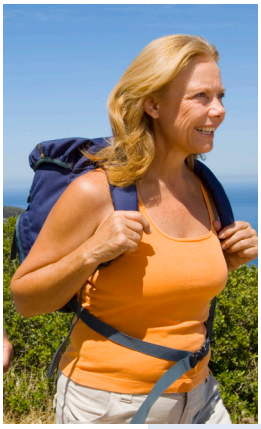
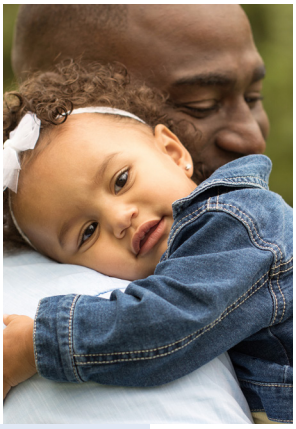
2018

Climate Change and Public Health in Oregon







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CLIMATE CHANGE AND PUBLIC HEALTH IN OREGON

Executive Summary

Climate change is already affecting human health in Oregon and is projected to increase health risks in the years to come. For example, during heat waves we have seen spikes in heat-related emergency room visits, and during recent wildfire events we have seen increases in respiratory-related hospital visits. No one in Oregon is immune to the health effects of climate change, but some communities are more at risk than others.

Oregon-specific vulnerability assessments point to social determinants as the primary driver of climate vulnerability. These findings are in alignment with national assessments, such as the US Climate and Health Assessment and vulnerability analyses conducted in neighboring jurisdictions. The 2014 Oregon Climate and Health Profile Report concluded that certain communities that already bear a disproportionate burden of disease, including communities of color and low-income households, are most at risk. These groups are more susceptible to climate-related health effects and have fewer resources to plan for, and recover from, climate impacts.

In Oregon, the transportation sector is the top producer of greenhouse gases (GHG), and also produces "co-pollutants"—other air pollutants that are harmful to human health. Traffic pollution comprises a number of toxics, including particulate matter, nitrogen dioxide, sulfur dioxide, polycyclic aromatic hydrocarbons, mercury, and volatile organic compounds. For Oregon, reducing GHG emissions in the transportation sector, and their associated co-pollutants, is likely to provide substantial public health benefits.

There is a well-established connection between exposure to air pollution and increased risk of heart disease, stroke, respiratory disease and cancer, four of the top five leading causes of death in Oregon. While the principal causes of these diseases are risk behaviors, such as tobacco use, poor diet, and lack of physical activity, air pollution is a significant contributor, although Oregon-specific data are lacking.

National studies have demonstrated that low-income communities and communities of color are more likely to be exposed to air pollution because of where they live, work, and go to school. These communities are also more likely to have higher background rates of these diseases. In Oregon, adults with household incomes less than $20,000 are nearly three times as likely to have a heart attack as adults with household incomes above $50,000 and African Americans, American Indians and Alaska Natives have a higher prevalence of heart attacks than other racial and ethnic groups in Oregon.

Strategies to reduce greenhouse gas emissions have the potential to create multiple health "co-benefits" (improvements to population health in addition to the mitigation of climate change). These health benefits arise from lowering exposure to "co-pollutants" and through the creation of healthy alternatives and community assets, such as increased access and use of active transportation infrastructure. Health benefits are greatest when these improvements occur among populations most vulnerable to the health effects of climate change.

Even with climate projections pointing to more natural disasters and environmental health hazards in Oregon, many health effects of climate change can be avoided through enacting changes in our policies, systems, and environments. Investing in our environmental public health infrastructure and early warning systems can help us prepare for projected health risks.

Many strategies to reduce climate pollution are the same strategies that we must implement to reduce health inequities. When communities are more connected, they have greater potential to thrive and adapt, and this connectedness is often facilitated by good community design. Transportation and land use planning and policies can increase or decrease a community's quality of life, health, economic prosperity and safety by improving air quality, access to healthy food, active transportation options, and more.

A number of Oregon-specific studies address questions related to climate and health, but more work is needed to understand the economic value of health benefits and burdens. Over the past decade studies at the regional, statewide, and local level have qualitatively characterized implications for health care and public health systems, impacts to vulnerable populations, and the importance of community engagement. Policy makers seeking to optimize climate decisions would benefit from improved economic valuation of health benefits and burdens associated with climate impacts, mitigation, and adaptation.

Overview

- Purpose of this paper
- Five questions
- Information sources

Purpose of this paper

The Oregon Health Authority, Public Health Division prepared this paper in response to inquiries from the Oregon Governor's Carbon Policy Office regarding health risks of climate hazards and co-pollutants of greenhouse gas emissions. This paper seeks to answer the five questions below with the best information currently available.

Questions

1. **Which populations in Oregon are most vulnerable to adverse health effects of climate change?**
2. **Which populations in Oregon have historically experienced disproportionate adverse health effects of carbon co-pollutants (e.g., particulates)?**
3. **What are the effective public health interventions for building resilience within communities most impacted by climate change?**
4. **What climate adaptation and mitigation strategies yield the most health co-benefits?**
5. **What Oregon-specific studies inform questions related to climate and health?**

Information Sources

The responses to these questions draw from the most recent scientific literature on climate change impacts, related health effects and evidence-based interventions. Oregon-specific studies are cited when available.

Introduction

- Climate change in Oregon
- Health effects of recent climate hazards in Oregon
- Health effects from greenhouse gas co-pollutants
- Climate change is a 'threat multiplier'

Climate Change in Oregon

Climate change is already affecting human health in Oregon and is projected to increase health risks in the years to come. The Northwest will continue to warm during all seasons, although the rate of warming will depend on current and future greenhouse gas emissions[1]. By 2050, average temperatures in Oregon are expected to rise by 3 to 7 degrees and snowpack is expected to be less than half of what it was last century[2]. Years of abnormally low precipitation and extended drought conditions are expected to occur throughout the century and extreme events, like wildfires, flooding and heat waves, are anticipated to occur more often[3]. Poorer air quality is expected to increase respiratory illnesses in the decades to come, with particulate levels from wildfires projected to increase by at least 160% by mid-century[4]. Climate change in Oregon may introduce some potential positive health factors. For example, longer summer seasons could lead to an increase in outdoor recreation that supports positive health outcomes. However, the rate of change, and the evidence to date, point to current and growing adverse health impacts such as those detailed in Box 1, *Health Effects of Recent Climate Hazards in Oregon*. These impacts and more are detailed in the Oregon Health Authority's 2014 Oregon Climate and Health Profile Report.[5]

Health effects from greenhouse gas co-pollutants

Greenhouse gas emissions arise from numerous human activities and natural processes, but the key emissions targeted in strategies to slow the pace of global climate change are carbon dioxide emissions from burning fossil fuels. Because these emissions also contain air pollutants that have direct adverse health impacts to humans, strategies to reduce or mitigate greenhouse gas emissions also produce health "co-benefits" from reductions in harmful greenhouse gas "co-pollutants." Co-pollutants and associated health effects, including respiratory and cardiovascular disease and cancer, are discussed in more detail in the answer to Question 2. Strategies for reducing greenhouse gas emissions that also produce public health co-benefits are discussed in more detail in the answer to Question 4.

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[1] Rupp DE, Abatzoglou JT, Mote PW. 2016. Projections of 21st century climate of the Columbia River Basin. Climate Dynamics 1–17. DOI: 10.1007/s00382-016-3418-7.

[2] Dalton, M.M., K.D. Dello, L. Hawkins, P.W. Mote, and D.E. Rupp (2017) The Third **Oregon Climate Assessment** Report, Oregon Climate Change Research Institute, College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Corvallis, OR.

[3] Brewer MC, Mass CF. 2016b. Projected Changes in Western U.S. Large-Scale Summer Synoptic Circulations and Variability in CMIP5 Models. Journal of Climate 29(16): 5965–5978. DOI: 10.1175/JCLI-D-15-0598.1

[4] Liu JC, Mickley LJ, Sulprizio MP, Dominici F, Yue X, Ebisu K, Anderson GB, Khan RFA, Bravo MA, Bell ML. 2016. Particulate air pollution from wildfires in the Western US under climate change. Climatic Change 138(3–4): 655–666. DOI: 10.1007/s10584-016-1762-6

[5] Haggerty B, York E, Early-Alberts J, Cude C. Oregon Climate and Health Profile Report. Oregon Health Authority. September 2014: Portland, OR.

Climate change is a 'threat multiplier'

No one in Oregon is immune to the health effects of climate change, but some communities are more at risk than others. Climate change is described by the US Department of Defense (DOD) as a "threat multiplier." In their 2015 report entitled, *National Security Implications of Climate-Related Risk and a Changing Climate,* DOD concluded that climate change is a present security threat, not strictly a long-term risk. DOD reported already observing climate shocks and stressors to vulnerable communities, including in the United States[6]. In other words, climate change makes existing threats worse. Communities that already face greater risks will bear a disproportionate share of climate-related burdens. These same groups often have fewer resources and opportunities to plan for, and recover from, climate impacts[7].

Box 1: Health Effects of Recent Climate Hazards in Oregon

Oregon Health Authority tracks emergency department visits in the state, which tend to increase during extreme weather events. During the 2017 wildfire season, total emergency department and urgent care visits were above expected levels, with respiratory-related visits peaking on September 5, 2017 with a 20 percent increase over the number of statewide visits expected for that day. During the heat waves in the summer of 2015, the Oregon Health Authority recorded a spike in heat-related emergency room visits.

Changes in our climate are also a factor in infectious diseases. For example, the number of cases of tick-borne disease in Oregon is steadily rising and is associated with warmer temperatures and changing tick habitat. Another example is the spread of a fungus that causes cryptococcal infections, which before 1999 was limited to the tropics, but is now established in Northwest soil and caused 76 cases in Oregon in 2015.

[6] US Department of Defense. 2015. National Security Implications of Climate-related Risks and a Changing Climate. Available at: https://archive.defense.gov/pubs/150724-congressional-report-on-national-implications-of-climate-change.pdf?source=govdelivery

[7] Haggerty B, York E, Early-Alberts J, Cude C. 2014. Oregon Climate and Health Profile Report. Oregon Heath Authority: Portland, OR

1. Which populations in Oregon are most vulnerable to adverse health effects of climate change?

Summary:

- Approaches to identifying vulnerable populations
  - Oregon Climate and Health Profile Report
  - Oregon Social Vulnerability Assessment
  - PSU Findings Brief on Equity Considerations for Cap and Trade Legislation
  - California methods for identifying vulnerable populations
  - Washington methods for identifying vulnerable populations
- Social determinants are the primary driver of climate vulnerability
  - Exposure, sensitivity, and adaptive capacity
  - Both quantitative and qualitative data are needed

Approaches to identifying vulnerable populations

The conditions where people live, work, learn and play affect a wide range of health risks and vulnerabilities[8]. These conditions are known as social determinants of health and are the biggest predictors of our length and quality of life. For example, we know that poverty limits access to healthy foods[9], stable housing and safe neighborhoods[10]. By applying what we know about social determinants, we can improve population health, health equity[11] and community resilience[12]. Identifying vulnerable populations is, therefore, best supported by a quantitative and qualitative approach that includes data-driven tools.

Demographic data from the US Census can be used to understand social determinants and social vulnerability in Oregon. Combining data into a "vulnerability index" is a common approach to assessing risks from exposure to a hazard. Numerous jurisdictions have developed and applied climate-specific vulnerability indices to help identify risks to health[13]. There are also some national indices, or screening tools, that use this approach to assist communities in identifying vulnerable populations, including the Environmental Protection Agency's (EPA's) EnviroScreen and the Center for Disease Control and Prevention's (CDC) Social Vulnerability Index. The role of demographic factors in shaping people's life outcomes in Oregon is discussed further in the answer to Question 2.

With each year, more relevant data are becoming available and can offer a clearer picture of how social vulnerability overlaps with climate-specific vulnerabilities. For example, the CDC's National Environmental Public Health Tracking Portal includes climate change indicators such as the number of extreme heat days. In the future, we may be able to incorporate additional climate-related data such

[8] Healthy People 2020. Social Determinants of Health

[9] Walker RE, Keane CR, Burke JG. Disparities and access to healthy food in the United States: a review of food deserts literature. Health & Place 2010;16(5):876-884.

[10] Adler NE, Newman K. Socioeconomic disparities in health: pathways and policies. Health Affairs 2002;21(2):60-76

[11] Williams DR, Costa MV, Odunlami AO, Mohammed SA. Moving upstream: how interventions that address the social determinants of health can improve health and reduce disparities. Journal of Public Health Manag Pract 2008;14(Suppl):S8.

[12] Marmot M, Commission on Social Determinants of Health. Achieving health equity: from root causes to fair outcomes. The Lancet 2007;370(9593):1153-63.

[13] Cutter, S.L., Boruff, B.J., & Shirley, W.L. (2003). Social vulnerability to environmental hazards. Social Science Quarterly, 84(2), 242-261.

as flood plain zones, drought-prone areas and urban heat islands. Any methodology used to determine vulnerability must be revisited as new data becomes available to ensure sound science-based decision-making. Several social vulnerability assessments have been conducted in Oregon and neighboring states in order to identify populations most impacted by climate change and are briefly summarized below.

Oregon Climate and Health Profile Report

OHA's Climate and Health Program prepared a full analysis of health risks related to Oregon's projected climate impacts, and a description of the populations most vulnerable to these risks, in the 2014 Oregon Climate and Health Profile Report[14]. The report serves as the state's first climate and health risk assessment supported by a literature review and the input of a number of technical advisors.

The report concluded that certain communities within Oregon are affected more than others, including communities of color and low-income households, who already bear a disproportionate burden of disease in Oregon. These same groups face more exposures to hazards and have fewer resources to recover from climate change related impacts. In this way, climate change is likely to make Oregon's current health disparities worse.

Type of Vulnerability	Populations Identified in the Oregon Climate and Health Profile Report
Demographic	• People with existing illness • People with disabilities • Older adults • Mothers, infants and children • Low-income communities • American Indians • Immigrants, refugees and linguistically isolated • Communities of color
Geographic	• Urban heat islands • Wildland-urban interface • Agricultural communities • Coastal communities • Households reliant on private water systems • Housing on steep slopes

[14] Haggerty B, York E, Early-Alberts J, Cude C. Oregon Climate and Health Profile Report. Oregon Health Authority. September 2014: Portland, OR.

Type of Vulnerability	Populations Identified in the Oregon Climate and Health Profile Report
Occupational	• Wildland firefighters • Outdoor workers • Growers, ranchers and farmworkers • First responders and health care workers • People who work in agricultural communities

Oregon Social Vulnerability Assessment

In 2015 OHA produced the first phase of a Social Vulnerability Assessment[15] which included a set of maps highlighting social vulnerability indicators to inform climate resilience planning in Oregon. This initial set of maps included a composite score of social vulnerability that combined 11 measures of demographics, socioeconomic status, and health:

- **Birth Outcomes:** Percentage of infants born at less than 36 weeks of pregnancy
- **Children**: Percentage of population aged less than 18 years
- **Chronic Disease**: Age-adjusted mean body mass index
- **Educational Attainment**: Percentage of adults aged 25 years or older without a high school diploma
- **Foreign-born Population**: Percentage of population born outside of the United States
- **Isolated Older Adults**: Percentage of households that are single-person age 65 years or older
- **Older Adults**: Percentage of population aged 65 years or older
- **Race and Ethnicity**: Percentage identifying as a race other than non-Hispanic white
- **Socioeconomic status**: Percentage of households with incomes less than 200% of the Federal Poverty Level
- **Tenure:** Percentage of housing occupants occupied by renters
- **Unemployment:** Percentage of population aged 16 years or older who are unemployed

This index could be further expanded to encompass additional measures of climate exposures (such as extreme heat) and measures of adaptive capacity (such as access to air conditioning) to more accurately identify communities in the state that are most vulnerable to climate impacts.

PSU Findings Brief on Equity Considerations for Cap and Trade Legislation

In the fall of 2017, researchers at Portland State University were commissioned by the Coalition of Communities of Color, Oregon Environmental Council and Portland State University Institute for Sustainable Solutions to investigate equity concerns related to possible Oregon cap-and-trade

[15] Haggerty B. Oregon Climate and Health Vulnerability Assessment. Oregon Health Authority. September 2015: Portland, OR.

legislation.[16] The study examined methods for defining and mapping communities most vulnerable to climate change and co-pollutants of greenhouse gas emissions.

In the PSU Findings Brief, the authors recommended using the following demographic variables to determine which community members are most vulnerable to climate change across the state:

- **Race**: Percentage of the population that is nonwhite (US Census)
- **Income**: Percentage of an area's population with income below 200% of the federal poverty level (US Census)
- **Education**: Percentage of the population 25 years of age and older without a high school degree/diploma (US Census)
- **Unemployment rate**: Percentage of the eligible population over 16 years of age not employed (US Census)
- **Age**: Percentage of the population 65 years of age or older, and percentage of the population under 10 years of age (US Census)

The study also used two environmental exposure data sets to capture risks related to air toxics:

- **Cancer Risk:** An estimate of an individual's cancer risk as the result of a lifetime of exposure to a range of point and mobile source air toxins (US Environmental Protection Agency National Air Toxics Assessment).
- **Respiratory Hazard Index:** An estimate of adverse health effects identified by length of time and concentration of exposure to a range of point and mobile source air toxins (US Environmental Protection Agency National Air Toxics Assessment).

Using these indicators of vulnerability, the researchers produced an index and conducted spatial analysis to identify and locate climate change-vulnerable communities in Oregon. The maps display the top 10%, 25% and 50% of Oregon census tracts based on their vulnerability index score.

California methods for identifying vulnerable populations

The State of California's Cap and Trade program uses a California-specific version of the EPA's EnviroScreen to determine eligibility for investments intended to benefit communities most impacted by climate change and co-pollutants of greenhouse gas emissions. CalEnviroScreen is an environmental justice tool that identifies California communities by census tract that are disproportionately burdened by, and vulnerable to, sources of pollution. Another tool recently developed by a coalition of local health departments in California, called the Healthy Places Index,[17] incorporates more climate indicators and has been recommended by the state health department for use by communities to inform local strategies for building climate resilience.

[16] Zapata M, Liu JH, Harris M. Findings Brief for Equity Considerations for Greenhouse Gas Emissions Cap and Trade Legislation in Oregon. Study commissioned by: Coalition of Communities of Color, Oregon Environmental Council, and Portland State University Institute for Sustainable Solutions. October 2017. Portland, OR.

[17] https://healthyplacesindex.org/

As the California Climate Investment programs are designed and implemented, the State of California is incorporating health equity guidelines into selection criteria. A state "Health in All Policies" Task Force has helped to ensure that partner agencies are supported in incorporating health and equity considerations. California is dedicating cap and trade revenues to many of the types of investments described in the answers to Questions 3 and 4 of this paper (including sustainable community and sustainable agriculture programs).

Washington methods for identifying vulnerable populations

In Washington State, several efforts in recent years have worked to highlight populations vulnerable to climate-sensitive hazards, improve information about vulnerabilities, and support community actions to address those risks. In 2012, the state published a multi-agency Integrated Climate Response Strategy[18] in which the Health Chapter prioritizes "Protect Vulnerable Populations" as the A-1 strategy, recommending improvements in assessment and protection. Since that time, the Washington Department of Health has developed geospatial data visualization tools on the Washington Tracking Network (WTN)[19], including a "Social Vulnerabilities to Hazards Index" which combines socio-economic, housing, and demographic data, allowing the public and community leaders to examine underlying vulnerabilities (e.g., population 65+ living alone, overcrowded housing, unemployment) in locations across the state. The Washington Department of Health is currently working with a community organization and the University of Washington to include additional environmental justice information to the WTN visualization tool.

Several carbon policy bills in the state legislature have included language that requires investments in disproportionately impacted communities termed "Priority Health Action Areas", and similar language has been used in a climate-related initiative that will be on Washington's ballot in November 2018.

Social Determinants are the Primary Driver of Climate Vulnerability

As reflected in the summaries above, there is growing consensus across scientific communities and jurisdictions that climate vulnerability is largely driven by social determinants. The 2015 US Climate and Health Assessment[20] concluded that over time, the "accumulation" of multiple, complex stressors among populations of concern is expected to become more evident as climate impacts interact with stressors associated with existing mental and physical health conditions and with other socioeconomic and demographic factors.

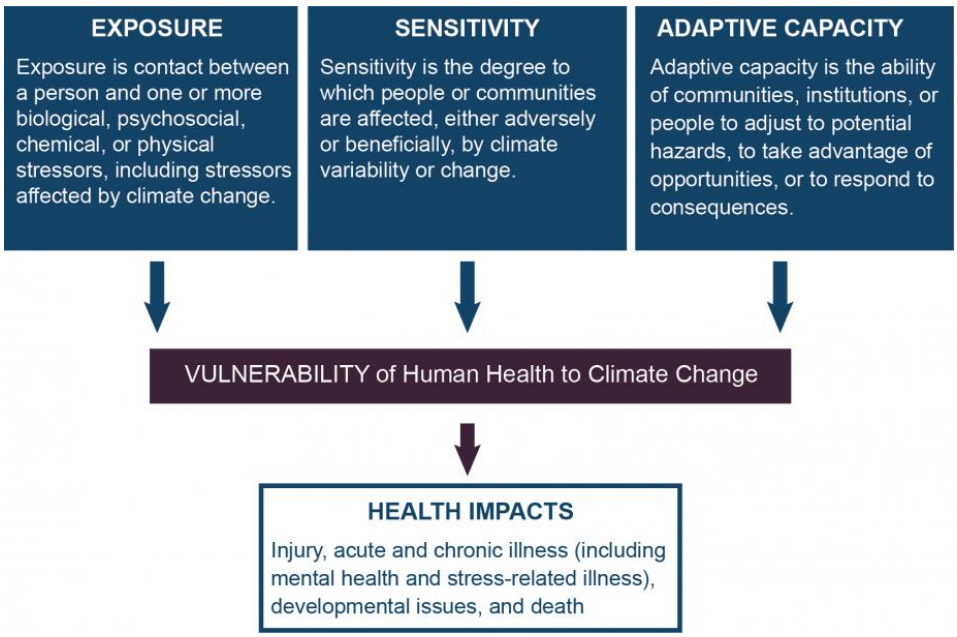
- **Exposure, Sensitivity and Adaptive Capacity**
  Specific populations and neighborhoods that bear multiple social vulnerabilities are therefore most at risk of the health effects of climate change. For example, in Oregon this includes populations living in both isolated rural areas and in impoverished urban areas where people

[18] https://fortress.wa.gov/ecy/publications/documents/1201004.pdf

[19] https://www.doh.wa.gov/DataandStatisticalReports/EnvironmentalHealth/WashingtonTrackingNetworkWTN/InformationbyLocation

[20] USGCRP, 2016: The Impacts of Climate Change on human Health in the United States: A Scientific Assessment. Crimmins, A, J. et al. U.S. Global Change Research Program, Washington, DC. https://health2016.globalchange.gov/

are not only more at risk of climate exposures but also social and economic stressors that affect their susceptibility and ability to cope and adapt. Sensitivity to climate threats and adaptive capacity are not evenly distributed across any given geographic region or jurisdiction within Oregon.



2015 US Climate and Health Assessment[21]

- **Both Quantitative and Qualitative Data are Needed**
  Data-driven tools for identifying these populations can provide valuable inputs into decision-making but are considered only part of a complete vulnerability analysis. Using community-based participatory methods and engaging meaningfully with identified populations to ground findings with additional qualitative data are a necessary step in ensuring that any limitations and assumptions are modified based on local lived experiences.

[21] USGCRP, 2016: The Impacts of Climate Change on human Health in the United States: A Scientific Assessment. Crimmins, A, J. et al. U.S. Global Change Research Program, Washington, DC. https://health2016.globalchange.gov/

2. Which populations in Oregon have historically experienced disproportionate adverse health effects of carbon co-pollutants (e.g., particulates)?

Summary:

- Climate co-pollutants can harm health
  - The economic and social burden of chronic diseases and adverse birth outcomes in Oregon is large
  - Air pollution may make a substantial contribution to disease burden in Oregon
- Some groups face a disproportionate burden of disease in Oregon
  - People with low income
  - Racial and ethnic minorities
- Some people may be more susceptible to health effects of pollution
- Some groups are more likely to be exposed to air pollution
- Reducing exposure to air pollution can improve public health

Climate co-pollutants can harm health

Burning of fossil fuels is the principal generator of climate co-pollutants in Oregon and globally. These co-pollutants include particulate matter, nitrogen dioxide, sulfur dioxide, polycyclic aromatic hydrocarbons, mercury, and volatile organic compounds, all of which have been shown to harm public health[22].

There is a well-established connection between exposure to particulate air pollution and increase risk of:

- heart disease[23]
- respiratory disease[24,25]
- stroke[26]
- cancer[27]

[22] Perera F. 2017. Multiple Threats to Child Health from Fossil Fuel Combustion: Impacts of Air Pollution and Climate Change. Journal of Environmental Health Perspectives. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5289912/

[23] Cai, X., Li, Z., Scott, E.M. et al. (2016). Short-term effects of atmospheric particulate matter on myocardial infarction: a cumulative meta-analysis. *Environ Sci Pollut Res.*23: 6139. https://doi.org/10.1007/s11356-016-6186-3

[24] Khreis, H., & Nieuwenhuijsen, M. J. (2017). Traffic-Related Air Pollution and Childhood Asthma: Recent Advances and Remaining Gaps in the Exposure Assessment Methods. *International Journal of Environmental Research and Public Health*, *14*(3), 312. http://doi.org/10.3390/ijerph14030312

[25]DeVries, R., Kriebel, D., Sama, S. (2017.) Outdoor Air Pollution and COPD-Related Emergency Department Visits, Hospital Admissions, and Mortality: A Meta-Analysis. *COPD: Journal of Chronic Obstructive Pulmonary Disease*, 14:1, 113-121, DOI: 10.1080/15412555.2016.1216956

[26] Shah, A. S. V., Lee, K. K., McAllister, D. A., Hunter, A., Nair, H., Whiteley, W., … Mills, N. L. (2015). Short term exposure to air pollution and stroke: systematic review and meta-analysis. *The BMJ*, *350*, h1295. http://doi.org/10.1136/bmj.h1295

[27] Chen, G., Wan, X., Yang, G., & Zou, X. (2015). Traffic-related air pollution and lung cancer: A meta-analysis. *Thoracic Cancer*, *6*(3), 307–318. http://doi.org/10.1111/1759-7714.12185

These are four of the top five leading causes of death in Oregon.[28] While the principal causes of these diseases are risk behaviors, such as tobacco use, poor diet, and lack of physical activity, air pollution is a significant contributor. However, Oregon-specific data to quantify the proportion of these diseases that is attributable to air pollution are lacking.

Some health effects of air pollution occur in response to levels of exposure below current regulatory standards. This was the case in a study that found an association between air pollution and mortality in the over-65 population.[29] This is relevant in Oregon, where the over-65 population grew 18% between 2010 and 2014, a trend projected to increase.[30]

In Oregon, transportation is the largest source of greenhouse gas emissions.[31] Traffic and diesel trucks emit particulate matter and complex mixtures of other climate co-pollutants that can harm health. Living near major roadways[32] has been linked to increased risk of asthma symptoms.[33] It has also been correlated with increased risk of premature death[34] and stroke[35]. Diesel exhaust is of particular concern. The International Agency for Research on Cancer has classified it as a known human carcinogen.[36] An EPA analysis estimated that the direct and indirect public health costs of diesel exhaust may be up to $3.5 billion per year in Oregon alone.[37]

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[28] Oregon Health Authority, 2017. Leading causes of death. https://www.oregon.gov/oha/ph/ProviderPartnerResources/PublicHealthAccreditation/Documents/indicators/leadingcausesofdeath.pdf

[29] Di, Q., Wang, Y., Zanobetti, A., Wang, Y., Koutrakis, P., Choirat, C., … Schwartz, J. D. (2017). Air Pollution and Mortality in the Medicare Population. *The New England Journal of Medicine*, *376*(26), 2513–2522. http://doi.org/10.1056/NEJMoa1702747

[30] State of Oregon Office of Economic Analysis, 2017. Oregon's Demographic Trends.

[31] Oregon Department of Environmental Quality. Oregon Greenhouse Gas Sector-Based Inventory Data. https://www.oregon.gov/deq/aq/programs/Pages/GHG-Inventory.aspx. Accessed October 5, 2018.

[32] OHA has a project underway to generate Oregon-specific data characterizing the size and composition of populations living near roadways; this information will be available in late fall 2018.

[33] HEI Panel on the Health Effects of Traffic-Related Air Pollution. 2010. Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. HEI Special Report 17. Health Effects Institute, Boston, MA. https://www.healtheffects.org/system/files/SR17TrafficReview_Exec_Summary.pdf

[34] Requia WJ, Koutrakis P. Mapping distance-decay of premature mortality attributable to $PM_{2.5}$-related traffic congestion. Environ Pollut. 2018 Dec;243(Pt A):9-16. doi: 10.1016/j.envpol.2018.08.056. Epub 2018 Aug 21. https://www.ncbi.nlm.nih.gov/pubmed/30170207

[35] Kulick ER, Wellenius GA, Boehme AK, Sacco RL, Elkind MS. Residential Proximity to Major Roadways and Risk of Incident Ischemic Stroke in NOMAS (The Northern Manhattan Study). Stroke. 2018 Apr;49(4):835-841. doi: 10.1161/STROKEAHA.117.019580. Epub 2018 Mar 14. https://www.ncbi.nlm.nih.gov/pubmed/29540609

[36] International Agency for Research on Cancer Working Group on the Evaluation of Carcinogenic Risk to Humans. Diesel and gasoline engine exhausts and some nitroarenes. 2012: Lyon, France. https://monographs.iarc.fr/wp-content/uploads/2018/06/mono105.pdf

[37] Oregon Department of Environmental Qaulity. 2015. The Concerns about Diesel Engine Exhaust https://www.oregon.gov/deq/FilterDocs/DieselEffectsReport.pdf

Air pollution and the economic and social burden of chronic diseases and adverse birth outcomes in Oregon

It is not possible to calculate the total cost of disease caused by air pollution because estimates of the fraction of disease attributable to air pollution are not available for all relevant health outcomes. Furthermore, risk factors for disease in Oregon may differ slightly from what is observed nationally. While we don't know what portion of these diseases is caused by air pollution in Oregon, the total social and economic burden of these diseases in our state is high.

Several national studies have estimated the portion of specific health outcomes that may be caused by exposure to air pollution. For example, a panel of health experts estimated that 10–35% of childhood asthma in the United States is caused by exposure to outdoor air pollution, at a cost of $728 million to $2.5 billion.[38,39] Similarly, information from epidemiological studies indicate that an estimated 3.2% of premature births in the United States can be attributed to air pollution, with estimated total costs of $5.1 billion.[40]

Some groups face a disproportionate burden of disease in Oregon

Oregon Health Authority data indicates that baseline health risks are elevated in several of the populations that are most vulnerable to climate change. People with low incomes, and racial and ethnic minority groups in Oregon experience disproportionately high rates of health outcomes that can be impacted by climate co-pollutants. While we know that exposure to pollution can increase risk of these health outcomes, it is important to note that we are not able to calculate the degree to which pollution contributes to increased rates of disease in specific groups.

[38] Landrigan, P. J., Schechter, C. B., Lipton, J. M., Fahs, M. C., & Schwartz, J. (2002). Environmental pollutants and disease in American children: estimates of morbidity, mortality, and costs for lead poisoning, asthma, cancer, and developmental disabilities. *Environmental Health Perspectives*, *110*(7), 721–728.

[39] Trasande, L., and Liu, Y. (2011). Reducing The Staggering Costs Of Environmental Disease In Children, Estimated At $76.6 Billion In 2008. Health Affairs 2011 30:5, 863-870

[40] Trasande, L., Malecha, P., & Attina, T. M. (2016). Particulate Matter Exposure and Preterm Birth: Estimates of U.S. Attributable Burden and Economic Costs. *Environmental Health Perspectives*, *124*(12), 1913–1918. http://doi.org/10.1289/ehp.1510810

Populations facing a disproportionate burden of disease in Oregon[41,42]

Health Outcomes	Populations facing a disproportionate burden
Heart disease	**Low-income people.** Adults with household incomes of less than $20,000 are two times as likely to report heart disease and nearly three times as likely to report having had a heart attack as adults with household incomes above $50,000. **African Americans, American Indians and Alaska Natives.** The prevalence of high blood pressure and heart attacks is higher among African American non-Latino and American Indians and Alaska Native non-Latino Oregonians than in other racial and ethnic groups in Oregon.
Stroke	**Low-income people.** Adults with household incomes of less than $20,000 are almost two times as likely to have had a stroke as adults with income greater than $50,000. **African Americans and American Indians and Alaska Natives**. African American non-Latino and American Indian and Alaska Native non-Latino Oregonians are almost twice as likely to have had a stroke as white non-Latino Oregonians.
Asthma	**African Americans and American Indians.** American Indian and African American people in Oregon experience higher rates of asthma in Oregon compared to all other groups. **Low-income people.** People living in households with an annual income of less than $20,000 report higher rates of asthma than Oregonians with higher household incomes.
Premature birth	**African Americans.** African American mothers are more likely to give birth to low birthweight babies than other mothers in Oregon[43]. This is consistent with national trends of higher rates of premature birth among African American mothers (March of Dimes, 2016).

Some people may be more susceptible to health effects of pollution.

Exposure to stress, violence, food insecurity, and other social factors may make some people more susceptible to the health effects of pollution. Chronic stress has clearly established physiological impacts that can aggravate the health effects of environmental exposures[44]. Several studies have

[41] Oregon Health Authority, Public Health Division, Health Promotion and Chronic Disease Prevention section. Chronic diseases among adults by race and ethnicity, Oregon 2010-2011. https://www.oregon.gov/oha/PH/DiseasesConditions/ChronicDisease/DataReports/Pages/index.aspx. Created August 11, 2014. Accessed 6/28/2018.

[42] Oregon Health Authority, Public Health Division. Oregon Behavioral Risk Factors Surveillance System, 2016. Unpublished data.

[43] Oregon Health Authority, Public Health Division, 2016. Medical and health characteristics of birth by race/ethnicity https://www.oregon.gov/oha/PH/BIRTHDEATHCERTIFICATES/VITALSTATISTICS/BIRTH/Documents/Outcomes/2014-2016/TOTALChar1416.pdf

[44] Cooney, C. M. (2011). Stress–Pollution Interactions: An Emerging Issue in Children's Health Research. *Environmental Health Perspectives*, *119*(10), a431–a435. http://doi.org/10.1289/ehp.119-a430

demonstrated that exposure to levels of air pollution that are too low to cause measurable health effects in the general population can increase health risks in people experiencing chronic stress[45,46]. For example, one study found that children exposed to air pollution were more likely to experience breathing problems if they also experienced a high level of stress at home[47].

Some groups are more likely to be exposed to air pollution

Low-income communities and communities of color are more likely to be exposed to air pollution because of where they live, work, and go to school. In Oregon, industrial facilities reporting air emissions are disproportionately located in racial and ethnic minority neighborhoods and low-income neighborhoods[48].

Several nationwide studies have also demonstrated that racial minorities and people with lower socioeconomic status are more likely to be exposed to high levels of air pollution[49,50]. For example, EPA researchers found that industrial facilities in the United States are disproportionately located in communities of color and communities experiencing poverty[51]. Similarly, nonwhite people are more likely to be exposed to levels of traffic-related pollution that exceed health-based guidelines.[52]

Disproportionate exposure to pollution has been documented in sensitive groups like pregnant women and children. Hispanic, African American and Asian/Pacific islander mothers in the United States are more likely to live in areas with high air pollution during pregnancy than white mothers.[53] In California, schools with higher levels of traffic pollution have been shown to also have more students of color and

[45] Clougherty, J. E., Levy, J. I., Kubzansky, L. D., Ryan, P. B., Suglia, S. F., Canner, M. J., & Wright, R. J. (2007). Synergistic Effects of Traffic-Related Air Pollution and Exposure to Violence on Urban Asthma Etiology. *Environmental Health Perspectives*, *115*(8), 1140–1146. http://doi.org/10.1289/ehp.9863

[46] Hicken, M. T., Dvonch, J. T., Schulz, A. J., Mentz, G., & Max, P. (2014). Fine particulate matter air pollution and blood pressure: The modifying role of psychosocial stress. *Environmental Research*, *133*, 195–203. http://doi.org/10.1016/j.envres.2014.06.001

[47] Islam, T., Urman, R., Gauderman, W. J., Milam, J., Lurmann, F., Shankardass, K., … McConnell, R. (2011). Parental Stress Increases the Detrimental Effect of Traffic Exposure on Children's Lung Function. *American Journal of Respiratory and Critical Care Medicine*, *184*(7), 822–827. http://doi.org/10.1164/rccm.201104-0720OC

[48] Neumann C.M., Forman D.L., Rothlein J.E. (1998). Hazard screening of chemical releases and environmental equity analysis of populations proximate to toxic release inventory facilities in Oregon. *Environ. Health Perspect.* 106:217–226. doi: 10.1289/ehp.98106217.

[49] Pratt, G. C., Vadali, M. L., Kvale, D. L., & Ellickson, K. M. (2015). Traffic, Air Pollution, Minority and Socio-Economic Status: Addressing Inequities in Exposure and Risk. *International Journal of Environmental Research and Public Health*, *12*(5), 5355–5372. http://doi.org/10.3390/ijerph120505355

[50] Bell, M. L., & Ebisu, K. (2012). Environmental Inequality in Exposures to Airborne Particulate Matter Components in the United States. *Environmental Health Perspectives*, *120*(12), 1699–1704. http://doi.org/10.1289/ehp.1205201

[51] Mikati I, Benson AF, Luben TJ, Sacks JD, Richmond-Bryant J. (2018). Disparities in Distribution of Particulate Matter Emission Sources by Race and Poverty Status. *Am J Public Health*. Apr;108(4):480-485. doi: 10.2105/AJPH.2017.304297.

[52] Clark, L. P., Millet, D. B., & Marshall, J. D. (2017). Changes in Transportation-Related Air Pollution Exposures by Race-Ethnicity and Socioeconomic Status: Outdoor Nitrogen Dioxide in the United States in 2000 and 2010. *Environmental Health Perspectives*, *125*(9), 097012. http://doi.org/10.1289/EHP959

[53] Woodruff, T. J., Parker, J. D., Kyle, A. D., & Schoendorf, K. C. (2003). Disparities in exposure to air pollution during pregnancy. *Environmental Health Perspectives*, *111*(7), 942–946.

low-income students. These same schools experience higher rates of asthma-related visits to the emergency room.[54]

Reducing exposure to climate co-pollutants can improve public health

"Natural experiments" in which sources of air pollution are removed allow researchers to study the effect of improved air quality on public health. For example, the temporary closure of a steel mill in Utah Valley, Utah was linked to temporary improvements in air quality and health. Rates of premature birth were significantly lower among women who were pregnant while the mill was closed than among women who were pregnant before or after the closure.[55] Children's hospital admissions for pneumonia, bronchitis and asthma were two to three times higher when the mill was opened than when it was closed.[56]

In several locations across the country, researchers have observed improvements in birth outcomes following the closure of coal fired power plants. In Pennsylvania, the risk of giving birth to low-birthweight babies decreased in communities near a coal-fired power plant after the plant was closed.[57] Similar trends have been seen in multiple communities in California, where coal-fired power plant closures were accompanied by reductions in premature birth rates.[58]

In Southern California, efforts to reduce traffic and industrial air pollution were accompanied by meaningful improvements in children's respiratory health. As air quality improved, the percent of children with decreased lung function was cut in half,[59] and children with asthma were 30% less likely to experience symptoms of bronchitis.[60]

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[54] Gaffron, P., & Niemeier, D. (2015). School Locations and Traffic Emissions — Environmental (In)Justice Findings Using a New Screening Method. *International Journal of Environmental Research and Public Health*, *12*(2), 2009–2025. http://doi.org/10.3390/ijerph120202009

[55] Parker JD, Mendola P, Woodruff TJ. Preterm birth after the Utah Valley Steel Mill closure: a natural experiment. Epidemiology. 2008 Nov;19(6):820-3. doi: 10.1097/EDE.0b013e3181883d5d.

[56] Pope CA 3rd.Respiratory disease associated with community air pollution and a steel mill, Utah Valley. Am J Public Health. 1989 May;79(5):623-8.

[57] Muzhe Yang, Shin-Yi Chou. The Impact of Environmental Regulation on Fetal Health: Evidence from the Shutdown of a Coal-Fired Power Plant Located Upwind of New Jersey. *Journal of Environmental Economics and Management*, 2017; DOI: 10.1016/j.jeem.2017.11.005

[58] Joan A Casey, Deborah Karasek, Elizabeth L Ogburn, Dana E Goin, Kristina Dang, Paula A Braveman, Rachel Morello-Frosch; Coal and oil power plant retirements in California associated with reduced preterm birth among populations nearby, *American Journal of Epidemiology*, https://doi.org/10.1093/aje/kwy110

[59] Gauderman WJ, Urman R, Avol E, Berhane K, McConnell R, Rappaport E, Chang R, Lurmann F, Gilliland F. Association of improved air quality with lung development in children. N Engl J Med. 2015 Mar 5;372(10):905-13. doi: 10.1056/NEJMoa1414123

[60] Berhane K, Chang CC, McConnell R, Gauderman WJ, Avol E, Rapapport E, Urman R, Lurmann F, Gilliland F. Association of Changes in Air Quality With Bronchitic Symptoms in Children in California, 1993-2012. JAMA. 2016 Apr 12;315(14):1491-501. doi: 10.1001/jama.2016.3444.

3. What are the effective public health interventions for building resilience within communities most impacted by climate change?

Summary

Public Health Interventions

- Policies
  - Proactive Environmental Health Policies
  - Health Impact Assessments (HIAs)
  - Community Partner Compensation
  - Statewide Climate Policy
- Systems
  - Environmental Public Health Infrastructure
  - Early Warning Systems
  - Public Education and Engagement
  - Adaptive Management
- Environments
  - Healthy Homes
  - Safe Schools
  - Connected Communities

Public Health Interventions

The most effective public health interventions are those that benefit communities most impacted by climate change. This does not need to be limited to a geographical or spatial approach and will be best informed by the communities that investments aim to serve.[61] Vulnerability assessments can help to characterize populations most at risk; however, meaningful community engagement can help to ensure that climate adaptations and public health interventions are successful.[62][63]

Even with climate projections pointing to increasing natural disasters and environmental health hazards in Oregon, many health effects of climate change can be avoided through enacting changes in (1) policies, (2) systems, and (3) environments.[64] The following public health interventions are organized by these three categories of public health action.

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[61] Zapata, Liu, and Harris. 2017. Findings Brief for Equity Considerations for Greenhouse Gas Emissions Cap and Trade Legislation in Oregon. Study commissioned by: Coalition of Communities of Color, Oregon Environmental Council, and Portland State University Institute for Sustainable Solutions. Available at: https://www.oregonlegislature.gov/helm/workgroup_materials/WG%204%20-%20Marisa%20A.%20Zapata%20Findings%20Brief.pdf

[62] Cyril S, Smith B, Possamai-Inesedy A, Renzaho A. 2015. Exploring the role of community engagement in improving the health of disadvantaged populations: a systematic review. Journal of Global Health Action. Available at: https://www.tandfonline.com/doi/abs/10.3402/gha.v8.29842

[63] Ebi K, Semenza J. 2008. Community-Based Adaptation to the Health Impacts of Climate Change. American Journal of Preventive Medicine. Available at: https://www.sciencedirect.com/science/article/pii/S0749379708006843

[64] USGCRP, 2016: The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. Crimmins, A., J. Balbus, J.L. Gamble, C.B. Beard, J.E. Bell, D. Dodgen, R.J. Eisen, N. Fann, M.D. Hawkins, S.C. Herring, L. Jantarasami, D.M. Mills, S. Saha, M.C. Sarofim, J. Trtanj, and L. Ziska, Eds. U.S. Global Change Research Program, Washington, DC, 312 pp. http://dx.doi.org/10.7930/J0R49NQX

1. Policies

- **Proactive Environmental Health Policies –** Environmental health policies including those related to safe drinking water and clean air, can be identified and implemented in a way that considers future climate risks and adaptations that may need to occur. Rather than waiting for a public health emergency to act, jurisdictions have used climate and health data, stakeholder expertise and lessons learned from other states to make informed policy changes that protect health.

- **Health Impact Assessments** - When decision-makers are able to incorporate the analysis of health benefits and burdens associated with proposed policies they can make a more informed decision that optimizes overall impacts of the policy. Some existing public health tools for this kind of alignment include health impact assessments (HIAs), health analysis incorporation or consultations, inclusion of public health experts on advisory groups and work groups and developing inter-agency agreements between public health departments and partner agencies to inform policies and programs. For example, considering health benefits of alternative transportation investments can help prioritize actions that achieve transportation goals while advancing public health.[65]

- **Community Partner Compensation -** Covering the cost of community-based organizations and diverse community leaders to serve on project teams and advisory committees that shape public policy (such as through honorariums or writing into budgets as technical service providers) can help to ensure meaningful engagement among groups who otherwise would have to participate in a volunteer capacity. For example, the Oregon Health Authority is providing mini-grants to non-profit agencies to solicit feedback from communities most impacted by health disparities to inform the 2020 Oregon State Health Improvement Plan.[66] Community participation in our government planning and policy-making that reflects the diversity of the communities served, can lead to innovative, cost-effective solutions,[67] especially when government programs have the support to explore alternative approaches proposed by community partners.

- **Statewide Climate Policies** – Statewide climate policies have helped states link and align across agencies and scales of government, creating the opportunities for efficiencies and innovations in climate adaptation and mitigation strategies. Establishing statewide plans, systems and

[65] Health and Transportation: Making the Connection. 2016 Status Report. Oregon Department of Transportation and Oregon Health Authority Public Health Division. Available at: https://www.oregon.gov/ODOT/Programs/TDD%20Documents/Health-and-Transportation-2016-Status-Report.pdf

[66] https://www.oregon.gov/oha/PH/ABOUT/Documents/ship/mini-grant.pdf

[67] Cyril S, Smith B, Possamai-Inesedy A, Renzaho A. 2015. Exploring the role of community engagement in improving the health of disadvantaged populations: a systematic review. Journal of Global Health Action. Available at: https://www.tandfonline.com/doi/abs/10.3402/gha.v8.29842

mechanisms for improved coordination among government agencies and with community partners has been shown to increase the impact of public investments.[6869]

2. Systems

- **Environmental Public Health Infrastructure** - People live "downstream" from a range of environmental factors that affect health. Individuals generally have limited capacity to assess and take action to address "upstream" environmental factors. Environmental public health workers have an important role to play, in conjunction with partner environmental agencies, in assessing and supporting actions to address environmental public health threats. In 2015 the Oregon legislature directed OHA to assess state and local health department capacity related to environmental health. The assessment found over 95% of Oregon's Public Health Departments had minimal-to-partial ability to identify and address environmental health hazards in their jurisdiction.[70]

A federal funding opportunity allowed OHA to offer mini-grants to five local county health departments in Oregon in 2017. The resulting actions (see Box 2: *OHA Climate and Health Mini Grants to Local Health Jurisdictions*) illustrate how investments in environmental public health infrastructure can increase a local public health department's capacity to address climate change.[71] Such environmental public health infrastructure is key to implementing public health interventions to build resilience within communities most impacted by climate change.

Box 2: OHA Climate and Health Mini Grants to Local Health Jurisdictions

OHA's Climate and Health Program prioritized a set of state and local strategies in the 2017 Climate and Health Resilience Plan. The program awarded small grants to five local health jurisdictions (LHJs) to begin engaging in local climate and health work. The collaborative of LHJs serves as a model for how Oregon can plan and implement locally-relevant climate interventions designed to protect health[76]. For example, the North Central Health District provided well water quality testing for 50 residents in drought-prone areas. Another mini-grant enabled Crook County Health Department to participate in air quality interventions and pilot a community workshop series. An umbrella contract between the Oregon Health Authority Public Health Division and all 33 LHJs across the state helps to facilitate timely dispersal of funds for local public health projects, when funds are available.

[68] Howes M et al. 2013. Towards networked governance: improving interagency communication and collaboration for disaster risk management and climate change adaptation in Australia.
[69] Wang H, Horton R, 2015. Tackling climate change: the greatest opportunity for global health. The Lancet.
[70] Oregon Public Health Advisory Board. 2016. State of Oregon: Public Health Modernization Assessment Report. Available at: www.oregon.gov/oha/ph/About/TaskForce/Documents/PHModernizationReportwithAppendices.pdf
[71] Grossman, Elena, MPH; Hathaway, Michelle, MPH; Bush, Kathleen F., PhD; Cahillane, Matthew, MPH; English, Dorette Q., MA; Holmes, Tisha, PhD; Moran, Colleen E., MPH, MS; Uejio, Christopher K., PhD; York, Emily A., MPH; Dorevitch, Samuel, MD, MPH. 2018. Minigrants to Local Health Departmetns: An Opportunity to Promote Climate Change Preparedness. Journal of Public Health Management and Practice. doi: 10.1097/PHH.0000000000000826

- **Early Warning Systems** – National, state, and local jurisdictions have developed tools that combine public health surveillance, meteorological forecasting, public alert systems, and response protocols to more effectively prepare for and respond to an array of projected climate risks. Statewide monitoring systems for climate-related hazards and their associated health risks have been developed for surveillance of harmful algal blooms, disease-carrying vectors, contaminated waters, air pollution, occupational health risks, etc. Outbreak investigations have incorporated increased analysis of environmental and climate factors; the data collected through investigations has been subsequently analyzed to identify necessary climate adaptations. Improved early warning systems, however, will not be effective in reaching our most vulnerable populations without targeted, long-term investments in building partnerships with community organizations and local, culturally-specific media who often serve as the most trusted channels for reaching vulnerable populations.[72]

- **Public Education and Citizen Engagement -** Oregon has successful projects such as the Oregon Smoke Blog[73] and the OSU PREP project[74] that employ community engagement and 'citizen science' tools to allow community members to collect, report and read data about timely issues, concerns, and solutions in their communities. Investments that support information sharing and community capacity building among vulnerable populations can lead to innovative and effective solutions.[75] Community-level initiatives and community-driven dialogs have been shaped around a range of topics including: environmental improvements, culturally-specific preparedness planning, civic engagement and leadership trainings. Community-led projects to build climate resilience can be piloted in partnership with public health practitioners and researchers through a community-based participatory research (CBPR) model[76] to evaluate effectiveness and contribute to the climate and health evidence base.

- **Adaptive Management** - The natural resource sector regularly practices adaptive management to solve dynamic problems that have a high degree of uncertainty using real-time evaluation of alternative approaches. Adaptive management involves a structured, iterative process of decision making in the face of uncertainty, with an aim to reduce uncertainty over time through monitoring and learning. Implementing this kind of management approach in public health

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[72] Grossman, Elena et al. 2018. Minigrants to Local Health Departments: An Opportunity to Promote Climate Change Preparedness. Journal of Public Health Management and Practice
Lejano R et al. 2018. Weather, Climate, and Narrative: A Relational Model for Democratizing Risk Communication. Journal of the American Meteorological Society.

[73] http://oregonsmoke.blogspot.com/

[74] https://citizen.science.oregonstate.edu/

[75] Decorby-Watson K et al. 2018. Effectiveness of Capacity Building Interventions Relevant to Public Health Practice: A Systematic Review. BMC Public Health. Available at: https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-018-5591-6

[76] Israel B et al. 2010. Community-Based Participatory Research: A Capacity-Building Approach for Policy Advocacy Aimed at Eliminating Health Disparities. American Journal of Public Health. Available at: https://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2009.170506

practice can improve the climate resilience of public health systems[77] and institutional ability to address emerging risks. To effectively implement adaptive management and respond to the changing needs of communities served, public health systems need capacity for nimble intervention.

3. Environments

- **Healthy Homes -** The intentional pairing of energy efficiency and weatherization improvements with healthy home protections (ventilation, wood stove replacements, air conditioners, air filters, radon mitigation, cool roofs, etc.) is a key alignment opportunity that has the potential to achieve both climate mitigation and adaptation goals.[78] In addition to weatherization, targeted investments in low-income communities and communities of color could also include healthy homes improvements and guidance to households about actions they can take to decrease exposure to a range of environmental hazards.

- **Safe Schools -** Communities across Oregon have public school facilities that lack the necessary protections to keep children safe from climate hazards. Effective interventions for schools include retrofitting with appropriate air conditioning, air filtration, and other measures that both protect children in schools[79] and enable school facilities to serve as community "safe spaces" during the extreme weather events projected to increase over the next few decades.[80]

- **Connected Communities -** When communities are more connected, they have greater potential to thrive and adapt, and this connectedness is often facilitated by good community design.[81] For example, providing sidewalks and crosswalks in urban areas and walking/biking trails in rural areas give people - especially children and the elderly - safe routes to services, reduced pollution, and active transportation, all of which benefit health outcomes. These and other changes in the built environment can increase or decrease a community's quality of life, economic prosperity, ability to gather safely, breath clean air, access healthy food, and more. Transportation and land use policy can support community connectedness and health, especially when designed to facilitate active transportation.[82]

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[77] Hess J, McDowell J, Luber G. 2012. Integrating climate change adaptation into public health practice: using adaptive management to increase adaptive capacity and build resilience. Journal of Environmental Health Perspectives. Available at: https://www.ncbi.nlm.nih.gov/pubmed/21997387

[78] Kuholski K, Tohn E, Morely R. 2010. Healthy Energy-Efficient Housing: Using a One-Touch Approach to Maximize Public Health, Energy, and Housing Programs and Policies. Journal of Public Health Management and Practice. Available at: https://journals.lww.com/jphmp/Fulltext/2010/09001/Healthy_Energy_Efficient_Housing___Using_a.11.aspx

[79] Disaster Preparedness Advisory Council, Committee on Pediatric Emergency Medicine. 2015. Ensuring the Health of Children in Disasters.

[80] Wang J et al. 2016. Study on the context of school-based disaster management. International Journal of Diaster Risk Reduction.

[81] Marshall W, Piatkowski D, Garrick N. 2014. Community Design, Street Networks, and Public Health. Journal of Transport & Health. Available at: https://www.sciencedirect.com/science/article/pii/S2214140514000486

[82] Mueller N et. al. 2015. Health impact assessment of active transportation: A systematic review. Journal of Preventive Medicine. Available at: https://www.sciencedirect.com/science/article/pii/S0091743515001164

4. What climate adaptation and mitigation strategies yield the most health co-benefits?

Summary:

Climate and Health Co-Benefits
- Cleaner Air
- Physical Activity
- Improved Nutrition

Climate Mitigation and Adaptation
- Reduce Green House Gas (GHG) Emissions
- Healthy Community Design
  - Active Transportation
  - Green Infrastructure
  - Healthy Homes
  - Safe Schools
- Sustainable Food Systems

Climate and Health Co-Benefits

In Oregon and the rest of the United States, most of the primary causes of poor health and premature death are chronic diseases. Many climate mitigation, sequestration, and adaptation strategies can help to improve public health by preventing and reducing the burden of chronic diseases[83]. Today, more than half of Oregon adults live with one or more chronic diseases.[84] Chronic diseases are long-term conditions that reduce people's quality of life;they can be managed but rarely have a cure. Behaviors such as tobacco use, poor diet, and lack of physical activity are primary risk factors for many chronic diseases. Creating environments that help people engage in healthy behaviors such as eating better, moving more, and breathing clean air is crucial to preventing chronic diseases, managing existing chronic conditions, and improving the day-to-day experience of people living with chronic disease.

Cleaner Air - Air pollution's contributions to chronic disease burden have been discussed above in Section 2. The U.S. Government Accountability Office (GAO) recently published a report warning of health-related costs of climate change. The GAO estimated that by 2050, air quality improvements associated with reducing greenhouse gas emissions would avoid an estimated $160 billion dollars annually in health costs.[85] Global average co-benefits of avoided mortality have been valued between

[83] Watts N et al. 2018. The Lancet Countdown on health and climate change: from 25 years of inaction to a global transformation for public health. Available at: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(17)32464-9/fulltext

[84] Oregon Health Authority Public Health Division. 2016. Chronic diseases among adults. Available at: https://www.oregon.gov/oha/PH/DISEASESCONDITIONS/CHRONICDISEASE/DATAREPORTS/Documents/datatables/ORAnnualBRFSS_diseases.pdf

[85] U.S. Government Accountability Office. 2017. Climate Change: Information on Potential Economic Effects Could Help Guide Federal Efforts to Reduce Fiscal Exposure. Available at: https://www.gao.gov/assets/690/687466.pdf

$50–380 per ton of carbon dioxide[86]. These kinds of analyses illustrate how potential health co-benefits of climate mitigation investments made now, could counterbalance the health costs of projected climate hazards in the decades to come.

Physical Activity – Physical inactivity is one of the primary contributors to chronic diseases, including heart disease, stroke, diabetes, obesity, cancer, arthritis, depression, and others. While many factors contribute to whether a person gets regular physical activity, research has demonstrated that when people have access to safe and convenient opportunities for walking and biking, they are more likely to be physically active.[87] Climate strategies that reduce automobile use by promoting active transportation, such as improving sidewalks, transit service, and bicycle infrastructure, make it easier for people to be active and can increase rates of physical activity enough to produce measurable changes in health.

In 2014, OHA's Climate Smart Strategy Health Impact Assessment assessed the extent to which the Metro Regional Government's proposed Climate Smart Strategies (aimed at reducing per capita vehicle miles traveled in the region) would increase physical activity, reduce exposures to air pollutants, and prevent traffic collisions. The results showed that by 2035 Metro's approach would avoid 126 premature deaths. By reducing chronic diseases and traffic-related injuries and fatalities, the study estimated that Metro's proposed climate strategy would reduce health care spending by more than $100 million each year[88], with the majority of savings attributed to the projected increase in physical activity.

Improved Nutrition – A safe and nutritious food supply is a vital component of food security. The impacts of climate change on food production, prices and trade for the United States and globally have been widely examined, including in the recent report "Climate Change, Global Food Security, and the U.S. Food System.[89]" An overall finding of that report was that climate change is very likely to affect global, regional, and local food security by disrupting food availability, decreasing access to food, and making utilization more difficult. Poor nutrition contributes to chronic diseases, including heart disease, stroke, diabetes, obesity, cancer, arthritis, depression, and others. Many factors can influence a person's nutrition intake, including the availability and accessibility of nutritious foods.

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[86] West, JJ, Smith, SJ, Silva, RA et al. Co-benefits of mitigating global greenhouse gas emissions for future air quality and human health. *Nat Clim Chang*. 2013; 3: 885–889

[87] Community Preventative Services Task Force (2016) "Physical Activity: Built Environment Approaches Combining Transportation System Interventions with Land Use and Environmental Design" available on-line at: https://www.thecommunityguide.org/sites/default/files/assets/PA-Built-Environments.pdf.

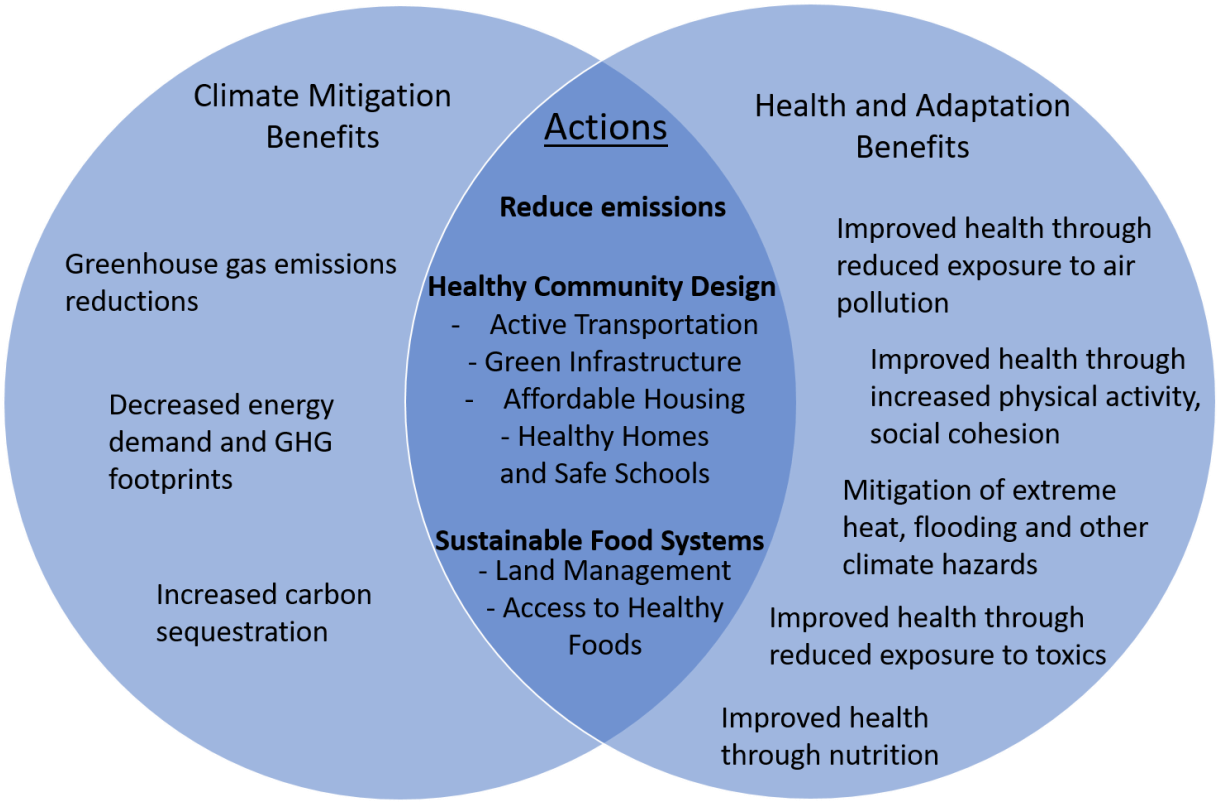
[88] OHA Climate HIAs Available at: https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/TRACKINGASSESSMENT/HEALTHIMPACTASSESSMENT/Pages/CSCHIA.aspx

[89] Brown, M.E., et all, 2015: Climate Change, Global Food Security and the U.S. Food System. U.S. Global Change Research Program.

Climate strategies that increase the sustainability of Oregon's food systems and improve access and affordability of healthy food in low-income communities can have population-wide benefits[90] and are discussed more in sections below.

Climate Mitigation and Adaptation

In earlier times, climate-related work often identified climate mitigation and climate adaptation as completely different sets of strategies (mitigating climate change by reducing emissions to slow global warming versus adapting to climate change impacts). However, the field is now recognizing several areas of investment that advance both mitigation and adaptation benefits.[91] The discussion below describes three main strategy areas and how these strategies contribute to both climate mitigation and adaptation, while also providing public health benefits.



Reduce Emissions - Strategies that reduce GHG emissions will increase population health by decreasing exposure to co-pollutants (e.g., particulate matter, ozone). Any strategy that improves air quality can be considered a climate adaptation strategy because it decreases baseline exposures and therefore a population's sensitivity to the array of climate effects that threaten health (e.g., excessive heat, vector-

[90] Oregon Food Bank and Spencer Masterson, 2013. The State of our community food system: A summary of community food assessments in rural Oregon.

[91] Shaw A. et al. 2014. Accelerating the Sustainability Transition: Exploring synergies between adaptation and mitigation in British Columbian communities.

borne diseases). A healthier community also has more capacity to adapt to climate-related hardships.[92] In Oregon, transportation continues to be Oregon's largest in-state contributor to GHG emissions (accounting for 36% of total emissions in 2015). A relatively smaller proportion of GHG emissions are from large industrial sources (6% of total GHG emissions). Reducing GHG emissions in the transportation sector, and their associated co-pollutants, are likely to be an important source of public health benefits.

Healthy Community Design – In a well-designed community, homes, parks, stores, and schools are connected by safe walking, biking, and transit routes. Such routes allow all members of the community a chance to enjoy the outdoors and get physical and mental health benefits[93]. Below are three areas of community design that result in considerable public health benefits as evidenced in the literature, while also helping to achieve climate mitigation goals.

- **Active Transportation** investments and initiatives, such as bikeways, cross-walks, safe routes to school, rails-to-trails projects, transit service, and transit-oriented development, have been shown to increase physical activity, reduce air pollution, and increase access to community amenities and services. Connected communities have reduced driving times, safer streets, places to gather, more food options, and other amenities that enable people to more easily make healthy lifestyle choices.

- **Green Infrastructure** including tree canopies, bio-swales, parks, trails and natural areas can improve air quality, provide cooling during extreme heat, serve as flood protection, increase social cohesion and physical activity, and decrease neighborhood crime.[94] Green infrastructure can be a large determinant in how a place is valued and whether people spend time outdoors. A growing body of evidence points to the public health benefits of being outdoors, including healthier birth weights, reduced risk of obesity, and academic performance among children. In addition to all these health and adaptation benefits, green infrastructure also has the capacity to sequester carbon dioxide.

- **Affordable Housing** was identified as the most pressing issue related to the social determinants of health in Oregon's most recent State Health Assessment[95]. Public health departments can work with housing partners to develop and enforce housing guidelines

[92] Experts estimate that pollution accounts for up to 30% of asthma attacks in the US (Zheng X, 2015) and heart disease is the second leading cause of death in Oregon, costing Oregonians an estimated $3.6 billion each year (CDC Chronic Disease Cost Calculator). Emerging research also indicates that exposure to air pollution during fetal development may increase risk of still birth (Siddika N, 2016) and premature birth (Sun X, 2015). There is also evidence that children exposed to air pollution in early life are more likely to have decreased lung function and asthma later in life (Clifford A, 2016).
[93] https://www.cdc.gov/healthyplaces/healthtopics/parks.htm
[94] As an example, a recent study by PSU researchers found that NO2 reduction associated with trees in Portland could result in significantly fewer incidences of respiratory problems, providing a $7 million USD benefit annually (Rao M, 2014).
[95] Oregon Health Authority Public Health Division. 2017 State Health Assessment: https://www.oregon.gov/oha/PH/ABOUT/Pages/HealthStatusIndicators.aspx

and codes and to promote healthy, affordable housing solutions[96,97]. People experiencing homelessness or unstable housing are more vulnerable to climate hazards and stressors. When affordable housing is located in neighborhoods with active transportation choices, and access to services, goods, and amenities, residents are likely to exercise more, eat better, and live healthy lives[98]. Well-designed affordable housing can reduce vehicle miles traveled.

- **Healthy Homes & Safe Schools –** Taking a coordinated approach to improving buildings where people live and learn can result in increased energy efficiencies, a reduction of environmental health exposures, and increased climate resilience. Energy efficient improvements can reduce chronic diseases associated with exposures to indoor air pollution, extreme heat and cold, and allergies associated with pests and mold. Installing appropriate ventilation, air conditioners, air filtration and radon mitigation systems at the same time as weatherization improvements can improve health and protect occupants from climate hazards.

Sustainable Food Systems A sustainable food system is one that provides healthy food to meet current needs while maintaining healthy ecosystems that can also provide food for generations to come. Sustainable food systems help protect farmers and farmworkers, consumers and communities from environmental and other health risks.[99] These systems can reduce greenhouse gas emissions from farming, while also providing public health benefits.[100] Examples include healthy soil practices that store carbon and improve water and nutrient retention and minimizing the use of chemical fertilizers to decrease health risks of water pollution and chemical exposures.

Krieger J, Higgins D. 2002. Housing and Health: Time Again for Public Health Action. American Journal of Public Health. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1447157/

[97] Kottke T, Abariotes A, Spoonheim J. 2017. Access to Affordable Housing Promotes Health and Well-Being and Reduces Hospital Visits. The Permanente Journal. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5737920/

[98] Dannenberg, A., et al (2011). Making Healthy Places: Designing and Building for Health, Well-Being, and Sustainability. Island Press, Washington DC.

[99] https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2014/07/29/12/34/toward-a-healthy-sustainable-food-system

[100] http://www.who.int/nutrition/events/2016_side-event_healthandclimate_8jul/en/

5. What Oregon-specific studies inform questions related to climate and health? Please summarize and provide a current analysis.

Summary

Regional	US Global Change Research Group - NCA4: NW Regional Chapter
Statewide	Oregon Climate Change Research Institute - 2017 Oregon Climate Assessment Report Oregon Health Authority - Oregon Climate and Health Profile Report - Oregon Climate and Health Resilience Plan - Climate Smart Scenarios Health Impact Assessments - Local Climate and Health Adaptation Plans - Oregon Climate and Health Program Annual Report
Local	Partners of Most Impacted Populations - Equity study commissioned by: Coalition of Communities of color, Oregon Environmental council, and Portland State University Institute for Sustainable Solutions) - Cross Cultural Climate Justice Leaders - Portland African American Leadership Forum (PAALF) People's Plan: Environmental Justice

Overview

Over the past decade, studies at the regional, statewide, and local level have qualitatively characterized implications for health care and public health systems, impacts to vulnerable populations, and the importance of community engagement to inform priorities. A notable gap is the lack of economic analyses, both at the level of Oregon and nationally, of health benefits and burdens due to climate change, including the costs of inaction. Policy makers seeking to optimize climate decisions would benefit from improved economic valuation of health benefits and burdens associated with climate impacts, mitigation, and adaptation.

2018 National Climate Assessment, Northwest Chapter (forthcoming)

Summary: The National Climate Assessment is a quadrennial assessment mandated by the US Global Change Research Act of 1990. The assessment is produced under the leadership of the US Global Change Research Program (USGCRP) comprised of 13 Federal agencies. The fourth National Climate Assessment on Climate Change (NCA4 Vol. II) is scheduled to be published at the end of 2018 and includes a chapter on climate change impacts, risks and adaptation in the Pacific Northwest (Oregon, Washington and Idaho). A draft of the chapter was released for public comment in early 2018, providing a preview of the latest climate research in our region.

Analysis: A key message in the draft chapter focuses on the health impacts of climate change in the Northwest. This section warns of a lack of surge capacity in our regional social and healthcare systems to expand quickly beyond normal service levels if cascading climate hazards occur. Noting existing data on food insecurity, homelessness, and mental health in Oregon, the report emphasizes that the Northwest's collective safety net is already stretched thin with current demands and will be further challenged by climate stressors. The chapter provides examples of how climate change will exacerbate existing health disparities, the likelihood of acute hazard events, and disruptions in local economies and food systems that could result in more chronic disease risks. It also points to the potential health co-benefits of future climate mitigation investments that could help to counterbalance these risks.

2017 Oregon Climate Assessment

Summary: The Oregon State Legislature established the Oregon Climate Change Research Institute (OCCRI) in 2007. OCCRI is a network of over 150 researchers at Oregon State University (OSU), the University of Oregon, Portland State University, Southern Oregon University, and affiliated federal and state labs. Per its legislation, OCCRI is tasked with periodically assessing the state of climate science and climate research in Oregon. The most recent report, the Third Oregon Climate Assessment, was published in January 2017.

Analysis: The seventh chapter of the 2017 Oregon Climate Assessment focuses on 'Human Health'. This chapter assesses how climate change threatens the health of Oregonians, noting that the projected increase in heat waves are expected to increase heat-related illness and death. Poor air quality due to an increased frequency of wildfires is projected to increase respiratory illnesses. Warmer temperatures and extreme precipitation are also expected to increase the risk of exposure to some vector- and waterborne diseases. The report acknowledges that access to sufficient, safe, and nutritious food may be jeopardized by climate change. It also states that extreme climate or weather events can lead to adverse, and sometimes lasting, mental health outcomes. The elderly, the young, the poor, pregnant women, persons with chronic medical conditions, persons with disabilities, outdoor workers, immigrants and limited English proficiency groups, and Indigenous peoples were identified as populations that will be disproportionately affected by climate-related health impacts.

2014 Oregon Climate and Health Profile Report

Summary: This 2014 report produced by the Oregon Health Authority Public Health Division provides a full analysis of health risks and vulnerabilities associated with Oregon's projected climate impacts. The report was made possible through a cooperative agreement with the US Centers of Disease Control and Prevention (CDC)'s Climate-Ready States and Cities Initiative.

Analysis: The report summarizes observed climate impacts and climate projections and outlines the various causal pathways by which Oregonians' health and safety are at risk. The report emphasizes that climate change threatens our access to clean air, clean water, and healthy food and that changes in the climate have already begun to affect health in Oregon. A large section of the report focuses on vulnerable populations, highlighting that health risks are higher among certain groups. Vulnerability analysis is divided into three types of vulnerability; demographic vulnerability, geographic vulnerability, and occupational vulnerability. Communities of color and low-income households are identified as

already bearing a disproportionate burden of disease and an increased risk of exposure to climate hazards in Oregon.

2017 Oregon Climate and Health Resilience Plan

Summary: The 2017 Oregon Climate and Health Resilience Plan outlines a set of recommendations for Oregon's Public Health System to build resilience to the health risks of climate change. The strategies recommended in the plan represent the findings and collaboration of numerous local, state, and national partners. The plan was made possible through a cooperative agreement with the US Centers of Disease Control and Prevention (CDC)'s Climate-Ready States and Cities Initiative.

Analysis: The plan provides an overview of how climate change threatens to increase existing health disparities and affect access to clean air, clean water, and healthy food. It takes an "all hazards" approach, prioritizing 16 overarching strategies that emphasize changes in policies, systems and environments. Each strategy has specific actions that state and local health authorities can implement within a five-year period (2017-2021) using foundational public health capabilities. It includes links to video case studies featuring local public health action already underway in Oregon.

OHA Climate Smart Scenarios Health Impact Assessments

Summary: Between 2011 and 2014, the Oregon Health Authority Public Health Division conducted a series of three health impact assessments (HIAs) on a series of decisions within Metro's Climate Smart Communities (CSS) planning project. The HIAs were requested by Metro to ensure that Metro decision-makers had access to public health evidence and best practices as they shaped and approved a greenhouse gas reduction plan for light duty vehicles in the Portland metropolitan region. The Health Impact Assessments were made possible through a cooperative agreement with the Centers for Disease Control and Prevention (CDC)'s Healthy Community Design Initiative and grants from the Robert Wood Johnson Foundation and the Pew Charitable Trust.

Analysis: Using in-depth literature reviews, expert analysis, and risk assessment-based modeling tools, the HIAs found that the scenarios under consideration during the CSS planning process could impact health by influencing physical activity levels, road safety for all users, and exposure to transportation-related air pollutants. The Climate Smart Strategy adopted by Metro Council could reduce chronic diseases like heart disease, stroke, and diabetes 2-4%. The Portland metro region currently spends $1.2 billion each year on heart disease alone; tax-funded programs like Medicaid and Medicare pay for 35% percent of that total. By reducing cancer, chronic diseases, and traffic-related injuries and fatalities, the adopted Strategy could reduce health care spending by more than $100 million each year. The HIAs also found that some members of the community bear more than their share of the costs for transportation and land use policies and investments. For example, people who bike and walk are exposed to greater risks on our region's roads leading to higher rates of injury and death; and people who live and work near high volumes roads are exposed to higher levels of air pollution, leading to higher rates of asthma, heart disease, and stroke.

Local climate and health adaptation plans

Summary: In 2011, five local health jurisdictions (LHJs) were awarded mini-grants (made possible through a cooperative agreement with the US Centers of Disease Control and Prevention (CDC)'s Climate-Ready States and Cities Initiative) to develop local climate and health adaptation plans; Benton County Health Department, Crook County Health Department, Jackson County Health Department, Multnomah County Health Department, and North Central Health District (Wasco, Gilliam, and Sherman Counties). Each LHJ led a stakeholder engagement process to assess risks and prioritize actions in their local jurisdiction. The full plans, along with 2-page summaries, can be found on the Oregon Climate and Health Program webpage.

Analysis: The local climate and health adaptation plans identified different priorities based on their local climate hazards and health risks. Collectively, they identified statewide risks to human health to include morbidity and mortality related to extreme weather events, water and vector-borne diseases, respiratory diseases, food security, and mental health. Examples of strategies include increased surveillance and monitoring and increased risk communications. Lessons learned have been compiled into a "local climate and health resilience planning" toolkit. LHJs have begun to implement strategies in their plans.

Oregon Climate and Health Program Annual Report

Summary: The Oregon Climate and Health Program, housed in the Environmental Public Health Section of the Oregon Health Authority Public Health Division, produces annual program progress reports and publishes the summaries online. The progress report summaries provide an update on implementation of the strategies prioritized in the Oregon Climate and Health Resilience Plan and local climate and health adaptation plans.

Analysis: In year one, 48% of the Climate and Health Resilience Plan strategies had begun to be implemented. Over 105 partnerships were built of strengthened through the collective climate work led by state and local health departments. The summary also reports on changes in policies and systems that have been implemented in the last year. The annual progress reports illustrate the commitment of Oregon's public health system to protect public health from climate change risks.

Oregon Climate and Health Vulnerability Assessment

Summary: In 2015 OHA produced the first phase of a Social Vulnerability Assessment[101] which included a set of maps highlighting social vulnerability indicators to inform climate resilience planning in Oregon. This initial set of maps include a composite score of social vulnerability that combines 11 measures drawn from US Census data and health statistics from the Oregon Health Authority (listed on page 6). The assessment was made possible through a cooperative agreement with the US Centers of Disease Control and Prevention (CDC)'s Climate-Ready States and Cities Initiative.

Analysis: Census tracts with higher social vulnerability are distributed in many parts of the state, and largely overlap with broad indicators of socioeconomic status such as educational attainment. This

[101] Haggerty B. Oregon Climate and Health Vulnerability Assessment. Oregon Health Authority. September 2015: Portland, OR.

index could be further expanded to encompass additional measures of climate exposures (such as extreme heat) and measures of adaptive capacity (such as access to air conditioning) to more accurately identify communities in the state that are most vulnerable to climate impacts.

Findings Brief for Equity Considerations for Greenhouse Gas Emissions Cap and Trade Legislation in Oregon

Summary: This 2017 study was commissioned by the Coalition of Communities of Color, Oregon Environmental Council, and Portland State University Institute for Sustainable Solutions. The research investigated equity concerns related to possible cap-and-trade legislation in Oregon, examining communities most vulnerable to climate change impacts and greenhouse gas co-pollutants. The research group took a spatial analysis approach using 7 indicators of vulnerability at the US Census tract level.

Analysis: The top 50% of Census tracts identified as most vulnerable to climate change is similar (but not identical) to the census tracts identified as most vulnerable in the 2015 Climate and Health Vulnerability Assessment. Both assessments draw on social determinants of health and emphasize the role of demographic factors in shaping people's life outcomes, particularly the role of race and income. The study group recommended additional work with community groups to ensure that any climate investments support the needs of the most vulnerable communities to climate change.

Tyee Khunamokwst "Leading Together": Cross Cultural Climate Justice Leaders

Summary: The Native American Youth & Family Center, OPAL Environmental Justice Oregon Coalition of Communities of Color (CCC) and six other CCC member organizations created this 2016 Climate Justice Action Plan[102] for communities of color in the Portland-Metro region. The plan prioritizes specific policy areas with measurable objectives. The planning process was designed using the Relational Worldview Model approach overlaid with a Trauma-Informed Collaborative Model. The plan was made possible through a grant from the Kresge Foundation.

Analysis: The strategies prioritized in this collaborative Climate Justice Action Plan are in the focus areas of: (1) transportation, (2) housing, (3) green infrastructure, and (4) disaster resilience. The plan discusses both climate adaptation and climate mitigation policies and emphasizes the importance of community-based leadership in ongoing resilience work.

Portland African American Leadership Forum (PAALF) People's Plan: Environmental Justice

Summary: The 2018 PAALF People's Plan[103] includes strategies identified by the Portland Black community to actively shape the city they live in. The Environmental Justice section of the People's Plan focuses on addressing climate change through racial justice. It emphasizes the importance of both ecological and social sustainability and identifies climate justice as a key component of community-building and community health within black communities in Portland. The project engaged over 400 black community members.

[102] https://static1.squarespace.com/static/5501f6d4e4b0ee23fb3097ff/t/571e5e492eeb8164565faac4/1461608489635/Final+Implementation+Plan_NAYA.pdf

[103] http://www.paalf.org/ej-section

Analysis: Strategies prioritized in the PAALF People's Plan include: (1) safe and efficient transportation options, and (2) land use planning that supports community wellbeing. Specific examples highlighted in the plan include increasing urban agriculture opportunities, equitable access to transit, green spaces and parks, and toxic-free places.

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