserving tribal access to traditional foods in the Pacific Northwest** – Lynn et al. (2013) describe a range of adaptation strategies and implementation measures

underway to preserve tribal access to traditional foods, including habitat and landscape planning that increase ecosystem resilience to impacts such as wildfire. Tribes in the Pacific Northwest are working with a range of federal partners and non-governmental organizations to collaboratively maintain culturally vital resources and practices in the face of a changing climate.

> **"Tribal participation in climate change research, policy development and planning can help identify more solutions that fully consider tribal cultural values. Climate change will not obey the jurisdictional boundaries between tribal, private, state, and federal lands."**
>
> - Lynn et al., 2013

- **Swinomish Climate Change Initiative, Washington State** – The Swinomish Indian Tribal community is actively addressing multiple climate-related hazards. The climate adaptation strategy developed by the Tribe in 2010 includes revisions to shoreline codes, protection plans for low-lying land on the reservation, reservation-wide wildfire risk reduction efforts, a system to measure knowledge of climate-related impact, and ways to prepare the tribal community to respond to health impacts (from Mauger et al., 2015; Swinomish Indian Tribal Community, 2010).

CLIMATE/RISK COMMUNICATION AND EDUCATIONAL MATERIALS

Here are a few examples of technical and communications tools relevant to on-the-ground resilience efforts:

- **Washington Tracking Network, Washington State** – The Washington State Department of Health developed a set of climate and health indicators aimed at helping raise awareness and increase access to a range of health and environmental exposure information for communities across the state (Washington Tracking Network, 2018). Individuals and communities can directly explore datasets about community characteristics (e.g. educational attainment, economic indicators, housing density and quality) and population characteristics in relation to environmental conditions including

air quality, flood risk, urban heat, exposure to extreme events. Access to these data can help communities identify unique characteristics and vulnerabilities, increasing access to relevant climate information and exposure resources (Washington Tracking Network, 2018). This knowledge can be critical for building dialogue about the relevant impacts, intersections with other issues and disparities, and the complexities of climate change facing diverse communities.

- **Developing culturally relevant communications strategies, Baltimore, MD, Oakland, CA, City of Boulder, CO** – Many cities and community action groups are working across communities to develop methods and determine best-practices for communicating climate risk and preparedness information. In Oakland, CA, climate-risk and preparedness information delivery includes translation of materials into a range of commonly-spoken languages (Yeun et al., 2017). The City of Baltimore has a *"Make a Plan. Build a Kit, Help Each Other"* campaign that encourages conversation about how to be climate-ready in the neighborhoods most vulnerable to climate impacts (Baja, 2014; Yuen et al., 2017). In Boulder, Colorado, a Mobile Resilience Lab uses a community outreach program to disseminate information about climate hazards to a range of communities across the city (City of Boulder, 2016). Other examples of communications and knowledge sharing efforts are available in Yeun et al. (2017).

LEGISLATION TO DIRECT FINANCIAL RESOURCES TO REDUCING CLIMATE RISKS TO 'DISADVANTAGED' AND 'LOW-INCOME' COMMUNITIES

Here is an example of where state revenue has been specifically allocated to support climate-risk reduction for frontline communities:

- **California's Greenhouse Gas Cap-and-Trade System** – This system has allowed the legislature to appropriate over $6 billion for climate-related programs and projects (Cal EPA, 2018). Recent legislation (SB 535 in 2012 and AB 1550 in 2016) directed the state of California to invest a significant portion of cap-and-trade revenue into "disadvantaged" and "low-income" communities (Cal EPA, 2018).

  "Disadvantaged" designations are derived from census-tract scoring by Cal Enviro Screen, which integrates indicators related to pollution burden, health, and socioeconomic vulnerability. "Low-income" can apply to households or census tracts and is generally below 80% of the median income for the respective region, or for the whole state (Cal EPA, 2017).

To date, the investments have been focused on reducing greenhouse gas emissions; however, many projects have likely had co-benefits related to the types of climate risks and climate vulnerabilities highlighted in this report. For example, investments for disadvantaged communities included projects to improve transportation access and systems, restore wetlands and watersheds, and bolster urban forests. With the recent passage of California Assembly Bill 398 (2017), climate adaptation and resilience will become an eligible priority for projects supported by cap-and-trade revenues, potentially boosting the resources available for managing climate risks in communities of color, low-income communities, and others disproportionately exposed or vulnerable to climate impacts.

CHAPTER 7. RESEARCH GAPS

Throughout the research and writing process with University of Washington faculty and the Front and Centered Steering Committee, we identified a range of research gaps and questions to be explored more deeply. Many of these questions could inform future efforts by research organizations and community groups (which may be one in the same):

- **What alternative conceptual models can be developed to better highlight equity or justice in climate actions?** The conceptual model presented in this report is based upon climate risk, with an emphasis on exposure and vulnerability. Although this risk-based model has appeared extensively in the academic research and lends itself to state or national-scale mapping applications, it focuses primarily on loss and the negative aspects of climate impacts. Would alternative models (e.g., the asset indicators presented in NAACP, 2015) that have a primary focus on community assets and strengths, such as social cohesion, provide greater insight into actions that promote resilience to climate impacts in communities of color, for indigenous peoples and in communities with lower incomes? Would such models have more appeal at the local level, given that they often relate to concepts more closely aligned with community experiences and priorities (e.g., social networks; housing quality; quality and reliability of existing infrastructure)?

- **What are the economic dimensions of climate impacts on communities of color, indigenous peoples and communities with lower incomes in the state of Washington?** Information on the costs associated with climate impacts on different communities was not readily available. Examples of key questions include the following: What are the health care costs associated with extreme heat events or episodes of poor air quality from smoke events? Who bears these costs? How do these events affect worker productivity, and in what sectors? Do these extreme events have longer-term employment consequences (e.g., loss of employment, injuries that lead to disability or chronic health problems)? How are some of Washington's key industries responding to extreme events (e.g., relocation out of the state), and how might this affect labor opportunities for low-income individuals or those with limited education?

- **In what ways will climate change impact food systems in Washington state, and beyond?** Concerns about access to healthy food emerged during the Listening Sessions. While information is available regarding potential climate impacts on crop yields or nutritional value, as well as impacts on dairy production

and fisheries, it is less clear how those impacts might play out at the consumer level. How might access, price, or nutritional value of food at the market change? And how would these changes affect communities of color, indigenous peoples or lower income communities where access to healthy, affordable food may already be an issue? To what extent will global changes in food supplies affect the Northwest? Answering these questions requires a more detailed understanding of how regional and global climate impacts on food commodities will ripple through the complex systems of food processing, transportation, and distribution. In addition, it requires consideration of the many other factors that affect food supplies, including fuel prices, trade policies, and labor agreements.

- **In the wake of climate change-related extreme events such as floods and wildfires, how is the cost of living affected?** Related to concerns about access and price of food, Listening Session discussions often touched on issues related to the rising cost of living. To what extent can policies aimed at reducing greenhouse gas emissions or bolstering resilience also reduce (or at least not further increase) costs related to housing, utilities, and transportation? In the wake of extreme weather events such as floods and fires, how is the cost-of-living affected? How are the costs of these events, distributed among residents, utility rate-payers, and commuters?

- **To what extent do climate change-related hazards exacerbate health, including mental health conditions?** Understanding the extent to which climate change-related hazards exacerbate threats to health, including mental health conditions, is needed. Emerging research indicates that mental health can be affected by extreme heat. Many communities of color, indigenous peoples and communities with lower incomes already experience health disparities and tend to have more limited access to healthcare. These communities also face relatively high levels of stress or contend with significant trauma related to historical and contemporary discrimination and institutionalized racism. Understanding the extent to which climate hazards may exacerbate threats to health conditions, like mental health, would be valuable for public health professionals, emergency managers and hazard planners.

- **What are the demographics of the regions most exposed to flood and wildfire in Washington?** Demographic information for areas exposed to flood and wildfire would improve our understanding of risks faced by communities of color, indigenous peoples and communities with lower incomes. Additionally, it would be valuable to know more about the housing stock in these areas, level and types of insurance coverage, as well as the trajectory of development and

population change (e.g., Are these areas growing? Who is moving to these areas, and what is known about their racial/ethnic identity and socioeconomic status? What types of infrastructure is in these areas? Does recent development deepen the commitment to keep these areas settled?) How do changes in development and population relate to demographic changes in other parts of the state or region (e.g., are people moving to these areas because of rising costs in nearby urban areas?)? Do land-use policies in jurisdictions exposed to flood and fire help to minimize or raise risks? How do the common definitions for "floodplains" and "wildland-urban interface" relate to the areas where impacts that have been observed recently, as well as those likely to occur in the future?

- **What can we learn about exposure, vulnerability and risk in Washington state through more detailed research of individual hazard events?** To go beyond the anecdotes collected in this report, more systematic investigation is needed regarding the experiences of communities of color, indigenous peoples and communities with lower incomes during and after extreme weather events. This type of work would identify the relative importance of factors that affect vulnerability, the perception of risk following an event, and the institutions that facilitate coping with or impede recovery. Such work could also highlight differences between urban and rural communities, or among different racial/ethnic groups**.**

- **What is the efficacy of mitigation and adaptation policies for improving equity?** Which policies are effective at reducing greenhouse gas emissions or improving climate resilience while adequately addressing equity concerns? What are the indicators and metrics for success? How would these indicators and metrics vary across different locations in the state, based on the types of risks that they face, or among communities, based on their respective culture, values, and priorities?

- **What are the place-based differentials between climate-related vulnerabilities of urban and rural communities?** What are the differential risks facing urban and rural populations in Washington state? How does urbanization contribute to the exposure and vulnerability of communities? How do housing quality/access/affordability and the availability of services vary across these spaces and contribute to exposure and vulnerability to climate change-related hazards? What is the relationship between displacement and climate change in Washington state?

- **How are climate risks being managed for port infrastructure, and do these plans consider risks in surrounding neighborhoods?** Ports are important hubs of employment and economic activity for the Washington state. However, they are also sources of air and water pollution, and emit significant amounts of greenhouse gases. Ports are also directly exposed to periodic flooding and sea-level rise. In Seattle and Tacoma, the neighborhoods surrounding the ports are historically non-white and low-income. The confluence of these factors makes ports potentially important locations for thinking about greenhouse gas reductions, climate resilience, and equity issues. How are climate risks being managed for port infrastructure, and do these plans consider risks in surrounding neighborhoods? What are the demographics of port employees? Is the port a major employer of nearby communities, or do many of the workers come from other parts of the city or region? How might climate impacts on exports or imports affect port operations, and in turn, how might that affect employment opportunities? How might climate mitigation policies affect port operations, if at all (in most locations, many port activities are exempt from carbon policies)?

- **What are the potential impacts of climate change on groundwater?** There is substantial research on the potential impacts of climate change on surface water supplies, but less is known about groundwater. Groundwater supplies are spatially variable, making it more challenging to characterize how climate change might affect groundwater. However, many rural, lower-income communities depend on groundwater for their water supplies and groundwater can be critical for maintaining agriculture during drought. Although groundwater can serve as a valuable backup supply to surface water, overuse of groundwater can compromise its quality, or future availability. It will be important to understand the ways in which important groundwater supplies around the state could be affected by climate hazards, the limits to which groundwater can be a buffer to variability in surface water supplies in different locations and the locations and vulnerabilities of communities that are rely on groundwater.

CHAPTER 8. REFERENCES

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