Cleaner Air Spaces in Lane County: Policy Interventions for Mitigating the Health Impacts of Smoke Intrusion Events

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UNIVERSITY OF OREGON | Institute for Policy Research and Engagement

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The Institute for Policy Research and Engagement (IPRE) is a research center affiliated with the School of Planning, Public Policy, and Management at the University of Oregon. It is an interdisciplinary organization that assists Oregon communities by providing planning and technical assistance to help solve local issues and improve the quality of life for Oregon residents. The role of IPRE is to link the skills, expertise, and innovation of higher education with the transportation, economic development, and environmental needs of communities and regions in the State of Oregon, thereby providing service to Oregon and learning opportunities to the students involved.

About the UO – Lane County Policy Lab

The University of Oregon's School of Planning, Public Policy and Management and the government of Lane County started a partnership in 2018 to provide applied learning experiences for students, applied research settings for faculty and staff, and technical assistance to the Lane County government.

This project was funded in part by the UO – Lane County Policy Lab.

Land Acknowledgement

The University of Oregon is located on Kalapuya Ilihi, the traditional indigenous homeland of the Kalapuya people. Following treaties between 1851 and 1855, Kalapuya people were dispossessed of their indigenous homeland by the United States government and forcibly removed to the Coast Reservation in Western Oregon. Today, descendants are citizens of the Confederated Tribes of Grand Ronde Community of Oregon and the Confederated Tribes of the Siletz Indians of Oregon, and continue to make important contributions in their communities, at UO, and across the land we now refer to as Oregon.

IPRE operations and projects take place at various locations in Oregon, and wishes to acknowledge and express our respect for the traditional homelands of all of the indigenous people of Oregon. This includes the Burns Paiute Tribe, the Confederated Tribes of the Coos, Lower Umpqua and Siuslaw Indians, the Confederated Tribes of the Grand Ronde Community of Oregon, the Confederated Tribes of Siletz Indians of Oregon, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of Warm Springs, the Coquille Indian Tribe, the Cow Creek Band of Umpqua Tribe of Indians, and the Klamath Tribes. We also express our respect for all other displaced Indigenous peoples who call Oregon home.

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Executive Summary

Air pollution events have the potential to disrupt daily life and lead to health impacts on the population. Current projections estimate a four- to five-fold increase in the incidence of wildfires, as well as increased wildfire severity, over the next 20 years in Lane County. Intense wildfire smoke intrusions into populated areas of Lane County have the potential to be exceptionally harmful to public health as the region's mild climate means that many dwellings in the county do not have HVAC systems which can adequately filter particulate matter from the smoke.

This report summarizes current cleaner air space policies, as well as examines areas in Lane County where populations that are more susceptible to the effects of air pollution events reside. Our recommendations present leaders in Lane County with policy options to advance the resiliency of the county while confronting the threat of increasing air pollution events in the future.

Our study was conducted between January 2020 and June 2020 and grew out of a need for the Lane Regional Air Protection Agency (LRAPA) and the Lane County Public Health Department to have a comprehensive plan to designate and activate cleaner air shelters in the county.

The research team conducted a review of relevant academic and grey literature, as well as examined case studies from jurisdictions in the U.S. with cleaner air shelter policies. After reviewing the literature and case studies, the team interviewed 12 key stakeholders with LRAPA and Lane County Public Health which presented qualitative findings. Concurrently, the research team conducted a quantitative and geospatial analysis using GIS software and publicly available data from the U.S. Census Bureau and the PurpleAir air quality monitor website. For this aspect of the analysis, we defined vulnerable populations as low income, impoverished, immobile, 65 and up, those without medical insurance, and persons with disabilities. A summary of the team's findings from the GIS analysis and interviews are below.

Summary of Findings

Lane County:

- Large, rural Lane County census tracts, particularly in the east, possess higher incidences of individuals that are low income, impoverished, immobile, 65 and up, or possess a disability. This makes these populations increasingly incapable of independently mitigating poor air quality events, as well as obtaining access to LRAPA or Lane County Public Health services, such as a cleaner air shelter.

Eugene/Springfield Metro Area:

- West Eugene, downtown Eugene, and east Springfield have the highest populations and proportions of poor air quality vulnerable populations. It is imperative that these populations can access cleaner air spaces either through the implementation of a cleaner air space within these areas, or subsidies for the purchase of air filtration/cleaning technology.

Locations of Potential Cleaner Air Spaces in Lane County:

- Further GIS analysis was conducted by using government data to identify buildings owned by local, county and state governments. This analysis created maps highlighting buildings in the Eugene/Springfield metro area that are publicly owned and could potentially be used as cleaner air spaces. We limited these analyses to areas where census data revealed higher proportions of vulnerable populations: west Eugene, downtown Eugene, and east Springfield. While many buildings in these areas have the potential to be designated as cleaner air spaces, more research and data is needed to accurately designate some of these publicly owned buildings as cleaner air spaces.

Criteria for Cleaner Air Spaces:

- Several potential criteria for the identification of cleaner air spaces in Lane County emerged from the interviews including capacity, public or private cleaner air spaces, geographic location in Lane County, type of cleaner air space needed (daytime or overnight), and type of filtration system in building.

Organizational Policy During Wildfire/Smoke Intrusion Events:

- Interviewees from both LRAPA and Lane County Public Health outlined their roles and responsibilities in the event of a wildfire or smoke intrusion event. For example, in the arena of technical advice, LRAPA is to monitor and focus on data management, while Lane County Public Health is to take the lead on advising on the use of cleaner air spaces, as well as monitoring and data management. For a table and detailed description, please see pages 39-40.

Summary of Recommendations

These recommendations were distilled from the findings above to give LRAPA, Lane County Public Health, and other key stakeholders some first steps in order to have a comprehensive cleaner air space policy. For further discussion, please see the "Recommendations" section on pages 52-54.

1. Criteria for Cleaner Air Spaces: Establishing criteria for potential cleaner air space sites and documenting specific sites in a spreadsheet would be helpful so when a particular type of cleaner air space is needed, information will be readily available. Also, publicly sharing these cleaner air space locations and associated criteria would allow residents to make informed decisions about which cleaner air space to go to during a smoke intrusion event.

2. Locations of Potential Cleaner Air Spaces in Lane County: Our analysis revealed publicly owned buildings in areas with higher numbers of people vulnerable to air pollution events and/or wildfire smoke intrusion are needed. However, more detailed data and information on these buildings will be necessary to facilitate the designation of these buildings as potential cleaner air spaces.

3. Organizational Policy During Wildfire/Smoke Intrusion Events: Preliminary organizational policies listed within this report will require further examination and verification by the parties who will be implementing these policies. Concise documents detailing LRAPA/Lane County Public Health's wildfire/smoke intrusion policy need to be created, published and available to share between organizations as well as the public.

Introduction

Background

According to the City of Eugene's Climate Action Plan 2.0 projections, wildfires in the southern Willamette Valley will increase 400% to 500% by 2040. Severe and recurrent wildfires will produce elevated levels of fine particulate matter (PM 2.5) and cause more frequent air pollution events in Lane County and the region. PM 2.5 are fine particles of 2.5 micrometers or smaller, or about 30 times smaller than the diameter of a human hair. According to the EPA, particles of 10 micrometers and smaller can be inhaled into the lungs and may enter the bloodstream, and of these particles, fine particles of 2.5 micrometers or smaller pose the greatest risk to health. Elevated levels of PM 2.5 will likely lead to increased adverse health impacts on the local population, and there will likely be several vulnerable populations that are more susceptible to the adverse health effects from air pollution events.

As wildfires are projected to be more frequent and severe over the next 20 years, the Lane Regional Air Protection Agency (LRAPA) and other local agencies are looking to develop resilient responses to natural disasters. Lane County government has expressed an interest in developing responses to mitigate the effects of wildfire smoke and other air pollution events, and LRAPA will be an integral part of the emergency management process and response to wildfire and other air pollution events.

LRAPA's mission is "to protect public health, quality of life and the environment as a leader and advocate for continuous improvement of air quality in Lane County." Therefore, mitigating the burdens of air pollution events, including wildfires, on Lane County residents is aligned with the client's mission. Mitigation strategies also include a focus on public health consequences of air pollution for vulnerable populations during these events. These vulnerable populations include young children, the elderly, the unhoused, individuals with compromised immune systems, those with respiratory conditions, and those of certain socioeconomic statuses. These populations are particularly vulnerable to the effects of fine particulate matter from wildfires and other air pollution events.

Currently, there are opportunities to improve Lane County's response plan in regard to the use of cleaner air spaces during air pollution events. The Lane County Public Health website has no readily accessible list of cleaner air spaces where the public can take shelter during air pollution events. Furthermore, resilience preparedness and funding in Lane County and the region seems to be focused on cataclysmic events such as earthquakes and tsunamis, rather than wildfires and air pollution events.

LRAPA, Lane County Public Health, and other local agencies are increasing the resilience of the county and mitigating the impacts of increasingly frequent wildfire and air pollution events. One such strategy to increase resilience and mitigate the health impacts of air pollution events in Lane County is to establish a network of cleaner air spaces where Lane County residents can take shelter during air pollution events. This framework, along with a communications strategy for informing the public, should be developed and/or improved. All of these recommendations will be based on robust data and established best practices.

This project strives to provide data and research in order to accomplish the following objectives:

1. Review and analyze clean air space policies and programs.
2. Assess best practices in the identification of cleaner air spaces.
3. Conduct interviews and research to determine the locations of cleaner air spaces in Lane County.
4. Provide recommendations to LRAPA and Lane County Public Health, including an ideal
5. framework for successful communications and policies necessary for effective use of cleaner air
6. spaces during an air pollution event.

Methods

This project follows a descriptive research design utilizing multiple qualitative and quantitative data sources including published academic literature, government publications, census and air quality data from online data repositories, as well as interviews with relevant government stakeholders.

These data assist in summarizing cleaner air space policy best practices in regard to components such as communication strategies, the use of different types of cleaner air spaces, and overall public health in order to protect the population of Lane County from air pollution events.

Primary air quality data was obtained from PurpleAir sensors (low-cost air quality monitors) and will be used to support recommended communication strategies and a framework policy for Lane County. These sensors are more widespread and simpler to install and maintain, compared to LRAPA's eight large, specialized and expensive monitoring equipment. Geographic Information System (GIS) will also be utilized to analyze, manage and present geographic and spatial data.

Air Quality Data

Due to the scope of the project where multiple cleaner air space policies in different geographic locations are being examined, utilizing an online data repository of air quality as opposed to primary data collection was determined to be a more cost and time effective option when taking into account the project timeline and resources.

Current Lane County Cleaner Air Space Policy

To ensure individual interpretations did not lead to an idiosyncratic account of Lane County's current cleaner air space policy, a descriptive base was established and individuals from several organizations in many different roles were interviewed. Interviews generally were composed of 10 questions. A memo was provided giving a brief overview of the project along with areas of interest prior to interviews.

Subject Protections in Place

Due to interaction with human subjects during study, University Institutional Review Board approval was sought and obtained. All interview subjects were asked to sign an informed consent form or verbally consent before any formal interviews took place.

Literature Review

This review looks at academic and government/grey publications in order to construct an account of four interest areas, including: (1) air quality, specifically what defines clean air, (2) environmental justice, (3) emergency management, and (4) health impacts of PM 2.5 exposure. Case studies highlighting aspects of cleaner air space policies in Washington State, Montana and California are also available in the Appendix figure 1. The higher proportion of government/grey publications is due to gaps in academic literature on cleaner air space policy.

Air Quality

The Air Quality Index (AQI) developed by the United States Environmental Protection Agency (EPA) is perhaps the most well-known air quality standard around the world. However, it was designed to be more robust than it is typically calculated and can be inaccurate at times. Regardless, the AQI is simple to understand and relatively easy to calculate, making it an excellent simple measure of air quality.

Air pollutant levels in the United States are set by the EPA through the Clean Air Act (U.S. EPA, 2014). The Clean Air Act directs the EPA to set specific levels of air pollutants that are harmful for public health and the environment (2014). These specific levels of pollutants are the National Ambient Air Quality Standards (NAAQS). These pollutants are calculated to find ambient levels, and different pollutants have different averaging times according to the EPA (2014).

The EPA regulates eight pollutants in the NAAQS. These are carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter (PM 2.5 and PM 10), and sulfur dioxide. All of these pollutants negatively affect public health in different ways, and all of them are weighted by the EPA differently and with different averaging periods (i.e. one hour, eight hours, 24 hours, etc.), making the measurements confusing for laypersons.

This confusion led to the introduction of the Air Quality Index (AQI), which is based on the levels of five NAAQS pollutants. The AQI is organized into six color-coded categories ranging from “good” to “hazardous” based on the current levels of pollutants. On paper, the AQI is calculated using the levels of five pollutants (Air Quality Index Rule, 1999).

Figure 1: The Air Quality Index Categories

Daily AQI Color	Levels of Concern	Values of Index	Description of Air Quality
Green	Good	0 to 50	Air quality is satisfactory, and air pollution poses little or no risk.
Yellow	Moderate	51 to 100	Air quality is acceptable. However, there may be a risk for some people, particularly those who are unusually sensitive to air pollution.
Orange	Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is less likely to be affected.
Red	Unhealthy	151 to 200	Some members of the general public may experience health effects; members of sensitive groups may experience more serious health effects.
Purple	Very Unhealthy	201 to 300	Health alert: The risk of health effects is increased for everyone.
Maroon	Hazardous	301 and higher	Health warning of emergency conditions: everyone is more likely to be affected.

https://www.airnow.gov/aqi/aqi-basics

However, in practice the AQI is calculated using the highest level of one of the five NAAQS pollutants, and this is known as the driver pollutant (Perlmutt et. al., 2017). Very often, the driver pollutant is PM 2.5, or fine particulates that are 2.5 microns across--much smaller than the diameter of a human hair--and are small enough to enter a person's bloodstream via the lungs.

State clean air agencies, such as the California Air Resources Board (CARB), oversee California Ambient Air Quality Standards (CAAQS), which predate the Clean Air Act and NAAQS. In addition to setting standards for more pollutants than the NAAQS, these standards can be more stringent as well (California Ambient Air Quality Standards). While NAAQS include eight pollutants, CAAQS add visibility reducing particles, sulfates, hydrogen sulfide, and vinyl chloride.

Internationally, air quality standards measure similar pollutants. The EU uses a standard called the European Air Quality Index based on the concentrations of five pollutants (PM 10, PM 2.5, ozone, nitrogen dioxide and sulfur dioxide). These are also standardized into an index with six color-coded levels ranked from "good" to "extremely poor" (European Air Quality Index, n.d.). Similarly, the World Health Organization has air pollution guidelines based on the same pollutants as EU standards (WHO | Air quality guidelines – global update 2005).

The information on air quality is important to this research project in order to determine if consensus and/or variation exists in how clean air is defined and then applying this information to create a framework for the use of cleaner air spaces in Lane County.

Environmental Justice

While the air we live in is a common space, the incidence of burden from air pollution can disproportionately affect vulnerable and lower-socioeconomic populations. Creating effective air pollution-event mitigation policies require that all populations are considered. It is imperative to ensure that vulnerable and lower-socioeconomic populations are given equal protections and accessibility of protection from air pollution-events.

A litany of academic and professional research that explores the burden of incidence of vulnerable populations has been incorporated into this report to ensure that the framing, analysis, and

recommendations presented are inclusive. Previous research repeatedly identifies that when left to individuals to mitigate their own incidence of burden to air-pollution events, there is inequity in mitigation and mitigation abilities.

A study by Cong et al., (2017) found that during high air pollution events in China, higher-income earners are better able to mitigate exposure to air pollution than low-income earners. By having the wealth to purchase indoor air filtration equipment, higher-income earners are able to limit their exposure to both indoor and outdoor pollution. Lower-income earners are only found to purchase less effective respiratory masks, some of which do not filter PM 2.5, and not purchase indoor air purifying equipment due to its costs. Using data from online sales of air filtering equipment in tandem with air quality data, the authors of this study argue that these findings have large public health implications in China as income disparity increases.

While this study was conducted with data from China, a similar trend in income inequality in the United States raises concerns for the authors of this study. Additionally, with wildfire seasons projected to last longer and produce more intense fires globally, the ability to combat poor air quality will become an increasingly pressing public health and policy issue for all nations. For populations that are sensitive to air pollution, such as the elderly, sick, and children, the ability to provide effective and accessible air pollution mitigation technology and policies is even more imperative.

Another study, by Jerrett et al,. (2001), uses statistical modelling and data from 23 air quality monitoring stations across Hamilton, Canada, as well as socioeconomic spatial data, to find that lower-income areas of Hamilton are in fact more likely to experience increased incidence of air pollution exposure. The motivation for this study comes from previous research in Canada and the United States that repeatedly finds a similar relationship. This study differs from these previous studies in that it considers spatial-autocorrelation, or, in other words, how things that are close to each other influence each other. By addressing this phenomenon, Jerrett et al., (2001) have a more complete picture of how much low-socioeconomic areas of a city are impacted by air pollution.

By controlling for this spatial autocorrelation, as well as using “Kriging interpolation,” or spreading the data over the study area to cover missing data, Jerrett et al., (2001) present more evidence supporting this phenomenon than in previous similar studies. Jerrett et al., (2001) argue that these findings have implications for future law making and city planning. Additionally, the Kriging interpolation technique used in this study is not ideal in that it is not exact data. Jerrett et al. (2001) argue that many cities could not even perform Kriging because of a lack of air sensors monitoring pollution, as well as a lack of knowledge of the technique. With the higher number of sensors in Lane County this technique may provide insight that is not possible in other settings.

Overall, Jerrett et al. (2001) highlight a ‘triple jeopardy’ issue within their study. This ‘triple jeopardy’ means that disadvantaged lower-socioeconomic individuals face direct negative impacts to health from behavioral choices, as well as, secondary and tertiary effects from higher incidence of exposure to ambient air pollution and disproportionately large negative health effects from air pollution than better-off groups.

Given these implications, Jerrett et al. contend that future government policies that address air pollution should both ensure that air pollution can be monitored in an equitable way, as well as argue that the largest health benefits to reducing air pollution would be in addressing ambient air pollution in low-socioeconomic areas.

In addition to identifying private individual's susceptibility to unequal air pollution exposure and subsequent mitigation approaches, additional literature has found these same considerations hold in public spaces. Carrier et al. (2014), explore the relationship between elementary school locations in poor and rich neighborhoods and children's exposure to air pollution. This study uses a combination of spatial analysis and statistical tests and finds that 1) elementary schools are located on city blocks where there are fewer city roads, 2) nitrogen dioxide concentrations at schools are positively associated with deprivation, and 3) schools with higher levels of deprivation tend to be located in more polluted areas.

The study by Carrier et al., (2014) use information from 319 elementary schools in Montreal, Canada and pollution data generated by the City of Montreal to perform a study analyzing the school children's exposure to nitrogen dioxide, a hazardous air toxin emitted from vehicles. Carrier et al., (2014) perform an analysis of outside surrounding air pollution within 200 meters of schools and conclude that there is a positive and statistically significant relationship between the deprivation of a school and the levels of ambient nitrogen dioxide. In their study, Carrier et al., (2014) select two control groups: children between 5 and 12 years old and the total population of Montreal. By studying these two separate groups, Carrier et al., (2014) contend that they can pinpoint pollution exposure of children from their home environment and their school environment.

By citing previous medical research, Carrier et al., (2014) argue that these results have social and health implications for children. Childhood exposure to nitrogen dioxide is associated with detriments in learning ability and a higher likelihood to develop asthma. By documenting the increased pollution exposure incidence in deprived schools, Carrier et al., (2014) contend that there are also significant social equity and environmental justice issues at play. Not only are children from lower socioeconomic backgrounds going to schools with less funding, but they are also exposed to higher levels of air pollution. This has significant later-in-life implications for this already vulnerable population.

In closing, Carrier et al., (2014) prescribe that policies be implemented to ensure the reduction of air pollution at all schools so that socioeconomic composition of an elementary school does not also translate to lower environmental health for children too. The authors advocate for the placement of air quality sensors outside of schools, as well as giving a random assortment of students' air quality monitors to pinpoint all sources of their day-to-day pollution.

While the studies highlighted in this section hail from the international community, the lessons are still very relevant for Lane County. Vulnerable populations are not only more at risk to the detriments of air pollution, they are also more likely to be exposed to air pollution events. Given the stratifications of incomes across Lane County, as well as Lane County's geography and topography causing unequal exposure to air pollution, incorporating these findings into the analysis and final recommendations of this report will help serve all citizens of Lane County.

Emergency Management

Defining the concept of emergency management is important to this research project since the use of cleaner air spaces falls into multiple aspects of emergency management including preparedness and response. Using a pre-defined concept will also assist in analysis of other jurisdictions' policies in regard to the use of cleaner air spaces.

There are four phases of emergency management: mitigation, preparedness, response, and recovery. Mitigation includes any activities (before or after an emergency) that prevent or reduce the chance of an emergency occurring, or that limit or reduce the emergency's effects. Preparedness includes activities such as plans or preparations for an emergency that take place before its occurrence. Response includes all actions taken during an emergency situation that put the plans into action. Recovery, the final phase, includes all actions taken to return to normal after an emergency event (Waugh & Strieb, 2006).

Health Impacts

The health impacts of air pollution have been researched extensively in the field of academia. For example, Sacks et al., (2010) examined around 100 epidemiological and toxicological studies that examine the health effects of particulate matter (PM 2.5) based on six health and social characteristics including age, socioeconomic status, ethnicity, gender, pre-existing conditions, and obesity. For pre-existing conditions such as respiratory illness or heart problems, the authors state that on the U.S. west coast, about 10% of the population have been diagnosed with heart problems and about 11% have breathing problems. Most unhealthy people on the west coast were 65 years or older. Also, in regards to age, children were determined to be more susceptible to the effects of PM 2.5 due to increased time spent outdoors because their bodies, including their lungs, are developing (Sacks, et al., 2010).

Cooper et al. (2014) conducted a review of academic and grey literature on cleaner air space policies. The authors looked for research examining the effectiveness of recommending that people stay indoors, limiting time outdoors, and canceling public outdoor events due to hazardous air quality. The results of their review include finding studies stating that staying inside may help, but it largely depends on the type of building and what type of filtration system is in place. In regards to providing advance warning to the public, the authors found studies indicating that people who are susceptible to the effects of air pollution, who work full time, or have a higher chance of being outside are more likely to remember public service announcements or warnings of poor air quality from the government (Cooper et al., 2014).

These meta-analyses on health impacts of air pollution is particularly important in the context of this research project due to the need to identify vulnerable communities that may be disproportionately impacted or at risk in Lane County during an air pollution event such as a wildfire.

Data Synthesis

Description of the Data Collection Process

The research team used multiple data sources including semi-structured interviews with LRAPA and Lane County Public Health employees, PurpleAir air quality data, and U.S. Census data to complete the project objectives. The data collection process for each of these sources is described below.

Interviews

After getting permission from the UO to conduct interviews, the team contacted 21 individuals from LRAPA and Lane County Public Health by email or in person to set up the semi-structured interviews. The team interviewed 12 of these 21 individuals for a 52% response rate. Four of 12 interviews were conducted over the phone and the remaining eight were conducted in person. To ensure individual interpretations did not lead to an idiosyncratic account of Lane County's current cleaner air space policy, the team established a descriptive base and interviewed individuals from several organizations in many different roles. Interviews generally included 10 questions (Appendix Figure 2). Further information on the roles of the interviewees and the organization they belong to is provided in the description of the criteria section. Case studies and literature review assisted in the creation of interview questions. A memo was provided to interviewees giving a brief overview of the project along with areas of interest prior to the interviews. Team members recorded, transcribed, and organized the interview responses by question.

PurpleAir

PurpleAir has an open data portal for free data downloads of PurpleAir sensor data. To collect the data for relevant Lane County sensors, team members generated a Python script that scraped the PurpleAir website of sensors in Lane County, followed by visualizing and cleaning these data in Python and then transferring to ArcGIS for analysis and visualization.

U.S. Census Data

The team then combined PurpleAir data with the U.S. Census data to illustrate which populations are getting access to air quality data, as well as to generate recommendations as to where future sensors could be placed. The U.S. Census data presented in the report is made available directly from the U.S. Census Bureau website. The team downloaded the 2017 five-year American Community Survey (ACS) data since it provides the most accurate and up to date illustration of Lane County demographics. The demographic variables chosen are based on pre-existing literature that identifies populations sensitive to air quality or face accessibility challenges. These data assisted the research team in the visualizations of potential areas in Lane County where vulnerable populations to poor air quality reside.

Description of the Method of Analysis

Interviews

After recording and transcription, team members grouped interview answers from each interviewee together by question for subsequent analysis in a Microsoft Word document.

Air Quality Sensors

Data retrieved from PurpleAir was uploaded into ArcMap and displayed over Lane County census tracts. All of Lane County air quality sensors and census tracts are illustrated, as well as close-ups of Eugene and Springfield. A high-level visual analysis of maps is performed to identify relationships between air quality sensors retrieved from PurpleAir and their relation to census data.

U.S. Census Data

Demographics included in GIS visualization include census tract level educational attainment, health insurance coverage, age, median income, people with disabilities, poverty status, citizenship status, and vehicle ownership. These variables were chosen based on the review of published academic literature detailing the potential health effects of poor air quality on different populations based on these socioeconomic factors.

Description of the Criteria

Analysis of the data is organized by quantitative data analysis including PurpleAir data and U.S. Census Shapefile data followed by qualitative data analysis from the LRAPA and Lane County Public Health employee interviews. A list of potential criteria and additional considerations for cleaner air spaces follows data analysis.

Quantitative Data Analysis

Geographic Analysis of Air Quality Sensors and Vulnerable Populations in Lane County

Due to public health concerns, especially to vulnerable populations, it is imperative that access to accurate and real-time air quality information is made available for Lane County residents. This ensures that people are informed as to when they should utilize cleaner air spaces or mitigation technology, either privately or through LRAPA and Lane County Public Health services. Additionally, not all individuals are equally capable of creating or accessing a cleaner air space due to a myriad of factors such as not being able to afford air filtering devices or being incapable of relocating to a cleaner air space, i.e. being low income, lacking a vehicle, or having a disability.

The following section presents a series of maps that illustrate the location of PurpleAir sensors, as well as the populations they serve using U.S. Census data. These maps illustrate how geographically equitably disturbed the placement of air quality sensors are, show public health officials where populations vulnerable to poor air quality reside, and highlight populations that may have an increased difficulty in

obtaining a cleaner air space. Presenting this information may aid LRAPA and Lane County Public Health in the allocation of air quality event mitigation resources.

Key Findings - Lane County

- Large, rural Lane County census tracts, particularly in the east, possess higher incidences of individuals who are low income, impoverished, immobile, 65 and up, or possess a disability. This makes these populations increasingly incapable of independently mitigating poor air quality events, as well as obtaining access to LRAPA or Lane County Public Health services, such as a cleaner air shelter.
- Rural census tracts have fewer air quality monitoring sensors, likely a consequence of limited internet availability.

Key Findings - Eugene/Springfield

- West Eugene, downtown Eugene, and east Springfield have the highest populations and proportions of poor air quality vulnerable populations. Due to public health and environmental justice concerns, it is imperative that these populations can access cleaner air spaces either through the implementation of a cleaner air space within these tracts, or subsidies for the purchase of air filtration/cleaning technology.
- North and south Eugene possess more affluent and mobile populations. These populations are more likely to be capable of independently mitigating air quality events either through the purchase of in-home filtration equipment or travelling to a cleaner air shelter.

The basemap (Figure 2) illustrates the location of all PurpleAir and other air sensors, both LRAPA installed and public, in Lane County. Sensors are located throughout the county with a large concentration of sensors in Eugene and Springfield. In total there are 61 sensors across Lane County with 35 of those within Eugene and Springfield urban growth boundaries (UGBs) (Figure 3). Due to clustering at smaller scale, the exact number of PurpleAir monitoring stations cannot be seen on the following figures.

Maps

Figure 2: Basemap - Lane County

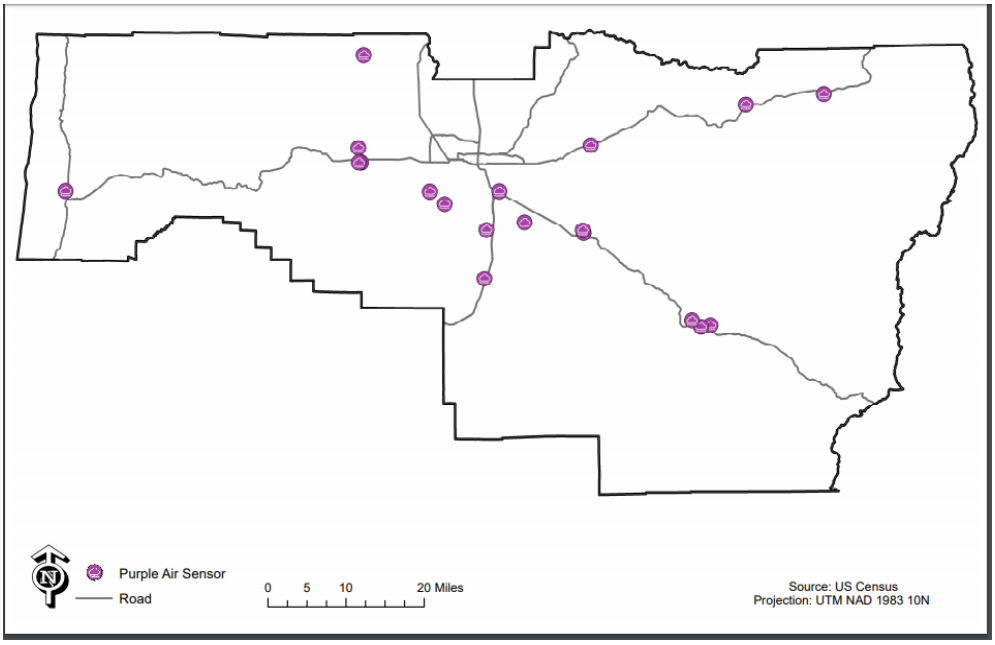
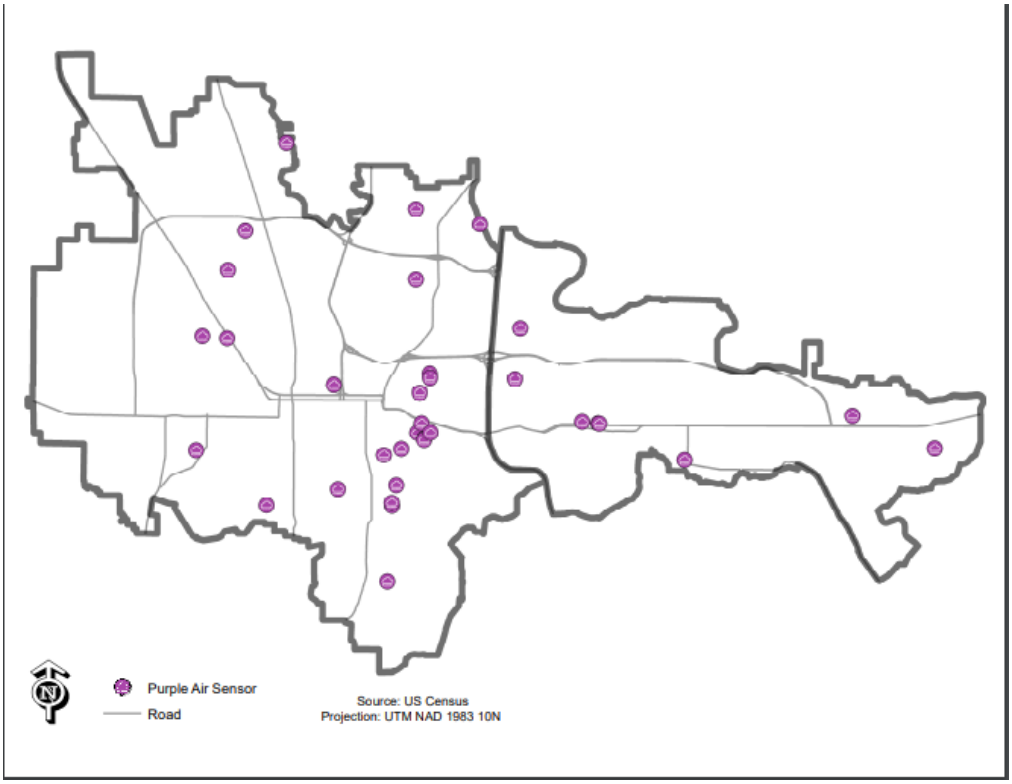


Figure 3: Basemap - Eugene/Springfield



Lane County encompasses 4,722 square miles, which equates to one sensor for every 77 square miles, if evenly distributed. With the combined Eugene and Springfield UGBs land area of 24 square miles, there are approximately one sensor every 0.68 miles. The higher concentration of air quality sensors in Eugene and Springfield is to be expected given that Eugene/Springfield is the population hub of a predominantly rural county. The appropriate density of sensors is not fully known; however, the more sensors that are online, the clearer the understanding is of air quality in a region and at the local level.

Forty maps were created to illustrate the location of air quality sensors, in addition to key demographic variables in Lane County. These maps also show an enhanced view of Eugene and Springfield. The key variables were selected after the literature review in which studies explore the relationship between air quality information and equity, as well as literature that highlights populations vulnerable to poor air quality or who may have difficulty accessing services to combat poor air quality.

The variables that are explored in these maps are total population, median income, count and proportion of tracts with at least a bachelor's degree, living below the poverty threshold, without health insurance, population that is classified as disabled, non-workers without a vehicle, and percent of population that is not a U.S. citizen, respectively. This information is illustrated at the census tract level and all data is obtained from the 2017 five-year ACS.

Figure 4: Total Population - Lane County

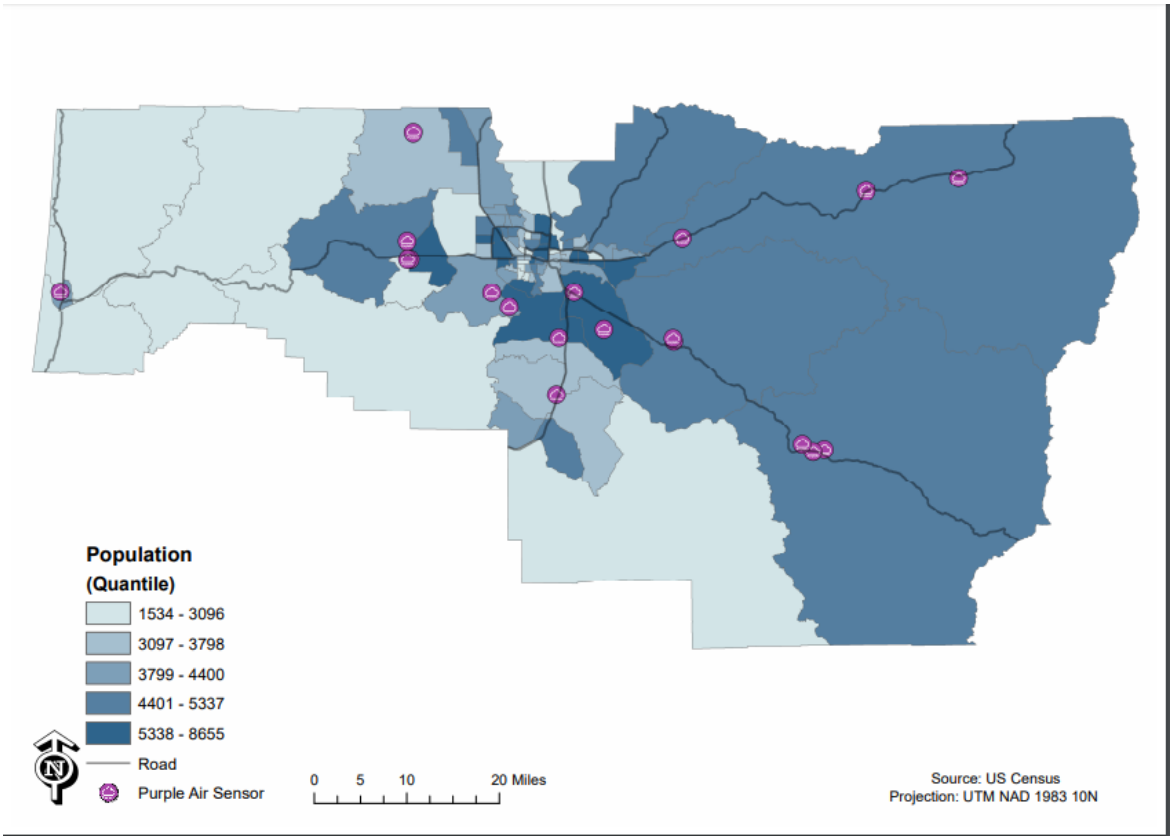
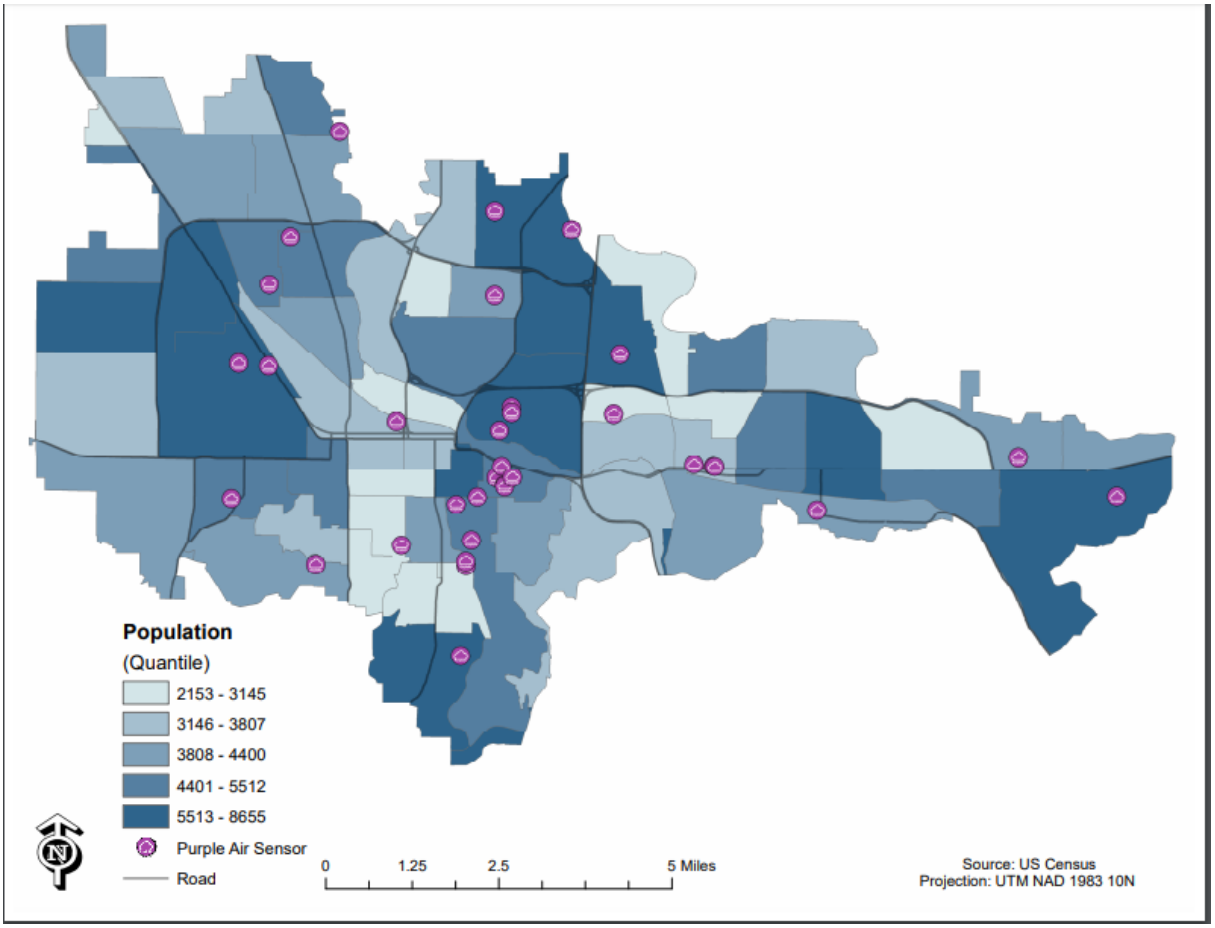


Figure 5: Total Population - Eugene/Springfield



Figures 4 and 5 illustrate the total population of each census tract in Lane County and Eugene/Springfield. Outside of Eugene and Springfield, the tract with the largest population is a very large tract to the northeast. Upon preliminary inspection, there appears to be a relationship between population density and number of air quality sensors. This is likely due to the fact that where there is higher population density it is more likely that a small percentage will have air quality monitors and that internet connectivity will be more robust. In addition to smaller populations in rural areas, limited internet connectivity may be an issue.

Figure 6: Age - Over 65 - Lane County

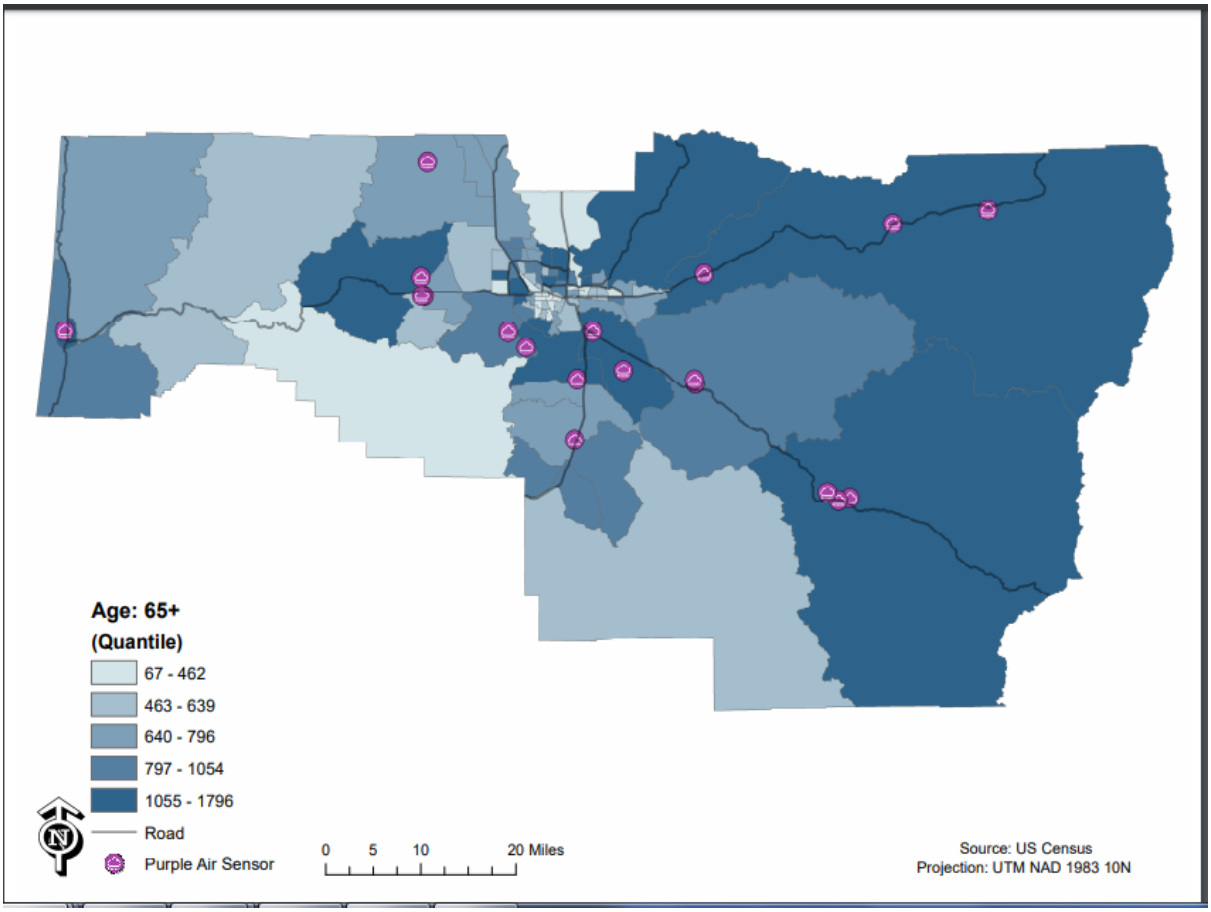
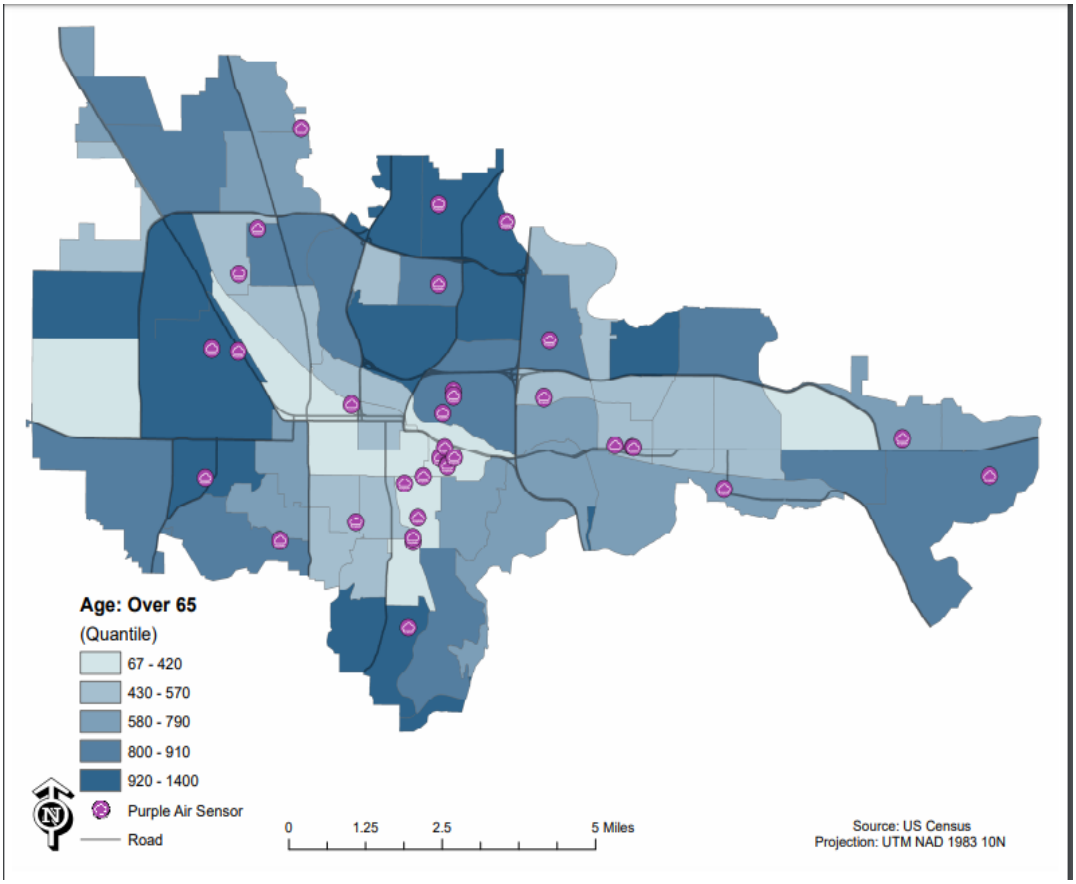


Figure 7: Age - Over 65 - Eugene/Springfield



Figures 6 and 7 illustrate the count of individuals age 65 and up in Lane County and Eugene/Springfield. People who are 65 and older tend to have underlying health conditions which may mean increased health vulnerabilities to poor air quality. At the county level there is a high count of individuals age 65 living in the rural areas of east Lane County. At the Eugene/Springfield level, there are high counts of individuals ages 65 and older in the peripheral neighborhoods of Eugene.

Figure 8: Age - Non-Adult - Lane County

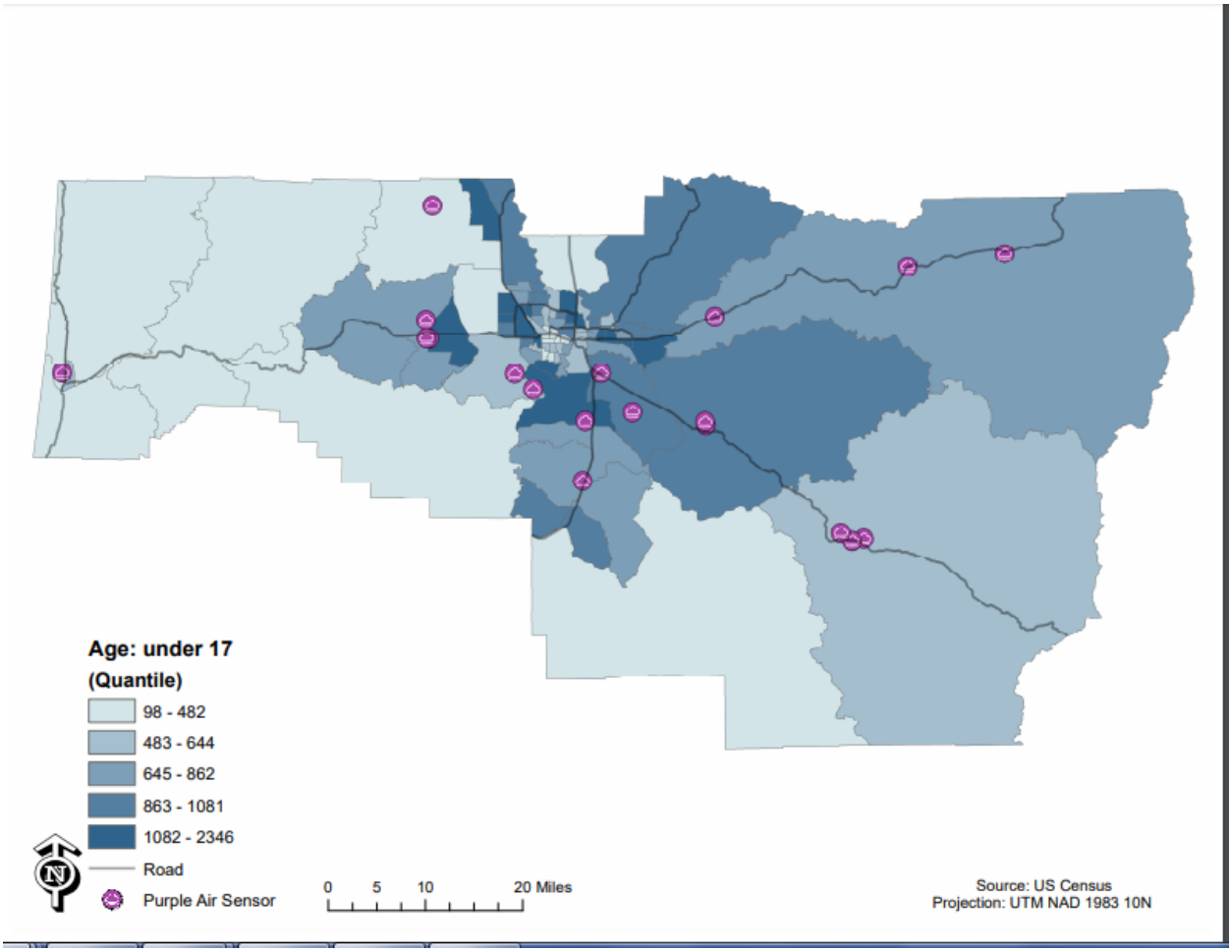
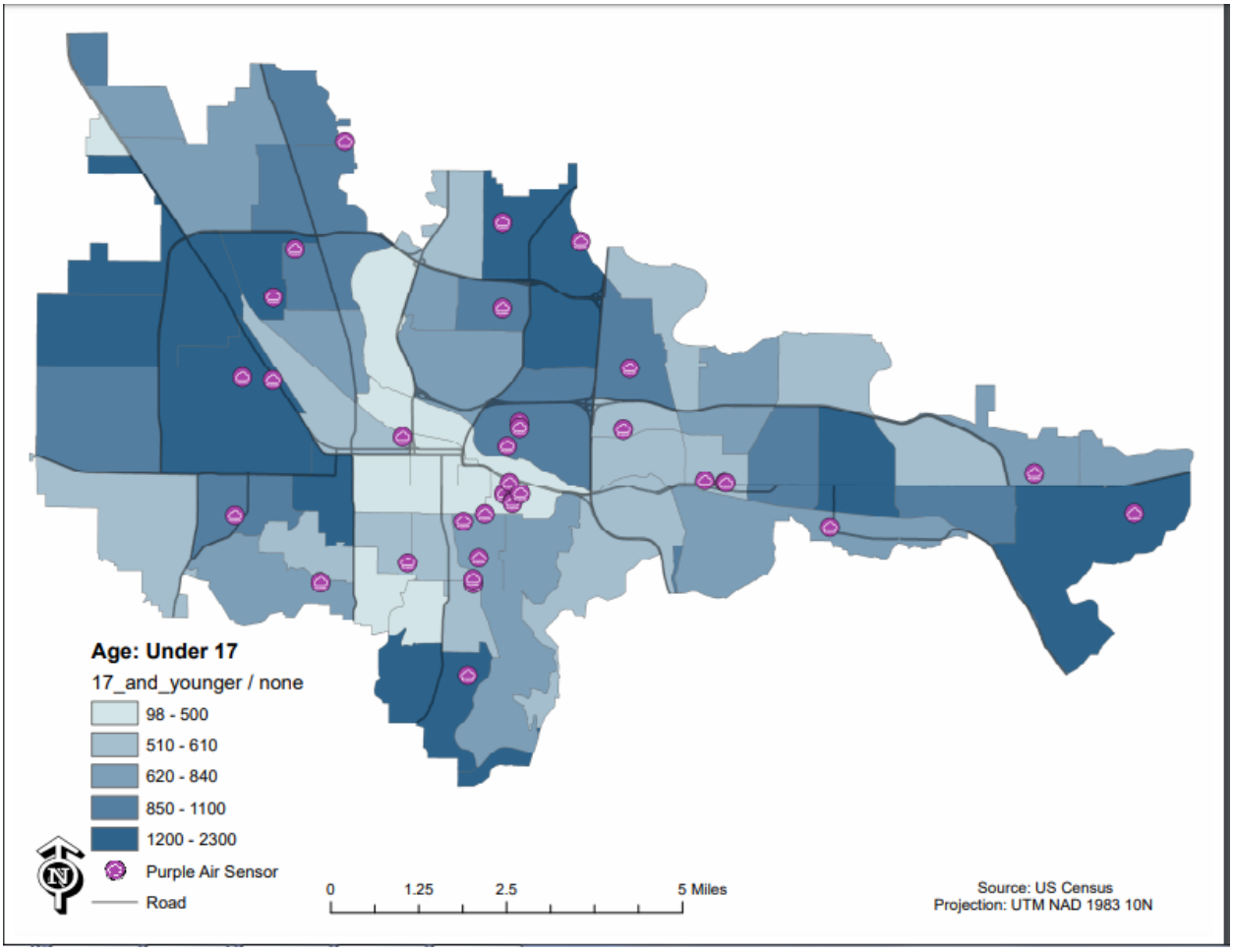


Figure 9: Age - Non-Adult - Eugene/Springfield



Figures 8 and 9 illustrate the count of individuals age 17 and under in Lane County and Eugene/Springfield. In addition to the elderly, children are more vulnerable to the health consequences of poor air quality due to the fact that their lungs are still developing, and they breathe more rapidly. At the county level, there is an inverse relationship of younger people to older people with high counts of people 17 and under living near Lane County's more urban areas. As with individuals 65 and up within Eugene and Springfield there are higher counts of those 17 and under in the peripheries of Eugene and Springfield. This is likely due to most housing and residential neighborhoods being outside of downtown Eugene.

Figure 10: Median Income - Lane County

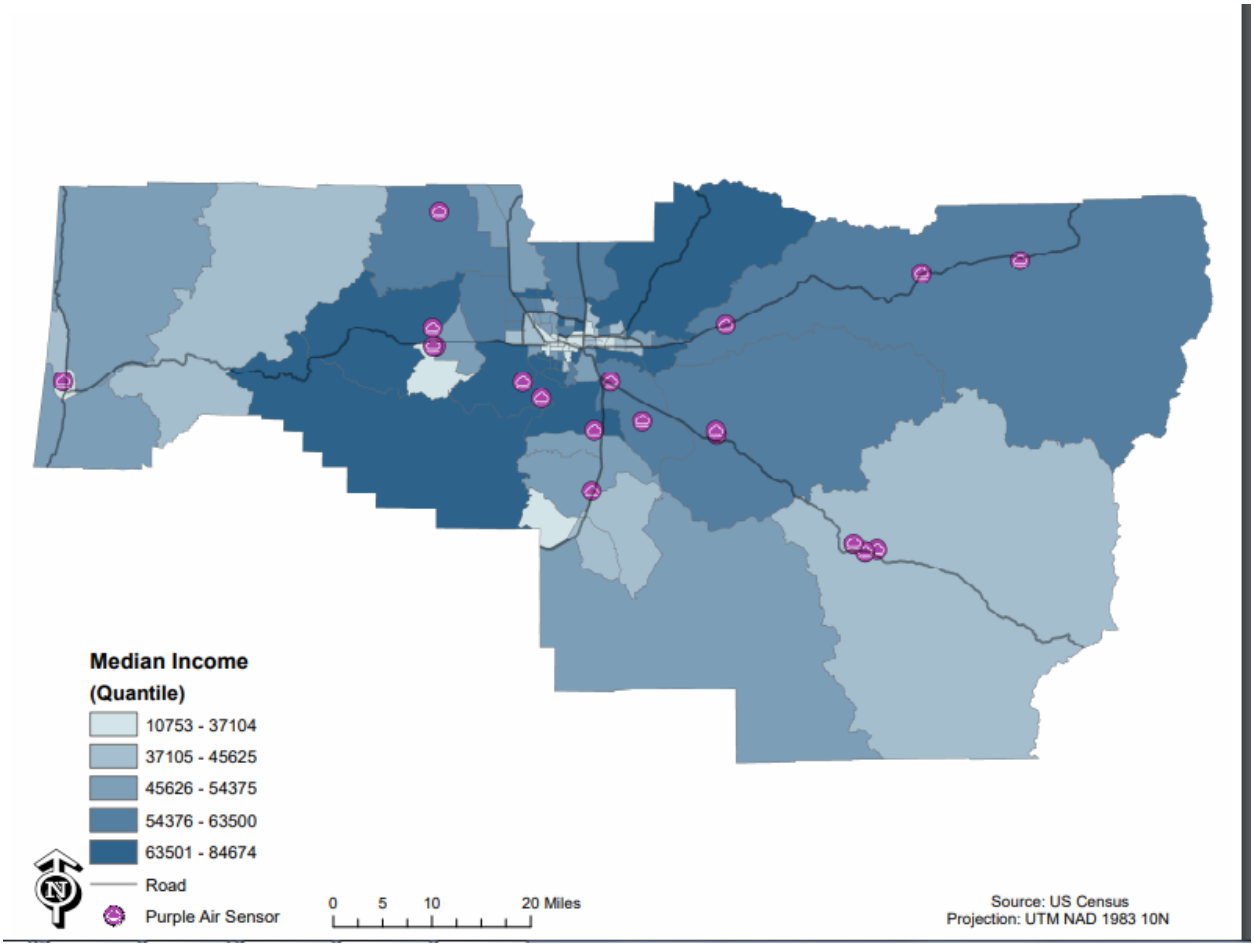
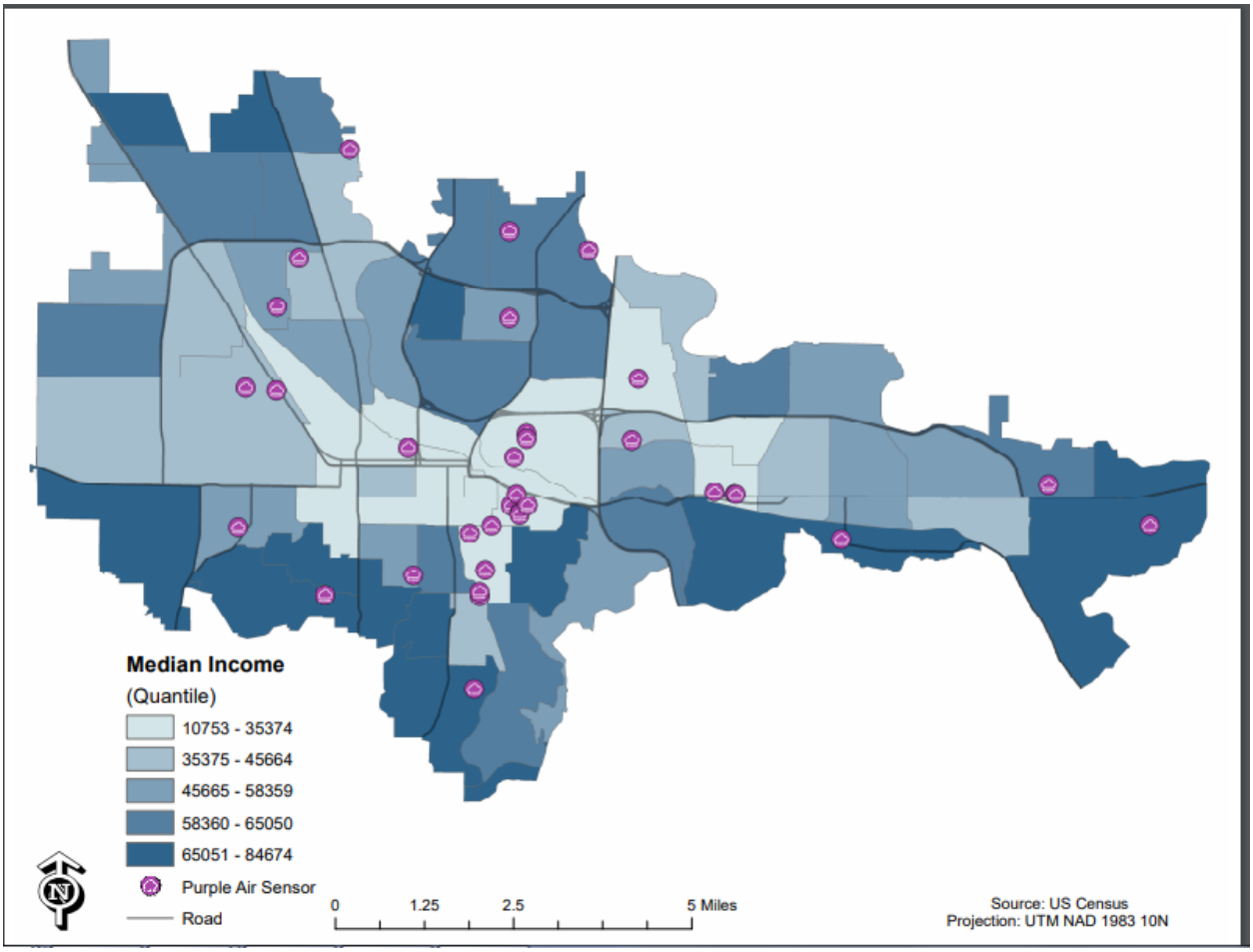


Figure 11: Median Income - Eugene/Springfield



Figures 10 and 11 illustrate median income by census tract and location of air quality sensors within Lane County and Eugene/Springfield. While there is a large range of median incomes by tract across Lane County, there is no easily visually identifiable relationship between median income values and location of sensors. Within Eugene, there appear to be fewer sensors farther from the city core and away from the University of Oregon. There also appears to be a pattern that median income by tract increases farther from the city core or university. This makes sense as these are more suburban areas with single family homes and higher-income non-students. There also appears to be a lower incidence of PurpleAir sensors in these areas, both installed by LRAPA or privately. The absence of LRAPA sensors could correspond with the necessity for a public internet source, which is less likely to be found outside of Eugene and Springfield's urban cores.

Figure 12: Education - Lane County

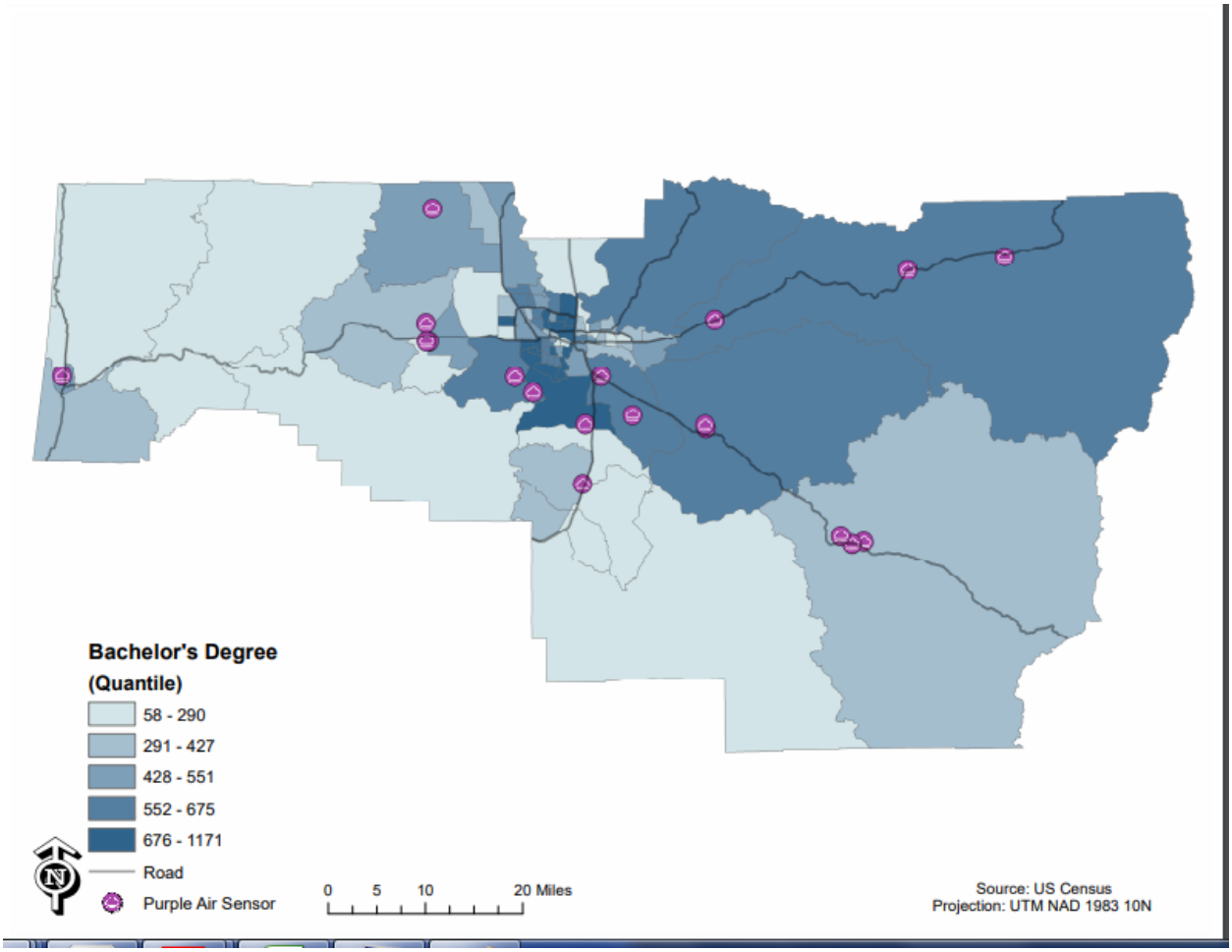
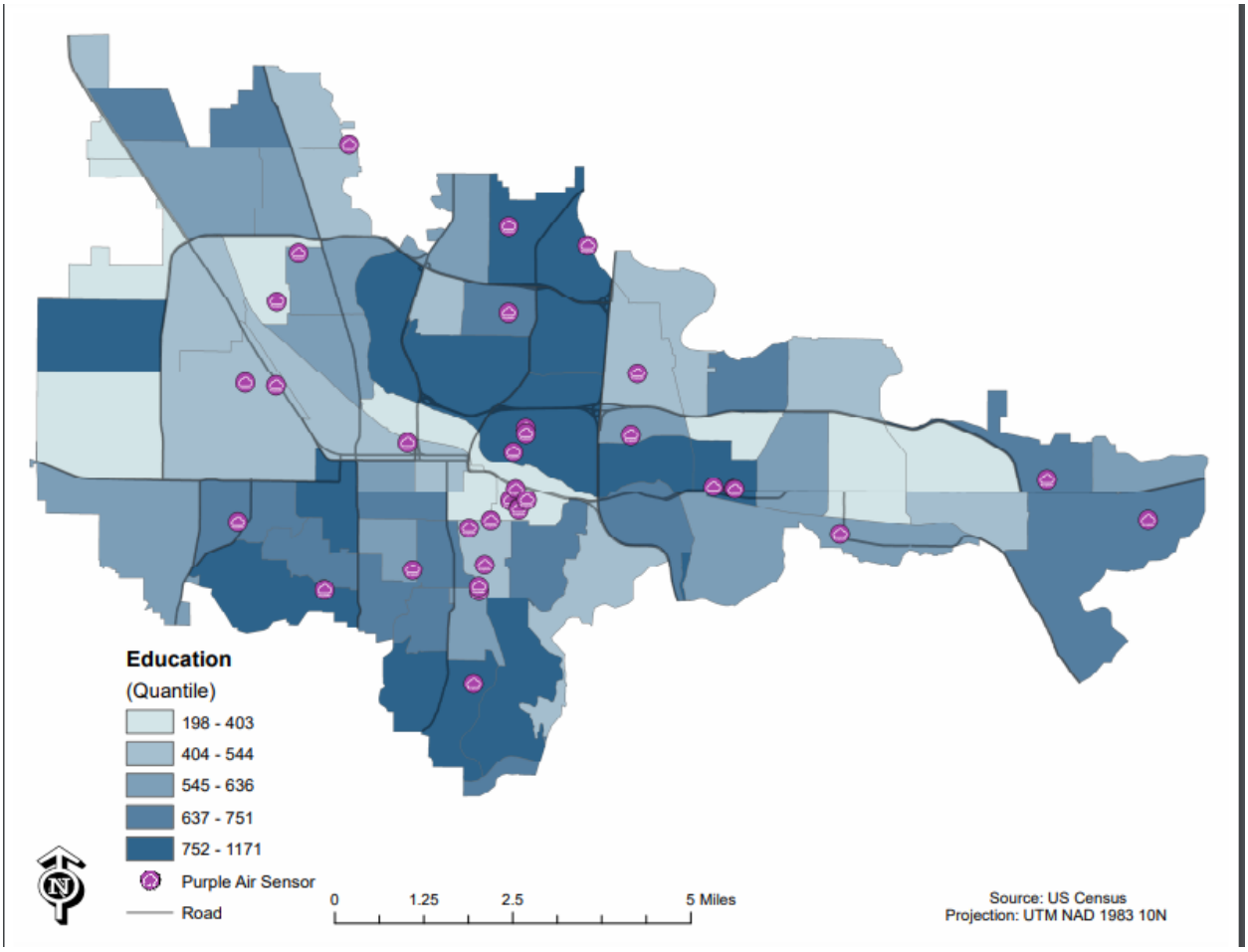


Figure 13: Education - Eugene/Springfield



Figures 12 and 13 present the Lane County and Eugene/Springfield census tracts by bachelor's degree or above. Following the pattern of median income, there is a high concentration of air quality sensors in the center of Eugene where there is a lower incidence and count of individuals with a bachelor's degree, as well as fewer sensors on the periphery of Eugene where there is a higher incidence and count of individuals with a bachelor's degree. Sensor placement does not appear to be correlated with educational attainment levels.

Figure 14: Poverty - Lane County

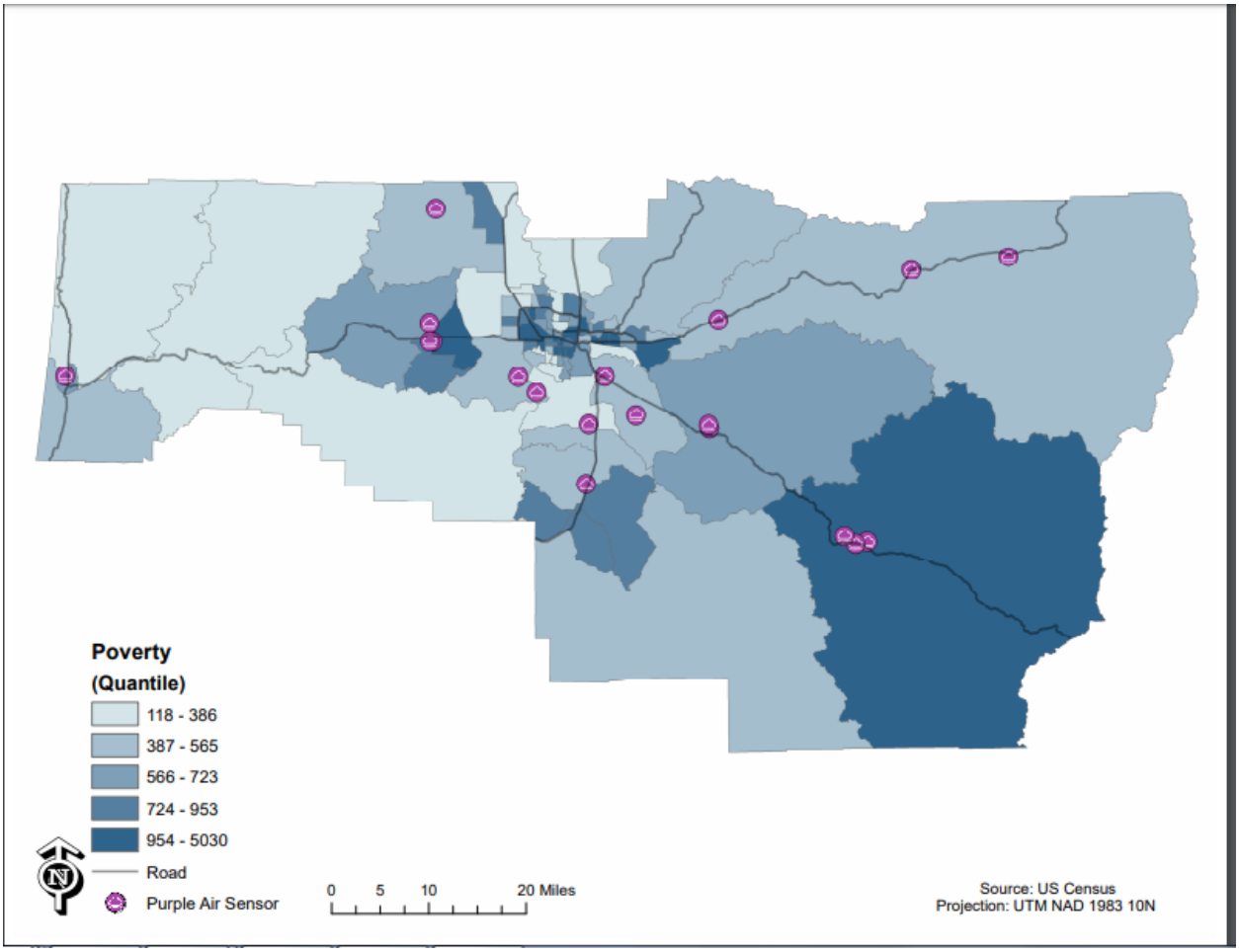
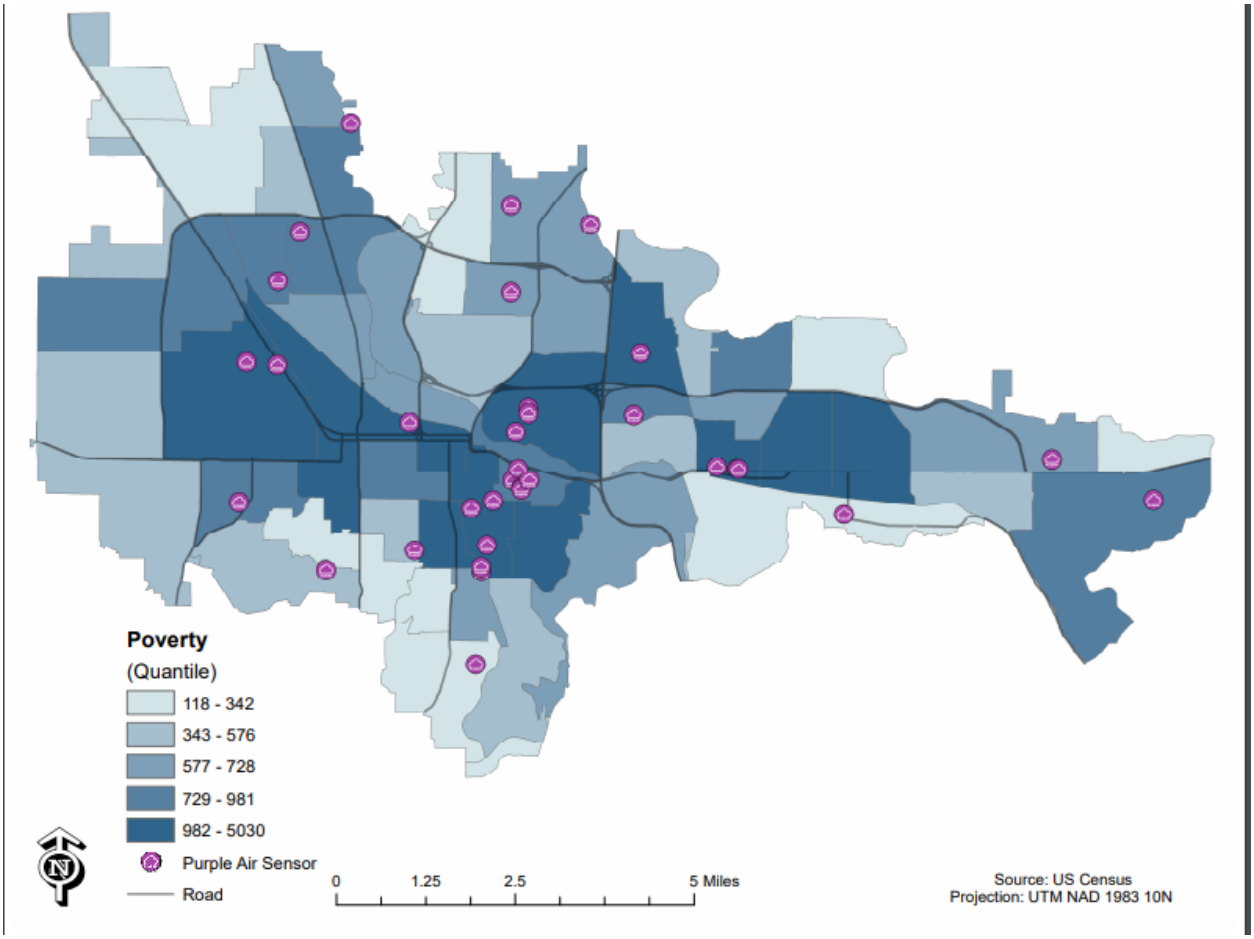


Figure 15: Poverty - Eugene/Springfield



To identify areas in Eugene where people may be financially distressed and unable to mitigate air quality events independently, or travel to cleaner air spaces or regions, figures 14 and 15 illustrate both the count of households below the poverty line, as well as proportion of census tract with households below the poverty line. The largest concentration of individuals, both by count and proportion, considered below the poverty line are in the downtown core of Eugene, west Eugene, as well as east Springfield.

Figure 16: Disability - Lane County

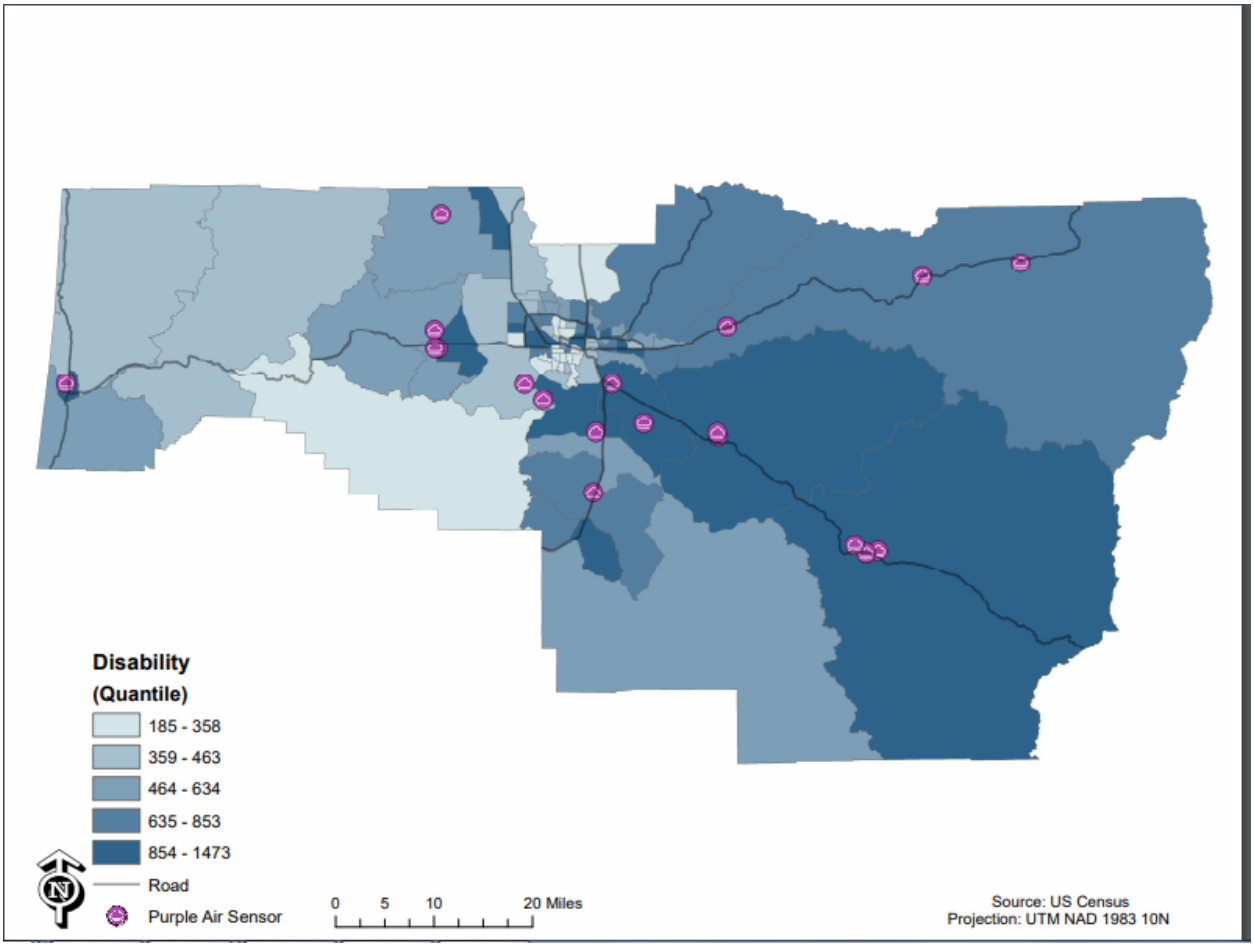
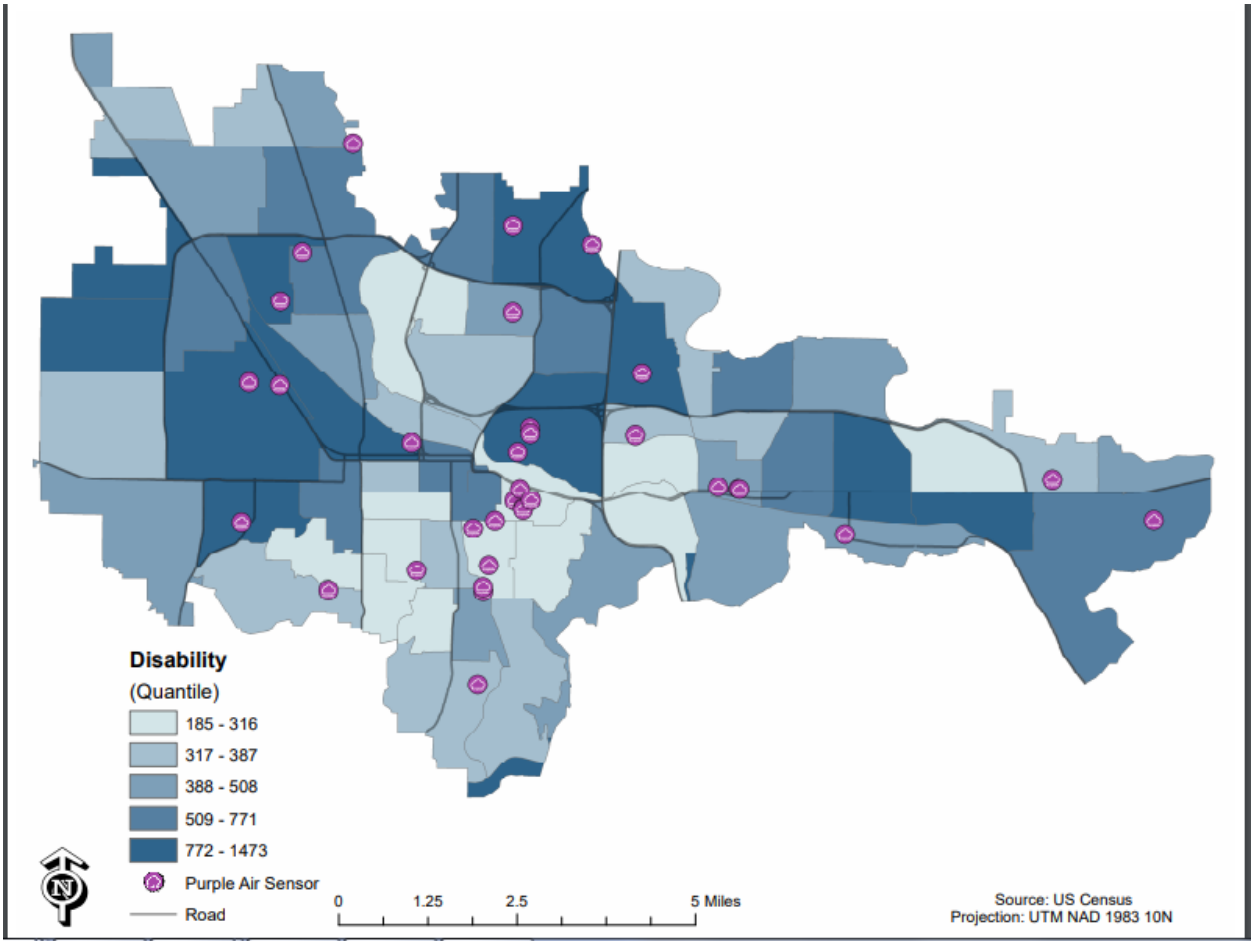


Figure 17: Disability - Eugene/Springfield



Figures 16 and 17 illustrate the count of individuals within census tracts who identify as having a disability, either physical or cognitive. People who have disabilities are less likely to have the mobility to travel to cleaner air spaces, and therefore may be more vulnerable to the impacts of poor air quality. The tracts with the highest proportion of people with a disability are in west Eugene and northwest Springfield. However, the largest populations of people with disabilities are east Springfield and west Eugene.

Figure 18: Vehicle Ownership - Lane County

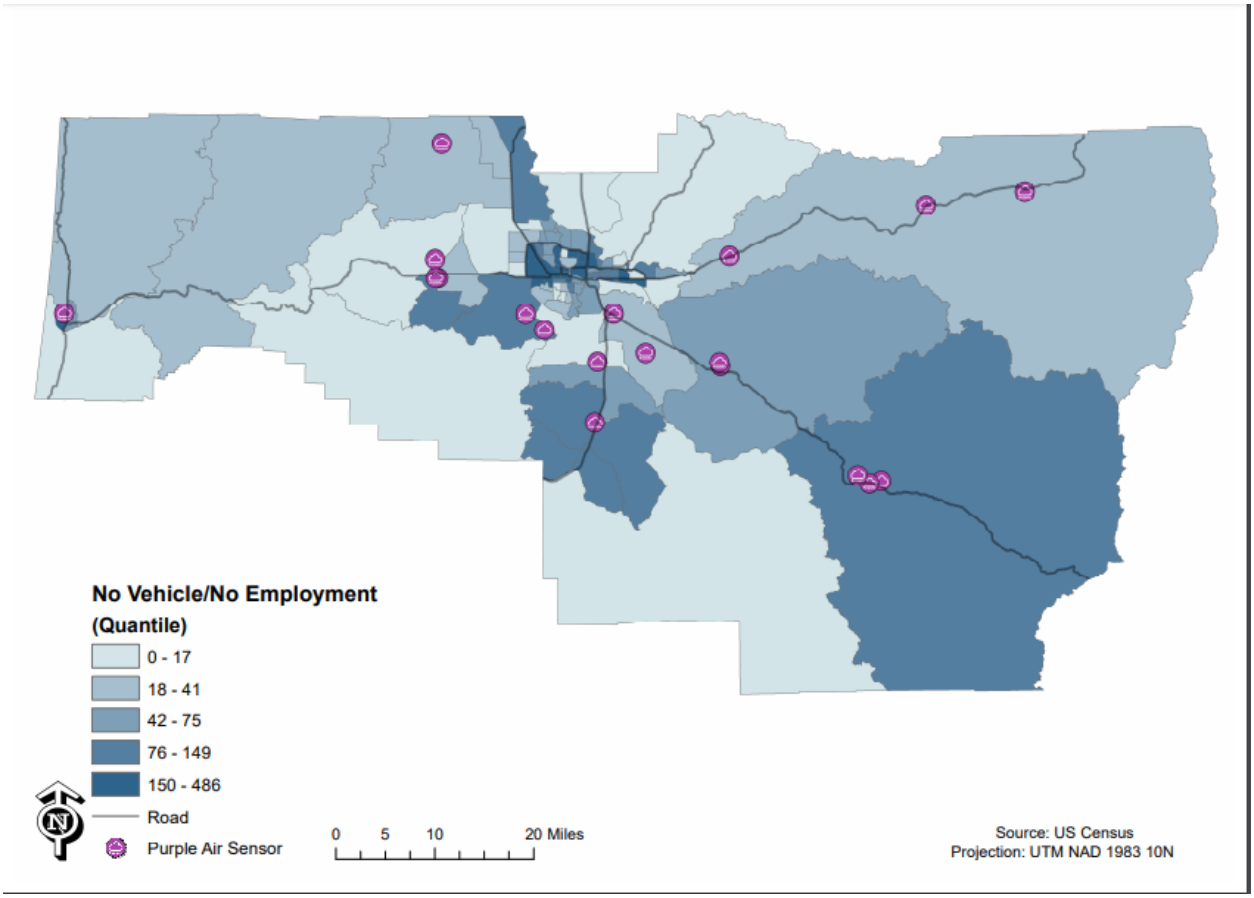
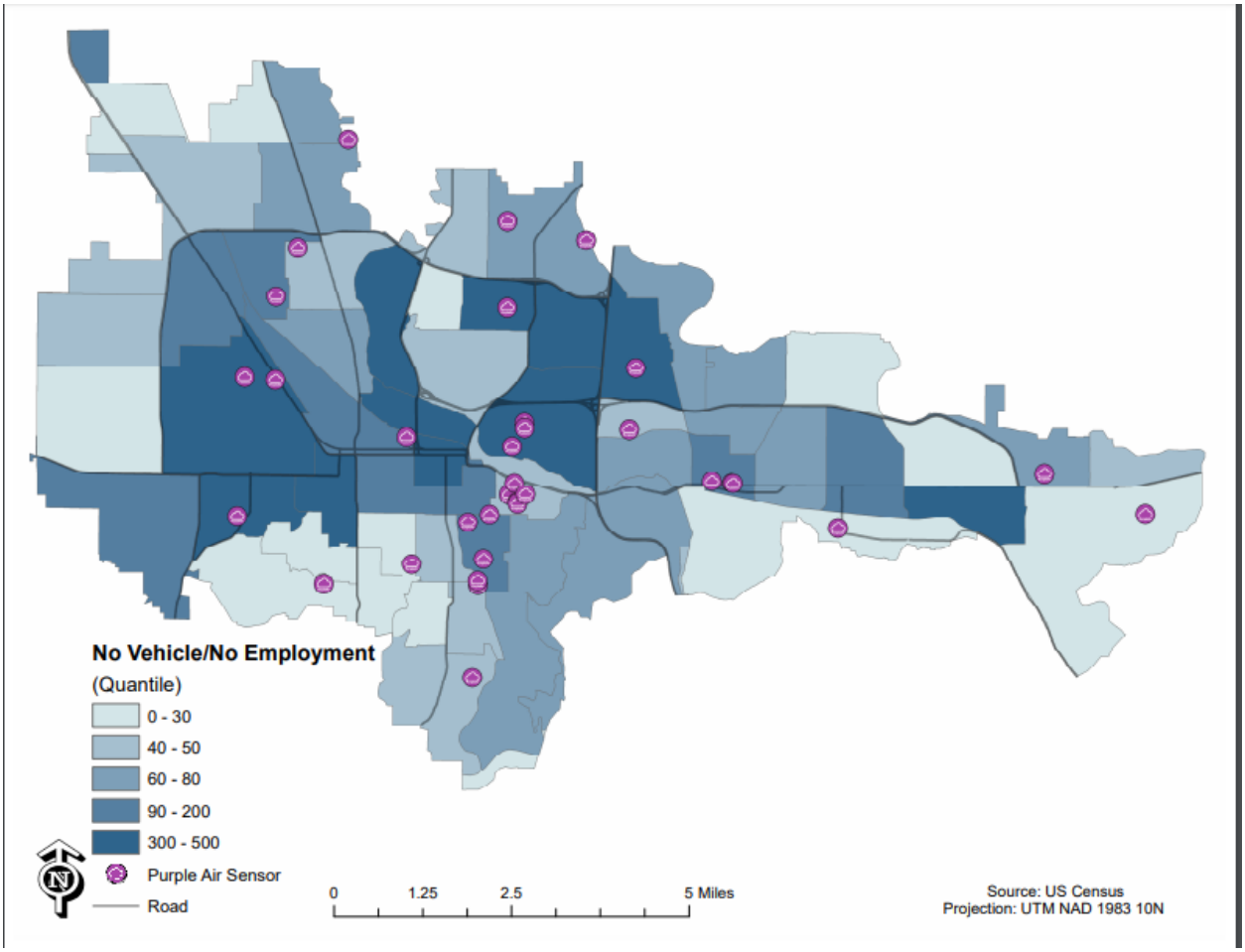


Figure 19: Vehicle Ownership - Eugene/Springfield



In addition to financial constraints, some households do not own a vehicle, creating a barrier to accessing a cleaner air space. Figures 18 and 19 illustrate the count of households by census tract where non-working households do not own a vehicle in Lane County and Eugene/Springfield, respectively. At the county level, large rural tracts have low counts of non-working individuals without a car. This is to be expected given the necessity of individual transportation to get to commercial and retail areas. Within Eugene and Springfield, there is a large count of individuals in west Eugene and north Eugene who do not possess a vehicle.

Figure 20: Health Insurance - Lane County

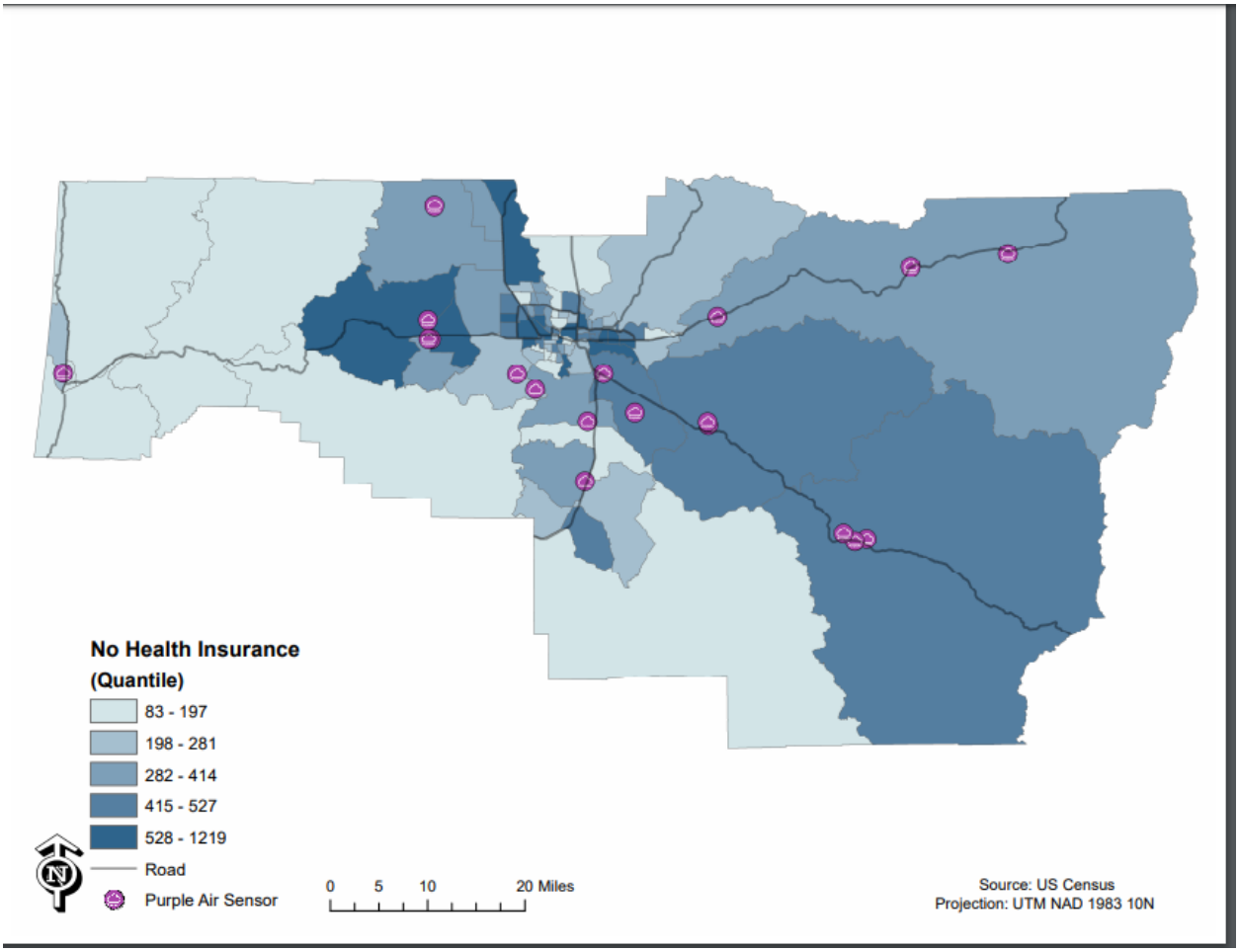
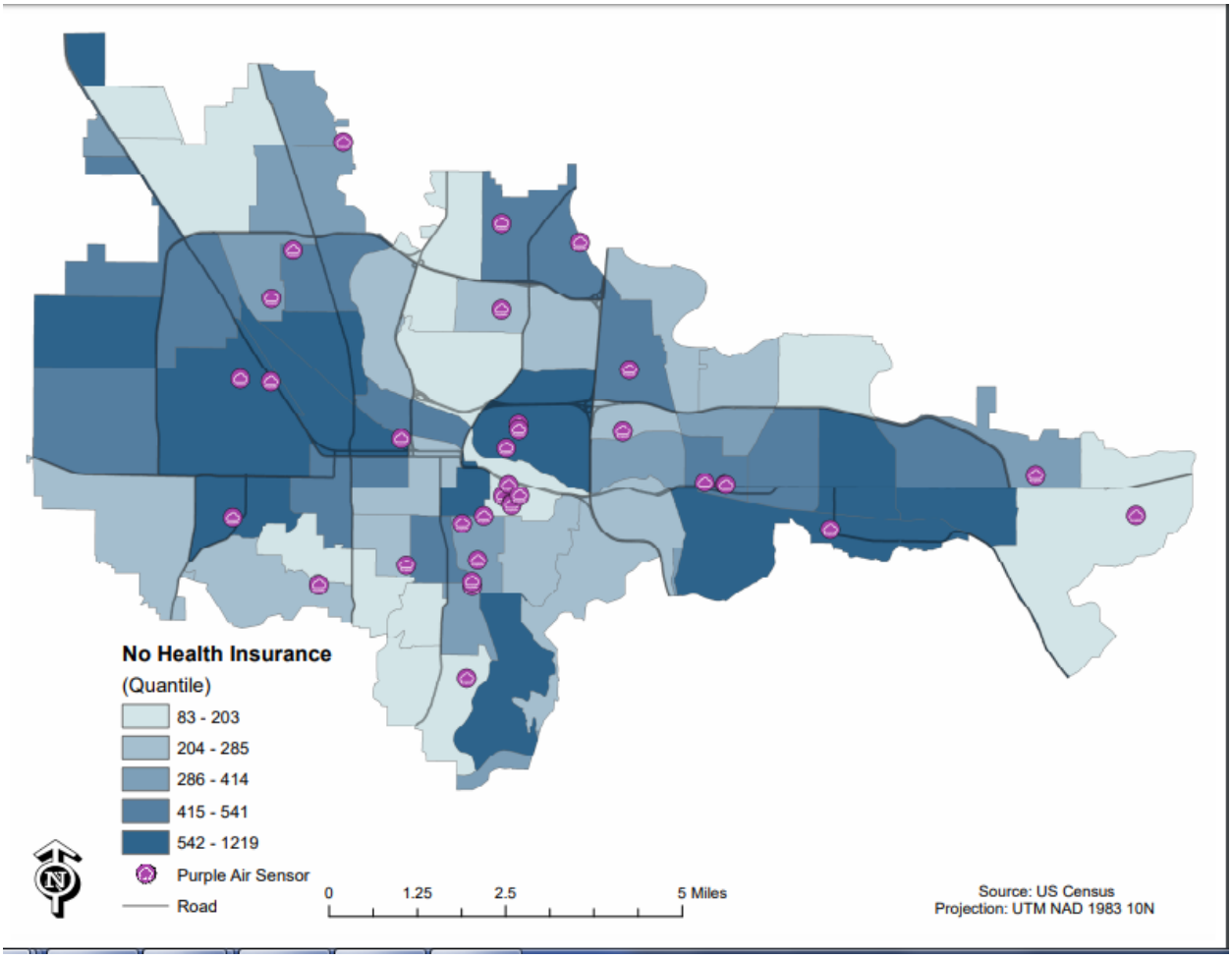


Figure 21: Health Insurance - Eugene/Springfield



To complement identification of vulnerable populations to poor air quality, Figures 20 and 21 illustrate the count of individuals and percent of people within census tracts who do not possess health insurance. Persons without health insurance may be less likely to seek medical attention for health issues brought on by high levels of air pollution. At the county level, there is a high count of individuals who do not possess health insurance just west of Eugene's UGB, as well as the southeast rural portion of the county. Within Eugene and Springfield, there are high counts of individuals without health insurance throughout both cities.

Figure 22: Non-Citizens – Lane County

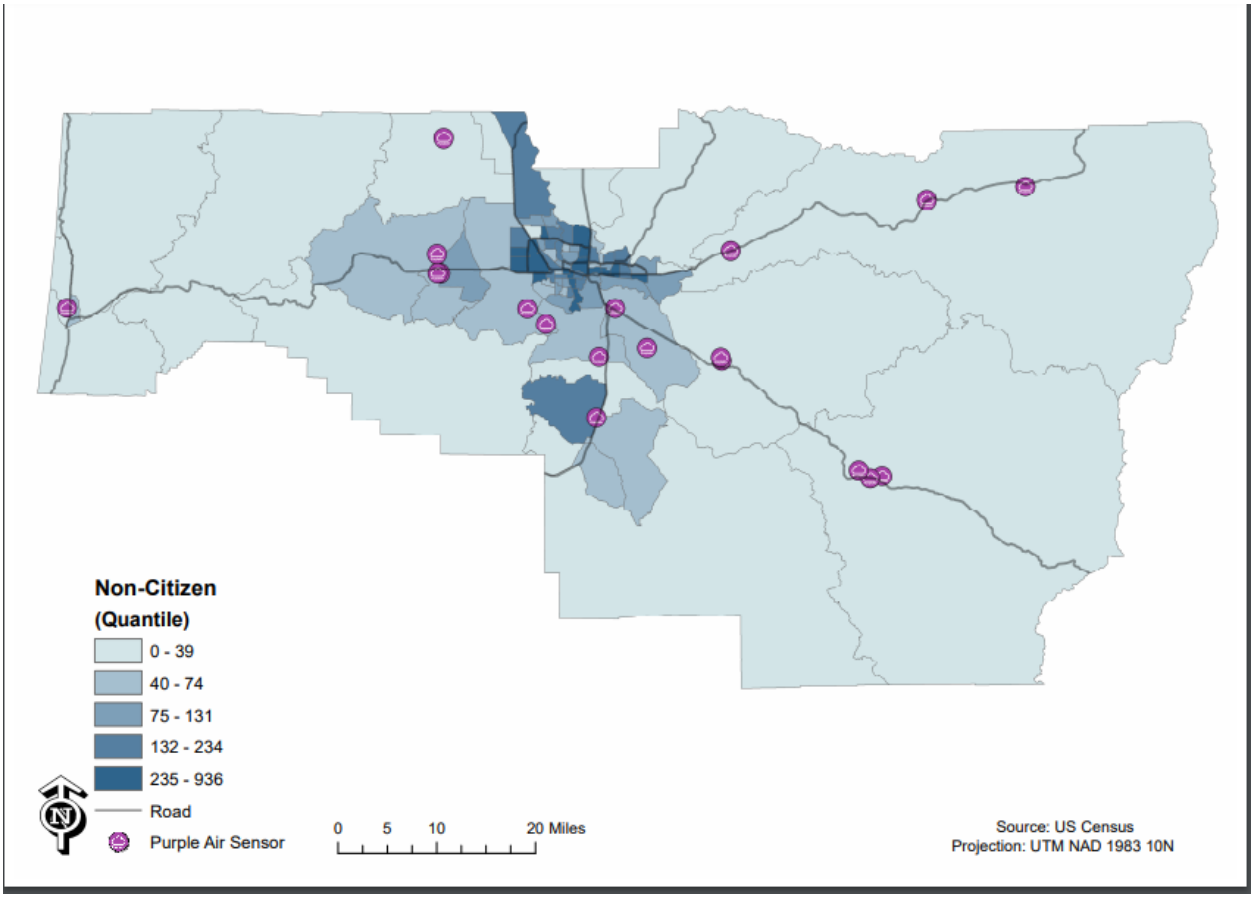
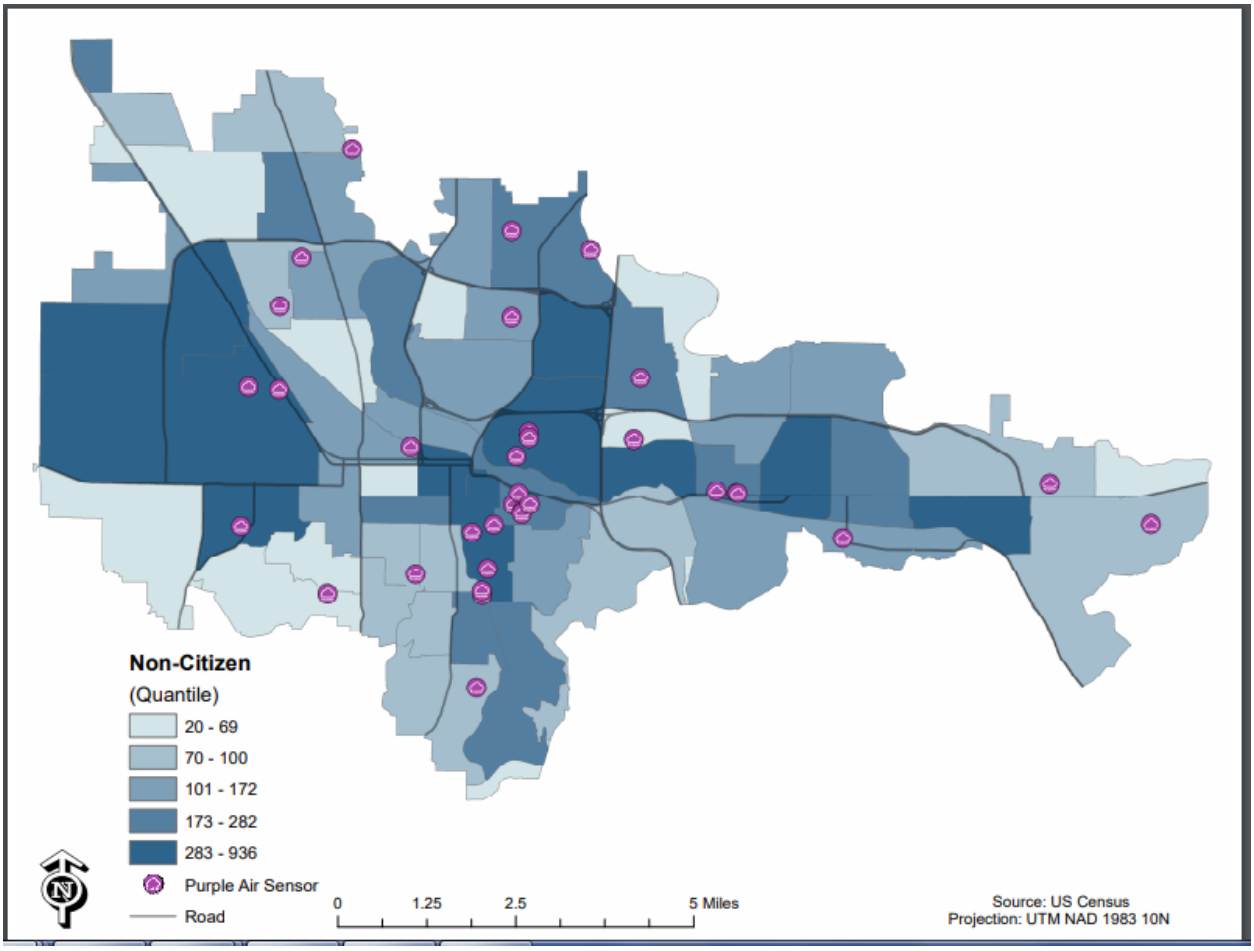


Figure 23: Non-Citizens - Eugene/Springfield



Another vulnerable population for air pollution events is non-citizens. Non-citizens face several barriers to public health resources such as limited English proficiency or fear of confrontation with law enforcement. Figures 22 and 23 identify both the count and percent composition of individuals who are non-citizens by census tract. At the county level, there are very few individuals that are non-citizens. Almost all individuals who are not citizens are within UGBs. This is likely due to the presence of the University of Oregon, as well as industry. These data suggest that cleaner air spaces and air-quality data should be presented in a multitude of non-English languages, especially within the Eugene and Springfield UGBs.

Qualitative Data Analysis

In the section below, each of the 10 interview questions are presented followed by a summary and an analysis of those responses. The research team sought key information from interviews including a description of LRAPA's and Lane County Public Health's current policy for the use of cleaner air spaces, existing coordination among agencies, organizations involved in the response to smoke intrusion and wildfire events in Lane County, and ideas on how to improve current cleaner air space policy.

Question 1: What is your role and some of your responsibilities?

The purpose of question one was to assist the research team in determining the roles of interviewees as well as some of their responsibilities. A total of 12 individuals were interviewed, nine from LRAPA and three from Lane County Public Health. Of the nine LRAPA interviewees, three worked as permit writers, one in data analytics, two in public affairs, one in administrative support, and two as citizen advisors. For the three Lane County Public Health interviewees, one was an executive and two worked in emergency preparedness/response.

When asked about general responsibilities, three of 12 interviewees stated permit writing was one of their key responsibilities. Also, four of 12 interviewees state they are actively involved in policy implementation and dissemination in regard to public health or environmental concern including air quality levels, health promotion and public safety information. Nearly half of the interviewees state they have direct contact with Lane County residents and assist them with health or environmental science education and work from protocols to advise residents on the potential best course of action when responding to poor air quality in Lane County. These actions range from sheltering in place to recommending the resident seek emergency medical services. Three of 12 interviewees state they are involved in coordination and response to public health emergencies such as communicable disease outbreaks or environmental emergencies such as wildfires and subsequent smoke intrusions in Lane County.

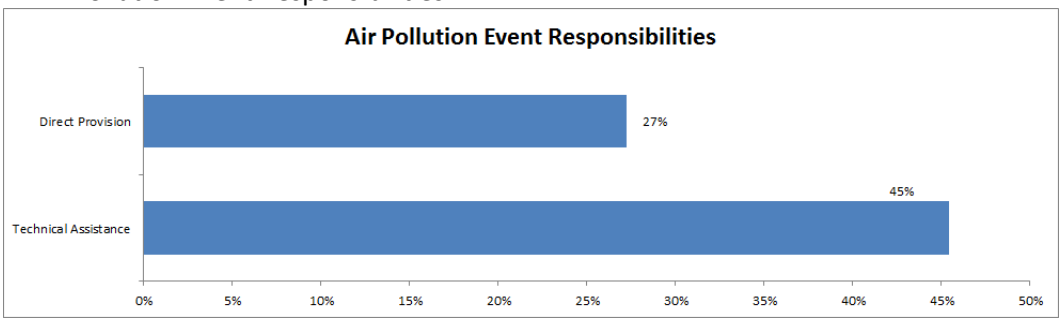
In summary, our key finding was there is substantial variation in roles with some overlap in responsibilities due to the interest in collaboration and the need to have multiple individuals trained to perform key responsibilities, especially during an emergency where there may be an increase demand of services in areas such as health and environmental science education.

Question 2: What are your responsibilities, if applicable, in an air pollution event (e.g. wildfires)?

The purpose of question two was to determine the interviewees' responsibilities during an air pollution event such as a smoke intrusion or wildfire. Answers ranged from providing technical assistance including health education, data monitoring and analysis to direct provision of services such as providing air purifiers to impacted communities or providing temporary accommodations to displaced residents.

Four of the 12 interviewees state they aren't directly involved or have minimal responsibilities during an air pollution event. Two of the five interviewees that do state they have an active role oversee or direct preparedness and response operations during these events ranging from issuing public advisories such as limiting time outdoors to providing air purifiers to impacted communities so cleaner air spaces can be created. One interviewee also states that s/he is responsible for social media posts and ensuring Lane County residents who follow LRAPA's social media accounts have up to date and accurate information in regard to air quality and recommendations during a smoke intrusion event. Two interviewees who do not have an active role during air pollution events note that an environmental policy called "Title 51" details operational changes to industries if the air quality reaches a certain threshold. However, they state that the thresholds are so high that reduced operations in an effort to combat poor air quality has not occurred to date. Figure 24 provides a percentage breakdown of air pollution event responsibilities.

Figure 24: Air Pollution Event Responsibilities



Overall, this question provided a robust description of wildfire/air pollution event specific responsibilities throughout LRAPA and Lane County Public Health. Our key finding was the majority of interviewees (six of 12) had specific wildfire/smoke intrusion responsibilities. Two of 12 interviewees state that they provide both technical assistance and direct provision of services during a wildfire/smoke intrusion event.

Question 3: What other departments and/or people within your organization do you collaborate with to accomplish your work?

All 12 interviewees state they collaborate with at least one other department within their organization. Six of 12 interviewees state they collaborate with more than one other department within their organization. Examples of collaboration include translating a description of the PurpleAir air quality monitoring system program to Spanish, data modeling or creating infographics of environmental data such as wind speed, direction and trends in air quality. The top four departments that interviewees collaborate with are public affairs (3), data analytics (2), permit writers (2), executive director (2). In Figure 24, an "X" denotes an interviewee in that role who states they collaborate or interact with another department within their organization. For example, for data analytics, interviewees in that role state they collaborate with public affairs, permit writers and executive positions.

Figure 25: Collaboration within organization table

ROLE / INTERACTS WITH	Public Affairs	Data Analytics	Permit Writers	Executive	Human Resources	Environmental Health	Communicable Disease
Data Analytics	X		X	X			
Executive	X						
Permit Writer	X	X			X		
Emergency Response	X					X	
Public Affairs		X	X	X			
Administrative Support	X						
Citizen Advisor		X		X		X	X

A key finding from this interview question is that an individual who works in a public affairs role typically collaborates with the most departments within an organization.

Question 4: Who do you collaborate with outside your organization to accomplish your work?

All 12 interviewees state they collaborate with at least one other agency. A total of 10 organizations were mentioned. Seven of 12 interviewees mentioned they collaborate with more than one organization. Most interviewees collaborate with four organizations--Oregon Department of Environmental Quality (DEQ), Lane County Public Health, Oregon Department of Forestry and Neighborhood Associations. Examples of collaboration include working with a Lane County school district to create a cleaner air space in an area affected by poor air quality. Figure 25 details the amount of times each organization was mentioned in regard to whether or not LRAPA or Lane County Public Health interviewees collaborated with them to complete their work. For example, Oregon DEQ was mentioned by four different interviewees as an agency they collaborate with outside their own organization. A key finding from this question is that there is substantial collaboration between governmental and nongovernmental organizations in Lane County as noted from over 50% of interviewees stating that they work with more than one other organization to complete their work.

Figure 26: Collaboration Outside Organization

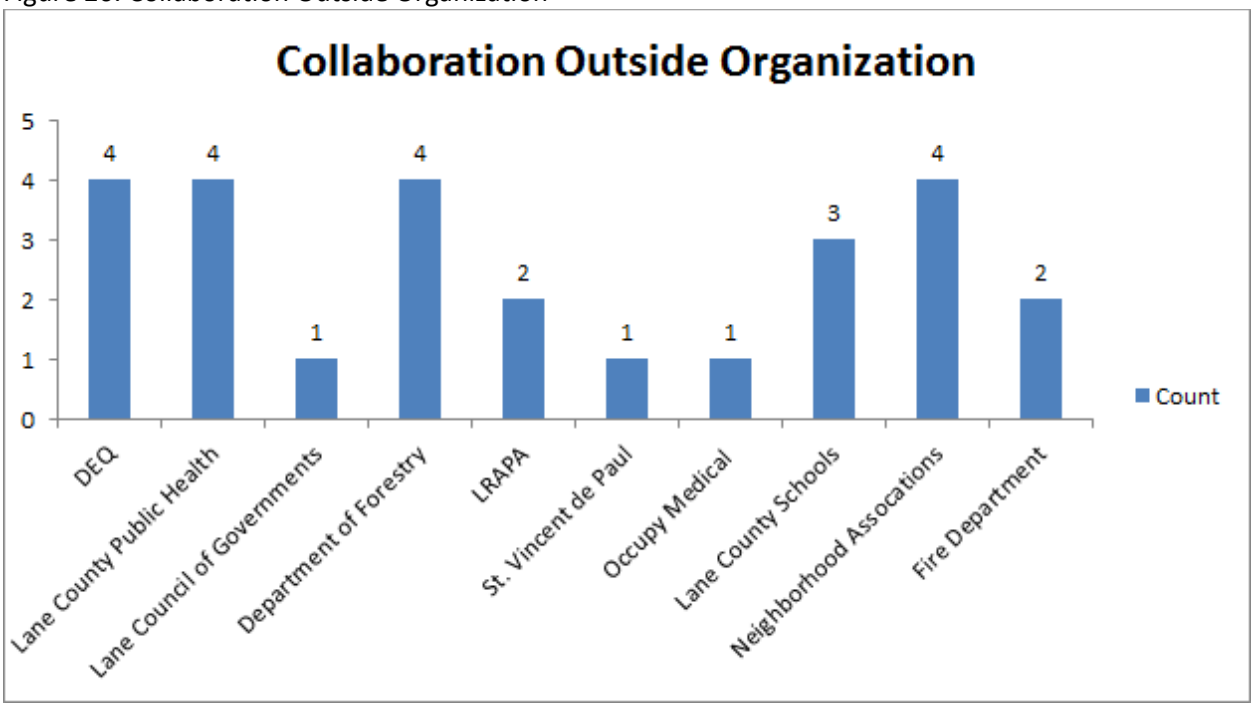


Figure 25

Question 5: What is your organization's policy or response to air pollution events (e.g. wildfires)?

Figure 27 details components of LRAPA's and Lane County Public Health's joint policies during wildfire and smoke intrusion events. This information was gathered from interviews with LRAPA and Lane County Public Health employees. Descriptions of each policy component by agency follow.

Figure 27: Policies by Agency During Wildfire / Smoke Intrusion Event

Policy Component	LRAPA	Lane County Public Health
Technical Advice	1. Monitoring and Data Management	1. Monitoring and Data Management 2. Advise on the use of cleaner air spaces
Direct Provision	1. Answering Questions / Complaints from the Public 2. Public Outreach and Education 3. Coordinating interagency relationships	1. Answering Questions / Complaints from the Public 2. Public Outreach and Education 3. Coordinate public health emergency preparedness and response operations 4. Provide air purifiers to assist in creation of cleaner air spaces

LRAPA Air Pollution Event Policy Components:

<u>Technical Advice</u>

1. **Monitoring and Data Management:**

"Our main responsibility is providing data. We are not a health agency. We get a lot of questions like 'should I go outside?' We can say here's the data and the guidelines and you need to make that decision."

-LRAPA employee

The above quote illustrates the view of at least two LRAPA employees. LRAPA has substantial capacity to monitor air quality throughout Lane County through the use of PurpleAir sensors. Other public and

private agencies in Lane County often solicit technical advice from LRAPA on the current state of air quality in Lane County to support policy or response decisions.

2. **Answering Questions/Complaints from the public:**

Although part of LRAPA's mission is to protect public health of Lane County residents, it is not within their employees' scope of practice to provide public recommendations on the best course of action, such as limiting time outdoors or canceling public events, during periods of poor air quality. However, certain staff members can restate information from Oregon state government published documents that provide recommendations such as the "Oregon Health Authority (OHA) Fact Sheet – Public Health Guidance for School Outdoor Activities During Wildfire Events." So, although these LRAPA employees aren't providing advice in this scenario, they can still reference OHA documents and restate recommendations to answer the public's questions in a timely and effective manner.

Direct Provision of Services:

1. **Public Outreach and Education:**

Although LRAPA does not provide specific recommendations on the best course of action relative to an air quality event, it does have a multi-pronged approach to public outreach and education. For example, seven interviewees state that LRAPA's public outreach and education spans multiple outlets including social media (e.g. Twitter, Facebook), TV interviews, newspaper press releases, radio interviews, phone text message alerts, and email. Overall, the majority of interviewees think this public outreach approach is effective, but with potential areas of improvement including the use of digital billboards showing air quality in high traffic areas throughout Lane County. LRAPA also has a public education component where the agency has provided in person presentations on material such as how to create personal air cleaners using a standard box fan and HEPA filter.

2. **Coordinating interagency relationships:**

LRAPA staff often interacts with several different agencies including Oregon Department of Forestry, fire departments within Lane County, and Lane County Public Health. For example, LRAPA public affairs staff has worked with fire department public information officers as well as Lane County Public Health to coordinate the information dissemination in regard to air quality.

Lane County Public Health

Technical Advice:

1. **Advise on the use of cleaner air spaces:**

Lane County Public Health follows state guidelines, specifically the "Oregon Wildfire Response Protocol for Severe Smoke Episodes" document, when recommending the use of cleaner air spaces in Lane County. This response protocol advises opening cleaner air spaces for sensitive groups when air quality is in the "Orange" or an AQI between 101-150. Examples given by interviewees of cleaner air space shelters include churches and public spaces such as a library or mall.

2. **Monitoring and Data Management:**

Lane County Public Health often uses data compiled by ESSENCE or OHA's disaster epidemiology data that examines Emergency Room/Urgent Care visits by type in Lane County to assist in emergency preparedness and response during wildfires or smoke intrusion events. Lane County employees also state that they work closely with LRAPA to determine a current air quality situation and what they are predicting in regards to air quality levels in the future.

Direct Provision of Services:

1. **Answering Questions / Complaints from the Public**

One interviewee states that Lane County Public Health is required to answer emails or questions posed by the public within 24 hours.

2. **Public Outreach and Education**

There is collaboration between LRAPA and Lane County Public Health in regard to information dissemination on air quality. One interviewee states that Lane County Public Health often uses the same social media post/language or re-posts informational releases from LRAPA during periods of poor air quality in Lane County. Lane County Public Health's public affairs officer also has worked closely with LRAPA's public affairs officer to ensure continuity in public information dissemination.

3. **Provide air purifiers to assist in creation of cleaner air spaces**

Three interviewees note that Lane County Public health has an inventory of eight air purifiers that can be used to help improve air quality of locations as needed. Prior to having these devices, Lane County Public Health acquired air purifiers from the state to assist in the creation of a cleaner air space shelter at a school in the Upper Mackenzie River area during a wildfire.

4. **Coordinate public health emergency preparedness and response operations**

Lane County Public Health also works closely with Lane County and city-level Emergency Management personnel as well as other public and private organizations during public health emergencies including smoke intrusion or wildfire events. For example, one interviewee states there has been at least one occasion where a shelter has been activated during a smoke intrusion event where Lane County Public Health worked with the City of Eugene. Another interviewee states that when following the states' protocols for smoke intrusions, there has never been an occasion where an overnight cleaner air space shelter was opened because of protocol; this response typically is not recommended unless there has been at least 24 hours of a sustained period where air quality is in the "Red" or an AQI between 151-200. However, during the 2017 wildfire season, there was one period of air quality where this 24-hour threshold of "Red" was almost met. A finding from interviews is that in these scenarios a list of potential cleaner air spaces are usually generated on the spot based on what buildings are available for use including places like libraries and senior centers.

Question 6: How do you see cleaner air spaces being utilized by Lane County residents?

Question six yielded a variety of answers. One area of agreement among four of 12 interviewees is that many houses in Lane County as well as Oregon overall don't have air conditioning units, most likely due to the region's mild climate. Also, four interviewees note that they have previously recommended that Lane County residents use public buildings like libraries and malls or other buildings such as community

centers or recreation centers as cleaner air spaces. However, two of these interviewees note that they envision these buildings used as a temporary daytime shelter so that individuals have the opportunity for a short recovery period for their lungs. Three interviewees state that they saw cleaner air space shelters being used by Lane County residents with compromised health, whether it be respiratory issues or other conditions, during periods of poor air quality. Another interviewee also notes that people experiencing homelessness and of lower income may also be individuals who could benefit from public cleaner air space shelters.

Overall, interviewees' answers to this question yielded valuable perspectives on different populations within Lane County that may benefit from public cleaner air spaces. Responses note historical challenges in Oregon without air conditioning in personal homes. Another key finding is that some interviewees envision these public cleaner air spaces being a temporary daytime shelter.

Question 7: Do you see any barriers to the utilization of cleaner air spaces within Lane County?

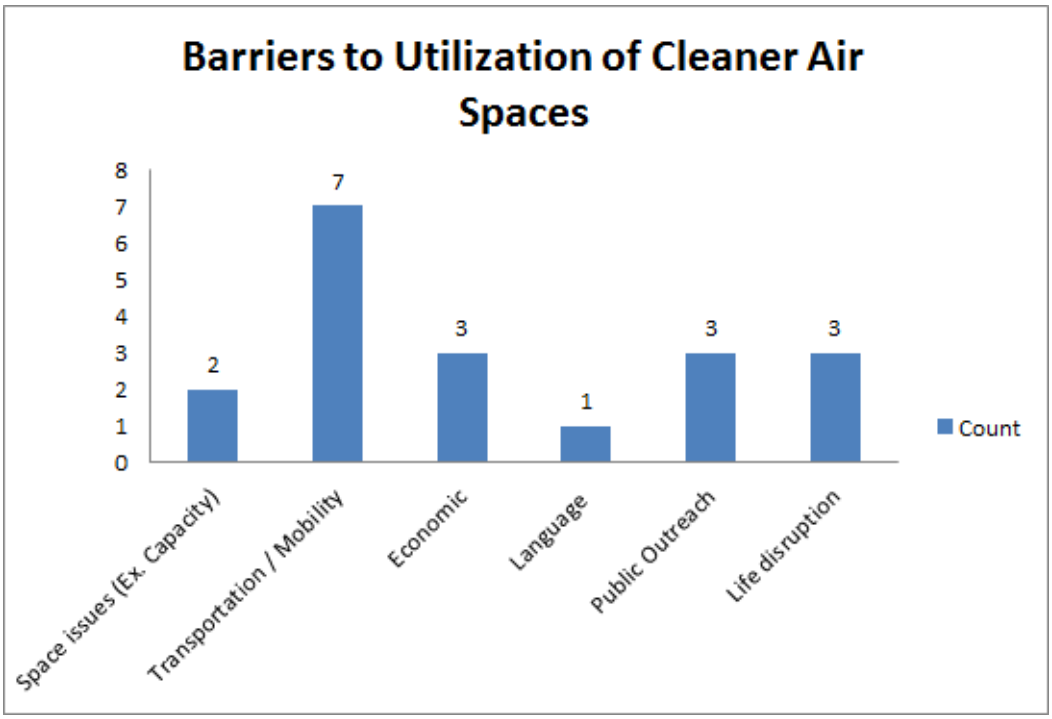
Interviewees noted several barriers to the utilization of cleaner air spaces by Lane County residents that fell into six categories including:

1. Space issues that can revolve around capacity or private ownership of a potential cleaner air space shelter
2. Transportation/mobility issues of residents such as no personal vehicle or differing levels of mobility due to age and/or medical condition that can make it challenging to move to a cleaner air space
3. Economic barrier examples include not being able to afford a bus pass to get to the cleaner air space
4. Language barriers include not knowing that cleaner air spaces are available due to limited English-speaking proficiency if majority of public outreach is conducted in English
5. Public outreach issues such as ineffective dissemination to the public that cleaner air spaces are open in Lane County and pertinent information relating to these spaces including capacity, hours open, and location.
6. Life disruption issues relate to Lane County residents not wanting to leave their homes and temporarily stay in cleaner air space shelters.

Figure 27 illustrates barriers mentioned most frequently by the 12 interviewees.

Figure 27: Barriers to utilization of cleaner air spaces

Figure 28

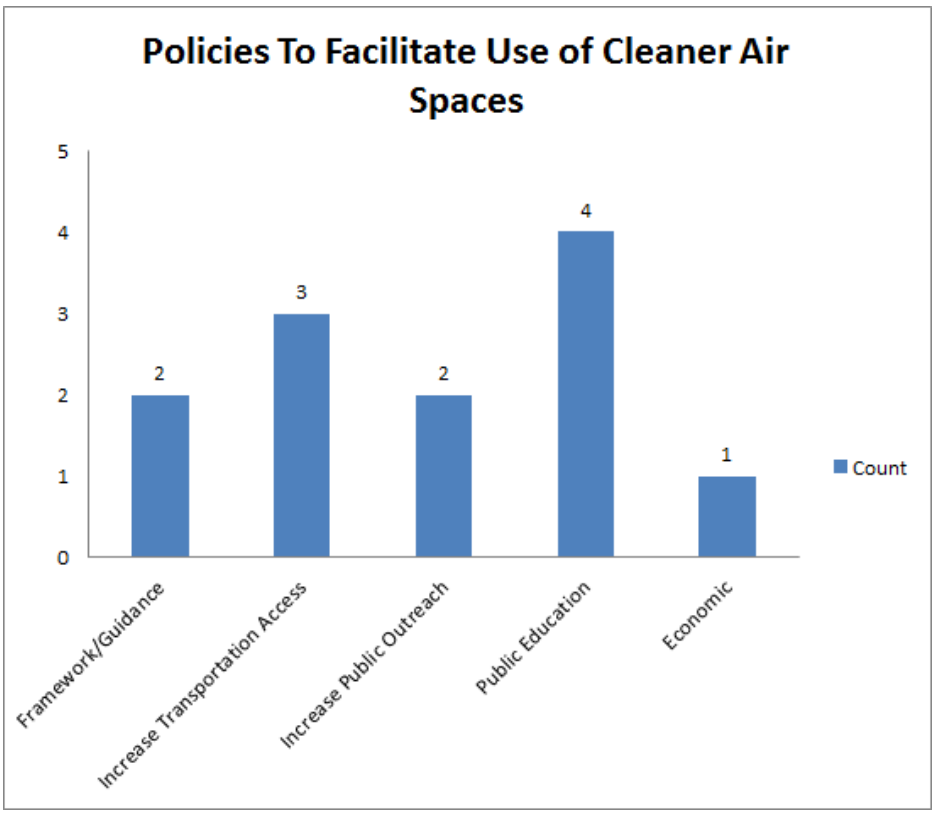


Overall, transportation was mentioned the most with seven of 12 interviewees stating this was a barrier. There were three categories, economic, public outreach, and life disruption, that were mentioned by three of 12 interviewees. The results or answers from this question are valuable because they highlight what our interviewees believe are major barriers that need to be eliminated so that opening cleaner air spaces can be an effective policy response during a wildfire or smoke intrusion event in Lane County.

Question 8: What additional policies or mechanisms do you believe can facilitate the use of cleaner air spaces within Lane County?

Question eight is similar to question seven with the key difference being that we were hoping to solicit policy responses to eliminating these barriers brought up in question seven. Figure 29 illustrates types of policies that interviewees mentioned.

Figure 29: Potential policies that facilitate use of cleaner air spaces



Overall, public education policies were mentioned the most by interviewees. One example is providing education on alternatives such as the use of N95 masks or sheltering in place and potential pros and cons of these alternatives in comparison to utilizing a cleaner air space shelter during a wildfire or smoke intrusion event in Lane County. One interviewee noted that there should be the avoidance of phrases such as "the research says" and that communicating health research can be very difficult to the general populace. Policies revolving around improving transportation to facilitate the use of cleaner air spaces was mentioned the second most with three interviewees offering potential policies. One interviewee noted that it may be beneficial to have cleaner air spaces close to major bus routes in Lane County and another interviewee noted that partnering with LTD to offer free bus rides to these cleaner air spaces may be policies that alleviate transportation barriers.

Question 9: [If they do not bring up PACs as mechanism in question 8, ask this] How extensively have personal air cleaners been tested prior to coming to this idea of starting shelters?

The purpose of question nine was to determine what our interviewees thought of the use of portable air cleaners. Three LRAPA interviewees brought up portable air cleaners, specifically a past response to a smoke intrusion event in Lane County where the LRAPA public affairs manager demonstrated the construction of a homemade portable air cleaner using a box fan and a HEPA filter to neighborhood

associations in Lane County. One interviewee noted opportunities for improvement including creating a training video that details assembly as well as effectiveness of the device such as how it can improve the air quality in a room up to 300 square feet if doors/windows in the room are kept closed. However, one potential issue brought up by an interviewee is that the temperature may be high enough outside during wildfire season that closing doors/windows may be problematic in that it could increase the temperature in the home to an uncomfortable level to its inhabitants. Interviewees note that this homemade portable air purifier option is inexpensive, potentially alleviating the economic barrier as well as appealing in that people do not have to leave their homes to go to a cleaner air space. One interviewee noted that HEPA filters may be hard to come by during wildfire season, especially ones typically available in stores.

Overall, the answers provided to this question gave insight to the research team in how an organization like LRAPA can assist Lane County residents in potentially creating private cleaner air spaces in their homes if there are barriers going to a public cleaner air space such as life disruption.

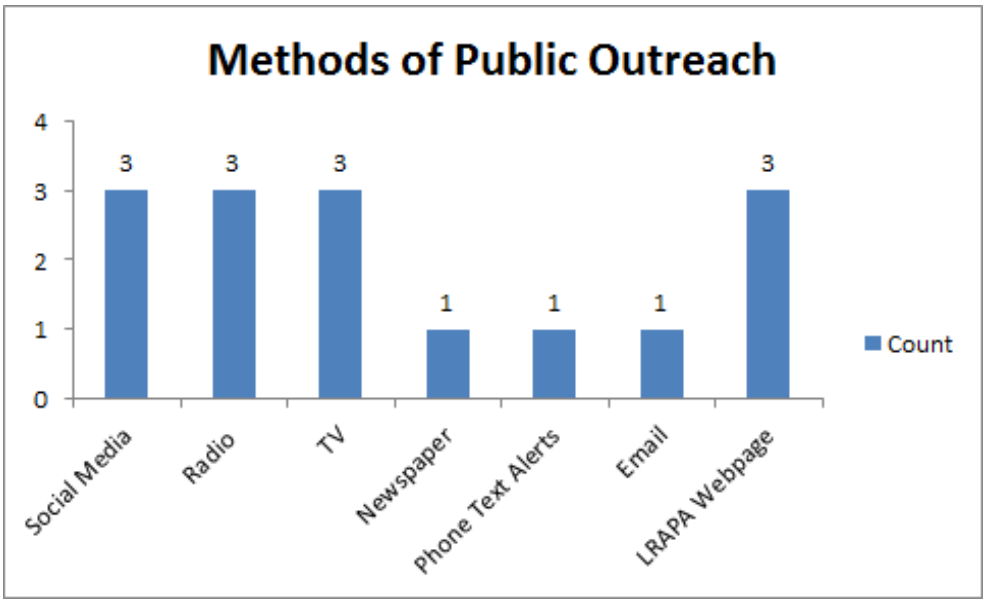
Question 10: [If they do not bring up public warnings as mechanism in question 5 or 8] What do you believe is the best approach/mechanism for delivering air quality information (PM 2.5 and availability of cleaner air spaces/mitigation strategies) to the public?

Do you feel that current mechanisms are adequate?

[If no] What additional mechanisms or changes to current mechanisms do you believe will facilitate adequate delivery of air quality information?

The purpose of question 10 was to prompt interviewees to elaborate on their thoughts on current mechanisms to disseminate information to the public if they didn't do so in questions five or eight. Figure 30 details which methods interviewees mentioned the most often as ways to disseminate information to the public in regard to LRAPA's and Lane County's response to a smoke intrusion or wildfire event.

Figure 30: Methods of Public Outreach



Social media, radio, TV, and LRAPA's webpage were mentioned by three different interviewees. Other methods include newspaper, text alerts, and email.

Potential Cleaner Air Space Criteria Identified By Interviewees

One of the primary objectives of this research project was to determine criterion that will assist in cataloging these spaces. Several potential criteria for the identification of cleaner air spaces in Lane County emerged from the interviews including:

1. Capacity (to be determined by square footage in the "Considerations for the Location of Cleaner Air Spaces" section)
2. Public or private cleaner air spaces (a private cleaner air space could be a church, which has historically been considered or utilized by Lane County Public Health preparedness/response officials during public health emergencies such as smoke intrusions)
3. Geographic Location in Lane County (considerations for social factors such as income, car ownership, urban/rural environment as well as air quality in surrounding area)
4. Availability (daytime or overnight)
5. Type of filtration system in building

Considerations for the Location of Cleaner Air Spaces https://www.airnow.gov/aqi/aqi-basics

Public Spaces

In an attempt to mass identify possible cleaner air spaces that could be utilized during a poor air quality event, GIS analysis utilizing data of buildings in Lane County is joined with additional data of tax lots owned by local, county, and state governments. This extracts buildings that are on government-owned land that may have the potential to be used as a cleaner air space. Given the large number of buildings, data are displayed as the sum of square footage of buildings by Lane County census tract. Also, the research team examined a list of public buildings in excel format.

Please see appendix C for examples of these data and how the research team examined each public space individually by type to determine candidacy as a cleaner air space. For example, community centers were identified as potential cleaner air spaces.

Maps of Potential Cleaner Air Spaces

Figure 31: West Eugene Cleaner Air Spaces

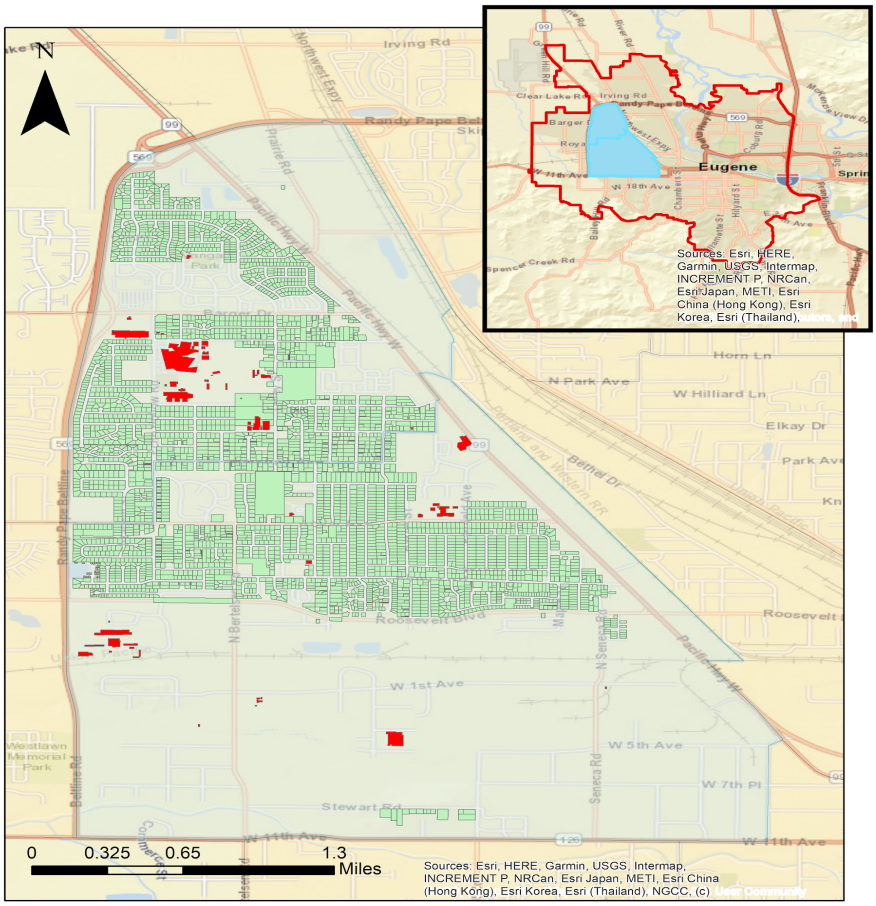


Figure 32: Downtown Springfield Cleaner Air Spaces

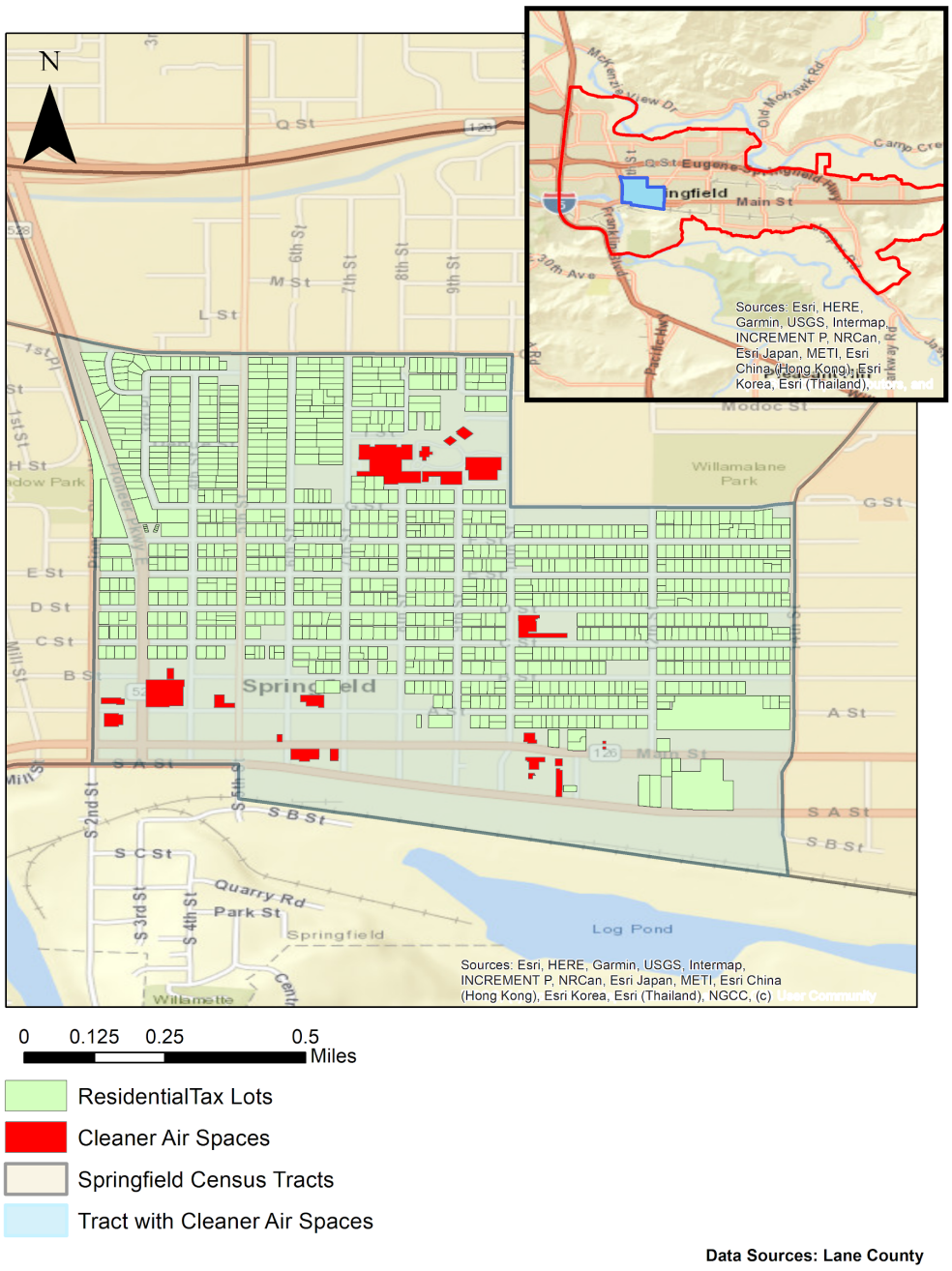


Figure 33: Downtown Eugene Cleaner Air Spaces

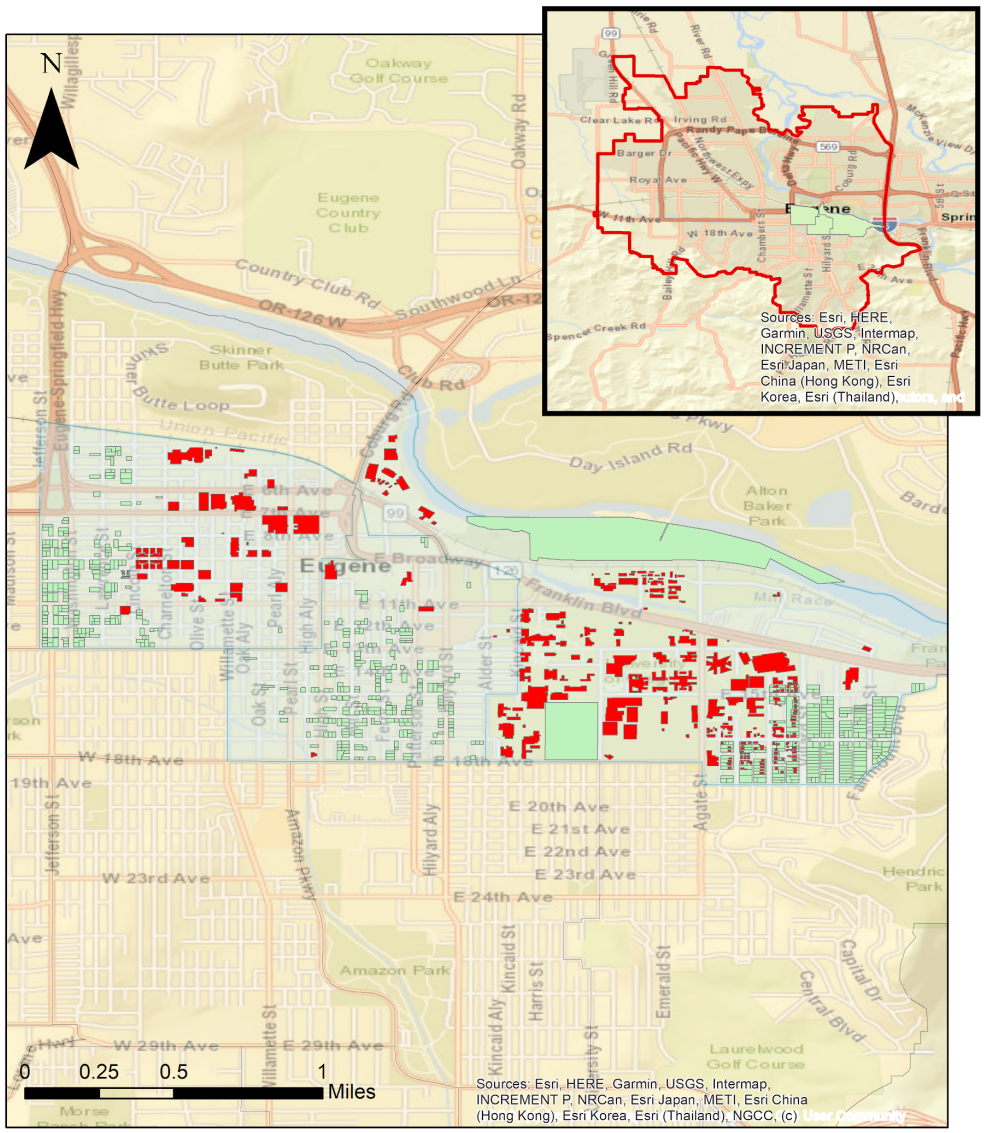


Figure 33

Figures 31, 32, and 33 show the available public spaces that could be used for cleaner air space shelters, focusing on the Eugene-Springfield metro area. These maps were created from public data describing the location, total square footage, and agency in charge of the building. The data do not describe the features that would be necessary to classify them as cleaner air spaces. This data will be crucial in determining the feasibility of use for each space. Significant gaps in coverage exist as well in the metro

area. Because of these gaps, public private partnerships could help achieve equitable availability for the entire metro area. Countywide data will be necessary to assess the availability and feasibility of spaces in those areas as well.

The Eugene maps (Figures 31 and 33) highlight two specific areas of the city that are hotspots for the socioeconomic populations that may be the most vulnerable to high levels of air pollution. For example, west Eugene showed the highest rates of disability and lack of medical insurance in the city. While the downtown area had a similar population to west Eugene, it lacked the same rates of disability. Downtown Springfield, on the other hand, has great access for residents in that area with most residents within walking distance of a potential shelter site. According to the building data, the majority of public buildings are located in the downtown area of both cities, which could present issues in determining the appropriate spaces for these shelters because of mobility and transportation barriers (such as lack of a private vehicle) shown in these populations in the maps.

The types of buildings are important because many are not usable such as university housing where student families reside. In addition to being private residences, they are not equipped with HVAC systems to filter PM 2.5, and they are not suitable for multiple family occupancy. However, there are many buildings that have potential as cleaner air spaces listed in the spreadsheets and shown on the maps. For example, Matt Knight Arena, Moshofsky Center, McArthur Court, or the Hult Center. All of these locations offer the necessary space for mass occupancy for day use but would require substantial support to hold people long-term.

Recommendations

Policies necessary for effective use of cleaner air spaces during an air pollution event

Tracking the utilization of cleaner air spaces

In response to feedback from LRAPA and Lane County Public Health employees, we believe it would be necessary to have a process in place to track the utilization of cleaner air spaces that are opened to the public. This process would be important to determine if the resources relative to the cost of opening and maintaining a cleaner air space are being utilized efficiently. For example, if there is minimal usage of a cleaner air space even after an information dissemination campaign to the public, then other alternatives such as a different cleaner air space location or a focus on a policy alternative such as the use of portable air cleaners in resident's homes may be indicated. If a cleaner air space is opened, we recommend a short survey be conducted to individuals using the cleaner air space asking their address, age, method of transportation as well as how did you hear about the cleaner air space. With these results one can also determine which residents, such as those with disabilities or with no personal vehicles, use cleaner air spaces.

Scenarios for decision makers: The research team also thought it would be beneficial to provide scenarios and a potential process to follow in the event of a smoke intrusion in Lane County and the use of cleaner air spaces is indicated based on AQI levels.

Scenario 1: Smoke intrusion in Eugene/Springfield metro area

If there is a smoke intrusion event in the Eugene/Springfield metro area, there can be several potential responses for public officials involved in the decision-making process to mitigate the health impacts of this event on residents with the use of cleaner air spaces. For example, Lane County can establish pre-determined cleaner air spaces in Eugene and Springfield where there are high concentrations of individuals experiencing poverty, lack of personal vehicle ownership, or lack of health insurance coverage among other social characteristics, such as west Eugene. These buildings can be determined prior to an upcoming wildfire season and protocols related to logistics, staffing, and the utilization of resources can be established to ensure timely availability if there is a poor air quality event. A starting point for identifying areas with high concentrations of vulnerable individuals to poor air quality and potential cleaner air spaces can be determined using maps and spreadsheets within this report. We recommend other features of these cleaner air spaces such as type of filtration system be documented as well. For an example list of cleaner air spaces that can be made available to the public please see Appendix C figure 2.

Scenario 2: Smoke intrusion in rural Lane County

Scenario 2 may present several challenges such as decreased availability of public or private buildings that can be used as cleaner air spaces in rural areas of Lane County. There could also be issues with

these cleaner air spaces not meeting other criteria such as lack of an effective air filtration system. However, Lane County Public Health has noted that at least eight high end portable air cleaners are available for distribution within Lane County if needed for the establishment of cleaner air spaces, especially in resource limited rural areas.

Portable air cleaners

Further study on the use of Portable air cleaners (PACs) is recommended based on interviewee responses as well as supporting scientific studies noted in the literature review on the potential effectiveness of PACs on mitigating health impacts of poor air quality. Using PACs in private residences may be a viable alternative for individuals who do not want to experience a life disruption of moving to a cleaner air space temporarily during the day or potentially overnight depending on sustained poor air quality. However, government subsidies or the provision of PACs to residents would need to be researched further to be a viable policy option.

Information dissemination

Based on the feedback from interviewees as well as relevant studies on effective information dissemination strategies, a multi-pronged approach to informing the public of the opening of cleaner air spaces and their locations is recommended. Infographics highlighting the location of cleaner air spaces as well as the benefits of utilization should be disseminated via social media, newspaper, LRAPA and Lane County Public Health websites as well as in high traffic public areas such as a public library or bus stops prior to and during wildfire season. Other outlets such as radio and television should also be utilized. Budget allocation to information dissemination can be adjusted based on resident provided feedback given via a survey at these cleaner air spaces. Neighborhood association meetings can be another potential outlet to disseminate information on cleaner air spaces. LRAPA and other public agency employees attending these meetings can help establish trust and transparency with community members by letting these residents know potential sites of cleaner air spaces and the rationale of why they were chosen.

Eliminating barriers to the use of cleaner air spaces: We also recommend that stakeholders consider the six barriers identified in this report and listed below when making decisions on the use of cleaner air spaces during periods of poor air quality in Lane County.

1. Space issues that can revolve around capacity or private ownership of a potential cleaner air space shelter. Decision makers should ensure any space issues are resolved or addressed prior to the opening of a cleaner air space. This includes ensuring an accurate estimate of capacity and any potential restrictions imposed by owners such as no pets or daily hours of operations.
2. Transportation/mobility issues of residents such as no personal vehicle or differing levels of mobility due to age and/or medical condition that can make it challenging to move to a cleaner air space. Decision makers should look into partnering with public or private transportation entities such as LTD to ensure individuals who lack reliable transportation, but wish to use cleaner air spaces, can still do so.
3. Economic barrier examples include not being able to afford a bus pass to get to the cleaner air space. Stakeholders should be aware that individuals may not be able to afford to move to a cleaner air space due to economic barriers relating to the cost of transportation or food. This barrier can be lessened with the provision of free public transportation to these cleaner air

spaces as well as free or affordable food available at these cleaner air spaces. Partnerships with local food banks or organizations such as Food for Lane County may be a possibility.

4. Language barriers include not knowing that cleaner air spaces are available due to limited English-speaking proficiency if the majority of public outreach is conducted in English. All maps, infographics, press releases should be translated to Spanish as it is the second most spoken language in Lane County. This will help alleviate the language barriers of many Lane County residents who have limited English-speaking proficiency.
5. Public outreach issues such as ineffective dissemination to the public that cleaner air spaces are open in Lane County and pertinent information relating to these spaces including capacity, hours open, and location. This barrier can be tracked with the use of the previously described surveys that can be given to individuals who utilize cleaner air spaces to determine how the individual heard about the cleaner air space.
6. Life disruption issues relate to Lane County residents not wanting to leave their homes and temporarily stay in cleaner air space shelters. Stakeholders should be aware that utilization of public cleaner air spaces may depend on Lane County residents' tolerance for life disruption where they are choosing to either shelter in their homes during a smoke intrusion event or go to a cleaner air space.

Ideal Framework for successful communications

Key stakeholders in the decision-making process of the use of cleaner air spaces include the Lane County Public Health Emergency Preparedness Coordinator, Lane County's Emergency Manager, LRAPA Public Affairs manager as well as city managers. To ensure a cohesive and collaborative response to these smoke intrusion events as well as wildfires within Lane County, a clear division of responsibilities needs to be established. In regard to technical advice and data provision to support decision making in the use of cleaner air spaces, LRAPA should take a lead in this role due to its air quality monitoring infrastructure and staff specializing in the gathering and analysis of these air quality data from PurpleAir sensors. Direct provision of services should also remain a responsibility of Lane County Public Health and Lane County Emergency Management due to existing relationships with other important stakeholders such as the Department of Forestry and Lane County public schools. When decisions in regards to the use of cleaner air spaces are made, ensure that the data or evidence used to make this decision, such as the maps detailing social characteristics of Lane County residents or the list of potential cleaner air spaces, is made available to each organization and have a designated representative that can champion or support this data driven model.

Appendix A

Case Studies for Seattle, WA, Montana and California

Seattle, Washington

In 2019, the City of Seattle announced that five public and community buildings would receive upgraded HVAC and filtration systems and be open to the public during wildfire events (Derrick, 2019). The community centers and exhibition halls were set to receive upgrades such as sealed doors and additional "scrubbers" or filters placed in the spaces as well. The superintendent of the Seattle Parks and Recreation was quoted as noting that 60 to 70 percent of homes in the Seattle area do not have indoor cooling or filtration systems, making residents of the city particularly vulnerable to increased exposure from more frequent wildfire events (2019).

Who are the stakeholders?

The press release announcing the cleaner air shelters named several different agencies that had been working together to make these spaces possible. In addition to the City of Seattle, it appears as though several other stakeholders are cooperating to have a unified response to the threat of wildfire smoke. Other partners named are King County Public Health, The American Lung Association, Seattle Parks and Recreation, Seattle Department of Neighborhoods, the Pacific Science Center, Puget Sound Clean Air Agency (2019).

Current wildfire / air pollution event response policy

The City of Seattle opened five cleaner air shelters in 2019. However, the city and region do not appear to have a universal air pollution event response policy. For example, the website for the Puget Sound Clean Air Agency does not have set levels at which it advises people to seek cleaner air shelters. The website states that when there is wildfire smoke, local residents should "Use [their] best judgement" or to find a cooling center like "a large commercial building with air conditioning and good air filtration" (Wildfire Smoke | Puget Sound Clean Air Agency, WA, n.d.).

How is efficacy measured?

The City of Seattle is working with a professor at the University of Washington to understand the efficacy of the pilot cleaner air centers in the city. Specifically, Dr. Dan Jaffe, Professor of Environmental Chemistry and Chair of the Physical Sciences Division at the University of Washington, will be working with Seattle to advise on the project. "Dr. Jaffe and his students will support the pilot by helping analyze and interpret air quality monitoring data collected inside and outside the community centers," notes the Office of the Mayor (Derrick, 2019). While the pilot project has been running for less than a year, it appears as though there are not yet any published studies as to the efficacy of the clean air shelters pilot project in Seattle.

Analysis

The City of Seattle's cleaner air space policy is less than a year old and still in development. While a partnership of organizations and agencies is working together to help inform and protect the public, the program is still very new and untested. Furthermore, due to the very recent policies establishing cleaner air spaces in the city, there are no studies showing the effectiveness (or lack thereof) of the cleaner air spaces. However, LRAPA and Lane County may be able to take valuable cues from the City of Seattle as

they develop and expand their cleaner air space policy. Furthermore, when and if studies are released evaluating the effectiveness of Seattle's cleaner air spaces, they will be another resource for LRAPA and Lane County as they work towards establishing an effective cleaner air space policy.

Montana

Montana adopted its first clean air legislation in 1995 which created a path for local jurisdictions to create, adopt, and implement their own clean air policies. In 2005 the City of Missoula and Missoula County adopted their own clean air response act in conjunction to specifically deal with wildfire smoke impacts on community members. The Missoula policy defines a procedural response to wildfire smoke events while also addressing air stagnation issues known to the area based on meteorological patterns in the Missoula Valley. Montana has an obligation to its citizens to provide shelter from natural disasters such as wildfire smoke that causes harmful air pollution and increases health risks for vulnerable populations within Montana, this section will describe how Montana serves these populations.

Who are the stakeholders?

Missoula City-County Health Department: Responsible for monitoring air pollution in Missoula City-County, sharing information with the public regarding the local air quality which can include air quality warnings, and enforcing the Missoula City-County Air Pollution Control Program (Missoula County, 2017).

Climate Smart Missoula: Climate Smart Missoula catalyzes "efforts to create a low-carbon, resilient, and equitable Missoula." Climate Smart Missoula connects and supports local groups that work on climate mitigation and adaptation by engaging local communities in the adoption of carbon-neutral plans. Climate Smart Missoula promotes an agenda of reaching carbon neutrality by 2050 in the greater Missoula area by using data driven policy reform (Climate Smart Missoula). To engage the community this agency uses a bucket strategy action plan in its outreach operations. This plan categorizes their outreach efforts into nine subject areas: renewable energy, zero waste, local food, green building & energy efficiency, forests & open lands, transportation & smart growth, healthy community, water, and sustainable development.

Montana Department of Environmental Quality: "The Montana Department of Environmental Quality is charged with protecting a clean and healthy environment as guaranteed to our citizens by our State Constitution. Our ultimate goal is to protect public health and to maintain Montana's high quality of life for current and future generations" (Montana DEQ > DEQAdmin > About). This agency oversees the statewide program allowing jurisdictions in Montana to create their own air quality standards and enforce them. The Montana DEQ issues warnings in conjunction with the Missoula City-County Air Pollution Control Program to warn residents in affected areas about harmful levels of PM2.5 and wildfire smoke.

Montana Department of Public Health & Human Services: The Department of Public Health & Human Services is mainly a social services-based agency, handling the state's social welfare programs. However, this agency regulates tobacco-related use in indoor spaces such as the workspace.

Current wildfire/air pollution event response policy

The policies in place for event response are limited in Montana, and specific to The Missoula Valley. While these policies are supported on a statewide level, they are enforced in this specific area only.

Support for the policies comes from the State of Montana Legislature, State of Montana Department of Environmental Quality, Missoula County, City of Missoula, and Climate Smart Missoula.

Missoula City-County Air Pollution Control Program: Defines a wildfire smoke event as, "a period of time in which the department determines, using available scientific and meteorological data, that wildfire smoke is the primary source of PM2.5 levels." A wildfire smoke event warning system is enacted that advises citizens via public media and a hotline to get current conditions and health advisories. This system uses a tiered approach that enacts different parts of the policy at each stage. Stage I is enacted when ambient levels of PM2.5 exceed 21 ug/m3 averaged over an eight-hour period. Stage II goes into effect when levels reach 35 ug/m3. Stage III happens when levels reach 80 ug/m3 over a twenty-four-hour period. Stage IV is a crisis stage and would be enacted at any level beyond Stage II (Missoula County, 2017).

Missoula County Air Stagnation and Emergency Episode Avoidance Plan: Instructs health officials what to do in the case of an air stagnation episode that could elevate PM2.5 levels to harmful levels, jeopardizing the health and welfare of residents in Missoula County. The county is required to issue warnings of these meteorological events for all or any portion of the county. This uses the same four-tier staging system of increasing levels of PM2.5 that the Missoula City-County Air Pollution Control Program uses. This policy also gives guidance on how the county is to use its HVAC and filtration systems in these conditions.

Montana Clean Air Indoor Act: This policy defines a clean indoor air space in Montana. This legislation was passed by the Montana legislative branch in 2005. The act calls for smoke-free indoor workspaces by eliminating the use of tobacco-related products in indoor spaces. While this policy doesn't address wildfire smoke or PM2.5 air pollution events, it could be a way that the framework for cleaner air spaces could be easily implemented into the existing policy by amending the current act. Adding provisions for statewide cleaner air spaces in these events would bolster this policy by supporting existing clean air policies simultaneously.

Analysis

Despite having adequate policies in place in specific areas, Montana is still in the developing phases of these kinds of event response policies. The current clean air policies are more than adequate in one specific geographic area and almost non-existent in the remainder of the state even though the resources to support such policies seem to be in place. The stakeholders involved are limited and central to state government outside of one nonprofit, Climate Smart Missoula. The Clean Air Indoor Act shows a path to easy implementation of cleaner indoor air spaces or a clean air shelter policy in Montana addressing wildfire smoke events by amendment.

California

Historically, California has been subjected to devastating wildfires. This section will describe California's response to wildfires on the city, local, and state level regarding emergency management as well as the use of cleaner air spaces.

Who are the stakeholders?

There are multiple stakeholders involved in California's cleaner air shelter policies and programs including:

California Air Resources Board: The California Air Resources Board (CARB) is California's clean air agency. CARB is responsible for protecting the public from the harmful effects of air pollution by developing policies and programs to mitigate, prevent, and respond to air pollution events (CARB, 2019).

California State Government: California's state government is responsible for the safety, health, and welfare of all who live within its jurisdiction's borders. California's state government is composed of multiple departments governed by the state's executive branch.

California Department of Forestry and Fire Protection (CAL FIRE): CAL FIRE is responsible for the stewardship and fire protection of approximately 31 million acres of California's privately-owned wildlands. CAL FIRE also provides emergency services to 36 of California's 58 counties through contracts with local governments (Fire.ca.gov, 2019).

California Department of Public Health (CDPH): The CDPH is charged with protecting the health of all Californians and is comprised of public health professionals, scientists, doctors, nurses, and other various support personnel. The CDPH also works to reduce health disparities among underserved and vulnerable populations in California (CDPH, 2019).

California Local/County Governments: Local and county level administrative entities in California may also have their own community-oriented wildfire emergency management framework regarding the use of cleaner air spaces.

Current wildfire / air pollution event response policy

Policies in place pertaining to wildfire/air pollution event response policy and the use of cleaner air spaces exist in multiple public and private entities in California. Also, the general population or local communities also created localized grassroots responses to these events. These policies will be discussed in the context of local air agencies such as CARB, similar to LRAPA and their relationship with other entities in California. Next, recent state and county level policies will be examined to determine what consensus and variation exists throughout the state of California regarding best practices towards responding to air pollution events.

California Local Clean Air Agencies

Currently, CARB partners with California's state government in the advising and creation of these policies and programs. Information on California's government wildfire response policy is detailed on response.ca.gov. In the "Power Outage and Fire Response Resources" section of the website, information on current wildfires in California, locations of cleaner air spaces and shelters, transportation impacts from wildfires, health services, food banks, and personal preparedness is provided. Also, an interactive map with current wildfire locations is provided to individuals on California's state government website in partnership with California's Department of Forestry and Fire Protection (CA.gov, 2019). CARB also provides a list of air purifiers they recommend Californians use as well as guidance on what type of purifier to use (CARB, 2020). The CDPH also recommends the use of air purifiers as an option of creating a cleaner air space (CDPH, 2020).

Barn et al. (2016) examine cleaner air space policies, specifically the use of Portable Air Cleaners (PAC) in response to hazardous air quality from wildfires. Several state's public health authorities including Colorado and Washington State, recommend the use of PACs in their cleaner air space policies.

However, the California EPA Air Resources Board does not have guidelines on the use of PACs in their cleaner air space policy (Barn et al., 2016). Although PACs may not be recommended by some clean air or health agencies in California, many residents still choose to buy them as well as breathing masks (Kreidler, 2019). During the 2018 wildfire season, specifically the November 2018 Camp Fire in Paradise, CA, a local family run Collier hardware store reported selling about 60,000 adult masks within a couple of weeks. Regarding air purifiers, the owner of the hardware store reported selling about 4 to 6 air purifiers a year, but during the fire smoke event they at one point sold 100 purifiers in one day. Another notable aspect of this community response was that the same hardware store stated that they gave away thousands of breathing masks specifically designed for children (Kreidler, 2019).

Recent State Level Policies

On the state level, California Governor Gavin Newsom signed 22 bills in response to the 2018 and 2019 wildfire seasons in California with the goal of improving mitigation, prevention and response efforts as well as looking at expanding clean energy sources.

One piece of legislation was focused on catastrophic wildfire prevention and response. One component of this policy was to provide a framework to determine best practices for community resilience against wildfires by creating defensible spaces and home hardening. Another component, AB 836, established a program that retrofits air ventilation systems in communities to create public cleaner air space centers with a priority on establishing these centers in areas with high cumulative smoke exposure burden.

These policies were created in part of the findings from a "Strike Force" or group of personnel the Governor tasked with examining California's recent increase in catastrophic wildfires (CA.gov, 2019). One of the 5 areas of focus of this group was catastrophic wildfire prevention and response. In the Strike Force's progress report to the Governor, the group's tasks regarding improving wildfire prevention and response include developing best practices for evacuation planning, drawing from best practices developed by state agencies and local governments. Developing a methodology of assessing communities that are in areas more likely to be impacted by wildfires was another point of focus.

County Level Policies

Regarding California's local government level policies, there is variation about the use of cleaner air spaces during a wildfire event. For example, for Santa Clara County government, a list of cleaner air spaces was released during the 2018 wildfire season by its Office of Emergency Services (sccgov.org, 2018). This list provided the names of cleaner air spaces (Ex. Los Altos Library) separated out by jurisdiction within the county (Ex. Gilroy, Palo Alto, etc.), capacity, address, restrictions (e.g. no pets) as well as hours the cleaner air space was open. Many of these cleaner air spaces were identified and provided with the help of Santa Clara County Office of Supportive Housing (OSH) (sccgov.org, 2018). In Los Angeles County, an after-action review (AAR) was released regarding the response to the Woolsey Fire that occurred in November 2018 (lacounty.gov, 2019). Over 250,000 people were successfully evacuated during this fire event and 9 shelters and 6 animal shelters were opened. These shelters were for people displaced from the fires due to smoke as well as fire intrusion in their communities.

Analysis

Overall, there seems to be hundreds of public and private entities involved in California's response to air pollution events, such as wildfires. There is a significant amount of information provided by these entities that can assist in informing LRAPA and Lane County Government in creating a framework for the use of cleaner air spaces including the use of interactive maps detailing air quality and location of

shelters. Santa Clara County government's response to poor air quality also presents possibilities of inter-organizational cooperation between entities in Lane County that assist the unhoused population if these relationships don't already exist in some capacity.

Appendix B

Interview Questions

1. What is your role and some of your responsibilities?
2. What are your responsibilities, if applicable, in an air pollution event (e.g. wildfires)?
3. What other departments and/or people within your organization do you collaborate with to accomplish your work?
4. Who do you collaborate with outside your organization to accomplish your work?
5. What is your organization's policy or response to air pollution events (e.g. wildfires)?
    1. How prepared do you feel overall for an air pollution event (e.g. wildfires)?
6. How do you see cleaner air spaces being utilized by Lane County residents?
7. Do you see any barriers to the utilization of cleaner air spaces within Lane County?
8. What additional policies or mechanisms do you believe can facilitate the use of cleaner air spaces within Lane County?
9. **[If they do not bring up PACs as mechanism in question 8, ask this]** How extensively have personal air cleaners been tested prior to coming to this idea of starting shelters?
10. **[If they do not bring up public warnings as mechanism in question 5 or 8]** What do you believe is the best approach/mechanism for delivering air quality information (PM 2.5 and availability of cleaner air spaces/mitigation strategies) to the public?
    1. Do you feel that current mechanisms are adequate?
    2. **[If no]** What additional mechanisms or changes to current mechanisms do you believe will facilitate adequate delivery of air quality information?

Appendix C

Examples of data used to find publicly owned buildings in the Eugene/Springfield area.

TYPE	TYPE_FULL	LABEL	LABEL_FULL	X_COORD	Y_COORD
fire	Fire Station	SANTA CLARA FIRE DISTRICT 62	Santa Clara Fire District Station 62	-123.1394544	44.12231657
mid	Middle School	MADISON	Madison Middle School	-123.1196747	44.11705204
fire	Fire Station	LANE FIRE AUTHORITY 115	Lane Fire Authority Station 115 (Irving)	-123.1674732	44.11480364
elem	Elementary Sch	SPRING CREEK	Spring Creek Elementary School	-123.1443266	44.11478064
elem	Elementary Sch	IRVING	Irving Elementary School	-123.1523112	44.11079873
fire	Fire Station	SANTA CLARA FIRE DISTRICT 61	Santa Clara Fire District Station 61	-123.1311401	44.10188217
fire	Fire Station	EUGENE STATION 11	Eugene Fire Station 11 (Santa Clara)	-123.1318559	44.10066046
shop	Shopping Center	SANTA CLARA SQUARE	Santa Clara Square	-123.1283412	44.10005887
pk&rc	LTD Park & Ride	LTD PARK & RIDE	LTD Park & Ride River Road Station	-123.1275005	44.0963686
post	Post Office	NORTH EUGENE	North Eugene Post Office	-123.1231238	44.09663549
trans	LTD Transit Sta	RIVER RD	LTD River Road Station	-123.1274856	44.09609536
elem	Elementary Sch	CORRIDOR	Corridor Elementary School	-123.1361022	44.09499247
elem	Elementary Sch	YUJIN GAKUEN	Yujin Gakuen Japanese Immersion Elementary School	-123.1369002	44.09503923
waste	Wastewater	METRO	Metro Wastewater Treatment Facility	-123.1197	44.09480308
high	High School	NORTH EUGENE	North Eugene High School	-123.1317362	44.0944936
shop	Shopping Center	RIVIERA CENTER	Riviera Center	-123.1265433	44.09453131
mid	Middle School	KELLY	Kelly Middle School	-123.142525	44.08743706
elem	Elementary Sch	HOWARD	Howard Elementary School	-123.1393385	44.08737807
libry	Library	BETHEL BRANCH LIBRARY	Bethel Branch Library	-123.1696561	44.0842014

TY	TYPE_FULL	LABEL	LABEL_FULL	X_COORD	Y_COORD
ccntr	Community Cntr	LORANE COMMUNITY CENTER	Lorane Community Center	-123.2417819	43.83772381
ccntr	Community Cntr	AMAZON	Amazon Community Center	-123.0825786	44.02787091
ccntr	Community Cntr	HILYARD	Hilyard Community Center	-123.0823689	44.03084659
ccntr	Community Cntr	CAMPBELL SENIOR	Campbell Senior Center	-123.0875088	44.05813281
ccntr	Community Cntr	SHELDON	Sheldon Community Center	-123.0740903	44.08102596
ccntr	Community Cntr	VENETA	Veneta Community Center	-123.3463704	44.05048121
ccntr	Community Cntr	WILLAMETTE	Willamette Activity Center	-122.4817489	43.74508601
ccntr	Community Cntr	COTTAGE GROVE	Cottage Grove Community Center	-123.0608776	43.799142
ccntr	Community Cntr	WILLAMALANE ADULT	Willamalane Adult Activity Center	-123.0275545	44.04853885
ccntr	Community Cntr	EMERALD PARK	Emerald Park Community Center	-123.1384476	44.0842271
ccntr	Community Cntr	PETERSON BARN	Petersen Barn Community Center	-123.1595012	44.0705911
ccntr	Community Cntr	TWO50 YOUTH	Two50 Youth Center	-122.9824575	44.04376832
ccntr	Community Cntr	RIVER RD ANNEX	River Road Annex Community Center	-123.1208513	44.07985478
ccctr	Community Cntr	VIDA-MCKENZIE	Vida-McKenzie Community Center	-122.5342154	44.12829645

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