Chapter 9: Adaptation

Description

The purpose of this element of the update is to strengthen the climate adaptation elements of the Climate and Energy Action Plan. When the CEAP was written, it was acknowledged that there would be greater focus on efforts to reduce greenhouse gas emissions (mitigation) than on efforts to adapt to the impacts of a changing climate (adaptation). In Ashland, the primary climate impacts that need to be addressed across community systems include wildfire, smoke, extreme heat, and flooding. Now, with a few years of implementation under our belt, it is time to revisit the adaptation elements of the plan to ensure that the Ashland community is prepared to meet climate change impacts that are now present in everyday life and will worsen with time.

Rationale

Climate change impacts are upon us. We have seen it over the past five years in extreme heat, wildfire threat, and smoke impacts from wildfires burning across the West. These impacts affect all community systems – economic, natural, built, human health, and cultural. While efforts to aggressively reduce greenhouse gas emissions are a critical element of a successful response to the climate crisis, we are no longer in a position where we can focus entirely on mitigation. As we saw with the Almeda Fire, climate change is here. The future of our community depends on our ability to navigate the impacts that are underway and worsening while we transform our relationship with energy. Strengthening the adaptation element of the Climate and Energy Action Plan is a critical first step to ensure that we protect that which makes Ashland Ashland, while we implement the mitigation elements of the plan to ensure a vibrant future for our community.

Task Plan

A climate vulnerability assessment was completed as an addendum to the formal CEAP and should serve as the basis of adaptation planning. It is here: https://www.climatewise.org/images/projects/Geos_RogueValleyVA2016.pdf

This adaptation element will need to be handled somewhat differently because the level of detail for adaptation does not match the level of mitigation detail in the CEAP. That needs to be corrected in this update process and that requires some amount of additional process.

Tasks and Timeline

CPC reviews vulnerability assessment and the current adaptation elements of the CEAP to create an outline of the issues that need to be addressed in the update of the adaptation elements. (February – March, 2021)
CPC develops an outreach and engagement plan to engage local stakeholders and integrate climate change trends and projections into existing processes that may accomplish the task of addressing particular vulnerabilities. For instance, economic development planning may address

climate adaptation needs for the local economy if the process integrates what is known about changing climate conditions. In that case, a separate process to address adaptation planning for our economic system may not be necessary. (April, 2021)

CPC works with the COCC to implement the outreach and engagement plan to identify and prioritize strategies to address the remaining vulnerabilities. This is likely to involve a stakeholder workshop in early summer. (May – July, 2021)

Adaptation strategies identified through this process (plus potentially questions related to other update elements of the CEAP) will be presented in a public forum with an electronic survey for attendees and interested members of the public. (August, 2021)

Feedback from the community is integrated into the adaptation element, and the final update package for the CEAP is approved by the CPC and presented to Council for approval (September, 2021)

Climate Change Vulnerability in Ashland and the Rogue Valley

GEOS INSTITUTE

SEPTEMBER 2016

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Mount Ashland by Alex Lockhart

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Key Findings

Climate change is already impacting the Rogue Valley. Residents and businesses of the area are feeling the impacts of more heat waves, lower snowpack, more smoke in the summer, and warmer rivers with water quality problems from algae and bacteria. We assessed the different populations and resources of the Rogue Valley to determine where our communities are most vulnerable to climate impacts. Our process included a review of climate model projections specific to our area, combined with an expert elicitation process to determine how climate impacts might affect the people and resources throughout the Rogue Valley, but also specific to Ashland, in support of the City's Climate and Energy Action Planning (CEAP) process.

We found that the most vulnerable NATURAL RESOURCES include:

- High elevation plants and wildlife
- Sensitive species such as Brewer spruce, Northern Spotted Owl, and wolverine
- Intermittent springs and wetlands
- Anadromous fish, amphibian, and migratory bird populations
- Intact ecosystems and overall biodiversity
- Habitat connectivity needed for species to shift ranges with warming climate

The most vulnerable SOCIOECONOMIC POPULATIONS AND RESOURCES include:

- Elders, who are sensitive to heat, and especially low-income without family nearby
- Outdoor workers and seasonal workers, most of whom have low incomes
- Seasonal and service industry workers (forest, ski area, restaurant, theater, hotel, etc.)
- Homeless populations, people lacking in transportation options
- Hydropower supply
- Low income Latino/a populations and families/single parents with young children
- People with respiratory illness, heart conditions or mental illness
- Manufacturing, retail, and service sector businesses
- Roads and other infrastructure in valley bottoms and along rivers
- Health care providers and emergency response staff
- Tourism and recreational based businesses, including the ski area and river rafting
- Water resources, especially water quality issues for TID and others


Photo by M. Koopman

Of note were the exacerbating factors of income level, environmental degradation, and development pressure for housing and renewable energy as stressors to numerous populations and resources. For instance, families with young children, Latino/a populations, seasonal workers, and elders were all considered more vulnerable to climate change if they have low incomes. Low income is associated with a loss of adaptive capacity, or having few resources with which to make changes. This indicates that addressing income/wealth inequality could increase overall community resilience to climate change. Similarly, reducing stressors to natural systems, such as pollution, water use, land use, and fragmentation of natural areas, could create more natural systems resilience, which in turn supports biological diversity, quality of life, recreation and tourism in the region.

The climate change variables of greatest concern included the increase in severity and frequency of extreme heat and heat waves (89 more days per year of extreme temperatures, which could be 12°F hotter), the increased potential for large storms and flooding (large downpours 1.3” larger), loss of snowpack (-86%) and the associated loss of water storage in winter, declines in water quality due to warmer temperatures and lower flow, and overall change in climate conditions leading to disruptions in native vegetation and wildlife.

Many of the most severe impacts can be prevented by aggressively reducing greenhouse gas emissions. The City of Ashland is currently creating a Climate and Energy Action Plan to set emissions targets over time. The City of Talent is creating a clean energy plan to shift away from fossil fuel sources and towards local and renewable energy. The City of Medford is working to update its emergency response plan with climate change model output. Other Southern Oregon communities will also need to take action to reduce emissions and protect our communities and the resources we rely on from increasingly severe impacts.

Introduction

The Rogue Valley in Southern Oregon has experienced changes in temperature, precipitation, and snowpack in the last few decades. As climate change accelerates, we can expect more days of extreme heat, fewer freezing nights, and more frequent periods of drought than there have been historically. Many of the most severe impacts, however, can be minimized if greenhouse gas emissions are reduced, creating a more positive future for residents of the Rogue Valley and around the globe.

The City of Ashland is working on a Climate and Energy Action Plan (CEAP) to reduce greenhouse gas emissions throughout the community. Another Rogue Valley community, Talent, is creating a plan for shifting to clean energy. Communities throughout the nation are taking action on reducing greenhouse gas emissions in efforts to prevent warming more than 1.5 - 2° C (2.7-3.6° F), which has been recognized by the international community as the mandatory level to prevent catastrophic warming.

In addition to reducing greenhouse gas emissions, however, communities need to respond to the changes already being felt and plan for those that are still to come, regardless of our emissions reductions. Because greenhouse gases can remain in the atmosphere for decades, we will continue to experience climate change impacts for decades, and even centuries, to come.

While greenhouse gases are measured globally, climate change impacts are locally specific. Each community feels climate change in a different way, depending on historic conditions and locally-specific climatic conditions and patterns of change. As these local impacts and changes worsen over time, we will need to prepare and protect our most vulnerable resources and populations from the impacts.

Climate Change Vulnerability Assessment

Determining which resources and populations are most vulnerable to ongoing and future impacts of climate change is the first step in developing effective strategies and sound solutions. Geos Institute staff held a series of workshops on climate change vulnerability in Ashland, Oregon. These workshops included experts in a variety of fields and topics. The workshops were intended to share knowledge on the science and future trends associated with climate change, as well as expected impacts to important sectors of our communities.

While the workshops were held in Ashland in support of Ashland's CEAP process, we invited experts from throughout the Rogue Valley to look at regional vulnerabilities and trends as well. Because climate change is an all-encompassing trend with both local and regional solutions, it is vital that we work together and develop a better understanding of cross-jurisdictional impacts as well as opportunities.

Climate Change Vulnerability is a function of three variables:

- **Exposure** - what changes the resource or population is expected to be exposed to
- **Sensitivity** - what the impacts are likely to be
- **Adaptive capacity** - what actions or resources are available to reduce or avoid impacts

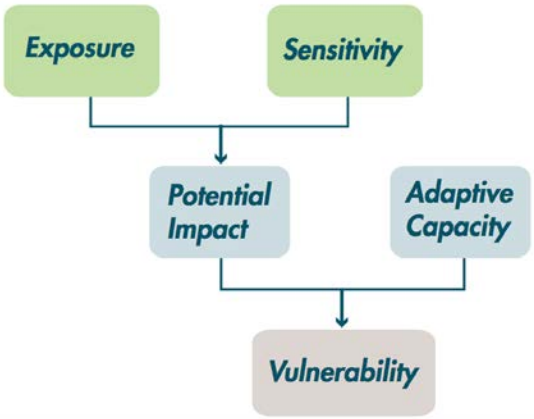


Figure 1. Vulnerability is a function of Exposure and Sensitivity, which together define the impact, and Adaptive Capacity, which can act to lessen overall vulnerability.

A vulnerability assessment, such as this one, determines the contributions of each of these variables to each of the target resources and populations, in order to help to prioritize and direct potential solutions.

1. EXPOSURE – Exposure is the specific impact or trend that is expected from climate change. Different resources and populations will be exposed to different components of climate change, which can be assessed using global climate models and recent trends and data. It is important to get information on exposure from reputable scientific institutions and knowledgeable scientists with an understanding of not just climate change, but also the potential impacts of climate change to our natural systems that communities depend on.

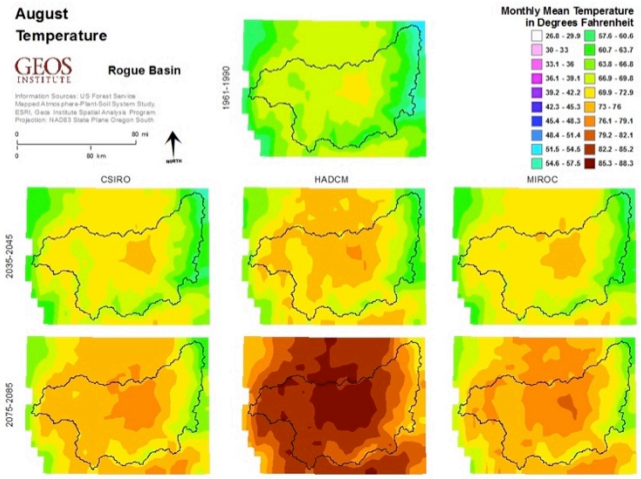


Figure 2. Climate model output, such as that shown here, can be used to investigate the level of exposure to climate impacts. This downscaled climate model output shows historic and projected future August temperature across the Rogue Basin, using three different climate models (CSIRO, HADCM, and MIROC) and two future timeframes (2035-45 and 2075-85). All three models agree on future warming, but some show faster warming than others.

For example, Mt. Ashland Ski Area's exposure to climate change impacts is high, because snowpack is expected to decline 70-80% by the 2080's, even if we reduce emissions. Exposure of Mt. Ashland's ski area to sea level rise impacts, however, is relatively low due to elevation and distance from the coast.

2. SENSITIVITY – Some resources and populations are more sensitive to changes than others, meaning that they experience a larger or more severe response to those changes. For example, Infants and elders are more sensitive to severe heat because they are less able to regulate their body temperature.

3. ADAPTIVE CAPACITY – People can respond to climate impacts in a variety of ways. There are many resources and behaviors available as adaptive capacity. For instance, people who can afford air conditioning have higher adaptive capacity during both heat waves and when smoke from wildfires makes outdoor air unhealthy, as compared to those without air conditioning or working and/or living outdoors.


Workshop participants discussing climate impacts with group facilitator, Eric Dittmer

In addition to each of the 3 variables associated with climate change vulnerability, we assessed the following variables:

STRESSORS – What are the current stressors that are affecting the target resource or population? Identifying current stressors provides valuable information for where to find solutions. Many stressors are exacerbated by climate change, such as ozone being exacerbated by heat, thereby affecting air quality and human health. By reducing the stressors, we can increase overall resilience of the target as climate change worsens and accelerates.

SECONDARY IMPACTS – Secondary impacts are impacts created from actions that we take in response to climate change, such as spraying more pesticides in response to increases in mosquito-borne disease. In many cases, the secondary impacts will be more serious than climate change itself.

POTENTIAL STRATEGIES – The focus of this effort was on identifying local vulnerabilities. These vulnerabilities will then inform CEAP and other planning processes to develop solutions. The experts in the workshops, however, had numerous ideas for sound solutions to climate impacts. Those are included in this report, but are not comprehensive across all sectors and topics.

Strategies to reduce our greenhouse gas emissions (called "mitigation") and those to protect people and resources from ongoing and worsening impacts (called "adaptation") are both needed.

Results

Climate Change Trends for Ashland and the Rogue Valley –

Numerous studies have detailed these impacts for our region (The Resource Innovation Group (TRIG) and Geos Institute, 2008; Southern Oregon Forest Restoration Collaborative 2013; Oregon Climate Change Research Institute (OCCRI) 2016). This overview pulls from those reports and others to provide the latest information on historical changes in climate, future projections, and expected impacts.

HISTORIC TRENDS – The average temperature in Ashland has increased by 2.5° F over the last century. This is about 1° F more warming than the average for the Pacific Northwest for the same time period (OCCRI 2016).

Average precipitation has decreased slightly in Ashland, although this is not a significant decline and is overshadowed by year-to-year variation (OCCRI 2016).

Among 13 monitoring stations in the Rogue Basin, 12 have recorded declines in snowpack, ranging from 3-60% (avg. = 26.8%). Averaged over all 13 stations, a decline in 17% was observed from 1960-2014 (calculated from OCCRI 2016).

Wildfire season lengthened by 28 days (averaging 1 day/yr.) from 1984-2011. The number of large wildfires has increased by 0.6 per year (Dennison et al. 2014).

PROJECTED FUTURE TRENDS – Global Climate Models (GCMs) are used to model the Earth's climate systems and provide insights into potential future change. Uncertainty in model output comes from an incomplete understanding of those systems and, more importantly, how people will respond to the need to reduce greenhouse gas emissions. Thus, there is a range of potential outcomes dependent on which models are used and whether or not the international community takes action on climate change.

In analyses by OCCRI (2016), projections based on continued higher emissions (RCP 8.5) were compared to those based on lower emissions (RCP 4.5), to assess the how much climate change impact can be avoided by taking action to substantially reduce emissions (Table 1).

Historic Trends

- Temp. ↑ 2.5° F since 1910[1]
- Precip. ↓ 0.9 in. since 1910[1]
- Snowpack ↓ 17% since 1960[1]
- Wildfire season ↑ 27 days since 1984[2]

Likely Future Trends

- Temp. ↑ 3-11° F by 2080s[1]
- Summer temp. ↑ 7-15° F by 2080s[3]
- Extended warm spells ↑ 89 days by 2080s[1]
- Snowpack ↓ 86% by 2080s[1]
- Runoff - earlier spring melt, higher winter flow, lower summer flow[1,3]
- Extreme precipitation events ↑ by 1.3 inches by 2080s[1]
- Dry spells 6 days longer by 2080s[1]

[1] OCCRI 2016
[2] Dennison et al. 2014
[3] TRIG and Geos Institute 2008

In general, all of the models predict warming, but some predict faster warming than others. Similarly, all models predict sea level rise, but some are showing much faster sea level rise than others. Most models agree on more intense storms, wetter winters, drier summers, lower snowpack, and more frequent extreme heat and wildfire.

Changes in precipitation are likely, but in any one area those changes are highly uncertain. Southern Oregon is especially uncertain, as areas further north are expected to become wetter, on average, and those further south are expected to become drier, according to many models. With higher temperatures, however, soils are expected to be drier. Thus, drought becomes more likely and vegetation will change, even with moderate increases in precipitation.

Climate Change Vulnerabilities –

We held five workshops covering the following topics: Equity and Disadvantaged Populations, Natural Systems, Health and Emergency Response, Business and Agriculture, and Infrastructure. Each workshop was attended by invited experts within the topic area. These experts first became familiar with the climate science and projections. Then they were asked to consider how target resources and populations would be affected. We built upon previous work (TRIG and Geos Institute 2008 and Southern Oregon Forest Restoration Collaborative 2013), and existing research for a more comprehensive assessment.

Table 1. Comparison of climate projections for the 2080s, if we lower emissions (RCP 4.5) or continue with business as usual (RCP 8.5) (adapted from OCCRI 2016).

	RCP 4.5 Low emissions	RCP 8.5 High emissions
Hottest day of the year	+7°F	+12°F
Duration of warm spells	+39 days/yr.	+89 days/yr.
Rainfall in an extreme storm	+0.8 inches	+1.3 inches
Snowpack	-71%	-86%

Workshop participants discussing climate impacts with group facilitator, Leslie Becknell-Marx

The vulnerabilities were discussed and documented during the workshops using large matrices written on flip charts hanging on the conference room walls. After the notes were transcribed, we ranked the vulnerabilities based on Adaptive Capacity (high, medium, or low) and Exposure/Sensitivity combined (high, medium, low) in order to display them in the matrix in Figures 3 and 4.

Figure 3. Natural systems vulnerabilities in Ashland and the Rogue Valley.

ADAPTIVE CAPACITY	SENSITIVITY AND EXPOSURE: High	Medium	Low
Low	**High elevation plants and wildlife** unable to shift in range yet intolerant of warming conditions, loss of snow. **Wolverine, Brewer spruce, Northern Spotted Owl**, and other sensitive species at risk from changing conditions. Mining, logging, rodenticides, and other stressors exacerbate the risk. **Intermittent springs and wetlands** at risk from changes in precipitation and snowmelt. Important breeding grounds for frogs and turtles.	**Intact habitats and ecosystems** at lower elevations at risk from climate change, invasive species, and development for housing, agriculture, and renewable energy. **Connectivity of habitat** that allows species to shift with climate change is at risk from ongoing stressors and also secondary impacts of climate change, such as renewable energy. **Migratory birds** affected by changes in seasonality and timing for food and migration. **Amphibians** exposed to drought stress and an inability to disperse to new areas.	**Plants and animals on north facing slopes**, where cooler temperatures may persist longer. These areas could become important refuges for biodiversity. **Cold water inputs from underground springs** are important for keeping water temperatures cool. Protecting and reconnecting rivers and streams to make cooler waters available to fish will be important.
Medium	**Anadromous fish populations** affected by warmer water, more sediment and erosion, lower flows, loss of food, ongoing pollution and dams. Connectivity required for short-term resilience to wildfire impacts. **Biodiversity** is expected to decline as climate change accelerates. Some species will benefit, but far more will decline and even go extinct.	**Mid-elevation coniferous forests** to suffer from disease, pests, and overall change. Wildfire expected to increase, but is also considered an important ecological process for maintaining forest health and diversity. Stressors from large-scale thinning, mining, harvest, and potentially increasing biomass for energy **Oak woodlands, grasslands** at risk from overall change and stressors such as agriculture, development and renewable energy.	**Generalist species** such as raccoons, black bears, black-tailed deer, American Robins, and others expected to be more able to adapt to changing conditions. Edge species and those that live in fragmented, disturbed, or early successional habitat also expected to persist.
High		**Chaparral, grasslands, and shrublands** could increase as coniferous forests contract while also being at risk from development at lower elevations.	**Invasive and non-native species** benefit from declines in native species, warmer water and air.

Figure 4. Socioeconomic vulnerabilities in Ashland and the Rogue Valley.

ADAPTIVE CAPACITY	SENSITIVITY AND EXPOSURE: High	Medium	Low
Low	**Outdoor workers, elders, and low income populations** will be vulnerable to severe heat. **Elders, especially disabled and low income individuals**, affected by severe heat, smoke, and storms. Many are far away from relatives or in rural areas. **People with mental illness**, and especially veterans, especially susceptible to impacts from heat and natural disasters. **Seasonal and service industry workers** at risk from all aspects of climate change that affect their lineup of jobs over the year. This can push people into poverty and/or make them look elsewhere for more stable employment. **Hydropower** to become less reliable due to reduced snowpack, loss of stream flow, drought and flooding. Also wildfire and heat to affect transmission. Increased demand in summer will stress systems at time when stream flow is lowest.	**Homeless residents**, especially the long-term homeless are often used to extreme conditions. However, once conditions become too extreme, they have little adaptive capacity. Most at risk from water quality and heat. **People without cars** vulnerable during wildfire, severe storms and natural disasters. **Low income residents, especially young children** at risk from extreme heat, smoke, and increased vector and food-borne disease. Higher water and electricity costs and need for air conditioning could be significant burden. **Manufacturing, retail, and service** sectors likely to experience higher fuel and transportation costs, heat and storm related disruptions. **Roads bordering rivers and streams, and in valley bottoms**, as well as unstable slopes at risk from increased frequency of large storms.	**Local reservoirs** exposed to more severe storms and larger precipitation events. Reeder reservoir is well maintained and has been rated for a 10,000 year storm. North Emigrant reservoir has had issues with turbid water from storms, expected to increase and worsen.
Medium	**People with asthma, respiratory and heart disease** impacted by smoke and ozone. **Low income populations, and especially Latino/a populations,** at risk from heat, smoke, and larger storms. Also loss of reliable employment. **Health care providers, emergency response staff** at increased risk with more extreme events, dealing with emergencies while also worried about their own families. **Rafting and other river-related recreation** industries impacted by water quality, low flow, and smoke. **Solar panels** affected by smoke –	**Human health** at risk from smoke, vector and water-borne disease, and increased use of pesticides due to mosquito spraying and agricultural pests. **Emergency response and evacuation** to become more difficult and frequent due to increase in natural disasters and closure of evacuation routes during storms. More funding will be needed. **Agricultural production** expected to decline with less reliable seasonality, more disease, and more uncertainty in harvest dates and length of seasons. **Local agriculture** will become stressed from pests, disease, drought, greater competition for water and land, and lower productivity from climate change.	**SOU students** highly mobile, connected. Most affected from poor air quality during fall sports, severe heat without air conditioning in late summer, and flooding associated with severe storms.

ADAPTIVE CAPACITY			
Medium	reduces production by up to 30%. **Tourism-based economy** affected by changes in natural beauty, smoke, severe heat, drought, water quality issues, and unpredictable seasons. Employee base could become more stressed. **Mount Ashland ski area** likely to become increasingly unprofitable as snowpack declines 70-80%. Will need to shift to other sports and activities. **Talent Irrigation District (TID) water** impacted by declines in water quality from wildfire, algae, warmer temperatures, more herbicides, etc. Also affected by evaporation and drought conditions.	Specifically, **wine grapes** expected to have more disease and shifts in the types of grapes. **Roads, buildings, bridges, and real estate** at risk from wildfires, floods, and heat impacts. With increased temperatures and smoke, biking and walking will become hazardous, making more people rely on vehicles. Culverts and road crossings often not built to high enough flood standards. **Municipal water supply** expected to see greater demand and lower supply due to higher temperatures and reduced snowpack. Cost of water could increase. Increase in algal outbreaks expected. Wildfire can cause water quality problems. Not enough redundancy of supply. **Energy infrastructure** at risk from heat (affects distribution), lower and less predictable stream flow, storms, and increase in summer demand with higher temps.	
High	**General population** at increased risk for disease outbreaks, but we have a Tier II hospital ready to deal with outbreaks of new diseases. **Fire fighters** at increased risk from fire as more homes are at risk and fires become more frequent. **Local creeks** already affected by E. coli and algae, likely to get worse, but management options exist to reduce impacts. **Stormwater infrastructure** at risk from larger storms.	**Health care providers, emergency response staff** at increased risk with more extreme events, dealing with emergencies while also worried about their own families. Could cause stress and mental health issues. **Landscaping** (SOU, Lithia Park, homes, etc.) exposed to changing conditions, water restrictions, and extreme temperatures. Over time, trees could die and new types of trees and plants will need to be planted. Drought resistant and fire resistant plants not always compatible. SOU's irrigation systems are out-of-date.	None identified in workshops.

Natural Systems

Natural systems are on the front line with climate change. Natural systems support biodiversity and functioning ecosystems. Natural systems also provide people with clean water, air, recreational and spiritual opportunities, and a variety of other services. Because our communities in Southern Oregon are highly dependent on natural systems for the local economy (tourism, forestry, agriculture, water) and our way of life (recreation, rural housing, natural beauty), the impacts of climate change on natural systems will have direct impacts on all other sectors considered.

The natural systems workshops participants identified numerous potential vulnerabilities of natural systems to climate change impacts. These stemmed from overall changes in temperature and precipitation, greater storm intensity with erosion and sedimentation, more extreme heat events, higher incidence of wildfire, substantial declines in snowpack, warmer river and stream temperatures, and changes to species distributions.


Photo by Ken Crocker

CONIFEROUS FORESTS – Forests in Southern Oregon are likely to be affected by changes to temperature and precipitation, increases in CO_2, changes in wildfire patterns and declines in snowpack. At lower elevations, conifers could be replaced by hardwoods. North facing slopes are expected to act as refuges for endemic species that require a slightly cooler microclimate. The high topographic complexity of the region and relatively mild climate could allow for higher likelihood of species persistence and diversity. This area served as an important refuge during times of glaciation due to this same topographic complexity and mild climate.

Some species that could be most sensitive to climate impacts include **Brewer Spruce**, **Northern Spotted Owl**, and **Fisher**. Current stressors from land use and resource extraction are likely to be exacerbated by climate change. **Wolverine**, which occur at higher elevations, could be impacted by declines in snowpack.

Wildfire is a natural occurrence and vital part of forest health in Southern Oregon forests. In fact many of today's mature forests developed during a previous warm dry period (1400-1650) with even more fires than we experience today (PNW Research Station 2003). Mature coniferous forests, with extensive canopy cover and complex understory, maintain moist microclimates that reduce the incidence of wildfire. The most effective way to increase forest resilience may be to restore mature forests. Because many native forest species are highly adapted to wildfire, wildfire is seen as a benefit, not a threat to ecosystem health.

Wildfire

Wildfire provides important ecological function in Southern Oregon's forests. Wildfire frequencies and intensity have changed and varied extensively over time, due to changes in climatic, ecological, and human influences. Because of this variation, there are different opinions about which baseline conditions and wildfire frequencies to manage for.

Today's forests developed under climatic conditions of the last millennium. The composition and structure of Southern Oregon's old growth forests may not occur again under modern climates and disturbance regimes (PNW Research Station 2003). Restoration efforts may need to be adapted to restore forest diversity suitable to future climate.

The total acreage burned in Oregon has increased by about 2.5 times since 1984 (EPA 2016). Yet Oregon forests have experienced times of higher wildfire incidence before, such as 8,000-10,000 years ago, 1,000 years ago, and 500 years ago (PNW Research Station 2003). The current increase is not unusual in the history of our forests and is not an ecological threat to forest ecosystems. Reducing the threat of wildfire to homes, water resources, and other infrastructure is included in the infrastructure section of this report.

Regrowth in recently burned coniferous forest of Southern Oregon. Photo by Kevin Schafer.

Stressors – Current stressors to coniferous forests of Southern Oregon include mining, logging, biomass harvest for energy production, fire suppression activities like mechanical thinning, and, at lower elevations, clearing for development of homes and vineyards. Invasive species and forest pests and diseases also stress coniferous forests. Climate change is expected to exacerbate many of these stressors. By reducing stressors to forest systems, they will become more resilient in the face of accelerating climate change.

Adaptive Capacity – North-facing slopes could function as important refuges that allow biodiversity to persist, if protected. Federal lands (USFS and BLM) have greater adaptive capacity than private lands because of the potential for increased protection and conservation-based management.


Photo by M. Sheer

LOWER ELEVATION OAK WOODLANDS AND NATIVE GRASSLANDS – Oak woodlands and grasslands are expected to be impacted by changes in temperature and precipitation, as well as increases in CO_2 and changes in wildfire patterns. Oak woodlands may displace conifers at higher elevations. Native grasslands are likely to increasingly lose ground to invasive and non-native species, as CO_2 and temperature/precipitation change give non-native species a competitive edge.


Photo by M. Koopman

Stressors – Current stressors to oak woodlands and grasslands include wildfire suppression, which precludes regeneration, and agriculture and housing development. Oak woodlands already are threatened by Sudden Oak Death, and could be prone to more diseases and pests as climate change progresses.

Adaptive Capacity – Protected and intact grasslands and oak woodlands have higher adaptive capacity than fragmented areas.

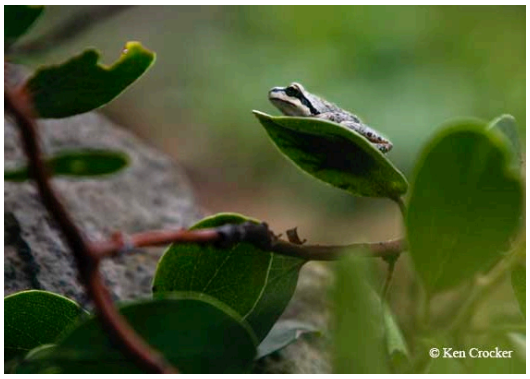
INTACT ECOSYSTEMS PROVIDING CONNECTIVITY – Intact ecosystems are vital to maintaining biodiversity and allowing species to shift and adapt over time. As climate change progresses, intact ecosystems and connected natural areas will become even more vital for the movement of species of plants and wildlife to new areas. Intact ecosystems are expected to be impacted by climate change through the loss of keystone species (from changes in temperature and precipitation) and/or vital ecosystems function. Regional planning for connectivity and more focus on conservation of natural areas could enhance ecosystem resilience in the face of climate change.


Photo by Kevin Shafer

> **Stressors** – Lower elevation ecosystems, such as oak woodlands and native grasslands, are especially at risk from development for homes and agriculture (wine grapes, marijuana, etc.). Continued encroachment of housing into the forest interface threatens coniferous forests, as does fire suppression, logging, mining, and biomass for energy.

AQUATIC AND RIPARIAN SPECIES AND ECOSYSTEMS – Greater storm intensity, lower streamflow, and warmer temperatures all threaten aquatic and riparian ecosystems and species. In addition, snowpack declines can greatly change the timing of streamflow, with impacts to spawning, migration, and food availability for salmonids. Warmer waters can cause increases in bacteria and disease, and decreased dissolved oxygen, which leads to fish kills. Salmonids, amphibians, macroinvertebrates, intermittent springs, wetlands, and vernal pools are all at risk from drought as well.

> **Stressors** – Many intermittent springs, vernal pools, and wetlands are already being destroyed or turned into year-round ponds that support invasive species such as bull frogs. Salmonids are affected by dams and other barriers that block passage to spawning areas and cooler, higher water. Salmonids are also affected by non-natural flow, such as that in Bear Creek in the summer.


© Ken Crocker

Many amphibians already suffer from chitrid fungus and are likely to have more disease and drought impacts with climate change. Grazing can destroy riparian vegetation and meadows, thereby leading to reduced ability to hold water and more flooding during extreme storms.

Additional target communities to assess include mesic dependent systems, endemic species, pollinators, bats, decomposers (fungi), restoration efforts, and others.
Workshop participants were not tasked with developing solutions as part of the vulnerability assessment, yet many were suggested.

Some suggested potential strategies and actions included:

- Place new renewable energy development and other development on already degraded and fragmented lands rather than intact natural systems.
- Change zoning to reduce residential development in high risk areas, such as flood zones and wildfire areas
- Restore riparian systems, reduce invasive species and increase native species.
- Rehydrate the watershed by creating beaver-like structures and/or introducing beavers.
- Decommission roads to reduce sedimentation in streams during large storms.
- Enforce the City's riparian ordinance. Retain dead trees for fish and wildlife.
- Trim the vegetation on Neil Creek near the airport to ensure a low canopy cover for shade, while also meeting airport requirements.
- Restore fish passage at Granite Street Dam to allow native migratory fish to use Ashland Creek up to Reeder where there is cold water habitat for winter steelhead.
- Encourage and mandate planting of native trees and shrubs, especially in new development.

For more potential strategies and actions, see Appendix A

Equity and Disadvantaged Populations

Climate change has the greatest impacts on those who not only have the least ability to protect themselves, but also those who have contributed the least to the problem itself. Disadvantaged populations include low income residents, people of color, people with disabilities, non-English speakers, homeless residents, and others who have had little input into our society's planning processes.

Similar to natural systems, disadvantaged populations are often on the front line when it comes to climate change. Outdoor workers and low income workers, for example, are exposed to the full impacts of severe heat and smoke from wildfire, and they have little adaptive capacity.

Historically, many societal norms and procedures have created preferential opportunities based on race, gender, sexual orientation, and other factors. Unfortunately, many systems and norms that promote inequity are still in place. As our awareness increases and we work to dismantle discriminatory practices, climate change threatens to add additional stressors that can exacerbate inequities, making our efforts to right historical wrongs even harder, yet more important.

The equity and disadvantaged populations workshop participants identified numerous potential vulnerabilities to climate change impacts.

ELDERS AND DISABLED ADULTS – Extreme heat, larger and more destructive storms and flooding, and increasing levels of smoke are all expected to have health and safety impacts to elders and disabled adults. Many elders and disabled adults have compromised health, which is exacerbated by climate impacts. Mobility may be limited, making it difficult to escape unsafe or unhealthy conditions. When cognitive abilities are compromised, elders and disabled adults have trouble communicating discomfort or understanding emergency procedures. They are often reliant on caregivers or facilities, which may or may not be well prepared for extreme conditions. Finally, many elders and disabled adults have fixed incomes that can limit their options for air conditioning, transportation, and housing in flood zones.

Stressors – Existing stressors include flood risk to many lower income homes, especially trailer parks situated in flood prone areas. Low income is also a stressor.

Adaptive Capacity – Medical facilities, case managers, assisted living, churches, and other community services that are routinely provided for elders and disabled adults can also act as support and communication hubs during extreme events.

A FEMA representative speaks with a homeowner after disaster. FEMA photo.

MENTAL HEALTH – Similar to elders and disabled adults, people suffering from mental health issues and especially veterans, can be hypersensitive to extreme and/or unexpected events, including severe heat, smoke, and extreme precipitation with flooding.

LOW INCOME POPULATIONS – Low income populations may be at risk from extreme events, including heat, storms and flooding, and smoke. Low income Latino/a populations are especially at risk due to cultural and language barriers. Many low income populations are less likely to prepare for emergencies or extreme events, and don't have information about where to go or how to get help.

Stressors – Low income residents, and specifically low income Latino/a residents, have fewer resources available during extreme events. They often have little or no access to affordable healthcare. Language barriers can also prevent people from getting the help and resources that are available, or understanding the risk. Negative experiences with law enforcement or other forms of authority create situations of distrust and a lack of support for people of color. People with a criminal record may have a harder time getting support services, access to shelters, jobs, and housing. Mental health and abuse issues, while prevalent in all income levels, can become exacerbated by climate change impacts because low income populations are already pushed to the edge. Many low income families do not have insurance, and can lose everything during an extreme event.

Adaptive Capacity – Overall, low income populations have little adaptive capacity because they are already in survival mode, often close to homelessness. Strong family and church connections among Latino/a communities provide some adaptive capacity for those that have low incomes. Many rural residents are more self-sufficient and able to protect themselves. Organizations like ACCESS and Energy Trust have funds for upgrades. RVTD has matching funds opportunities for transportation support. Work Source Rogue Valley has funds for job training that are often underutilized.


Photo by Joshua Wickerham / CC B[illegible]2.0

AGRICULTURAL AND FOREST WORKERS, OTHER OUTDOOR AND SEASONAL WORKERS – All of the climate change impacts that affect forests and agriculture will also affect forest and agricultural workers. For example, as forests become stressed from climate change, pests, and disease, forest workers may have trouble finding enough work. If heat, drought, and larger storms affect agricultural production, seasonal farm workers could experience less reliable employment. In addition, these workers are themselves affected by heat and storms, making their jobs more dangerous to their health. One of the greatest impacts may be the lack of predictability for seasonal workers who need to string together consistent employment.

Stressors – Some existing stressors for forest and agricultural workers include insufficient water and breaks, very low wages, periodic drought, a lack of power or representation to ensure good conditions and fair wages, lack of documentation for legal work, a lack of family medical coverage, and the physically demanding aspect of their jobs. Low income is also a stressor to outdoor and seasonal workers.

Adaptive Capacity – As agriculture and/or forestry jobs become less predictable, fire fighting jobs may become better options. Fire fighting generally has higher wages than agriculture and forestry jobs.

SERVICE INDUSTRY WORKERS – Many jobs in Southern Oregon and especially in Ashland are service industry jobs related to the tourist–based economy. If the natural beauty of the area is diminished from climate change, due to dead and dying forests, wildfire, and lower water quality and quantity in rivers and streams, the tourist-based economy is likely to suffer. Similarly, extreme heat and smoke from wildfire could keep tourists away from the region.


Photo by S. Nickel

Stressors – The service industry already experiences fluctuations in employment levels, creating uncertainty in income and a lack of job security for many workers. Many service industry workers rely on public transportation, which is limited, and are unable to evacuate in the case of a natural disaster such as a large wildfire or flood. In addition, low income housing is often placed in flood-prone areas. Low income in itself is also a stressor to service industry workers.

Adaptive Capacity – Low income service workers are often flexible in the type of employment they can fill, but have very little overall adaptive capacity. Because many people do not own homes, they have some flexibility allowing them to move to areas with more jobs, if needed.

HOMELESS – Homeless residents in Ashland and the Rogue Valley are highly sensitive to climate change. They are affected by extreme heat, larger storms causing flooding, poor air quality from smoke, poor water quality from bacteria and

Note on income: We found a common stressor among all socioeconomic groups that were vulnerable to climate change, and that was low income. Having a low income in addition to health problems, racial biases, job type, and age greatly exacerbates the impacts of climate change. By targeting the issue of wage disparity, numerous populations could become more resilient to the impacts of climate change.

toxins, and a lack of water due to drought. While shelters are set up to protect people from freezing temperatures, there are no cooling centers or shelters to protect people, and their pets, from extreme heat. Due to the lack of transportation, homeless people have a difficult time evacuating during emergencies.

Stressors – A lack of transportation makes it difficult for homeless residents to get the services and supplies they need, which in Ashland are on opposite ends of town. Many basic human needs, such as sleeping and relieving oneself, have been criminalized. As a result, confrontations with police, fines, and jail for people already dealing with mental health struggles are common. Community stress from climate change could create even less willingness by the public to accommodate the homeless, resulting in a lack of compassion and even more criminalization.

Adaptive Capacity – Homeless residents, and especially those homeless by choice or for a long time, may have high adaptive capacity because they are already used to dealing with climate extremes and are relatively savvy about outdoor living. Even so, many of the conditions projected by climate change models surpass those that have occurred historically, which could stress homeless populations.

Additional target communities to assess include non-English speakers, young children in low income households, LGBTQ community, indigenous people, renters, low income and homeless people with pets or service dogs, people with no health insurance, and isolated elders.

Workshop participants were not tasked with developing solutions as part of the vulnerability assessment, yet many were suggested.

Some suggested potential strategies and actions included:

- Develop system of cooling stations in convenient locations and public areas
- More consistent shelter openings, including shelters from the heat
- Develop more approaches like Hope Village in Medford (tiny homes village)
- Create job programs that link seasonal employment for more consistent income
- Proactively discuss equity and disadvantaged populations in all City planning processes
- Implement financial strategies for low income home owners to upgrade energy systems
- Provide incentives for landlords to invest in energy upgrades, air conditioning, comfort, and air quality in rental units
- Train people with relationships in different communities (Latino communities or churches for example) to do outreach on energy, water, heat impacts, and other issues
- Compensate people from diverse communities for participation in planning processes
- Provide opportunities for people with low incomes to become educators and leaders
- Ally different organizations - have them come together on climate change
- City commissions need to actively recruit people with a diversity of backgrounds

For more potential strategies and actions, see Appendix A

Health and Emergency Response

The impacts of climate change on human health are numerous and expected to be increasingly detrimental. For example, increased temperatures can cause ground level ozone to become far more concentrated, exacerbating respiratory and heart disease and leading to mortality. Also, extreme heat is the top source of mortality of all natural disasters (National Weather Service), and is expected to increase substantially in the years to come. The current outbreak and spread of Zika virus is an example of the increased disease risk associated with climate change. The relationship between human health and the myriad of climate impacts is well documented, from water-borne disease to mental health issues (Fig. 5).

	Climate Driver	Exposure	Health Outcome	Impact
Extreme Heat	More frequent, severe, prolonged heat events	Elevated temperatures	Heat-related death and illness	Rising temperatures will lead to an increase in heat-related deaths and illnesses.
Outdoor Air Quality	Increasing temperatures and changing precipitation patterns	Worsened air quality (ozone, particulate matter, and higher pollen counts)	Premature death, acute and chronic cardiovascular and respiratory illnesses	Rising temperatures and wildfires and decreasing precipitation will lead to increases in ozone and particulate matter, elevating the risks of cardiovascular and respiratory illnesses and death.
Flooding	Rising sea level and more frequent or intense extreme precipitation, hurricanes, and storm surge events	Contaminated water, debris, and disruptions to essential infrastructure	Drowning, injuries, mental health consequences, gastrointestinal and other illness	Increased coastal and inland flooding exposes populations to a range of negative health impacts before, during, and after events.
Vector-Borne Infection (Lyme Disease)	Changes in temperature extremes and seasonal weather patterns	Earlier and geographically expanded tick activity	Lyme disease	Ticks will show earlier seasonal activity and a generally northward range expansion, increasing risk of human exposure to Lyme disease-causing bacteria.
Water-Related Infection (*Vibrio vulnificus*)	Rising sea surface temperature, changes in precipitation and runoff affecting coastal salinity	Recreational water or shellfish contaminated with *Vibrio vulnificus*	*Vibrio vulnificus* induced diarrhea & intestinal illness, wound and blood-stream infections, death	Increases in water temperatures will alter timing and location of *Vibrio vulnificus* growth, increasing exposure and risk of water-borne illness.
Food-Related Infection (*Salmonella*)	Increases in temperature, humidity, and season length	Increased growth of pathogens, seasonal shifts in incidence of *Salmonella* exposure	*Salmonella* infection, gastrointestinal outbreaks	Rising temperatures increase *Salmonella* prevalence in food; longer seasons and warming winters increase risk of exposure and infection.
Mental Health and Well-Being	Climate change impacts, especially extreme weather	Level of exposure to traumatic events, like disasters	Distress, grief, behavioral health disorders, social impacts, resilience	Changes in exposure to climate- or weather-related disasters cause or exacerbate stress and mental health consequences, with greater risk for certain populations.

Figure 5. Examples of health impacts from climate change. From U.S. Global Change Research Program 2016.

ELDERS – Older adults, especially those with low incomes, substandard housing, or without air conditioning, are expected to have serious impacts from extreme heat, storms and flooding, drought, and smoke from wildfire. Many elders already experience health challenges, which are expected to be exacerbated by climate impacts. Decreased lung capacity, heart problems, lowered awareness, low mobility, physiological sensitivity to dehydration, and lowered body temperature regulation all make elders more sensitive to the impacts of climate change. Elders that live in rural areas and/or are isolated from family members are especially at risk.

Stressors – Additional stressors to elders include isolation, lack of public transportation combined with reduced mobility, long distances from family members, lack of affordable housing, and a quickly growing population without enough caregivers.

Adaptive Capacity – Adaptive capacity comes from many elders living in retirement communities or assisted care. Also, there are numerous civic and church organizations for elders, medical facilities that act as community hubs, case managers for those with extra medical support, and support programs to help with utility bills, health care, and emergency response. Jackson County Health, citizen alert programs like Everbridge, 1700 AM radio, and even ham radio were all listed as available resources for elders. The Rogue Valley Council of Governments has a Disaster Registry Program as well.

YOUNG CHILDREN – Young children are at risk from extreme heat, water- or vector-borne disease, smoke and ozone leading to asthma, and bacteria and toxins in water. Children of single mothers, young mothers, and low income parents are at especially at risk.

Stressors – Single parents and low income parents working full time have the additional stressors of a lack of childcare and summer supervision, when extreme heat and water quality are risks. Low income households also have less access to air conditioning.

Adaptive Capacity – La Clinica offers health care for low income families. Also, many parent and other support groups are available, including La Leche, ESL groups, and others.


Photo by Bev Sykes / CC BY 2.0


FEMA Photo

HEALTH CARE STAFF and FIRE FIGHTERS – Staff at hospitals, first responders, fire fighters, university health providers, and others are at risk due to the potential increase in extreme events and natural disasters associated with climate change. As these staff members serve the community, they also become concerned about their own families, homes, and other loved ones, making it more difficult to provide quality services and take care of their own mental and physical health. Fire fighters are already responding to longer and more extreme fire seasons, putting their own lives on the line and dealing with loss of fellow fire fighters.

Stressors – Mental health is often stigmatized, making it difficult for people to seek help and get support. Also noted was the shift from non-profit to for-profit for Hospice care, which can affect patient care, the types of services provided, and the larger communities (Aldridge et al. 2014).

Adaptive Capacity – FireWise program and CERT to increase fire readiness within the community. Because we have a Tier II hospital, procedures are already in place for a major disease outbreak in the area. Natural disaster and disease training exercises increase efficiency and effectiveness of response, reducing impacts to the public and to first responders as well.

RESIDENTS WITHOUT FAMILY NEARBY – Students at SOU are far from their families, without support during extreme events. Climate impacts include extreme heat, more extreme storms and flooding, and smoke and ozone. College students often leave for the summer, reducing their exposure to extreme heat. Many elders lack family nearby and have no evacuation plan.

Stressors – Many classrooms and apartments are not air conditioned. Athletes and outdoor recreationists can be exposed to heat and poor air quality during practice.

Adaptive Capacity – Students are young and physically more resilient than older adults. They are more able to withstand heat. Many students at SOU have cars and are able to evacuate during disasters.

PEOPLE WITH ASTHMA AND RESPIRATORY ILLNESS – People of all ages, but especially very young children and elders, with compromised respiratory systems are at risk from increase in ozone, smoke and particulates, and pollen associated with climate change.
HOMELESS – please see previous section on Equity and Disadvantaged Populations.

Additional target communities and resources to assess include people with low mobility (physical mobility and also due to a lack of transportation), international travelers, seasonal and migrant workers, people without health insurance, climate refugees from other areas, people with mental illness, first responders, people living in the forest interface, and outdoor enthusiasts.

Workshop participants were not tasked with developing solutions as part of the vulnerability assessment, yet many were suggested.

Some suggested potential strategies and actions included:

- Increase and strengthen efforts to improve water quality in streams and rivers
- Change land use codes to reduce building in high risk areas (such as forest interface and flood zones)
- Anticipate new health challenges related to climate change and address them proactively
- Implement the recommendations in the *Jackson County Climate and Health Action Plan*
- Partner with churches (such as Catholic church) to provide training in health and emergency response
- Create buddy system for those without family
- City should have greater emergency supply of water and food
- Map neighborhood residents so people know who needs support and resources
- Create systems of neighborhood captains
- Educate and provide people with the correct type of mask for smoke
- Need to have an evacuation plan for pets and livestock
- Distribute water purifiers for emergency situations

For more potential strategies and actions, see Appendix A

BUSINESS AND AGRICULTURE

Businesses in Ashland and the Rogue Valley are diverse, including manufacturing, agricultural production, outdoor recreation, tourism, retail, and other industries. Government and health care are the largest employers overall.

Agricultural production in the region includes fruits, treenuts, and berries, as well as cattle and, to a lesser amount, vegetables (USDA Ag Census 2012). Climate change impacts to agriculture include reduced fruit production from hotter nighttime temperatures, damage from extreme storms, and longer dry spells. Hot nights also stress animals, reducing meat, milk, and egg production (NCA 2014). Longer growing seasons could increase production of some crops.

The business and agriculture workshop participants identified numerous potential vulnerabilities to climate change impacts. These are not comprehensive, and many other vulnerabilities still need to be identified and quantified. Many of the business vulnerabilities identified in this report are focused on Ashland, due to Ashland's current efforts to develop a Climate and Energy Action Plan.


Photo by A. Nogues

TOURISM BASED BUSINESSES – Changes to the natural beauty of the area, changes to fish and wildlife, extreme heat, smoke, and severe storms are all likely to impact tourism, which makes up a significant portion of the local economy in Ashland and other areas of the Rogue Valley.

Stressors – High housing prices and limited public transportation already make it difficult for low income and seasonal workers in the tourism industries to live and work in Ashland.

Adaptive Capacity – Many tourist attractions can shift their seasons to shoulder seasons if summers become too hot and/or smoky. Inside theaters (such as those at the Oregon Shakespeare Festival), non-snow recreation, and diverse alternative tourist attractions such as wine tasting and mountain biking create more resilience and opportunity.

Photo by Michael Hanscom / CC BY-NC-SA 2.0

SEASONAL WORKERS – Mt. Ashland Ski Area, Oregon Shakespeare Festival, local hotels and restaurants, rafting guides, grape and pear harvesters, and a variety of other seasonal workers could experience disruptions in work availability due to climate change (from declines in snowpack, changes to forests, smoke impacts, drought and extreme heat) pushing them into poverty or to leave the area.

Stressors – High housing prices and limited public transportation already make it difficult for low income and seasonal workers to live and work in Ashland. Ski area workers already experience years without employment opportunities.

Adaptive Capacity – The diversity of seasonal jobs means that even with changes in one industry, options might still exist in other industries to sew together year-round work.

LANDSCAPING – SOU and the City of Ashland attract students and tourists with landscaping and parks. Bigger storms, extreme heat, water shortages from drought, and increased pests and disease could all take a toll on landscaping. Additionally, many of the current trees and plants may no longer grow well in new and changing conditions.

Stressors – Outdated irrigation systems make it difficult for large users such as SOU to save water, because pipes can burst from water pressure if the water isn't used. Many landscaping trees are already dying from disease, and tree removal is very expensive for property owners.

Adaptive Capacity – Many residents are already planting native and drought-tolerant species. The TID provides untreated water for many parks and yards at lower cost. Mulching offers another common way to save water. Many cities in the Rogue Valley have programs to help people save water, such as the lawn replacement program in Ashland.

Photo by R. May

ELECTRICAL PRODUCTION FROM SOLAR PANELS – The solar industry is growing quickly in Southern Oregon, as in many other parts of the nation. Yet smoke from more wildfires threatens to lower solar energy production. Smoke from wildfire can reduce output by 30%, and ash and other residue can coat solar panels, reducing their output until they are cleaned.

AGRICULTURE – Agriculture is already being affected by climate change, and will continue to be affected by new diseases and pests, a loss of important "chill hours" from freezing nights, extreme conditions (heat, storm damage, drought), declines in water quality, and declines in hydropower during drought, which could affect electricity costs for marijuana growing. Crops may become less hardy as there are fewer freezing temperatures in winter. Additionally, many crops will no longer be able to be grown in the area and new crops will need to be planted, making it more difficult to grow crops that require years before maturation, such as wine grapes and fruit trees (eg. Harry and David). Increased pesticide and herbicide use in response to climate change could create secondary impacts to farm workers, the public, water quality, and fish and wildlife.

> **Stressors** – New diseases are already affecting wine grapes, and harvest times are often difficult to predict. Competition with housing development can make land prices out-of-reach for farming. Most of our food is imported at lower cost than that grown locally.
>
> **Adaptive Capacity** – Many options are already available to reduce heat impacts and water use limitations. Kalonite can be applied to make plants reflective. Harry and David already import some of their fruit instead of growing it all locally. Because many current systems are outdated, the opportunities to save water are high, which could compensate for increased water use with higher temperatures.

HOMES AND ENERGY USE – see the next section on Infrastructure and Planning.

QUALITY OF LIFE – Our region is a tourism and retirement destination because of the beautiful forests, temperate climate, water availability, large rivers, and abundant fish and wildlife. Many of these features are threatened by climate change. Real estate values could decline if the area no longer acts as a draw. Alternatively, the area could become a destination for climate refugees. Sea level rise, lack of water, and extreme storms could make other areas less habitable.

Additional target communities and resources to assess include food supply (local and imported agricultural products), city trees, power lines, and water demand for businesses and manufacturing.

Workshop participants were not tasked with developing solutions as part of the vulnerability assessment, yet many were suggested.

Some suggested potential strategies and actions included:

- Choose robust plants and trees, climate adapted for future conditions
- Plant more trees for shade and air quality, especially near schools
- Use natural pest predators to reduce the need for pesticides, herbicides
- Look at international best practices and innovation to see what works in other places
- Support farmers in helping them conserve water
- Update building codes to make buildings more efficient
- Expand current outreach efforts, especially to new audiences
- Increase renewable energy installation, especially for low income homes
- Diversify energy sources

For more potential strategies and actions, see Appendix A

INFRASTRUCTURE AND PLANNING

Current infrastructure and planning processes are based on codes and protocols that have the same basic assumption of continued historic climate. Unless plans, codes, and guidelines have been updated to incorporate climate change model projections (such as Ashland's master water plan), they assume that risks from wildfire, floods, contaminants, and other variables will fall within the historic range of variation and averages. Unfortunately, we know that this assumption is false, and that many future conditions will not only be outside that historical range, but may also be unanticipated.

As 100-year floods become 20- or 10-year floods, and 80-year fire return intervals become 40-year fire return intervals (or less), all planning processes, codes, and guidelines will need to be updated. At this point in time, we need to not only be considering future conditions as we maintain and upgrade our existing infrastructure, but also consider likely future conditions and the magnitude of change in siting and sizing of new infrastructure.

The infrastructure and planning workshop participants identified numerous potential vulnerabilities to climate change impacts.

MUNICIPAL WATER SUPPLY (TREATED) – Risks to municipal water supply include less reliable precipitation, lower snowpack, increased evaporation from increasing temperatures, increased sedimentation from severe storms and wildfire, and increasing water demand with longer, hotter summers. Warmer temperatures are likely to lead to more algae blooms, and lower flows could cause higher contamination rates. Higher prices and limitations on businesses that use a lot of water (such as breweries) could cause impacts to low income populations and economic growth in the future.

Wildfire

A group of the nation's leading wildfire experts reviewed the science (Schoennagel et al. 2016) and laid out **7 key insights** that can be used to guide wildfire policy.

1. Fire size and frequency will increase with climate change.
2. Fuel reduction on forest lands will do little to reduce acreage burned and homes lost.
3. Not all forests need restoration
4. High severity fires have ecological benefits.
5. Insect outbreaks do not necessarily make fires worse.
6. Land use planning can reduce wildfire risk to homes and people.
7. Managing more fires to burn safely can reduce risk and increase ecological benefit.

The conclusions of this study were that wildfire is important for maintaining healthy forest systems. Also, we can never "treat" (log or thin) enough of our forests to change the trend of increasing fire. Changes in land use zoning and fire management near residences can reduce the risk to homeowners. Careful use of existing funds will be key to protecting homes, lives, and forest ecosystems.

Stressors – The Rogue River, which provides water for Medford and other communities, and is already over-appropriated, even without considering the impacts of climate change. Not enough redundancy in supply makes communities vulnerable during drought or extreme events. If water conservation is increased, pipes may need to be resized to withstand lower flows. Water from TAP (Talent-Ashland-Phoenix waterline intertie, which is Ashland's connection to the Rogue River) is more expensive than water from Reeder Reservoir, and could affect pricing. Impervious surfaces and pavement make it difficult for water to infiltrate groundwater. Clay soils also limit infiltration.

Adaptive Capacity – Connection to TAP (water from the Rogue River available now to Ashland) has provided a backup supply for Ashland. While Ashland's supply is more reliant on snowpack, Medford's is less so, creating some diversification in supply. Conservation programs in Ashland are already quite good and the community is engaged.

TALENT IRRIGATION DISTRICT – TID water is used for agriculture and also made available for landscape watering in certain areas in Ashland. Risks to the TID water supply are similar to those to municipal water supply. Water quality is expected to be an issue as water levels decline and evaporation increases. TID water is also used as a backup for municipal water in Ashland, and water quality issues could affect treatment cost. Additionally, TID water flows into Bear Creek and can affect algae blooms and bacteria outbreaks.

Stressors – TID water can contain pesticides, herbicides, bacteria, and other contaminants. Because the TID is not metered, waste is common. Delivery systems for TID are outdated and have some limitation. For example, large water users like SOU have issues with high water pressure that could cause pipes to burst without sufficient watering.

Adaptive Capacity – The Water for Irrigation, Streams, and Economy (WISE) project is moving forward, with plans to pipe the TID water, which reduces loss from evaporation and leakage.


Ashland Creek by Finetooth / CC BY-SA 3.0

LOCAL CREEKS – Local creeks, such as Bear Creek and Ashland Creek are expected to have lower low flows and more sedimentation during high flows. E. coli and other bacteria and contaminants could increase due to warmer waters, lower flows and more storms that wash contaminants into the streams.

WASTEWATER AND STORMWATER – Many areas are already prone to flooding, which is expected to worsen with larger storms. Downtown Ashland, neighborhoods near Bear Creek, homes along Clay Creek, and other known areas are all at risk.


Photo by Oregon Dept. of Transportation / CC BY 2.0

Stressors – Continued development of wetlands and other natural water storage features exacerbate the flood risk. Low income housing is often placed in flood zones, especially trailer and mobile homes, putting low income residents at a greater risk for life-changing events. Downtown Ashland already experiences flood damage, such as hundreds of thousands of dollars of damage last summer from an unexpected downpour, which affected local businesses. The 1997 flood, a 25-year event, caused extensive flooding especially in downtown Ashland.

Adaptive Capacity – The state revolving fund "SRF" provides better rates on loans when wastewater and stormwater are planned together.

WATER INFRASTRUCTURE – Dams and other water infrastructure are at risk from larger storms that increase sedimentation, cause turbidity, and quickly fill and stress water storage capacity. Reeder reservoir is the main water storage for Ashland, and has been rated as safe up to a 10,000 year flood event based on historical standards. Medford's water infrastructure could be at risk from more severe storms that create sedimentation in the Rogue River and require more water treatment at higher cost prior to delivery. Increased sedimentation of Emigrant Lake and other local reservoirs create turbid water conditions.

ENERGY INFRASTRUCTURE –The City of Ashland owns its own utility, and purchases power from Bonneville Power Administration (BPA). Medford, Grants Pass and other communities get their power from Pacific Power. Ashland's energy comes largely from hydroelectric power, which has been shown to be highly sensitive to climate impacts, including the loss of natural water storage in snowpack, changes to precipitation, more sedimentation, and more evaporation (van Vliet et al. 2016). BPA predicts a shortage of hydropower

Photo by M. Koopman

capacity during low water and extreme weather conditions (Northwest Power and Conservation Council 2016).

Pacific Power will be affected by the Clean Power Plan, which requires reductions in greenhouse gas emissions associated with fossil fuel based energy production. Risks to energy infrastructure include risks to transmissions lines and distribution systems, lowered distribution efficiency with higher temperatures, and increased demand for energy in summer with higher temperatures and increased use of electric vehicles.

Stressors – Ashland produces hydropower from Reeder Reservoir, and this dewaters portions of Ashland Creek, compromising about a mile of Steelhead habitat. The City's energy use now has a second peak in the summer, due to more use of air conditioning, which is likely to increase. Homes are designed to reduce heat loss more than they are for staying cool. Also, homes are often built without siting for solar panels, creating a missed opportunity for more clean energy.

Adaptive Capacity – The existing relationship between the City of Ashland and Bonneville provides relatively clean and inexpensive energy for the city. Solar panel installation is growing quickly and can provide an increasing portion of the city's power.

TRANSPORTATION – The primary risks to transportation and transportation infrastructure are extreme heat and more severe storms, both of which can impact roads and highways. Extreme heat can also cause train tracks to buckle. Large storms can destroy or damage bridges and culverts, and can cause extreme erosion and sedimentation from unpaved roads into rivers and streams. Additionally, extreme heat and smoke puts people at risk as the walk or bike, and are likely to reduce the success of efforts to get people to use alternative transportation more often.

Stressors – Many students and workers in Ashland cannot afford to live in Ashland and commute, putting stress on roads and highways. Insufficient public transportation leads to more cars on the road. Bikes lanes are insufficient and often bikes are forced to ride with cars, creating unsafe situations for bikers.

Adaptive Capacity – New funding was recently approved, allowing for improvements to Rogue Valley Transportation District (RVTD) routes and buses. This could reduce the need for individual vehicles and create more employment opportunities for low-income workers.

Photo by RVTD / CC BY-SA 3.0

CLIMATE CHANGE REFUGEES – Multiple workshop participants voiced concern that people are likely to move to the Rogue Valley in response to climate impacts in other parts of the nation. Sea level rise, water shortages, air quality, heat waves, and extreme storms could all cause climate refugees to seek areas with lower relative impacts. The impacts associated with increasing immigration include stress on water and energy systems, higher land values that make agriculture less viable, fewer options for low income and seasonal workers as rental properties become even less available, and greater stress to natural systems from development, pollution, recreation, and other land use pressures. An additional stress from immigration would be the difficulty in meeting greenhouse gas emissions targets that are being set to reduce the magnitude of climate change worldwide.

Additional target communities and resources to assess include wildland urban interface (WUI) planning, electric car infrastructure, best practices for urban trees (balance between shade, solar energy, and wildfire risk), water in creeks, reservoir production, etc.
Workshop participants were not tasked with developing solutions as part of the vulnerability assessment, yet many were suggested.

Some suggested potential strategies and actions included:

- Develop more and innovative water conservation measures
- Strengthen codes and standards, especially for multi-family housing
- Use bioswales, permeable pavement, and other green infrastructure approaches to reduce flood risk to homes
- Include climate change projections and information in EVERY planning process – plan for future range of variability and future conditions
- Increase regional coordination in planning
- Solar energy production on reservoirs
- Look at new technologies in using treated wastewater for use
- Reduce building in high risk areas (such as forest interface and flood zones)
- After floods, move development rather than reconstructing in high risk areas
- New homes in high risk areas should pay for protection
- Upgrade culverts to benefit fish
- Give food production priority for water (over marijuana and landscaping)
- Address equity through electricity rate structure
- Expand Rogue Valley Transportation District
- City should give preference to minority-owned and women-owned businesses

For more potential strategies and actions, see Appendix A

Conclusions

Climate change is a global threat with locally-unique impacts for communities. Because each region is affected differently, it is vital to assess vulnerabilities at the local level. Some of the most important impacts to the Rogue Valley include air and water quality declines, affecting human health and natural systems, as well as changes to our forests and more extreme storms, heat, and drought conditions. The most vulnerable residents and resources are generally those with the least adaptive capacity to deal with the additional impacts of climate change.

Many of the impacts of climate change in the Rogue Valley cannot be avoided and actions must be taken to protect the most vulnerable populations and resources from accelerating change. Because climate change affects all sectors and resources, coordinated actions are needed to increase overall resilience. Without coordination, actions in one sector could shift the impact to other sectors, vulnerable populations, and/or future generations. We are seeking solutions that build resilience across all populations and resources (including future generations) while also addressing historical stressors and inequities.

Efforts to reduce emissions quickly and aggressively are also needed. By keeping global average temperatures below 1.5° C (about 2.7° degrees F), and returning atmospheric carbon dioxide levels to 350ppm, we can protect young people and future generations from catastrophic impacts and runaway climate change.

As Ashland and other communities in the Rogue Valley take on the challenge of planning for climate change, we have an opportunity to do so in ways that create greater community resilience for ALL residents and resources. A recent review of climate change plans (Geos Institute, In Review) showed that some topics are not receiving adequate attention in the planning process. Even though climate change affects all sectors of our communities, disadvantaged populations, natural ecosystems, agriculture, and economic systems are rarely addressed

As Ashland completes the first comprehensive mitigation and adaptation plan in Southern Oregon, we have the opportunity to lead the way and demonstrate truly co-beneficial solutions to climate change. Such solutions would address economic and social inequities, increase ecological resilience, and reach out to other communities to work across jurisdictions and create new collaborations. Focus on strategies that create co-benefits would include things like clean energy and home upgrades for low income residents, watershed restoration benefitting fish and protecting homes from flooding, and outreach with diverse populations to develop job opportunities in the emerging clean energy economy. Such strategies focus on co-benefits, which reduce conflict, save money, and build relationships within and among communities.

Ashland and the Rogue Valley are at a turning point, and we believe our communities are heading in the right direction, by reducing emissions, creating new jobs in clean energy and creating more collaborative solutions. These solutions are ecologically sound and create the social equity and diversity that will allow our communities to thrive in coming decades.

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Who We Are

The Geos Institute is a non-profit organization focused on creating science based, ecologically sound, and equitable solutions to climate change. We have three main programs.

Forest Legacies provides policy makers and land managers with scientific information and management guidance to sustain temperate forests in changing climate conditions.

ClimateWise helps local leaders develop Whole Community adaptation strategies to address the impacts of climate change.

Working Waters is a science-based initiative dedicated to ensuring safe water for whole ecosystems: people, plants, and animals. We partner with water managers and other stakeholders to build strategies that heal and protect healthy watersheds.

The Geos Institute is located in Ashland, Oregon. We work all over the nation, yet were fortunate to conduct this project in our own backyard with friends, coworkers, and numerous new acquaintances. We look forward to seeing Southern Oregon become a climate leader!

Thank you!

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