



HUMAN HEALTH AND SAFETY

INTRODUCTION

Climate change can bring new health threats to new places and also exacerbate existing health problems that are sensitive to weather or climate [1]. This chapter explores some of these anticipated health and safety impacts from climate change, which include increased rates of the following [2]:

- Heat-related illnesses such as heat stroke and heat exhaustion.
- Air-quality-related respiratory illnesses such as asthma and allergies, resulting from increased allergen production, ground-level ozone, and wildfire smoke.
- Some diseases transmitted by food, water, and insects, such as shellfish poisoning, West Nile Virus, and fungal diseases (e.g., Valley Fever).
- Injuries resulting from exposure to extreme weather events.

The groups that are most likely to be vulnerable to climate change impacts on health include people over age 65, children, low-income individuals, people who spend a lot of time working outdoors, households that lack access to air conditioning, and people with existing cardiac, respiratory, or other underlying health problems are likely to be most vulnerable to climate impacts on health [1]. The Tribe's enrollment list has a smaller percentage of people over age 65 compared to Kitsap County more broadly (approximately 6% compared to 16.5%) [3, 4], but approximately the same percentage of children under age 5. The 2010 census showed that 15.3% of households on the reservation were below the poverty line [614].

EXISTING TRIBAL SERVICES

The Tribe's Health Services Department provides Tribal members with both medical and dental primary care services. For other services, including emergency care, the Department typically makes referrals to off-site medical facilities such as Harrison Medical Center in Bremerton. The Tribe also plans for disaster response and has a public health plan for emergency management.

Anecdotal observations by Health Services Department staff indicate that Tribal members may have higher rates cardiovascular diseases, asthma, and diabetes than the general population of the peninsula; however, funding constraints have limited the ability to study and document such differences.



CLIMATE CHANGE IMPACTS ON HEALTH

HEAT WAVES

Washington State residents can expect that climate change will bring longer and more frequent summertime heat waves, which can cause dehydration, heat stroke, heat exhaustion, or even death [5]. Globally, climate change is expected to cause 38,000 additional deaths per year between 2030 and 2050 due to heat exposure in elderly people [6]. According to the Centers for Disease Control and Prevention, in



the last decade more Americans have died from extreme heat than from any other weather-related cause. In the 2003 summer heat wave in Europe, there were between 30,000 and 70,000 additional deaths [1, 6]. In King County, past extreme heat days have shown a 78% increase in diabetic-related mortality [7].¹ There may be fewer cold-related deaths as the climate warms, but researchers expect that the reduction in cold-related deaths will be smaller than the increase in heat-related deaths [1]. Some studies have even predicted that cold-weather deaths will not change as the climate warms [8].

Accurately quantifying the number of heat-related deaths is difficult because the immediate cause of death is likely to be documented as something such as respiratory or cardiovascular failure [9]. A national study by Greene et al. estimated that from 1975 to 1995 Seattle had an average of two summertime extreme heat days per year, and an estimated average of 13 deaths could have been attributable to those extreme heat events [10]. Using the A1 scenario, which assumes very fast economic growth, the same study projects that climate change may lead to an average of 51 extreme heat days per year in Seattle from 2020 to 2029, 54 days from 2045 to 2055, and 57 days from 2090 to 2099 [10]. Their algorithm estimates an average of 14–18 deaths every summer for the second half of the century, a moderate increase from the past (assuming no change in public health response) but less than the increases anticipated in the eastern United States.

A local study by Jackson et al. looked at May to September heat events in several parts of the state, with the study area closest to the Port Gamble S'Klallam Tribe being Greater Seattle (King, Pierce, and Snohomish counties). Looking at the past (1980–2006), the researchers found that the risk of death due to non-traumatic causes and circulatory causes tended to peak on the fourth day of a heat event [9]. Under



the highest warming scenario, the study concluded that greater Seattle can expect 211 excess deaths in 2025, 401 in 2045, and 988 in 2085 among adults age 45 and older (but mostly among those age 65 and older) [9].² These rates were actually projected to be higher in the Seattle area than in eastern Washington, perhaps due to urban heat island effects or greater use of air conditioning in the eastern part of the state [9].

At the same time, people are increasingly able to tolerate extreme heat, as air conditioning becomes more prevalent and people adopt other responses [1]. The Tribe could take several actions to reduce the community's vulnerability to higher temperatures and summer heat waves. A key option is to provide cooling centers for those who do not have air conditioning. The Elders Center, Little Boston Library, and casino can serve as temporary cooling centers (although exposure to cigarette smoke in the casino may offset some of the

health benefits). It will be especially important to care for children and older adults, who are most vulnerable to extreme heat. Increased public awareness and heat warnings can also help reduce the risks.

¹ This study defined an extreme heat day as one with a humidex value over 36.1 degrees C or 97 degrees F. Humidex measures the combined effects of humidity and temperature on the human body.

² Excess deaths are those above the normal baseline—so those attributable to the heat event as opposed to other causes.



ALLERGIES, ASTHMA, AND RESPIRATORY ILLNESS

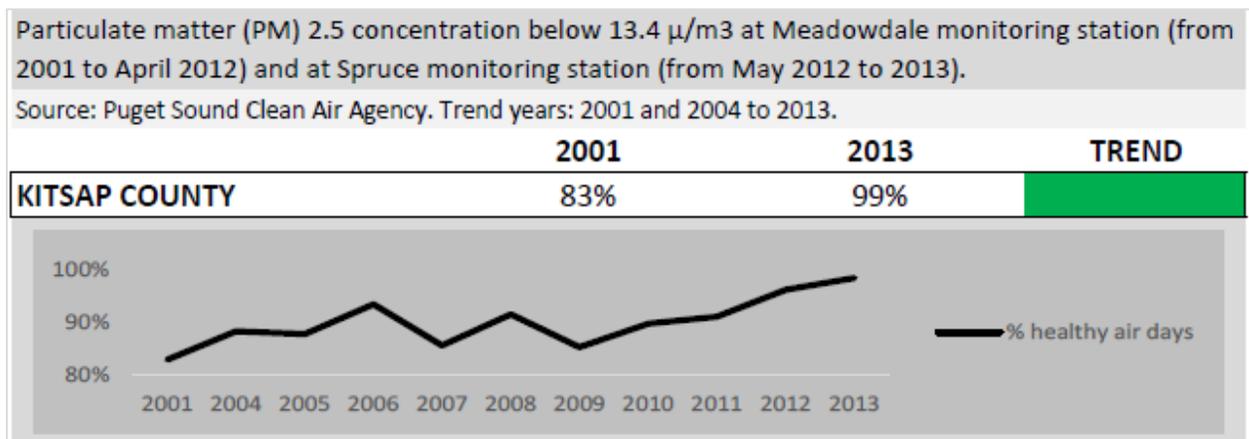
Outdoor Air

Pollen levels tend to be higher during times of extreme heat, and climate change may lengthen the pollen season [5, 6]. The pollen season is already starting earlier for some plants in some parts of the country [11]. Health Services Department staff noted that they frequently hear community members talk about allergens, the number of allergy complaints has increased, and people seem to be having a harder time managing allergy problems with antihistamines; however it is difficult to attribute these cases directly to climate change.

A study in Alaska found that communities that experienced “unseasonable environmental conditions” in a given 30-day period were more likely to report pollen allergy and asthma symptoms (as well as injuries, frostbite, hypothermia, and mortality) during that time [12]. During those periods, study participants had observed wildfire smoke and dust from dry road and river beds—factors that would increase air pollution and that can be linked to warm, dry days [12].

Fortunately, across both Kitsap County and Washington State, the asthma hospitalization rate has dropped significantly over the last two decades [13]. Kitsap County has also had an improving trend in healthy air days (see Figure 1) [14]. But while hospitalizations have gone down, overall asthma prevalence has gone up [1]. Asthma has been identified as an ongoing problem in the Port Gamble S'Klallam community.

Figure 1. Trend in days with healthy air across Kitsap County [13].



As the climate changes, wildfires may also bring increased particle pollution and reduced air quality, leading to more emergency room visits for respiratory problems and asthma [1, 5]. In Chelan and Kittitas counties, the 2012 wildfire smoke contribute to 350 more hospitalizations for respiratory conditions and many school absences [15]. A study of the 1987 California wildfires found a 30% increase in hospital attendances for asthma on days of fire activity; in 1999, California saw a 52% increase in respiratory symptoms coinciding with haze [16].

Jackson et al. reported that daily maximum 8-hour ozone concentrations may be 28% higher by mid-century in King County compared to the recent past (1997–2006 baseline) [9]. Sunlight and increased temperatures contribute to the formation of ozone in the atmosphere [9]. Excess deaths in May-September due to ozone in King County are projected to increase from 69 per year (1997–2006) to 132 per year by mid-century [9]. While the Jackson study looked only at mortality, higher ozone concentrations can also lead to hospitalization for asthma as well as missed school or work days [9].



Indoor Air

Many Tribal members use wood-burning stoves because wood fuel is cheaper than electricity, but those stoves can contribute to poor indoor air quality and be inefficient. Some studies have indicated that particulates from wood smoke might have more negative consequences for human health than particulates from other sources, making both wildfires and indoor wood-burning stoves causes for concern [16]. The Health Services Department did some home visits to help residents understand what they could do to alleviate the problem associated with wood fuel and health, but the initiative was constrained by limited funding.

Finally, while more research is needed to confirm linkages, climate change has the potential to increase indoor dampness in some parts of the country through greater humidity or moisture entry into homes during heavy rain events. Increased indoor dampness can lead to increased mold and consequently to more respiratory infections and exacerbated asthma [1].

FOODBORNE ILLNESS

Climate change could also heighten the risk of some foodborne illnesses. As noted in the Shellfish chapter and the Harmful Algal Blooms chapters, warmer air and water temperatures, ocean acidification, and increased nutrient runoff during heavy precipitation events can create more favorable conditions for toxic phytoplankton and bacteria outbreaks. These can in turn cause illnesses such as paralytic shellfish poisoning, amnesic shellfish poisoning, and diarrhetic shellfish poisoning in humans. In the past, the Tribal Health Services Department has received little interest from Tribal members in its offers to do blood drawings to check for toxicity levels resulting from shellfish consumption. Tribal members have responded that eating shellfish is too fundamental to their diets and their culture to be changed easily. The Tribe believes that their members consume shellfish at approximately the same rate found in a study of Suquamish tribal members: about half a pound daily, which is four times more than the amount consumed by recreational shellfish harvesters in the area [17]. A 2016 study by the U.S. Global Climate Change Research Program noted that tribes that continue to consume traditional diets—with large amounts of fish and shellfish—may encounter greater health risks due to contamination [1]. Kitsap County has had an improving trend in the number of shoreline miles classified as “open” for shellfish harvesting [14]; however, climate change could reverse that trend in the coming decades. Closures have still happened in recent years: as noted in the Shellfish chapter, many of the recreational shellfish beaches along Hood Canal were closed or under advisory in June 2015 because of toxins [18].

Other pollutants, such as arsenic, are also significant contributors to shellfish toxicity [17]. While these stem primarily from non-climate stressors and pollution sources (i.e., an old sawmill and log dump), increased heavy rainfall events projected under climate change scenarios may increase runoff of land-based pollutants into water sources in the future.

Many other foodborne illnesses are not reportable conditions in Washington state, leaving little data for analysis [9]. There has been minimal research on how their incidence may be affected by climate change. We do know that higher temperatures can enable bacteria to grow more quickly and increase *Salmonella* prevalence in food [1, 5]. In addition, rising sea surface temperatures will contribute to greater amounts of mercury in seafood as it lets it be more readily absorbed by fish tissue [1].

WATERBORNE DISEASE

Extreme precipitation is documented as a significant climate factor for waterborne disease, as a result of runoff carrying contamination into drinking water supplies [1]. Given that the Port Gamble S'Klallam Tribe can expect to see more frequent and more intense extreme precipitation events, the Tribe may need to



take steps to ensure that its wells do not become contaminated. More information on drinking water can be found in the Infrastructure chapter.

Runoff during heavy rainfall events can also contaminate lakes and the ocean. Tribal member who go swimming, fishing, or boating may be more exposed to enteric viruses from sewage runoff and therefore at risk of more gastrointestinal illnesses in the future [1].

INFECTIOUS DISEASES

Climate change can also contribute to the spread of infectious diseases, including fungal infections. It can be hard to tease out the precise role that climate plays, given that numerous other factors, including water and air quality, ecological change, health services, and migration also play key roles in the spread of such diseases [19]. Researchers will need to continue collecting data over many years to be able to make stronger conclusions [19].

One disease that has appeared recently in our region is linked to *Cryptococcus gattii*, a type of pathogenic yeast taken in by inhalation. *C. gattii* showed up in the Pacific Northwest within the last two decades, having previously been found in Southern California and places on other continents that also have warmer climates.³ Researchers are still trying to understand what brought it to the Pacific Northwest, but climate change impacts—such as milder winters—are considered to be one of the possible contributing factors [19]. It is possible that some strains may have been present—though dormant—for a few decades in the Pacific Northwest and then emerged when land use, climate, or other factors changed [20]. Studies in British Columbia indicate that *C. gattii* is most likely to be found at low-lying elevations where daily winter average temperatures are above freezing [20].

Meanwhile, *Coccidioides*, a fungus previously found mainly in the southwest, has recently appeared in south-central Washington State. This fungus, which grows in soil after heavy rains and is then spread through the air in hot and dry conditions, can lead to Valley Fever [1].

NATURAL RESOURCES SECURITY

The health of the Tribal community can also be harmed when climate change affects the abundance or accessibility of natural resources such as water, plants, fish, and wildlife. The 2014 Community Health Assessment noted an ongoing concern about the poor health of fish and shellfish in Port Gamble Bay, which can worsen due to climate change [4]. These kinds of impacts are described in more detail in the Salmon, Shellfish, and Harmful Algal Bloom chapters. The cascading impacts can affect not only the diets and nutrition of Tribal members, but also their mental and emotional wellbeing if they are not able to carry out cultural traditions in a satisfying way [21].

CLIMATE CHANGE IMPACTS ON SAFETY

Climate change will bring more floods, droughts, storms, landslides, wildfires, and other extreme events. These events all have corresponding safety and health implications [5]. Consequences can include physical injuries, reduced availability of potable water, interruptions in communications and health care services, damage to key transportation routes, and mental health impacts [11].

³ Although a few people have become seriously ill or died from this infection, it is not widespread or considered to pose significant risks.



The Tribe's main emergency and safety concern at this time is a big earthquake, not a climate-related disaster. However, climate change impacts may become a growing concern in the coming years, and Tribal members have already noticed changes in weather patterns. The reservation experienced three bad storms in March of 2016, which was different from past experience, as well as a very hot summer in 2015. As a Health Department staff member notes, "People are starting to think about this: is this going to be the norm now?"

In addition, many earthquake-preparedness measures—such as establishing shelters and training for emergency response—may also be helpful for dealing with storms, wildfires, or heat waves and for building climate resilience. The Tribe is building a new hotel next to the casino, for example, which could serve as an emergency shelter in different kinds of disaster situations. The Tribal gym could also serve as a shelter.

The Tribe's 2007 Comprehensive Emergency Plan includes hazard mitigation (with a focus on earthquakes) and will be updated soon. To date, this plan has looked at short-term response needs and not future risk and does not address climate change specifically. The Tribe also has a new public health plan for emergency management. There is an evacuation strategy for Tribal-owned facilities.

Tribal police and emergency responders use the incident command system (ICS) and National Incident Management System (NIMS) to respond to events and ensure continuity of operations. Given staff turnover since the last ICS training, the Tribe has noted that retraining is needed. The annual Canoe Gathering event unintentionally works as a kind of emergency preparedness drill for the Tribe, as they need to deal with large crowds and provide on-site food, shelter, and medical attention.

The Tribal Health Services Department has a generator to provide limited power for continuing medical services during power outages, which tend to happen during winter storms. Limitations in generator power during outages can prevent operation of computer systems, kitchen equipment, and other non-essential equipment, which makes it challenging for staff to keep working during such times. The Tribe is looking into ways to make adjustments to help address these limitations.

The Tribal community's ability to deal with climate and non-climate disasters and emergencies is enhanced by high levels of social cohesion. Community members often grew up together, know and take care of each other, and check on each other when incidents occur. This creates a high degree of adaptive capacity, which helps to reduce vulnerability and increase resilience. Still, it would be useful to consider climate change more explicitly in the Tribe's emergency preparedness plans and measures to further build resilience and keep community members safe.



LOOKING AHEAD

This chapter has explored a number of health and safety challenges that could face Tribal members as the climate changes. Some are exacerbations of existing problems. For example, asthma is already a concern that may be exacerbated by increased wildfires and a longer pollen season.

Another significant concern—and one that is particularly relevant to tribes—is the increasing risk of contaminated fish and shellfish. As important parts of the traditional diet and critical for the survival of cultural traditions, these resources are vital for community cohesion and mental and emotional wellbeing in addition to physical health.



Maintaining the connectedness of the community—together with proactive adaptation measures and education to protect health and safety—can help to counteract these challenges and support resilience into the future.

Going forward, the Tribe plans to consider climate change in the update to the Comprehensive Plan and obtain support from an emergency management planner to assist in this effort.

In addition, the Health Services Department runs a broad community preventative healthcare program that can help to build resilience. Four Community Health Representatives (CHRs) equivalent to 3.5 full time employees (FTEs) provide transportation to medical appointments, deliver prescriptions to individuals on the reservation, perform home visits, and work with Health Services Department staff on chronic illnesses such as hypertension and diabetes. These individuals are Tribal members who live in the community and therefore have strong relationships and a good understanding of local issues. When CHRs transport community members to health appointments, it could present an opportunity to discuss weather and climate issues. One adaptation measure worth considering would therefore be training CHRs about climate change and encouraging them to help raise awareness among the Tribal community. There is also a current effort to map the neighborhood and establish emergency contacts.



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