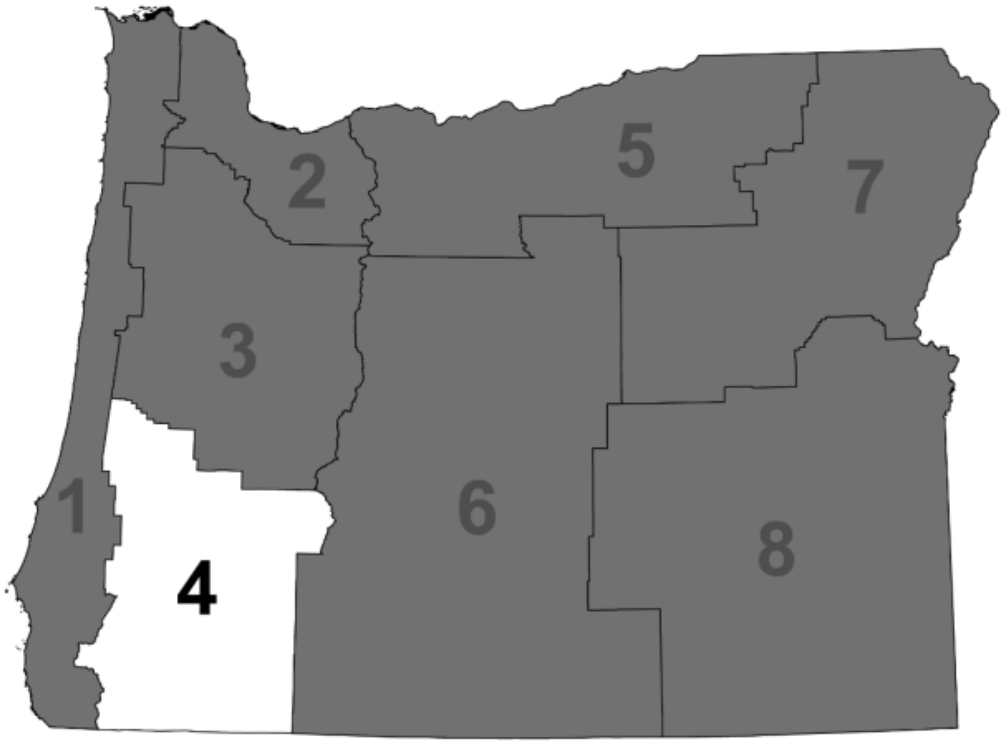
2.3.4 Region 4: Southwest Oregon

*Douglas (non-coastal), Jackson, and Josephine Counties



*Note: The coastal portion of Douglas County is within Region 1. Where data are available for the coastal areas of Douglas County, the data are provided within the Region 1 profile; otherwise, countywide datasets are reported in this profile.

2.3.4.1 Summary

Regional Profile

The region's demographic, economic, infrastructure and development patterns indicate that some populations, structures and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area's ability to bounce back after a natural disaster.

Social vulnerability across the region is driven by low median household incomes and a high proportion of senior citizens. There are several indicators of vulnerability at the county level, including: high numbers of tourists in Jackson County; a large share of seniors with disabilities in Douglas County; homelessness on the rise in Jackson and Josephine Counties; fewer college degrees in Douglas and Josephine Counties; and increases in poverty in Douglas and Jackson Counties.

Region 4 was hit particularly hard by the financial crisis that began in 2007 and continues to suffer from significantly low job recovery rates and below average wages. There are few key industries and employment sectors in Southwest Oregon. The area is particularly vulnerable during winter months when there are fewer employment opportunities.

Transportation networks across the state are vulnerable to seismic events. Following a CSZ earthquake, access along I-5 may be limited due to bridge collapse. Roughly 18% of the state-owned bridges in Southwest Oregon are distressed.

Energy facilities and conveyance systems in the region help support the regional economy and are vulnerable to damage and service disruptions due to natural hazard events. The region has multiple dams, hydroelectric and biomass power-generation facilities that service the state. Of the state-owned dams in the region, 28 have High Threat Potential and 42 have Significant Threat Potential. Natural gas pipelines run through Josephine and Douglas Counties and are vulnerable to seismic activity.

Older centralized water infrastructure is vulnerable to pollution and flooding, which can have implications for public health and water quality. During high-water events, the region's drinking water is vulnerable to high levels of pollutants entering waterways through combined sewer overflows (CSOs). Medford is the only city in the region that requires low impact development (LID) stormwater mitigation strategies in its development code.

Region 4 is developing at about half the rate of the state. The majority of growth is occurring in cities along I-5, particularly within Jackson County. Mobile homes comprise significant share of housing units and are inherently vulnerable to natural hazards. Roughly two thirds of homes in this region were built prior to current seismic building standards, making them especially vulnerable.

Hazards and Vulnerability

Region 4 is affected by nine of the state's 11 natural hazards. Coastal hazards and tsunamis do not directly impact this region.

Droughts: Droughts can affect commerce, agriculture, fisheries, and overall quality of life in all three counties. Jackson and Josephine Counties were declared federal primary natural disaster areas by the U.S. Department of Agriculture in 2013.

Earthquakes: Four types of earthquakes affect Region 4 (a)shallow crustal events, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) the offshore Cascadia Subduction Zone (CSZ) Fault, and (d) earthquakes associated with renewed volcanic activity. The CSZ is the chief earthquake hazard for Southwest Oregon. The region is particularly vulnerable due to the large area susceptible to earthquake-induced landslide, liquefaction, and ground shaking. In a 500-year model for a CSZ event or combined crustal events, all three of the region's counties rank among the top 15 counties with the highest expected earthquake damages and losses. The state's seismic lifelines along Interstate-5 and east-west routes that connect the region to the rest of the state are highly vulnerable to seismic events. There are 434 state-owned/leased facilities, valued at over $164.4 million, within this region's earthquake hazard zone. Of these, 34 are critical/essential facilities. An additional 1,069 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Floods: Floods affect Southwest Oregon in the form of riverine flooding often preceded by rapid snow melt and heavy rain. All of the region's counties are considered moderately vulnerable to flooding. There are 18 repetitive flood loss properties in Region 4. There are 102 state-owned/leased facilities, valued at approximately $45.4 million, located in the region's flood hazard zone. Of these, four are considered critical/essential facilities. An additional 80 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Landslides: Landslides can occur throughout the region, though more tend to occur in areas with steeper slopes, weaker geology, and higher annual precipitation. Rain-induced landslides can occur during winter months. Earthquakes can trigger landslides in the region. Vulnerability is increased in populated areas – such as in the Cities of Ashland and Medford – and in the Klamath Mountains. There are 434 state-owned/leased facilities, valued at over $164.4 million, located in this hazard zone in Region 4. Of these, 34 are critical/essential facilities. An additional 1,069 non-state-owned/leased critical/essential facilities are also located within this hazard zone.

Volcanoes: Volcanic activity may occur within the eastern areas of the region's counties that coincide with the crest of the Cascade mountain range. Particular areas of vulnerability include Crater Lake, upper reaches of the Umpqua and Clearwater Rivers, and the OR-62 corridor. Most volcanic activity is considered local. However, lahars and ashfall can travel many miles and small mountain communities, dams, reservoirs, energy-generating facilities, and highways may be vulnerable. There are no state-owned/leased facilities and no critical/essential facilities located in a volcanic hazard zone within Region 4.

Wildfires: In Southwest Oregon the combination of proximity of communities to wildland areas; high summer temperatures; rugged terrain; and likelihood of summer thunderstorm activity contribute to the region's vulnerability to wildfire. Wildfires are most common during the late

summer. Based on data from the 2013 West Wide Wildfire Risk Assessment, in Region 4 Douglas and Jackson Counties have a high percentage of wildland acres in the Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat categories, making them especially vulnerable. Other areas of vulnerability are within wildland-urban interface communities. There are 198 state-owned/leased facilities located in this region's wildfire hazard zone, with a value of approximately $44 million. Of these, 11 are identified as critical/essential facilities. An additional 408 non-state-owned/leased critical/essential facilities are also located in this hazard zone.

Windstorms: Windstorms can occur when Pacific Ocean winds travel inland in a northeasterly direction. These storms generally impact the region's buildings, utilities, tree-lined roads, transmission lines, residential parcels, and transportation systems along open areas such as grasslands and farmland.

Winter Storms: Cold weather and high precipitation impact the region annually. Severe winter storms can shut down the I-5 corridor passage through the Siskiyou Mountains, which can adversely impact the economy regionally and statewide.

Climate Change

The hazards faced by Region 4 that are projected to be influenced by climate change include drought, wildfire, flooding, landslides, and extreme heat.

Climate models project warmer, drier summers for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, Region 4 is expected to be affected by an increased incidence of drought and wildfire. In Region 4, climate change would result in increased frequency of drought due to low spring snowpack (*very likely*, >90%), low summer runoff (*likely*, >66%), and low summer precipitation and low summer soil moisture (*more likely than not*, >50%). It is *very likely* (>90%) that Region 4 will experience increasing wildfire frequency and intensity due to warmer, drier summers coupled with warmer winters that facilitate greater cold-season growth.

It is *extremely likely* (>95%) that the frequency and severity of extreme heat events will increase over the next several decades across Oregon due to human-induced climate warming (*very high confidence*).

Furthermore, flooding and landslides are projected to occur more frequently throughout western Oregon. It is *very likely* (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events and extreme river flows (*high confidence*) that is *more likely than not* (>50%) to lead to an increase in the incidence and magnitude of damaging floods (*low confidence*). Because landslide risk depends on a variety of site-specific factors, it is *more likely than not* (>50%) that climate change, through increasing frequency of extreme precipitation events, will result in increased frequency of landslides.

While winter storms and windstorms affect Region 4, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see Section 2.2.1.2, **Introduction to Climate Change**.

2.3.4.2 Profile

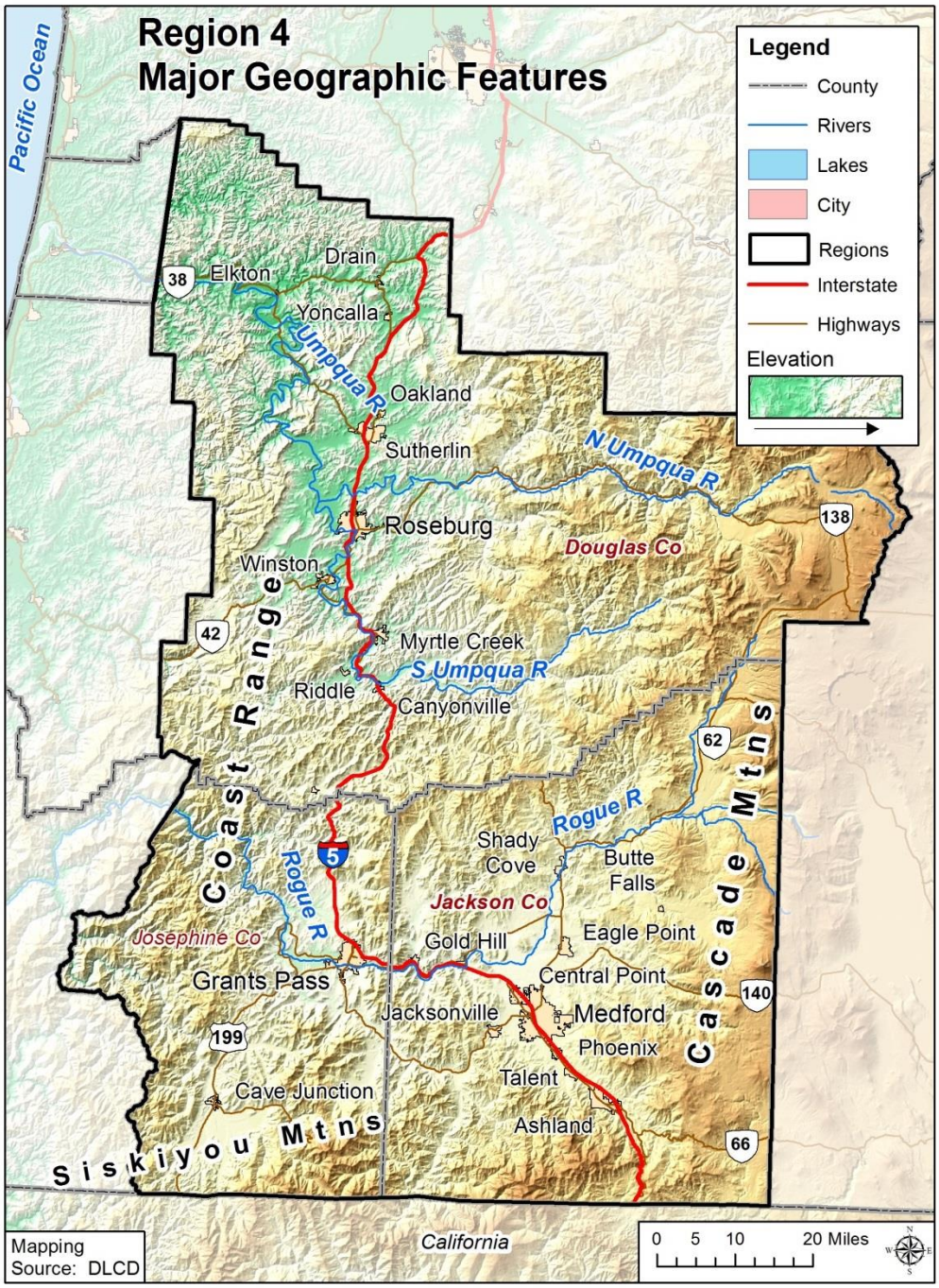
Requirement: 44 CFR §201.4(d): The Plan must be reviewed and revised to reflect changes in development…

Natural Environment

Geography

Southwestern Oregon is approximately 9,461 square miles in size, and includes Douglas (non-coastal), Jackson, and Josephine Counties. Mountain ranges and watersheds shape the region's topography. Region 4 begins at the Cascades in the east, and extends to the Klamath Mountains and Coast Range in the west. It extends from the Rogue-Umpqua Divide in the North to the Siskiyou Mountains at the California border in the south. Three rivers shape the region's main watersheds: the Umpqua River, the Rogue River, and the Illinois River (Downing, 2012).

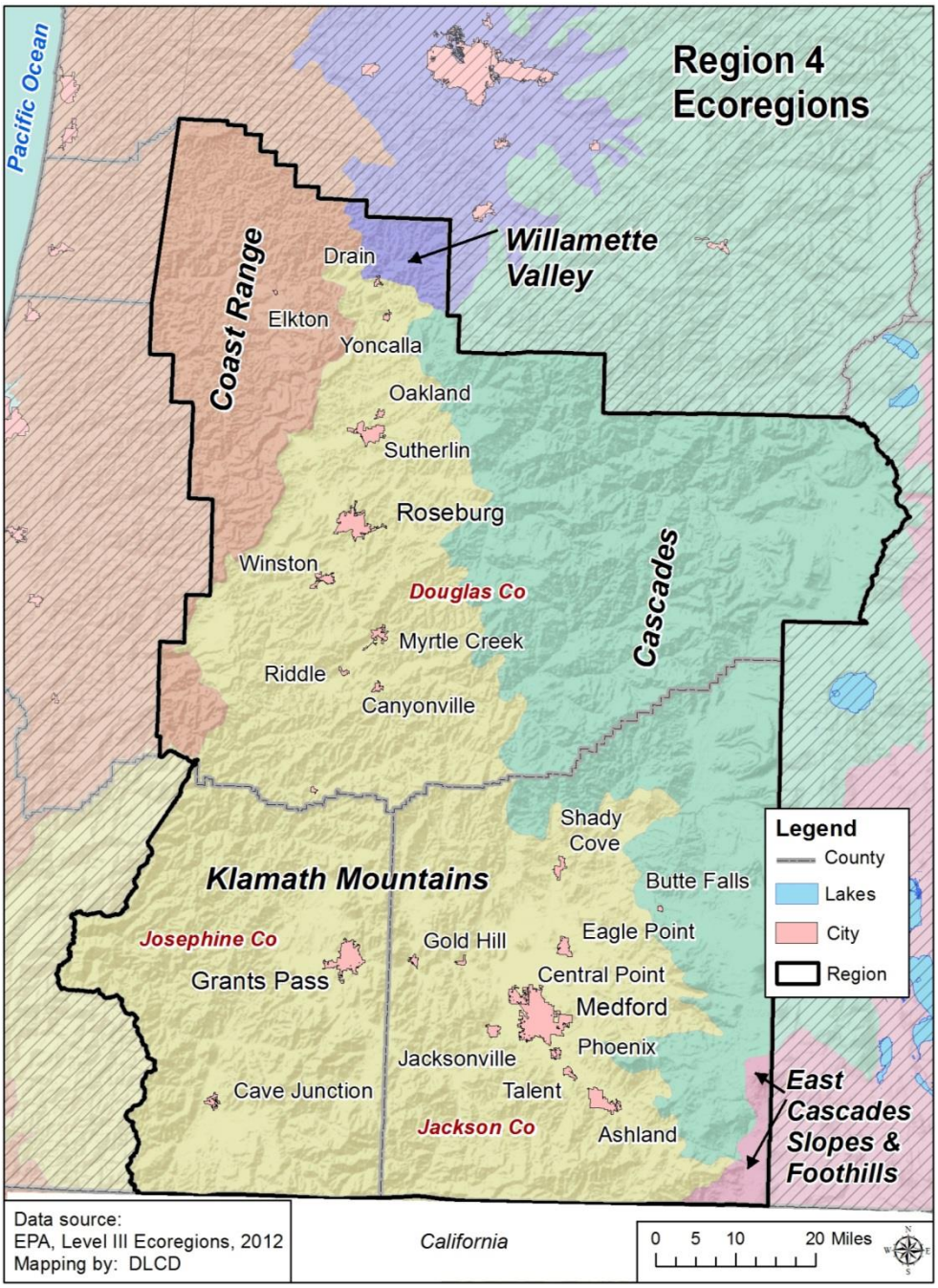
Figure 2-189. Region 4 Major Geographic Features



Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 4 is composed of three ecoregions: the Cascades, the Klamath Mountains, and the Coast Range (Figure 2-190).

Figure 2-190. Region 4 Ecoregions



Cascades: This ecoregion is underlain by volcanic soils. Naturally occurring mixed conifer forests have given way to predominantly Douglas fir forests that are managed for commercial logging. Logging activities have put a strain on the ecological health of streams in the area (Ecoregions of Oregon, http://www.epa.gov/wed). Waterways in the steeper valleys support threatened cold-

water salmonids including Chinook salmon, steelhead, and bull trout. Streams, lakes, reservoirs, rivers, and glacial lakes at higher elevations are key sources of water (Ecoregions of Oregon, http://www.epa.gov/wed).

Coast Range: The east slope of the Coast Range is located within Region 4. Sedimentary soils in this ecoregion are prone to failure following clearcuts, which may be of concern as the commercial Douglas fir forests located here are highly productive commercial logging areas. Landslides can impact the safety of nearby infrastructure and health of the region's waterways. The ecoregion's sedimentary soils can create more concerns for stream sedimentation than areas with volcanic soils (Ecoregions of Oregon, http://www.epa.gov/wed).

Klamath Mountains: A mixture of conifer and hardwood forests covers the Klamath Mountains ecoregion. A mosaic of soil types including sedimentary, granitic, metamorphic, and extrusive rocks underlies these forests. More extensive areas of hardwood and broadleaf evergreen canopies are evident in this ecoregion than in the Cascade Mountains ecoregion. Oregon white oak savannahs and woodlands, both habitat types that have been threatened by Douglas fir encroachment and human development, are present in foothills areas. This ecoregion has a dry, Mediterranean climate, which is prone to long summer droughts. The ecoregion's water quality and habitat continue to be negatively impacted by mine tailings (Ecoregions of Oregon, http://www.epa.gov/wed).

Climate

This section covers historic climate information only. For estimated future climate conditions and possible impacts refer to the **State Risk Assessment** for statewide projections.

Southwest Oregon's climate is characterized by warm summers—generally the warmest in the state—and cool winters—generally cooler than the rest of western Oregon. Precipitation generally occurs in the winter months accumulating a substantial snowpack in the higher elevations while the lowland valleys receive much less precipitation. The region's wet winters can lead to flood, landslide, and winter storm risks. Flooding can be a direct result of rain-on-snow events. Dry summers and years with low snowpack can lead to drought and wildfire risks. Localized variations in temperature and precipitation exist across the region's microclimates. **Table 2-339** displays 1981–2010 average precipitation and temperature for counties and climate divisions within Region 4 based on data from the NOAA National Centers for Environmental Information.

Table 2-339. Average Precipitation and Temperature in Region 4 Counties and Climate Divisions

Sub-Region	Annual Precipitation Mean & Range (1981–2010)	January & July Mean Precipitation (1981–2010)	Annual Mean Temperature (1981–2010)	January & July Average Min/Max Temperature (1981–2010)
Douglas County	53.75" (36.76"–86.28")	Jan: 7.72" Jul: 0.57"	50.9F	Jan: 33.6°F /46.1°F Jul: 51.8°F /79.0°F
Jackson County	36.7" (23.13"–59.85")	Jan: 5.1" Jul: 0.51"	50.3°F	Jan: 30.2°F /44.5°F Jul: 52.3°F /82.8°F
Josephine County	53.99" (29.93"–91.29")	Jan: 8.53" Jul: 0.36"	50.9°F	Jan: 33.0°F /45.3°F Jul: 52.4°F /81.1°F
Climate Division 3 "Southwestern Valleys"	47.48" (30.6"–78.07")	Jan: 6.87" Jul: 0.52"	50.6°F	Jan: 32.2°F/45.2°F Jul: 52°F/80.9°F

Source: NOAA National Centers for Environmental Information, Climate at a Glance: County & Divisional Time Series, published August 2019, retrieved on August 21, 2019 from https://www.ncdc.noaa.gov/cag/.

Demography

Population

Population forecasts are an indicator of future development needs and trends. Community demographics may indicate where specific vulnerabilities may be present in the aftermath of a natural hazard (Cutter, Boruff, & Shirley, 2003). Population change includes two major components: natural increase (births minus deaths) and net migration (in-migrants minus out-migrants) (USDA, 2020). If a population is forecast to increase substantially, a community's capacity to provide adequate housing stock, services, or resources for all populations after a disaster may be stressed or compromised.

Although each county within the region saw its population increase from 2010 to 2018, the region grew less quickly than the state as a whole. Jackson County experienced the largest total number of new residents and the greatest percentage increase during the period. All three counties in the region have an aging population and experienced natural decrease (more deaths than births) for the majority of the years between 2000 and 2018 (Population Research Center, Portland State University, 2019). Population growth, therefore, has largely been the product of substantial in-migration (Population Research Center, Portland State University, 2019). The region is projected to continue experiencing growth over the next decade, with the largest increases continuing in Jackson County.

Table 2-340. Population Estimate and Forecast for Region 4

	2010	2018	Percent Change (2010 to 2018)	2030 Projected	Percent Change (2018 to 2030)
Oregon	3,831,074	4,195,300	9.5%	4,694,000	11.9%
Region 4	393,586	417,330	6.0%	459,017	10.0%
Douglas	107,667	111,735	3.8%	119,212	6.7%
Jackson	203,206	219,200	7.9%	246,611	12.5%
Josephine	82,713	86,395	4.5%	93,194	7.9%

Source: Population Research Center, Portland State University, 2013; U.S. Census Bureau, 2010 Decennial Census. Table DP-1; Office of Economic Analysis, Long-Term Oregon State's County Population Forecast, 2010-2050, 2013

Tourists

Tourists are not counted in population statistics; and are therefore considered separately in this analysis. Three-quarters of tourism activities in Region 4 are centered on touring (traveling to experience scenic beauty, history, and culture), special events, and outdoor activities (Longwoods International, 2017). The average travel party contains approximately three persons and 67% of their trips originate from Oregon or California. In this region, the average number of nights spent in the region was between two and three (Longwoods International, 2017). From 2016-2018, Jackson County attracted more tourists than Douglas and Josephine Counties combined. The majority of those tourist stayed in private homes.

Difficulty locating or accounting for travelers increases their vulnerability in the event of a natural disaster. Furthermore, tourists are often unfamiliar with evacuation routes, communication outlets, or even the type of hazard that may occur (MDC Consultants, n.d.).). Targeting natural hazard mitigation outreach efforts to places where tourists lodge can help increase awareness and minimize the vulnerability of this population.

Table 2-341. Annual Visitor Estimates in Person Nights in Region 4

	2016		2017		2018	
	Number	Percent	Number	Percent	Number	Percent
Region 4	9,792		9,841		9,882	
Douglas	2,485	100%	2,465	100%	2,517	100%
Hotel/Motel	600	24%	590	24%	605	24%
Private Home	1,107	45%	1,107	45%	1,131	45%
Other	777	31%	768	31%	781	31%
Jackson	5,422	100%	5,478	100%	5,476	100%
Hotel/Motel	1,790	33%	1,852	34%	1,834	33%
Private Home	2,794	52%	2,799	51%	2,801	51%
Other	838	15%	827	15%	841	15%
Josephine	1,885	100%	1,898	100%	1,889	100%
Hotel/Motel	485	26%	491	26%	477	25%
Private Home	1,096	58%	1,106	58%	1,107	59%
Other	304	16%	300	16%	305	16%

Source: Oregon Travel Impacts: 1992–2018, March 2019. Dean Runyan Associates, http://www.deanrunyan.com/doc_library/ORImp.pdf

Persons with Disabilities

Disabilities appear in many forms. While some disabilities may be easily identified, others may be less perceptible. Disabled populations are disproportionately affected during disasters and can be difficult to identify and measure (Cutter, Boruff, & Shirley, 2003). A higher percentage of the population in Region 4 has a disability than statewide. The percentage with a disability is also higher in each county than in the state as a whole. In both Douglas and Josephine County, approximately one-fifth of all residents identify as having a disability. This is roughly five percentage points higher than the statewide estimate.

The percentage of younger people (<18) in the region with a disability is also higher than the statewide estimate. Each county in the region also has a higher percentage of young people with a disability than the state; however, the estimate for "under 18 with a disability" in Josephine County should be used with caution due to estimate reliability concerns. The percentage of older adults with a disability is also slightly higher in the region than in the state. Douglas County has the highest percentage of older adults with a disability while Josephine County's estimate is lower than both the region and statewide estimates.

Local natural hazard mitigation plans should specifically target outreach programs toward helping disabled residents better prepare for and recover from hazard events. Planning professionals might take a number of steps to mitigate risk for disabled community members. Inaccessible shelter facilities can pose challenges in a disaster event. Local officials should also strengthen partnerships with the disability community, and work with local media organizations to ensure emergency preparedness and response communications are accessible for all.

Table 2-342. People with a Disability by Age Group in Region 4

	With a Disability (Total Population)			Under 18 Years with a Disability			65 Years and Over with a Disability		
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	14.6%	☑	0.1%	4.6%	☑	0.2%	37.1%	☑	0.4%
Region 4	18.5%	☑	0.5%	5.1%	☑	0.6%	38.1%	☑	1.0%
Douglas	21.0%	☑	0.8%	5.1%	☑	1.1%	41.2%	☑	1.6%
Jackson	16.8%	☑	0.6%	5.1%	☑	0.9%	38.1%	☑	1.6%
Josephine	19.5%	☑	1.0%	5.0%	⊙	1.6%	34.4%	☑	2.2%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% – use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau, 20013–2017 American Community Survey 5-Year Estimates, Table DP02

Homeless Population

The U.S Department of Housing and Urban Development requires Continuums of Care to conduct the Point-in-Time Count, a biennial count of sheltered and unsheltered people experiencing homelessness. These are rough estimates and can fluctuate with many factors.

They should be understood as the absolute minimum number of people experiencing homelessness in the area (Oregon Housing & Community Services, 2019). Moreover, the PIT does not fully depict the extent of housing insecurity, as it excludes families or individuals that might be staying with friends or family due to economic hardship. The count also obscures the demographic composition of the houseless population, frequently undercounting people of color, for example (Oregon Housing & Community Services, 2019).

According to the PIT, between 2015 and 2019 the region experienced a 16% increase in its unhoused population. Homelessness in Douglas County grew most quickly; however, Jackson and Josephine both have greater absolute numbers of people experiencing homelessness. While these two counties saw a decline in homelessness from 2015 to 2017, the 2019 numbers surpass the 2015 count for all three counties. Statewide, people of color from almost every racial group are overrepresented in the homeless population (Oregon Housing & Community Services, 2019). In all Region 4 counties, Native Americans comprise a disproportionate share of the homeless population relative to their share of the overall population.

People experiencing homelessness are typically more physically and psychologically vulnerable compared to the general population and natural hazard events exacerbate vulnerability conditions. Disasters that result in damage to the built environment can place additional stress on temporary shelters (Peacock , Dash, Zhang, & Van Zandt, 2017). Local emergency management professionals should take a trauma-informed approach to providing services and include people with expertise in providing support to people experiencing homelessness in planning for natural hazard events (U.S. Department of Housing and Urban Development, 2016). Additionally, it is important to plan for episodic natural hazards as well as chronic events. For example, year-around access to shelter is becoming increasingly important as wildfire smoke becomes more common across the state.

Table 2-343. Homeless Population Estimate for Region 4

	2015	2017	2019	Period Average
Oregon	13,077	13,953	15,800	14,277
Region 4	1,966	1,746	2,284	1,999
Douglas	404	463	542	470
Jackson	679	633	712	675
Josephine	883	650	1,030	854

Source: Oregon Housing and Community Services. 2015-2019 Oregon Point in Time Homeless Count.

Retrieved From: https://public.tableau.com/profile/oregon.housing.and.community.services#!/vizhome/2019Point-in-TimeDashboard/Story1

Biological Sex and Gender

The concepts of sex and gender are often used interchangeably but are distinct; sex is based on biological attributes (chromosomes, anatomy, hormones) and gender is a social construction that may differ across time, cultures, and among people within a culture (U.S. Census Bureau, 2019). Moreover, the two may or may not correspond (U.S. Census Bureau, 2019).

The American Community Survey question was specifically designed to capture biological sex and there are no questions on the survey about gender (U.S. Census Bureau, 2019). According to the survey, there are fewer males in Region 4 than females (96.04 men to every 100 women).

Jackson County has the largest discrepancy (95.10 mean to every 100 women); however, all three counties have more women than men.

Primarily empirical research has begun to emerge about the ways in which gender influences resilience to disasters. It indicates that gender influence is much more pervasive and expressed differently among men, women, LGBTQ+, and non-binary populations than has generally been recognize (Enarson, 2017). This is an area deserving of more attention as the field develops.

Age

Older adults, persons aged 65 and older, comprise a larger share of the population in Region 4 than they do in the state as a whole. Notably, the share in Douglas and Josephine Counties is approximately eight percentage points higher than the statewide estimate. Older adults require special consideration in the planning process. They are more likely to have a disability and require assistance from others to complete routine tasks. Family or neighbors who might ordinarily assist them might be unable to help during a disaster event (Flanagan, Gregory, Hallisey, Heitgerd, & Lewis, 2011). Moreover, an older population requires special consideration due to sensitivity to heat and cold, reliance upon transportation to obtain medication, and comparative difficulty in making home modifications that reduce risk to hazards. In addition, older people may be reluctant to leave home in a disaster event. This implies the need for targeted preparatory programming that includes evacuation procedures and shelter locations accessible to all ages and abilities (Morrow, 1999).

The percentage of children in the region—and in each regional county—is slightly smaller than the statewide estimate. Special considerations should be given to young children, schools, and parents during the natural hazard mitigation process. Young children are more vulnerable to heat and cold, have fewer transportation options, and require assistance to access medical facilities. Parents might lose time from work and money when their children's childcare facilities and schools are impacted by disasters (Cutter, Boruff, & Shirley, 2003).

Table 2-344. Population by Vulnerable Age Group, in Region 4

	Total Population	Under 18 Years Old			65 Years and Older		
	Estimate	Percent	CV **	MOE (+/−)	Percent	CV **	MOE (+/−)
Oregon	4,025,127	21.5%	☑	0.1%	16.3%	☑	0.1%
Region 4	404,160	20.3%	☑	0.0%	22.4%	☑	0.1%
Douglas	107,576	19.5%	☑	0.1%	24.1%	☑	0.1%
Jackson	212,070	20.9%	☑	*	20.5%	☑	0.1%
Josephine	84,514	19.6%	☑	*	24.9%	☑	0.2%

*Indicates that the estimate has been controlled to be equal to a fixed value and so it has no sampling error.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau, 2013–2017 American Community Survey 5-Year Estimates, Table DP05; http://factfinder2.census.gov/

Language

Special consideration in hazard mitigation should be given to populations who do not speak English as their primary language. These populations are less likely to be prepared for a natural disaster if special attention is not given to language and culturally appropriate outreach materials. Compared to the statewide estimate, a smaller portion of Region 4 residents do not speak English "very well". Within the region, Jackson County has the largest population and the greatest share of people that might need translation services. Josephine County's estimate should be used with caution. Communities creating outreach materials used to communicate with and plan for populations who do not speak English very well should take into consideration the language needs of these populations.

Table 2-345. English Usage in Region 4

	Speak English Less Than "Very Well"				
	Estimate	CV **	MOE (+/−)	Percent	% MOE (+/−)
Oregon	222,428	☑	4,116	5.9%	0.1%
Region 4	8,977	☑	776	2.3%	0.2%
Douglas	1,200	☑	258	1.2%	0.3%
Jackson	6,697	☑	636	3.3%	0.3%
Josephine	1,080	⊙	363	1.3%	0.5%

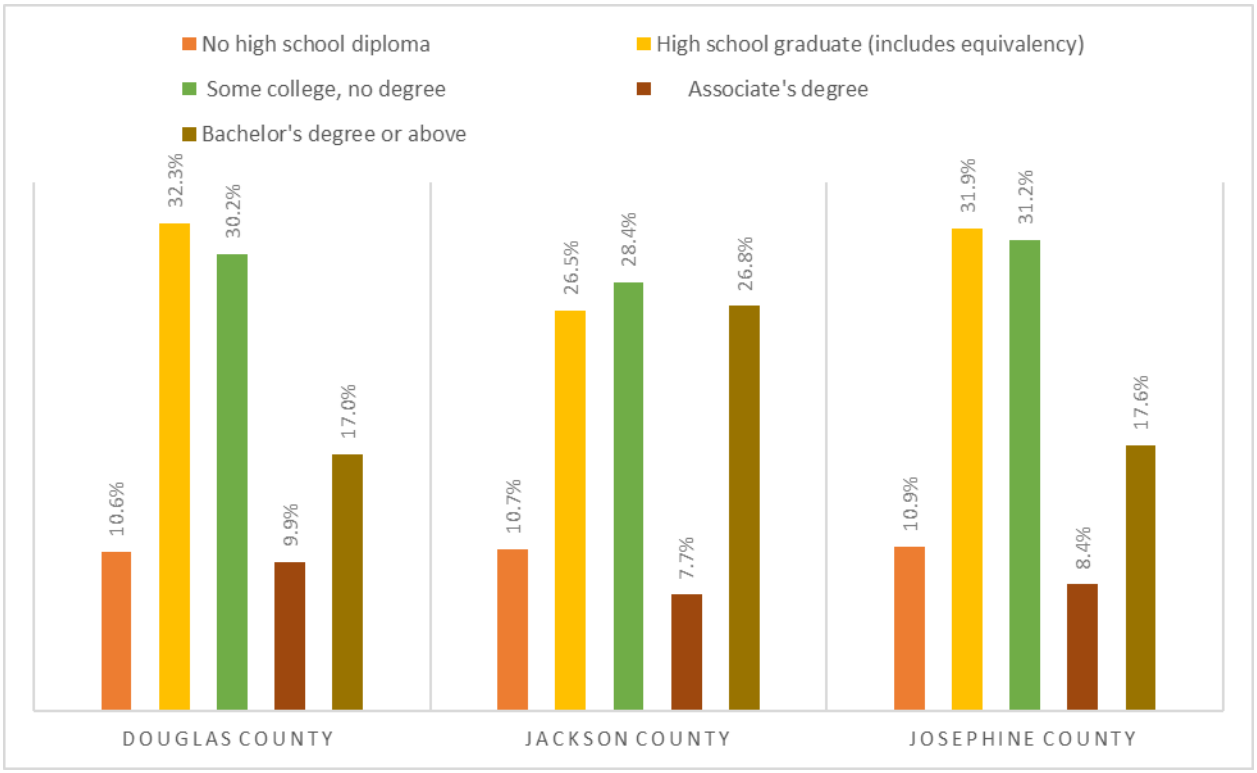
Source: U.S. Census Bureau (2018). Table DP02: Selected Housing Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from http://factfinder2.census.gov/

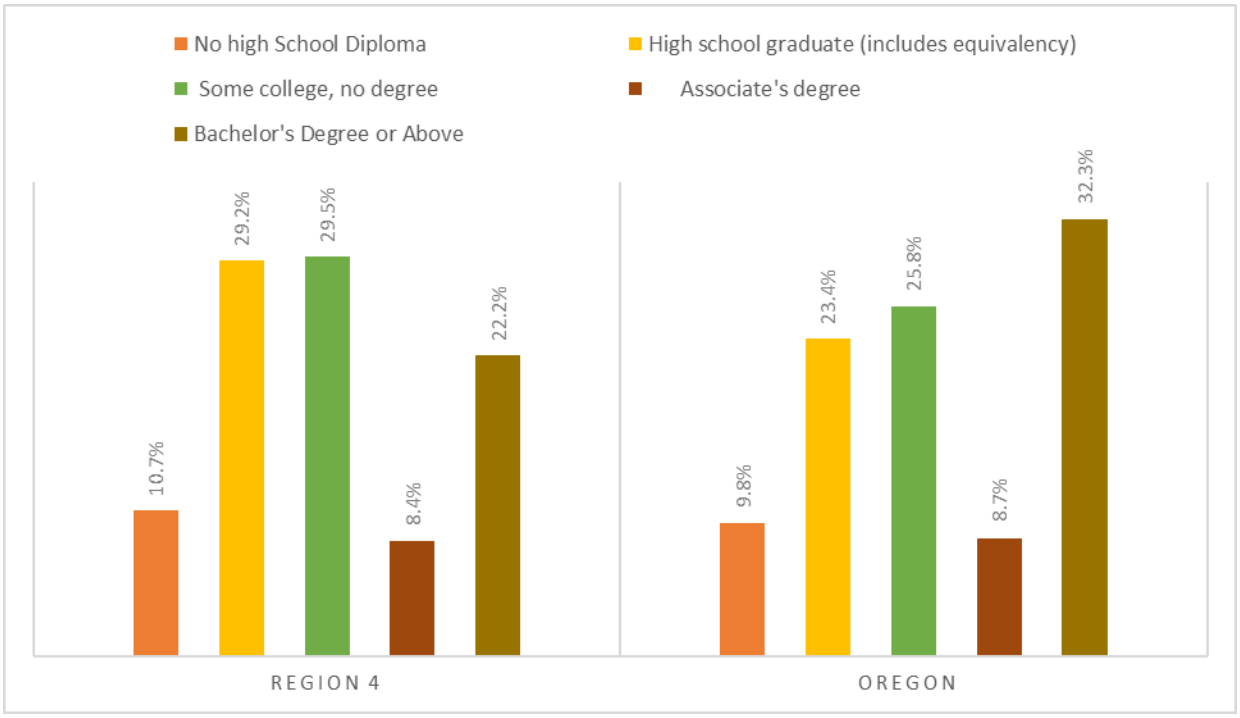
Education Level

Studies show that education and socioeconomic status are deeply intertwined, with higher educational attainment correlating to increased lifetime earnings (Cutter, Boruff, & Shirley, 2003). Furthermore, education can influence an individual's ability to understand and act on warning information, navigate bureaucratic systems, and to access resources before and after a natural disaster (Masozera, Bailey, & Kerchner, 2007).

While nearly 30% of Region 4 residents have some college credit, a much smaller percentage has a four-year degree vis-à-vis the state as a whole. Approximately 8% have an associate's degree and there is a slightly higher percentage of residents without a high school diploma compared to the share statewide. Jackson County has the highest percentage of residents with a bachelor's degree or more. This is likely influenced by the presence of Southern Oregon University in Ashland.

Figure 2-191. Educational Attainment in Region 4: (top) by County, (bottom) Regional vs. Statewide





Source: U.S. Census Bureau (2018). Table DP02: Selected Social Characteristics, 2013-2017 American Community Survey 5-Year Estimates. Retreived from http://factfinder2.census.gov/

Income and Poverty

The impact of a disaster in terms of loss and the ability to recover varies among population groups. "The causes of social vulnerability are explained by the underlying social conditions that are often quite remote from the initiating hazard or disaster event" (Cutter S. L., 2006). Historically, 80% of the disaster burden falls on the public (Stahl, 2000). Of this number, a disproportionate burden is placed upon those living in poverty. People living in poverty are more likely to be isolated, are less likely to have the savings to rebuild after a disaster, and are less likely to have access to transportation and medical care.

Across the region, median household income is $12,000-$15,000 less than the statewide median. Jackson County has the highest median household income and Josephine has the lowest. From 2012 to 2017, only Jackson County experienced a statistically significant change (increase) in median household income.

Table 2-346. Median Household Income in Region 4

	2008–2012			2013–2017			
	Estimate	CV **	MOE (+/–)	Estimate	CV **	MOE (+/–)	Statistically Different*
Oregon	$53,427	☑	$338	$56,119	☑	$370	Yes
Region 4	—	—	—	—	—	—	—
Douglas	$42,927	☑	$1,174	$44,023	☑	$1,555	No
Jackson	$46,783	☑	$1,146	$48,688	☑	$1,163	Yes
Josephine	$39,284	☑	$1,474	$40,705	☑	$2,203	No

Notes: 2012 dollars are adjusted for 2017 dollars. Data not aggregated at the regional level.

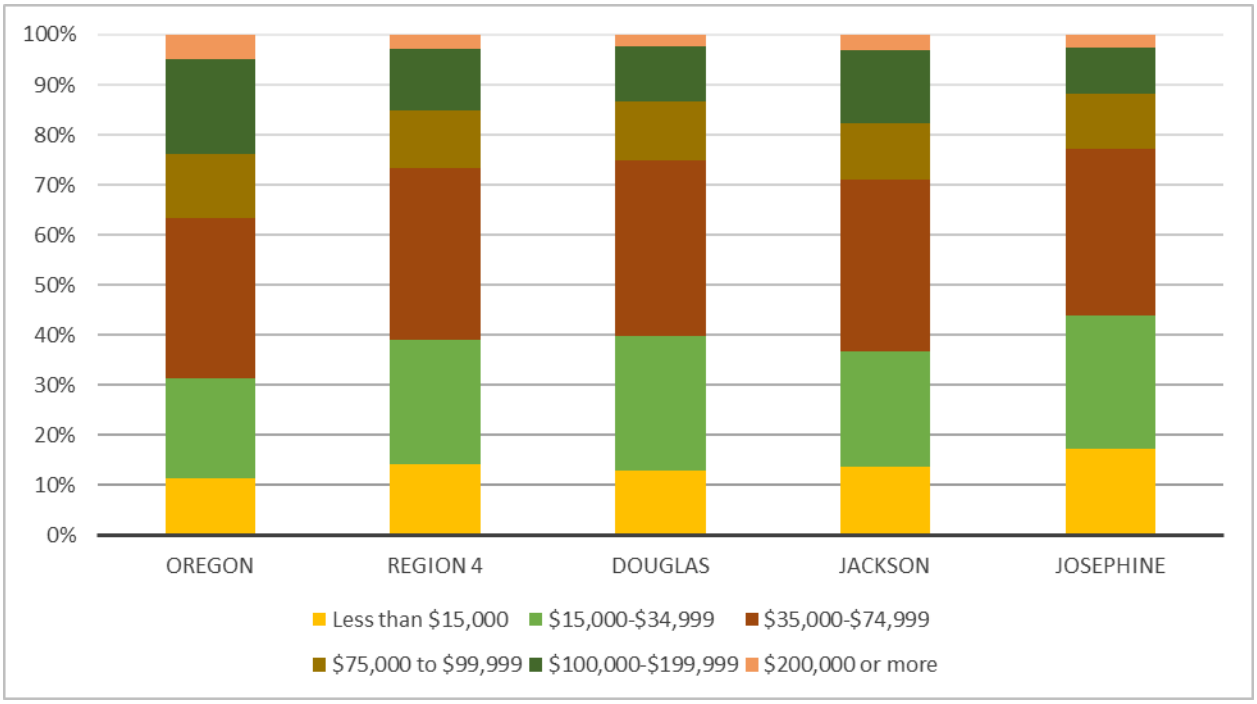
* Yes indicates that the 2013-2018 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates the two estimates are not statistically different.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% – use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau. 2008-2002 and 2013-2017. American Community Survey – 5-Year Estimates. Table CP03.

The region has a larger share of households earning less than $35,000 per year than the state as a whole. Within the region, Josephine has the highest percentage of low income earners, thirteen percentage points higher than the statewide estimate. Jackson County has the highest percentage of residents earning more than $75,000 annually, however, the share is still lower than the percentage for the state as a whole.

Figure 2-192. Median Household Income Distribution in Region 4



Source: U.S. Census Bureau (2018). Table DP03, 2013-2017 American Community Survey. Retrieved from http://factfinder2.census.gov/

The American Community Survey uses a set of dollar value thresholds that vary by family size and composition to determine who is in poverty (U.S. Census Bureau, 2018). Moreover, poverty thresholds for people living in nonfamily households vary by age—under 65 years or 65 years and older (U.S. Census Bureau, 2018). A greater share of the regional population overall is living in poverty compared to the state as a whole. The same is true for all counties in the region. Josephine County has the largest percentage of people living in poverty, approximately five percentage points higher than the statewide share. Between 2012 and 2017, there were no statistically significant changes in the poverty rate within the region.

A higher percentage of children in Region 4 are living in poverty compared to the statewide share. Josephine County was the only county to experience a statistically significant change in the child poverty rate between 2012 and 2017, a decline of approximately five percentage points. Jackson County has the smallest share of children living in poverty while Douglas and Josephine have a similar share.

Low-income populations require special consideration when mitigating loss to a natural hazard. Often, those who earn less have little to no savings and other assets to withstand economic setbacks. When a natural disaster interrupts work, the ability to provide housing, food, and basic necessities becomes increasingly difficult. In addition, low-income populations are hit especially hard as public transportation, public food assistance, public housing, and other public programs upon which they rely for day-to-day activities are often impacted in the aftermath of the natural disaster. To reduce the compounded loss incurred by low-income populations post-disaster,

mitigation actions need to be specially tailored to ensure safety nets are in place to provide further support to those with fewer personal resources (Cutter, Boruff, & Shirley, 2003).

Table 2-347. Poverty Rates in Region 4

	Total Population in Poverty						
	2008–2012			2013–2017			Statistical Difference?*
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	
Oregon	15.5%	☑	0.3%	14.9%	☑	0.3%	No
Region 4	17.6%	☑	0.8%	17.2%	☑	0.7%	No
Douglas	17.8%	☑	1.4%	17.0%	☑	1.4%	No
Jackson	16.6%	☑	1.0%	16.7%	☑	1.0%	No
Josephine	20.0%	☑	1.7%	18.6%	☑	1.4%	No

*Yes indicates that the 2013-2017 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates that the 2013-2017 estimate is not significantly different from the 2008-2012 estimate.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% – use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table S1701: Poverty Status in Past 12 Months, 2013-2018 American Community Survey 5-Year Estimates. Retrieved from: data.census.gov

Table 2-348. Child Poverty in Region 4

	Children Under 18 in Poverty						
	2008–2012			2013–2017			Statistical Difference?*
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	
Oregon	20.6%	☑	0.5%	19.0%	☑	0.6%	Yes
Region 4	25.7%	☑	1.8%	23.9%	☑	1.7%	No
Douglas	27.7%	☑	3.2%	25.3%	☑	3.3%	No
Jackson	22.9%	☑	2.6%	22.6%	☑	2.5%	No
Josephine	30.8%	☑	3.9%	25.4%	☑	3.2%	Yes

* Yes indicates that the 2013-2017 estimate is significantly different (at a 90% confidence level) than the estimate from 2008-2012. No indicates that the 2013-2017 estimate is not significantly different from the 2008-2012 estimate.

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% – use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018). Table S1701: Poverty Status in Past 12 Months, 2013-2018 American Community Survey 5-Year Estimates. Retrieved from: data.census.gov

Housing Tenure

Housing tenure, which captures whether someone owns or rents their home, has long been understood as a determinant of social vulnerability (Cutter, Boruff, & Shirley, 2003). Renters generally experience more housing challenges than homeowners; natural disasters frequently exacerbate those hardships (Lee & Van Zandt, 2019).

Homeownership is correlated with greater wealth, which can increase the ability to recover following a natural disaster (Cutter, Boruff, & Shirley, 2003). Renters often do not have personal financial resources or insurance to help recover post-disaster; they also frequently cannot access the same federal monies homeowners typically leverage following a disaster. They also might lack social resources, such as the ability to influence neighborhood decisions (Lee & Van Zandt, 2019).

Renters tend to be more mobile and have fewer assets at risk, however those assets might be more difficult to replace due to insufficient income. Renters typically have fewer options in terms of temporary shelter following a disaster and are less likely to stay with a relative or friend than in a public or mass shelter (Lee & Van Zandt, 2019).

The quality of construction for multi-family housing—more often rental—tends to be lower and is therefore more vulnerable to destruction during a disaster (Lee & Van Zandt, 2019). Moreover, renters have less ability to make improvements or alterations to their dwellings to enhance durability and structural safety (Lee & Van Zandt, 2019). Following a disaster, rental housing—especially affordable and subsidized housing—is frequently rebuilt more slowly, if at all (Lee & Van Zandt, 2019).

Each county in Region 4 has a higher home-ownership rate compared to the state overall. Douglas County has the highest percentage of owner-occupied households while Jackson County has the smallest.

Table 2-349. Housing Tenure in Region 4

		Owner-Occupied			Renter Occupied		
	Total Occupied Units	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,571,631	61.7%	☑	0.3%	38.3%	☑	0.3%
Region 4	166,637	65.0%	☑	0.8%	35.0%	☑	0.8%
Douglas	44,828	68.0%	☑	1.6%	32.0%	☑	1.6%
Jackson	86,195	62.9%	☑	1.0%	37.1%	☑	1.0%
Josephine	35,614	66.4%	☑	1.5%	33.6%	☑	1.5%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau (2018), 2013-2017 American Community Survey 5-Year Estimates. http://factfinder2.census.gov/. Table DP04: Selected Housing Characteristics

Families and Living Arrangements

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households. Living alone can also be a risk factor—especially in poorer communities that lack adequate social infrastructure (Klinenberg, 2016). The American Community Survey defines a family household as one that contains a householder and one or more other people living in the same unit who are related by birth, marriage, or adoption. Conversely, a nonfamily household is one where someone is either living alone, or with nonrelatives only.

Region 4 is predominately composed of family households. Similar to the statewide percentage, the share in each county is just under two-thirds. The region as a whole has a smaller percentage of households with children compared to the state. Josephine County has the smallest share, approximately six percentage points below the statewide estimate. In Douglas and Jackson Counties, approximately a quarter of all households have children, which is similar to the share statewide. The region as a whole as a similar share of single-parent households compared to the state. Jackson County has the highest percentage of single-parent households and Josephine has the smallest.

Table 2-350. Family vs. Non-family Households in Region 4

	Total Households	Family Households			Nonfamily Households			Householder Living Alone		
	Estimate	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,571,631	63.3%	☑	0.2%	36.7%	☑	0.2%	27.7%	☑	0.2%
Region 4	166,637	64.3%	☑	1.6%	35.7%	☑	1.4%	28.1%	☑	1.2%
Douglas	44,828	65.5%	☑	1.6%	34.5%	☑	1.6%	26.6%	☑	1.5%
Jackson	86,195	63.8%	☑	1.1%	36.2%	☑	1.1%	28.7%	☑	0.9%
Josephine	35,614	63.8%	☑	1.8%	36.2%	☑	1.8%	28.4%	☑	1.6%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau. 2013-2017 American Community Survey. http://factfinder2.census.gov/. Table DP02: Selected Social Characteristics

Table 2-351. Family Households with Children by Head of Household in Region 4

	Family Households with Children			Single Parent (Male or Female)		
	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	26.2%	☑	0.2%	8.1%	☑	0.2%
Region 4	22.9%	☑	0.7%	8.4%	☑	0.7%
Douglas	26.6%	☑	1.0%	8.0%	☑	1.1%
Jackson	25.0%	☑	0.9%	9.2%	☑	0.8%
Josephine	19.9%	☑	1.3%	6.8%	☑	1.0%

**The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a green checkmark, medium reliability (CV between 15-30% – be careful) is shown as a yellow circle within a circle, and low reliability (CV >30% - use with extreme caution) is shown with a red x-mark . However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error and the need for precision.

Source: U.S. Census Bureau. 2013-2017 American Community Survey. http://factfinder2.census.gov/. Table DP02: Selected Social Characteristics

Social and Demographic Trends

The social and demographic analysis shows that Region 4 is particularly vulnerable during a hazard event in the following categories:

- High numbers of tourists visit Jackson County.
- A higher percentage of the population in the region has a disability compared to the statewide estimate. The percentages are especially high in Josephine and Douglas Counties. Moreover, the share of people in vulnerable age—those under 18 and persons aged 65 and older—with a disability is higher across the region.
- Between 2015 and 2019, the number of people experiencing homelessness has increased in all three counties.
- The region has a higher share of older adults than the state
- A smaller percentage of the population has a college degree compared to the state, especially in Douglas and Josephine Counties.
- Median household income in each county is $12,000 to $15,000 less than the statewide median.
- The region has a larger share of households in the bottom income brackets, earning less than $35,000 annually, compared to the state as a whole.
- A greater share of the population is living in poverty compared to the state. Poverty is most severe in Josephine and Douglas Counties. All three counties have a greater share of children living in poverty compared to the share statewide.

Economy

The impact of natural hazards on economic conditions depends on many variables. For example the vulnerability of businesses' labor, capital, suppliers, and customers are all relevant factors (Zhang , Lindell, & Prater, 2009). Some industries rebound quickly and even thrive following a

disaster, manufacturing and construction, for example. Others, like wholesale and retail, rebound more slowly or never recover (Zhang , Lindell, & Prater, 2009). Economic resilience to natural disasters is far more complex than merely restoring employment or income in the local community. Building a resilient economy requires an understanding of how employment sectors, workforce participants, financial and natural resources, and critical infrastructure are interconnected and interdependent

Employment and Unemployment

Natural disasters do not impact all labor market participants equally. Unemployed and underemployed populations are disproportionately affected by disaster events. Research shows that employment outcomes can be especially bad for people physically displaced by a disaster (Karoly & Zissimopoulos, 2010). Moreover, those who are unemployed and many employed in low-wage positions lack access to employee benefit plans that provide income and healthcare supports (Flanagan, Gregory, Hallisey, Heitgerd, & Lewis, 2011). Income deprivation and inaccessible healthcare, ruinous in the best of times, are felt more severely following a disaster. It is important for local policy makers to understand existing labor force characteristics and existing market trends to build a resilient workforce and mitigate the scope and intensity of disruptions and economic pain.

Unemployment rates across Region 4 have been steadily declining since they peaked during the Great Recession; however from 2014 to 2018 all three counties maintained higher rates than the state as a whole. Within the region, Douglas and Josephine Counties consistently have higher rates than Jackson County.

Table 2-352. Civilian Labor Force in Region 4, 2018

	Civilian Labor Force	Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent
Oregon	2,104,516	2,017,155	95.8%	87,361	4.2%
Region 4	187,066	177,548	94.9%	9,518	5.1%
Douglas	46,374	43,869	94.6%	2,505	5.4%
Jackson	104,763	99,740	95.2%	5,023	4.8%
Josephine	35,929	33,939	94.5%	1,990	5.5%

Source: Oregon Employment Department, 2019

Table 2-353. Civilian Unemployment Rates in Region 4, 2014-2018

	2014	2015	2016	2017	2018	Change (2014-2018)
Oregon	6.8%	5.6%	4.8%	4.1%	4.2%	-2.6%
Region 4	8.8%	7.1%	6.0%	5.0%	5.1%	-3.7%
Douglas	9.1%	7.5%	6.3%	5.3%	5.4%	-3.7%
Jackson	8.4%	6.8%	5.7%	4.7%	4.8%	-3.6%
Josephine	9.4%	7.7%	6.5%	5.4%	5.5%	-3.9%

Source: Oregon Employment Department, 2019

Supersectors and Subsectors

The North American Industry Classification System (NAICS) is a framework used by the United States, Canada, and Mexico to collect, analyze, and publish data about the North American economy. The classification system groups "economic units that have similar production processes" according to a six-digit hierarchical structure (Office of Management and Budget , 2020). "The first two digits of the code designate the sector, the third digit designates the subsector, the fourth digit designates the industry group, the fifth digit designates the NAICS industry, and the sixth digit designates the national industry" (Office of Management and Budget , 2020). The U.S. Bureau of Labor Statistics through its Quarterly Census of Employment and Wages program adds to the NAICS hierarchy by grouping NAICS sectors into supersectors (U.S. Bureau of Labor Statistics, 2019). This plan looks at regional economic activity through these supersectors and then through three-digit NIAICS subsectors.

In 2018 the five major supersectors by share of employment in Region 4 were:

1. Trade, Transportation and Utilities
2. Education and Health Services
3. Leisure and Hospitality
4. Manufacturing
5. Local Government

Identifying supersectors with a large number of business establishments and targeting mitigation strategies to support them can help the region's resiliency. A business establishment is an "economic unit… that produces goods or provides services. It is typically at a single physical location and engaged in one, or predominantly one, type of economic activity" (U.S. Bureau of Labor Statistics, 2019). In Region 4, the following supersectors comprise a significant share of all business establishments.

- The Trade, Transportation, and Utilities supersector includes the highest number of establishments in Region 4, 17.4% of all businesses (QCEW, 2018).
- Other Services supersector is the second largest with 16.9% of all business establishments (QCEW, 2018).
- The Professional and Business Services supersector is third largest, with 12.4% of the regional share (QCEW, 2018).
- Education and Health Services supersector is fourth, constituting 11.0% of all establishments (QCEW, 2018).
- The Construction supersector is fifth largest, making up 10% of establishments (QCEW, 2018).

While supersectors are useful abstractions, it's important to remember that within are many small businesses employing fewer than 20 employees (Valdovinos, 2020). Due to their small size, these businesses are particularly sensitive to disruptions that may occur following a natural hazard event.

Table 2-354. Covered Employment by Sector in Region 4, 2019

Industry	Region 4	Douglas County		Jackson County		Josephine County	
	Percent	Employment	Percent	Employment	Percent	Employment	Percent
Total All Ownerships	100.0%	38,013	100.0%	89,743	100.0%	27,641	100.0%
Total Private Coverage	86.6%	30,755	80.9%	79,495	88.6%	24,385	88.2%
Natural Resources & Mining	3.7%	1,709	4.5%	3,228	3.6%	838	3.0%
Construction	4.9%	1,724	4.5%	4,760	5.3%	1,073	3.9%
Manufacturing	10.1%	4,862	12.8%	7,821	8.7%	2,987	10.8%
Trade, Transportation & Utilities	20.5%	6,785	17.8%	19,727	22.0%	5,337	19.3%
Information	1.1%	270	0.7%	1,191	1.3%	245	0.9%
Financial Activities	3.7%	1,046	2.8%	3,376	3.8%	1,269	4.6%
Professional & Business Services	8.7%	3,882	10.2%	7,443	8.3%	2,168	7.8%
Education & Health Services	18.0%	5,217	13.7%	16,936	18.9%	5,856	21.2%
Leisure & Hospitality	11.9%	3,448	9.1%	11,622	13.0%	3,368	12.2%
Other Services	4.1%	1,794	4.7%	3,353	3.7%	1,234	4.5%
Unclassified	0.0%	17	0.0%	39	0.0%	11	0.0%
Total All Government	13.4%	7,258	19.1%	10,247	11.4%	3,255	11.8%
Total Federal Government	2.2%	1,452	3.8%	1,765	2.0%	259	0.9%
Total State Government	1.3%	676	1.8%	964	1.1%	404	1.5%
Total Local Government	9.8%	5,130	13.5%	7,519	8.4%	2,592	9.4%

Note: (c) = confidential, information not provided by Oregon Employment Department to prevent identifying specific businesses.

Source: Oregon Employment Department. (2019). Quarterly Census of Employment and Wages. Retrieved from Qualityinfo.org

Each supersector faces distinct vulnerabilities to natural hazards. Identifying a region's dominant supersectors and the underlying industries enables communities to target mitigation activities toward those industries' specific sensitivities. Each of the primary private employment supersectors has sensitivity to natural hazards, as follows.

Trade, Transportation, and Utilities: Retail Trade is the largest employment subsector within the Trade, Transportation, and Utilities sector. Retail Trade is vulnerable to disruptions in the disposable income of regional residents and to disruptions in the transportation system. Residents' discretionary spending diminishes after natural disasters as spending priorities tend to focus on essential items. Retail businesses are concentrated in the larger cities of the region and disruption of the transportation system could sever the connectivity between people living throughout the region and these retail hubs.

Leisure and Hospitality: This sector primarily serves regional residents with disposable income and tourists. Following a natural disaster, residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

Education and Health Services: The importance of Health and Social Assistance industries is underscored in Region 1 because of the significant share of older adults and individuals with a disability. Health care is a relatively stable revenue sector regionally with an abundant distribution of businesses primarily serving a local population. Following a disaster, Health and Social Assistance industries will play important roles in emergency response and recovery.

Manufacturing: This sector is highly dependent upon transportation networks in order to access supplies and send finished products to outside markets. For these reasons, the manufacturing

sector may be susceptible to disruptions in transportation infrastructure. However, manufacturers are frequently less dependent on local markets for sales, which may contribute to the economic resilience of this sector.

Looking at industrial subsectors (three-digit NAICS) provides greater detail about the regional economy while maintaining a level of aggregation useful for analysis. The table below shows the top ten industries by share of employment within the region. Many of the top employment subsectors are similar across regions. For example, Food Services and Drinking Places and Educational Services are the two largest employment subsectors in Region 4. These subsectors also rank highly in other regions. Ambulatory Health Care Services—also known as outpatient services—and Hospitals are also major employers in Region 4 and across the state. Conversely, other subsectors, such as Wood Product Manufacturing, are more unique to the region.

Table 2-355. Industries with Greatest Share of Employment in Region 4, 2018

Industry	Employment Share	Employment (2018)
Food Services and Drinking Places	10%	18,480
Ambulatory Health Care Services	6%	11,601
Educational Services	6%	10,420
Administrative and Support Services	5%	9,859
Nursing and Residential Care Facilities	4%	6,684
Wood Product Manufacturing	4%	6,473
Hospitals	4%	6,386
Social Assistance	3%	6,162
Specialty Trade Contractors	3%	5,509
Food and Beverage Stores	3%	5,294

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for employment share and average employment by DLCD

Industry Concentration and Employment Change

A location quotient (LQ) is a metric used to identify a region's area of industrial specialization. It is calculated by comparing an industry's share of regional employment with its share of employment in a reference economy (Quinterno, 2014). If a LQ is higher than 1.0, employment in that industry is more concentrated in that region than in the reference economy. In this case, the reference economy is the United States as a whole. Industries with a high LQ indicate the region might have a competitive advantage and that the industry is potentially—but not always—exporting goods and services. Understanding regional competitiveness and targeting mitigation strategies that make exporting industries less vulnerable can help the region's resiliency. Location quotients, however, require careful interpretation; analysis of employment data should be paired with local knowledge of regional business dynamics.

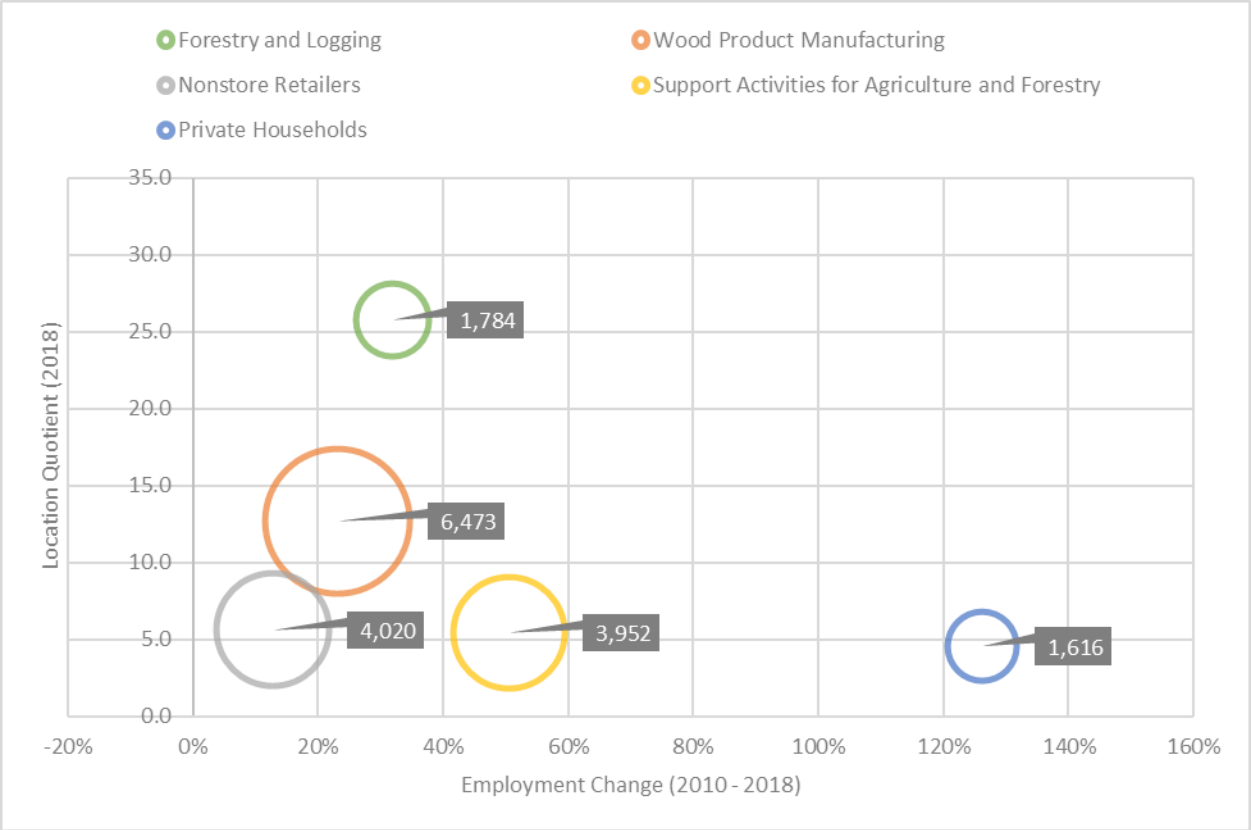
Table 2-356. Most Concentrated Industries and Employment Change in Region 4, 2018

Industry	Location Quotient	Employment (2018)	Employment Change (2010–2018)
Forestry and Logging	25.8	1,784	32%
Wood Product Manufacturing	12.7	6,473	23%
Nonstore Retailers	5.6	4,020	13%
Support Activities for Agriculture and Forestry	5.4	3,952	51%
Private Households	4.5	1,616	126%

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018), Retrieved from: https://ledextract.ces.census.gov/static/data.html; Calculations for location quotient, average employment, and employment change by DLCD

In addition to an industry's LQ value, it is important to consider the number of jobs and whether the industry is growing or declining. The scatter plot below presents this information for the five industries in Region 4 with the highest LQ values. It shows the percent change in employment over the last eight years, the total number of employees in the industry, and the LQ value.

Figure 2-193. Location Quotients, Employment Change, and Total Employment in Region 4, 2018



Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018), Retrieved from: https://ledextract.ces.census.gov/static/data.html; Calculations for location quotient, average employment, and employment change by DLCD

Three of the region's five most concentrated industries are natural resource based. Additionally, all have a location quotient higher than four—suggesting the region has a significant competitive advantage in each subsector vis-à-vis the nation. The Forestry and Logging subsector has the most significant location quotient. Employment in the region increased faster than in neighboring regions during the eight-year period but still comprises a relatively small share of overall employment. In terms of the total number jobs, more significant than harvesting trees is processing the wood into usable products. The Support Activities for Agriculture and Forestry and Wood Product Manufacturing subsectors collectively employed over ten-thousand people in 2018. In addition to natural resource based advantages, the region has employment concentrations in the Nonstore Retail—industries that sell goods using electronic methods, such as infomercials, paper or electronic catalogs, or vending machines—and the Private Households subsectors. The latter experienced significant growth during the eight-year period.

Fastest Growing and Declining Industries

Empirical analysis suggests that natural disasters can accelerate preexisting economic trends (Zhang , Lindell, & Prater, 2009). Therefore, it is important for local planners to understand their region's existing economic context, which industries are growing and which are declining.

Employment change can be caused by internal and external factors. The shift-share analysis helps us understand and separate regional and national influences on a local industry. There are three separate elements to the analysis that attempt to account for local and national forces. The national-share controls for the broad growth of the national economy; the industry-mix controls for broad national changes within an industry being analyzed; and the local-factor tries to explain what portion of employment change can be attributed to local factors. The bar chart below depicts a shift-share analysis for Region 4's fastest growing and declining industries.

Table 2-357. Fastest Growing and Declining Industries in Region 4, 2010-2018

Industry	Employment Change	Employment (2010)	Employment (2018)
Fastest Growing			
Museums, Historical Sites, and Similar Institutions	315%	92	381
Private Households	126%	715	1,616
Construction of Buildings	101%	1,417	2,856
Beverage and Tobacco Product Manufacturing	100%	313	625
Justice, Public Order, and Safety Activities	99%	838	1,667
Fastest Declining			
Electrical Equipment, Appliance, and Component Manufacturing	−96%	140	6
Telecommunications	−57%	884	381
Executive, Legislative, and Other General Government Support	−41%	4,597	2,727
Wholesale Electronic Markets and Agents and Brokers	−36%	548	352
Performing Arts, Spectator Sports, and Related Industries	−32%	1,352	913

Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for average annual employment, and employment change by DLCD

The Private Households industry experienced significant growth from 2010-2018. This sector employs workers "that work on or about the household premises…such as cooks, maids, butlers, gardeners, personal caretakers, and other maintenance workers" (Wallis, 2019). The increase in employment in the Private Households industry mirrors a statewide trend (Wallis, 2019). Demand is driven in part by an aging population's need for in-home care workers (Wallis, 2019).

Beverage and Tobacco Product Manufacturing industries experienced significant increases in employment within the region. Growth in the Beverage and Tobacco Product Manufacturing industry is likely driven by Oregon's thriving craft-beer scene, which continues to grow despite a crowded market (Lehner, 2020). Although the industry has been expanding nationally, the shift-share analysis shows that the growth was driven more by regional factors.

Growth in the Construction of Buildings subsector was strong during the eight-year period, adding approximately fifteen-hundred jobs, the most of the five fastest growing industries.

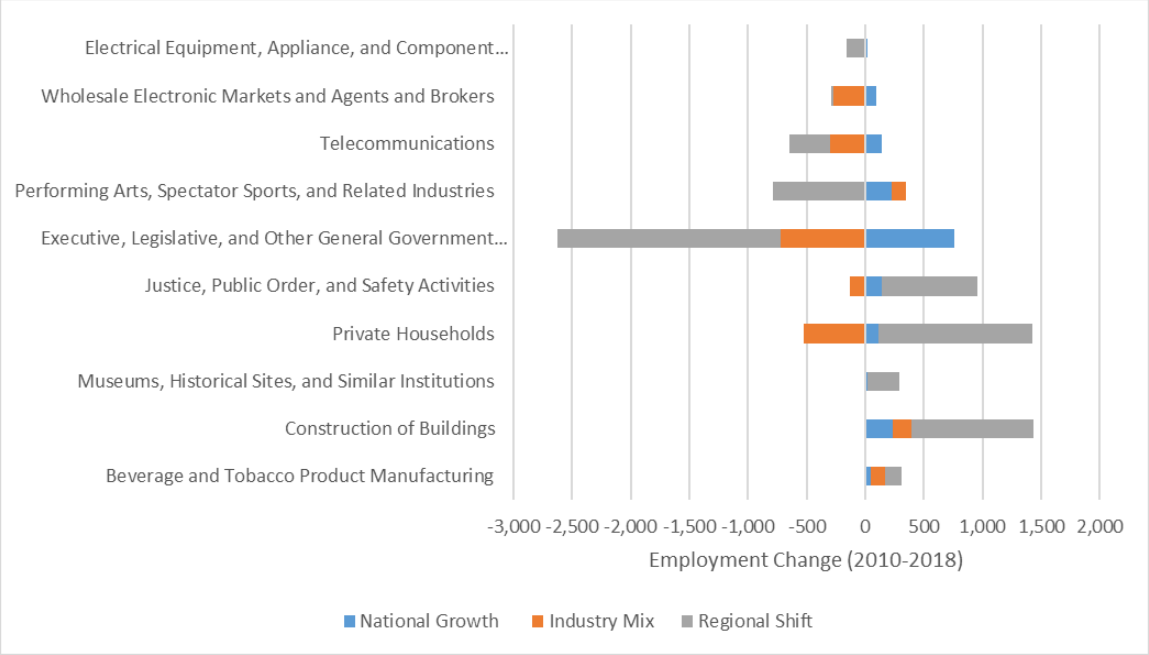
According to the shift-share analysis, the growth was mostly driven by regional factors. One reason for strong growth through the period, however, is that the subsector was severely impacted by the housing-bubble that led to the Great Recession. The decline in employment began around 2007 and was at its lowest point in 2010 (Cooke, 2019).

Museums, Historical Sites, and Similar Institutions had the highest percentage growth during the eight-year period, but the subsector comprises a very small share of employment region wide. The Justice, Public Order, and Safety subsector nearly doubled its total employment during the period. Growth in both subsectors was driven almost entirely by regional factors according to the shift-share analysis.

The Wholesale Electronic Markets and Agents and Brokers subsector—which coordinates the sale of goods owned by others, typically for a commission or fee—lost jobs during the 2010 to 2018 period. According to the shift-share analysis, the job loss was not driven by regional factors but forces impacting the industry nationwide. The subsector is part of the larger Wholesale Trade Sector, which generally saw an increase in employment in the state since the end of the Great Recession (Tauer, 2019).

Conversely, according to the shift-share analysis, losses in four of the five fastest declining subsectors can be attributed to regional factors. Those industries include: Executive, Legislative, and Other General Government subsector; the Telecommunications subsector; the Performing Arts, Spectator Sports, and Related Industries subsector; and the Electrical Equipment, Appliance, and Component Manufacturing subsector.

Figure 2-194. Shift-Share-Analysis of Fastest Growing and Declining Industries in Region 3, 2010-2018



Source: U.S. Census Bureau (2019), LEHD, Quarterly Workforce Indicators (2010 & 2018); Calculations for shift share by DLCD f

Table 2-358. Shift-Share-Analysis of Fastest Growing and Declining Industries in Region 4, 2010-2018

Industry	Employment Change	National Growth	Industry Mix	Regional Shift
Fastest Growing				
Beverage and Tobacco Product Manufacturing	312	51	116	145
Construction of Buildings	1,439	233	159	1,047
Museums, Historical Sites, and Similar Institutions	289	15	−2	276
Private Households	902	117	−525	1,309
Justice, Public Order, and Safety Activities	829	138	−127	818
Fastest Declining				
Executive, Legislative, and Other General Government Support	−1,871	755	−719	−1,907
Performing Arts, Spectator Sports, and Related Industries	−439	222	128	−790
Telecommunications	−503	145	−295	−353
Wholesale Electronic Markets and Agents and Brokers	−196	90	−273	−13
Electrical Equipment, Appliance, and Component Manufacturing	−134	23	−4	−153

Economic Trends and Issues

Because a strong and diverse economic base increases the ability of individuals, families, and communities to absorb impacts of a disaster and recover more quickly, current and anticipated financial conditions of a community are strong determinants of community resilience. The economic analysis of the region shows the following situations increase the region's level of vulnerability to natural hazard events:

- Unemployment in all three regional counties is consistently higher than the statewide average;
- Within the region, unemployment in Douglas and Josephine Counties is regularly higher than unemployment rates in Jackson County;
- The region is dependent on tourism which might increasingly be impacted by annually occurring disasters like wildfire and drought;
- Many of the region's most concentrated industries are natural resource-based or depend on natural resource industries. These sectors are especially vulnerable to the impacts of climate change;
- The regional economy has fewer opportunities for highly-skilled employees, limiting the income potential of residents in Region 4.

Supporting the growth of dominant industries and employment sectors, as well as emerging sectors identified in this analysis, can help the region become more resilient to economic downturns that often follow a hazard event (Stahl et al., 2000).

Infrastructure

Transportation

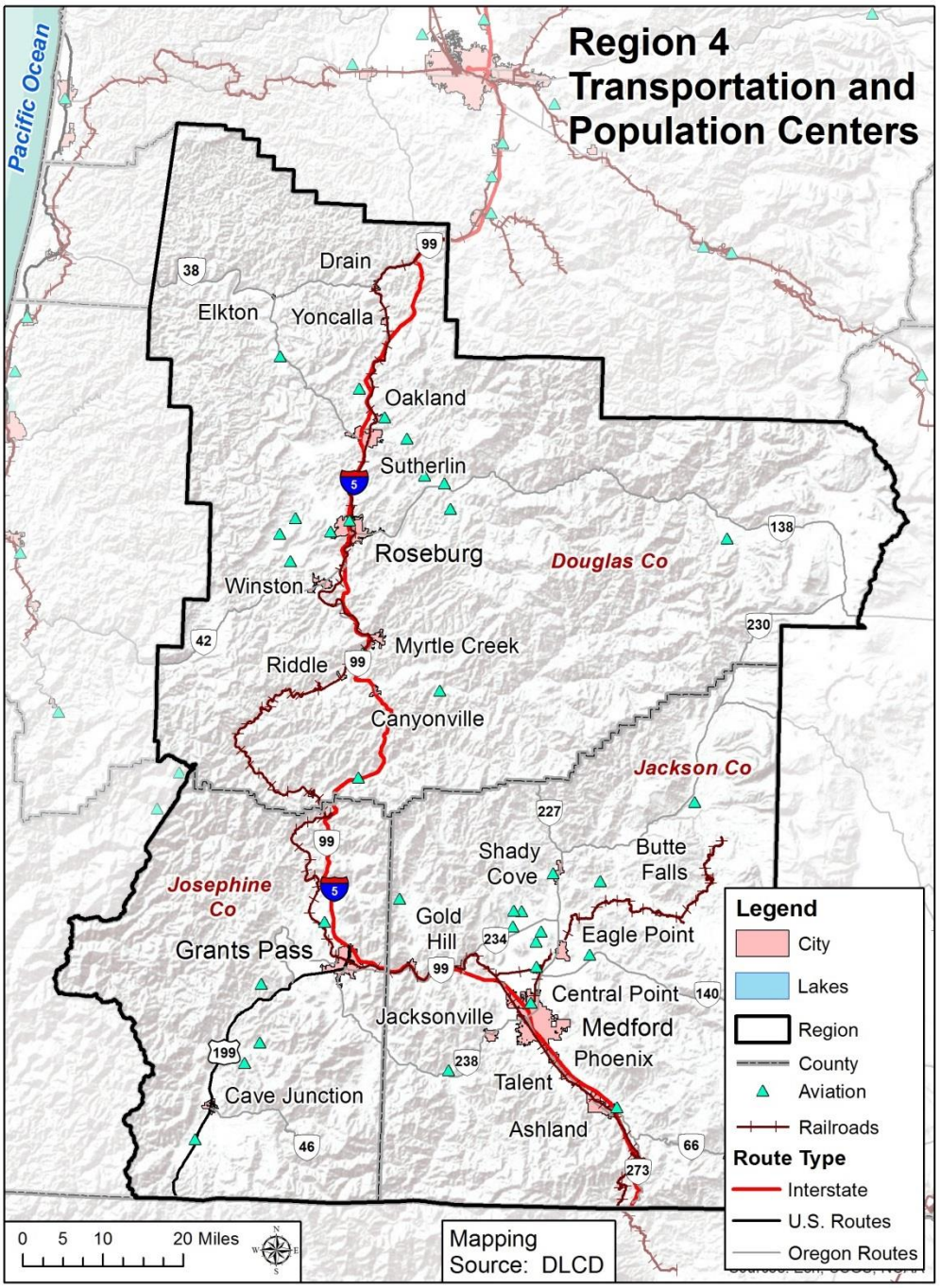
Roads

The largest population bases in Region 4 — the Cities of Ashland, Grants Pass, Medford, and Roseburg — are located along I-5. I-5 runs north-south through Region 4 and is the main passage for automobiles and trucks traveling along the West Coast.

Region 4's growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement on the I-5 corridor create additional stresses on transportation systems. Some of these include added maintenance, congestion, oversized loads, and traffic accidents. Natural hazards and emergency events can further disrupt automobile traffic, create gridlock, and shut down local transit systems, making evacuation and other emergency operations difficult. Hazards such as localized flooding can render roads unusable. Likewise, a severe winter storm has the potential to disrupt the daily driving routine of thousands of people.

According to the Oregon Department of Transportation's (ODOT's) 2014 Seismic Plus Report (**Appendix 9.1.12**), the region has exposure to earthquakes, especially a Cascadia Subduction Zone event. Therefore, the seismic vulnerability of the region's lifelines, including roadways and bridges, is an important issue. For information on ODOT's 2012 Seismic Lifelines Report findings for Region 4, see **Seismic Lifelines**.

Figure 2-195. Region 4 Transportation and Population Centers



Source: Oregon Department of Land Conservation and Development, 2014

Bridges

ODOT lists 953 bridges in the counties that comprise Region 4.

Because of earthquake risk in Region 4, the seismic vulnerability of the region's bridges is an important issue. Non-functional bridges can disrupt emergency operations, sever lifelines, and disrupt local and freight traffic. These disruptions may exacerbate local economic losses if industries are unable to transport goods. The region's bridges are part of the state and interstate highway system that is maintained by the Oregon Department of Transportation (ODOT) or are part of regional and local systems that are maintained by the region's counties and cities.

Table 2-359 shows the structural condition of bridges in the region. A distressed bridge (Di) is a condition rating used by the Oregon Department of Transportation (ODOT) indicating that a bridge has been identified as having a structural or other deficiency, while a deficient bridge (De) is a federal performance measure used for non-ODOT bridges. The ratings do not imply that a bridge is unsafe (ODOT, 2020). About 3% of the region's ODOT bridges are distressed, compared to 5% for the state.

Table 2-359. Bridge Inventory for Region 4

	State Owned			County Owned			City Owned			Other Owned			Area Total		
	Di	ST	%D*	De	ST	%D	De	ST	%D	De	ST	%D	D	T	%D
Oregon	42	2,760	2%	258	3,442	7%	30	643	5%	16	121	13%	346	6,966	5%
Region 4	6	372	2%	20	511	4%	4	60	7%	3	10	30%	33	953	3%
Douglas	2	176	1%	16	254	6%	3	24	13%	2	6	33%	23	460	5%
Jackson	4	137	3%	2	152	1%	1	34	3%	0	0	N/A	7	323	2%
Josephine	0	59	0%	2	105	2%	0	2	0%	1	4	25%	3	170	2%

Note: Di = ODOT bridges Identified as distressed with structural or other deficiencies; De = Non-ODOT bridge Identified with a structural deficiency or as functionally obsolete; D = Total od Di and De bridges; ST = Jurisdictional Subtotal; %D = Percent distressed (ODOT) and/or deficient bridges; * = ODOT bridge classifications overlap and total (ST) is not used to calculate percent distressed, calculation for ODOT distressed bridges accounts for this overlap.

Source: ODOT (2012, 2013)

Railroads

Railroads that run through Region 4 support cargo and trade flows. The region's rail providers are the Central Oregon & Pacific and the White City Terminal Railroad. There is no passenger rail line through the region. The Central Oregon & Pacific Line follows I-5 through the region, then runs west through Lane County and loops back into Region 4 through Reedsport. The White City Terminal Railroad is a short spur off the Central Oregon & Pacific Line in Jackson County (Loy et al., 1976). Oregon's rail system is critical to the state's economy, energy, and food systems. Rail systems export lumber and wood products, pulp and paper, and other goods produced in Oregon and carry products from other states to and through Oregon by rail (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in Region 4. Disruptions in the rail system can result economic losses for the region. The potential for harm from rail accidents can also have serious implications for local communities, particularly if hazardous materials are involved.

Airports

Rogue Valley International-Medford Airport is the only commercial airport in the region and is the third busiest airport in Oregon (Federal Aviation Administration, 2012). The airport is owned, operated and administered by Jackson County Aviation Authority. It serves eight hubs and four air carriers with approximately 56 arriving and departing flights daily (Jackson County, Oregon, airport website, http://www.co.jackson.or.us/SectionIndex.asp?SectionID=5).

In the event of a natural disaster, public and private airports are important staging areas for emergency response activities. Public airport closures will impact the region's tourism industries, as well as the ability for people to leave the region by air. Businesses relying on air freight may also be impacted by airport closures.

Table 2-360. Public and Private Airports in Region 4

	Number of Airports by FAA Designation				
	Public Airport	Private Airport	Public Heliport	Private Heliport	Total
Region 4	10	26	0	13	49
Douglas	4	12	0	4	20
Jackson	4	11	0	7	22
Josephine	2	3	0	2	7

Source: FAA Airport Master Record (Form 5010), 2014

Energy

Electricity

Several power supply companies serve Region 4. The Bonneville Power Administration is the area's wholesale electricity distributor. The majority of the region is powered by PacifiCorp (Pacific Power and Light). The Coos-Curry Electric Cooperative and the Douglas Electric Cooperative serve portions of Douglas and Josephine Counties. The Umpqua Indian Utility Cooperative serves the Cow Creek Band of Umpqua Tribe of Indians, including the site of the Seven Feathers Casino Resort located in Douglas County north of Grants Pass and south of Roseburg.

Table 2-361 lists electric power-generating facilities within Region 4. The region has a total of eight power-generating facilities: three are hydroelectric power facilities, and five are categorized as "other" (primarily biomass). In total the power-generating facilities have the ability to produce up to 391 megawatts of electricity.

Table 2-361. Power Plants in Region 4

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
Region 4	3	0	0	0	5	8
Douglas	1	0	0	0	3	4
Jackson	2	0	0	0	1	3
Josephine	0	0	0	0	1	1
Energy Production (MW)	**305**	**0**	**0**	**0**	**86**	**391**

* "Other" includes biomass, geothermal, landfill gas, solar, petroleum, and waste.

Source: Army Corps of Engineers; Biomass Power Association; Calpine Corporation; Eugene Water and Electric Board; Iberdola Renewables; Idaho Power Company; Klamath Energy LLC; Oregon Department of Energy; Owyhee Irrigation District; Form 10K Annual Report (2013), PacifiCorp; Form 10K Annual Report (2013), Portland General Electric; U.S. Geothermal, Inc.

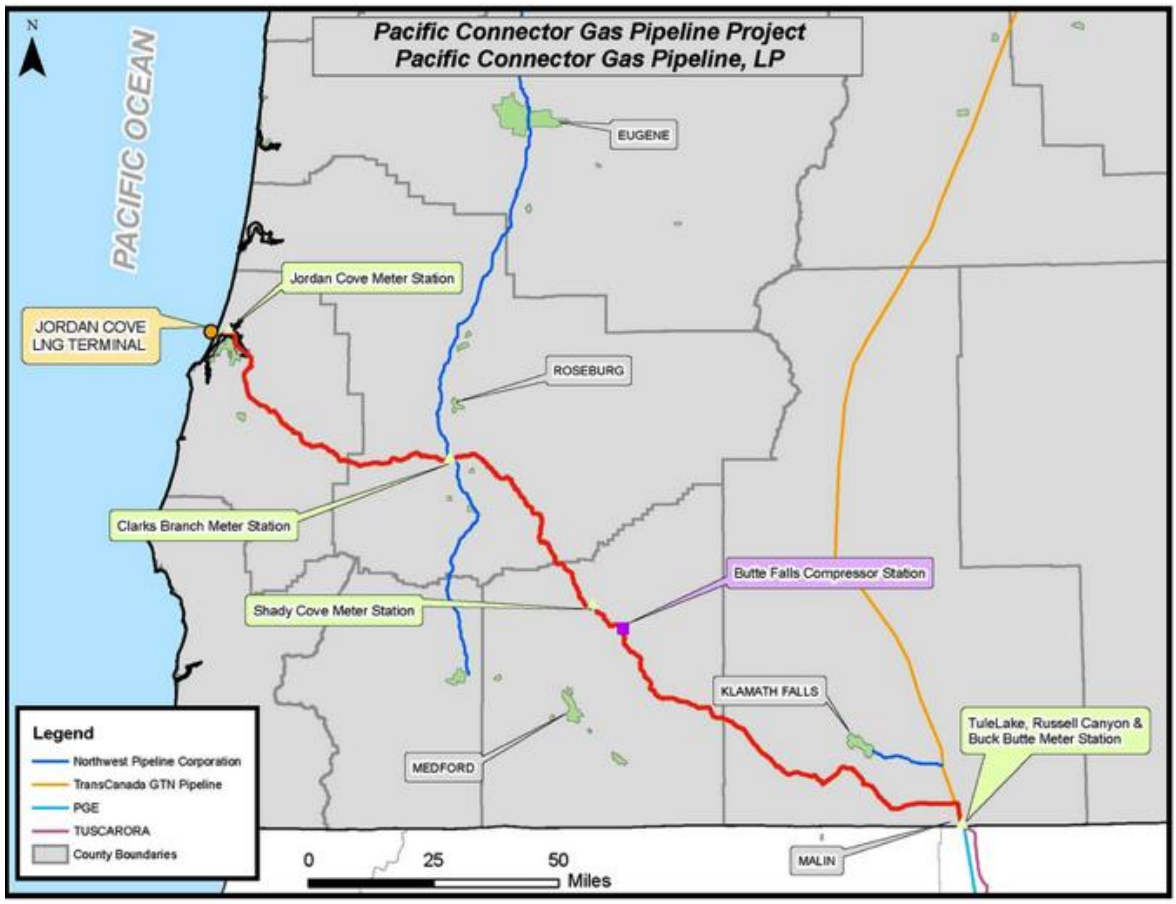
Hydropower

The majority of electrical power in Region 4 is generated through hydropower. Dams for hydropower generation are primarily situated on the Applegate, Rogue, and Umpqua Rivers. Dams operated by the Bonneville Power Administration (BPA) provide hydro-generated electricity to the state's consumer owned utilities. Major BPA dams in the region are located on the Applegate and Rogue Rivers.

Natural Gas

Although natural gas does not provide the most energy to the region, it does contribute a significant amount of energy to Pacific Power's portfolio. Liquefied natural gas (LNG) is transported via pipelines throughout the United States. Figure 2-196 shows existing LNG pipelines and the proposed Pacific Connector Gas Pipeline (in red) (Oregon Department of Environmental Quality, 2014). One pipeline, owned by the Northwest Pipeline Corporation, runs though Douglas and Josephine Counties. LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life, safety, and environmental impacts in the case of a spill.

Figure 2-196. Liquefied Natural Gas Pipelines in Region 4



Source: Oregon Department of Environmental Quality, 2014

Utility Lifelines

Southwestern Oregon primarily receives oil and gas from Alaska by way of the Puget Sound through pipelines and tankers. The region is at the southern end of this pipeline network. Oil and gas are supplied by Northern California through a separate network. The electric, oil, and gas lifelines that run through the county are both municipally and privately owned (Loy et al., 1976). These utility lifelines may be vulnerable to severe, but infrequent natural hazards, such as earthquakes.

The network of electrical transmission lines running through Region 4 is operated by Pacific Power and Light and primarily facilitates local energy production and distribution (Loy et al., 1976). Most of the natural gas Oregon uses originates in Alberta, Canada. Avista Utilities owns the main natural gas transmission pipeline (Loy et al., 1976).

Telecommunications

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio). Region 4 is part of the Southern Oregon Operational Area under The Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management (2013), which also includes Coos, Curry, and Klamath Counties. There is a memorandum of understanding between these counties that facilitates the launching of emergency messages for counties by Jackson County. Counties in this area can launch emergency messages by contacting the Oregon Emergency Response System (OERS) which in turn creates emergency messages to communities statewide.

Beyond day-to-day operations, maintaining communication capabilities during disaster events and other emergency situations helps to keep citizens safe by keeping them informed of the situation's status, areas to avoid, and other procedural information. Additionally, responders depend on telecommunications infrastructure to be routed to sites where they are needed.

Television

Television serves as a major provider for local, regional, and national news and weather information and can play a vital role in emergency communications. The local primary stations identified as emergency messengers by the Oregon State Emergency Alert System Plan are:

- KOBI-TV Channel 5, Medford; and
- Channel 49, Grants Pass.

Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 4. Broadband technology including mobile wireless is provided in the region via five primary technologies: cable, digital subscriber line (DSL), fiber, fixed wireless, and mobile wireless. Internet service is becoming more readily available in the region with a greater number of providers and service types available within major communities and along major transportation corridors (I-5, US-199, etc.) (NTIA, n.d.). Landline telephones are common throughout the region; however, residents in rural areas rely more heavily upon the service since they may not have cellular reception outside of major transportation corridors.

Wireless providers sometimes offer free emergency mobile phones to those impacted by disasters, which can aid in communication when landlines and broadband service are unavailable.

Radio

Radio is readily available to those who live within Region 4 and can be accessed through car radios, emergency radios, and home sound systems. Radio is a major communication tool for weather and emergency messages. Radio transmitters for the Southern Oregon Operational Area are (Oregon Office of Emergency Management, 2013):

- WWF-97, 162.475 MHZ, Ashland;
- WXL-85, 162.400 MHZ, Medford; and
- WXL-98, 162.550 MHZ, Roseburg.

Ham Radio

Amateur radio, or ham radio, is a service provided by licensed amateur radio operators (hams) and is considered to be an alternate means of communicating when normal systems are down or at capacity. Emergency communication is a priority for the Amateur Radio Relay League (ARRL). Region 4 is served by ARES District 5. Radio Amateur Civil Emergency Services (RACES) is a special phase of amateur radio recognized by FEMA that provides radio communications for civil preparedness purposes including natural disasters (Oregon Office of Emergency Management, n.d.). The official ham emergency station calls for Region 4 include (American Relay Radio League Oregon Chapter, www.arrloregon.org):

- Douglas County: K7AZW;
- Jackson County: K7VS; and
- Josephine County: none available at this time.

Water

Water infrastructure includes drinking water, stormwater, and wastewater systems. All of these systems possess some level of vulnerability to natural hazards that can have repercussions on human health, ecosystems, and industry.

Drinking Water

In Region 4 the majority of the municipal drinking water supply is obtained from surface water. In Jackson and Josephine Counties, the Rogue River provides municipal water supplies to most cities. The City of Cave Junction is an exception, obtaining water from the Illinois River. In Douglas County, most cities source their water from the Umpqua River and its tributaries.

Rural residents may get water from groundwater wells or surface water. Most rural residents in Douglas County use surface water sources for potable water. The majority of rural residents in Jackson and Josephine Counties use domestic wells outside of municipal boundaries. Areas with sedimentary and volcanic soils may be subject to high levels of arsenic, hydrogen sulfide, and fecal coliform bacteria, which can impact the safety of groundwater sources.

Surface sources for drinking water are vulnerable to pollutants caused by non-point sources and natural hazards. Non-point source pollution is a major threat to surface water quality, and may include stormwater runoff from roadways, agricultural operations, timber harvest, erosion, and

sedimentation. Landslides, flood events, and earthquakes and resulting liquefaction can cause increased erosion and sedimentation in waterways. Acid mine drainage from the Formosa mine, a U.S. Environmental Protection Agency Superfund site, is another non-point source of pollution. Acid mine drainage threatens the health of Middle Creek in southern Douglas County, a tributary to the Umpqua River.

Underground water supplies and aging or outdated infrastructure — such as reservoirs, treatment facilities, and pump stations — can be severed during a seismic event. Rigid materials such as cast iron may snap under the pressure of liquefaction. More flexible materials such as polyvinyl chloride (PVC) and ductile iron may pull apart at joints under the same stresses. These types of infrastructure damages could result in a loss of water pressure in municipal water supply systems, limiting access to potable water. This can lead to unsanitary conditions that may threaten human health. Lack of water can also impact industry, such as the manufacturing sector. Moreover, if transportation infrastructure is impacted by a disaster event, repairs to water infrastructure will be delayed.

Stormwater and Wastewater

In urbanized areas severe precipitation events may cause flooding that leads to stormwater runoff. A non-point source of water pollution, stormwater runoff can adversely impact drinking water quality. It can also lead to environmental issues such as increasing surface water temperatures that can adversely affect habitat health. Furthermore, large volumes of fast-moving stormwater that enter surface waterways can cause erosion issues.

Stormwater can also impact water infrastructure. Leaves and other debris can be carried into storm drains and pipes, which can clog stormwater systems. In areas where stormwater systems are combined with wastewater systems (combined sewers), flooding events can lead to combined sewer overflows (CSOs). CSOs present a heightened health threat as sewage can flood urban areas and waterways. Underground stormwater and wastewater pipes are also vulnerable to damage by seismic events.

In Region 4, most local building codes and stormwater management plans emphasize use of centralized storm sewer systems to manage stormwater. Requirements for stormwater mitigation vary in Region 4. Low impact development (LID) mitigation strategies can alleviate or lighten the burden on a jurisdiction's storm sewer system by allowing water to percolate through soil onsite or detaining water so water enters the storm sewer system at lower volumes, at lower speeds, and at lower temperatures. While some jurisdictions in Region 4 refer to LID techniques in their stormwater management plans, Medford is the only city that requires LID stormwater mitigation strategies in its development code. Promoting and requiring decentralized LID stormwater management strategies could help reduce the burden of new development on storm sewer systems, and increase a community's resilience to many types of hazard events.

Infrastructure Trends and Issues

Physical infrastructure is critical for everyday operations and is essential following a disaster. Lack or poor condition of infrastructure can negatively affect a community's ability to cope with, respond to, and recover from a hazard event. Diversity, redundancy, and consistent maintenance of infrastructure systems help create system resiliency (Meadows, 2008).

Older and structurally unsound bridges in Region 4 compromise transportation systems. The effects of bridge and road failures on the economy and health of the Region's residents could be devastating. About 18% of the region's bridges owned by the state are distressed.

The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy and is vulnerable to severe, but infrequent, natural hazards. There are eight power-generating facilities in Southwest Oregon. Three are hydroelectric power facilities. The others are primarily biomass facilities. The major Bonneville Power Administration dams in the region are on the Applegate and Rogue Rivers. Of the state-owned dams in the region, 28 have High Threat Potential and 42 have Significant Threat Potential.

Buried natural gas transmission lines run through Douglas and Josephine Counties and are vulnerable to seismic activity.

Decentralization and redundancy in the region's telecommunication systems can help boost the area's ability to communicate before, during, and after a disaster event. It is important to note that broadband and mobile telephone services do not cover many rural areas of the region that are distant from major transportation corridors. This may present a communication challenge in the wake of a hazard event. Encouraging residents to keep AM/FM radios available for emergency situations could help increase the capacity for communicating important messages throughout the region.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, and lack system redundancies Drinking water is primarily sourced from surface water. The region is at risk in case of high levels of pollutants entering waterways through CSO's during high-water events. The implementation of decentralized low impact development (LID) stormwater systems can increase the region's capacity to better manage high-precipitation events. Medford is the only city that requires LID stormwater mitigation strategies in its development code.

Built Environment

Development Patterns

Balancing growth with hazard mitigation is key to planning resilient communities. Therefore, understanding where development occurs and the vulnerabilities of the region's building stock is integral to developing mitigation efforts that move people and property out of harm's way. Eliminating or limiting development in hazard prone areas can reduce exposure to hazards, and potential losses and damages.

Since 1973, Oregon has maintained a strong statewide program for land use planning. The foundation of Oregon's program is 19 land use goals that "help communities and citizens plan for, protect and improve the built and natural systems." These goals are achieved through local comprehensive planning. The intent of Goal 7, Areas Subject to Natural Hazards, is to protect people and property from natural hazards (Department of Land Conservation and Development, website: http://www.oregon.gov/http://www.oregon.gov/).

Settlement Patterns

The U.S. Census Bureau defines "urban" as either an "urbanized area" of 50,000 or more people or an "urban cluster" of at least 2,500 people (but less than 50,000). Wheeler County does not

meet either definition; therefore all of its population is considered rural even though the county has incorporated cities.

Between 2000 and 2010 urban populations in Region 4 have grown by about 14%; more than 4 times the percent growth in rural areas. Jackson and Josephine Counties are experiencing the most urban growth in people and housing. Growth in Douglas County is more evenly distributed between urban and rural areas. Unsurprisingly, populations tend to cluster around major road corridors and waterways. This holds true for the major cities of Ashland, Medford, Grants Pass and Roseburg.

Table 2-362. Urban and Rural Populations in Region 4, 2010

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
Region 4	238,659	271,312	13.7%	118,735	122,274	3.0%
Douglas	58,411	63,332	8.4%	41,988	44,335	5.6%
Jackson	141,112	162,458	15.1%	40,157	40,748	1.5%
Josephine	39,136	45,522	16.3%	36,590	37,191	1.6%

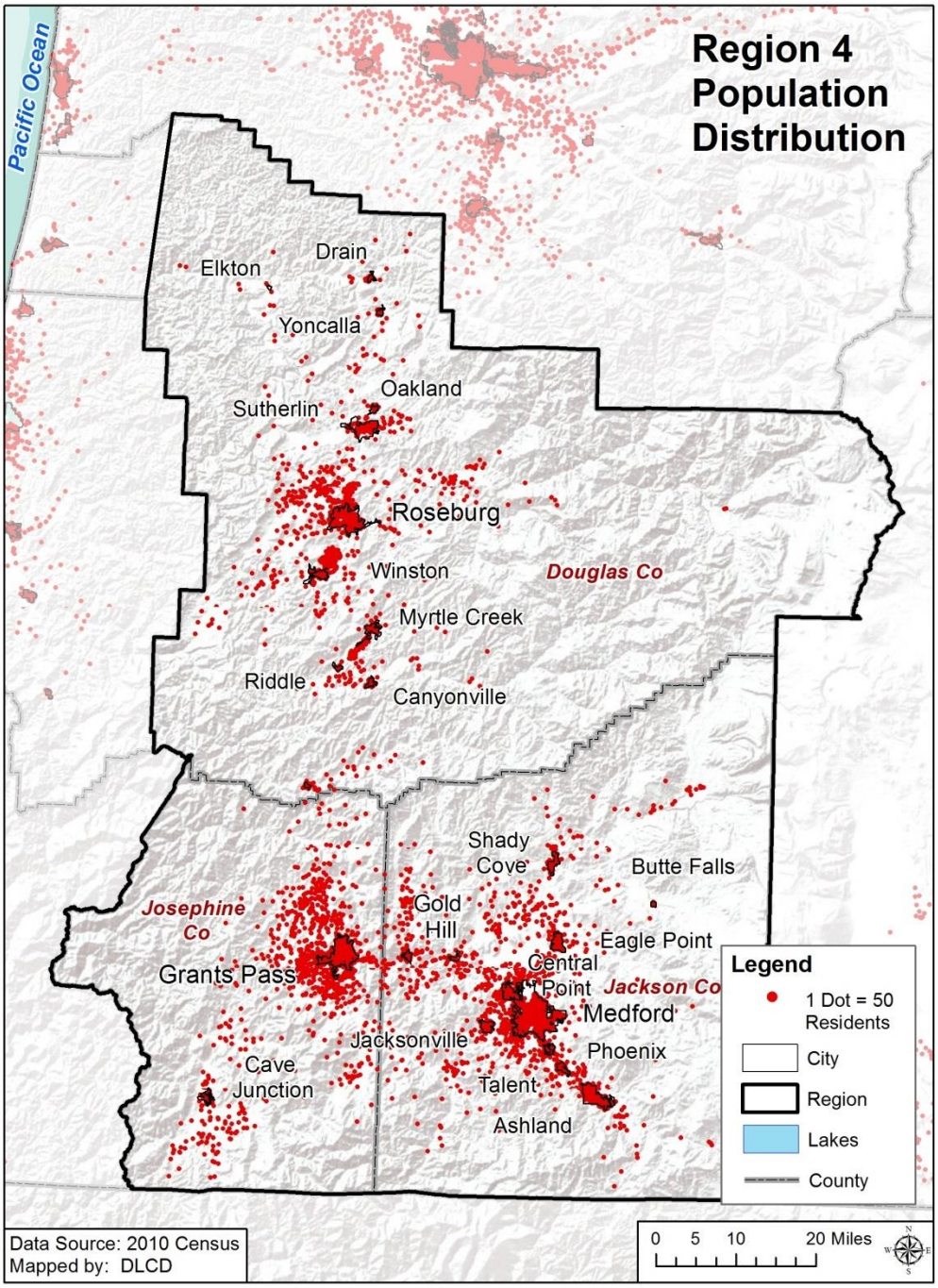
APA Citation: U.S. Census Bureau (n.d.). 2010 Decennial Census, Table P2;
U.S. Census Bureau (n.d.). 2000 Decennial Census, Table P002

Table 2-363. Urban and Rural Housing Units in Region 4, 2010

	Urban			Rural		
	2000	2010	Percent Change	2000	2010	Percent Change
Oregon	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
Region 4	101,546	121,709	19.9%	50,714	56,144	10.7%
Douglas	25,273	28,553	13.0%	18,011	20,362	13.1%
Jackson	59,255	72,470	22.3%	16,482	18,467	12.0%
Josephine	17,018	20,686	21.6%	16,221	17,315	6.7%

APA Citation: U.S. Census Bureau (n.d.). 2010 Decennial Census, Table H2;
U.S. Census Bureau (n.d.). 2000 Decennial Census, Table H002

Figure 2-197. Region 4 Population Distribution



Source: U.S. Census, 2012

Land Use and Development Patterns (Lettman, 2011)

Land use for Region 4 is dominated by forestry (78%), with the majority of land owned by the Federal Government. Agricultural activities (15%) are the second major land use, for primarily field crops, orchard and livestock.

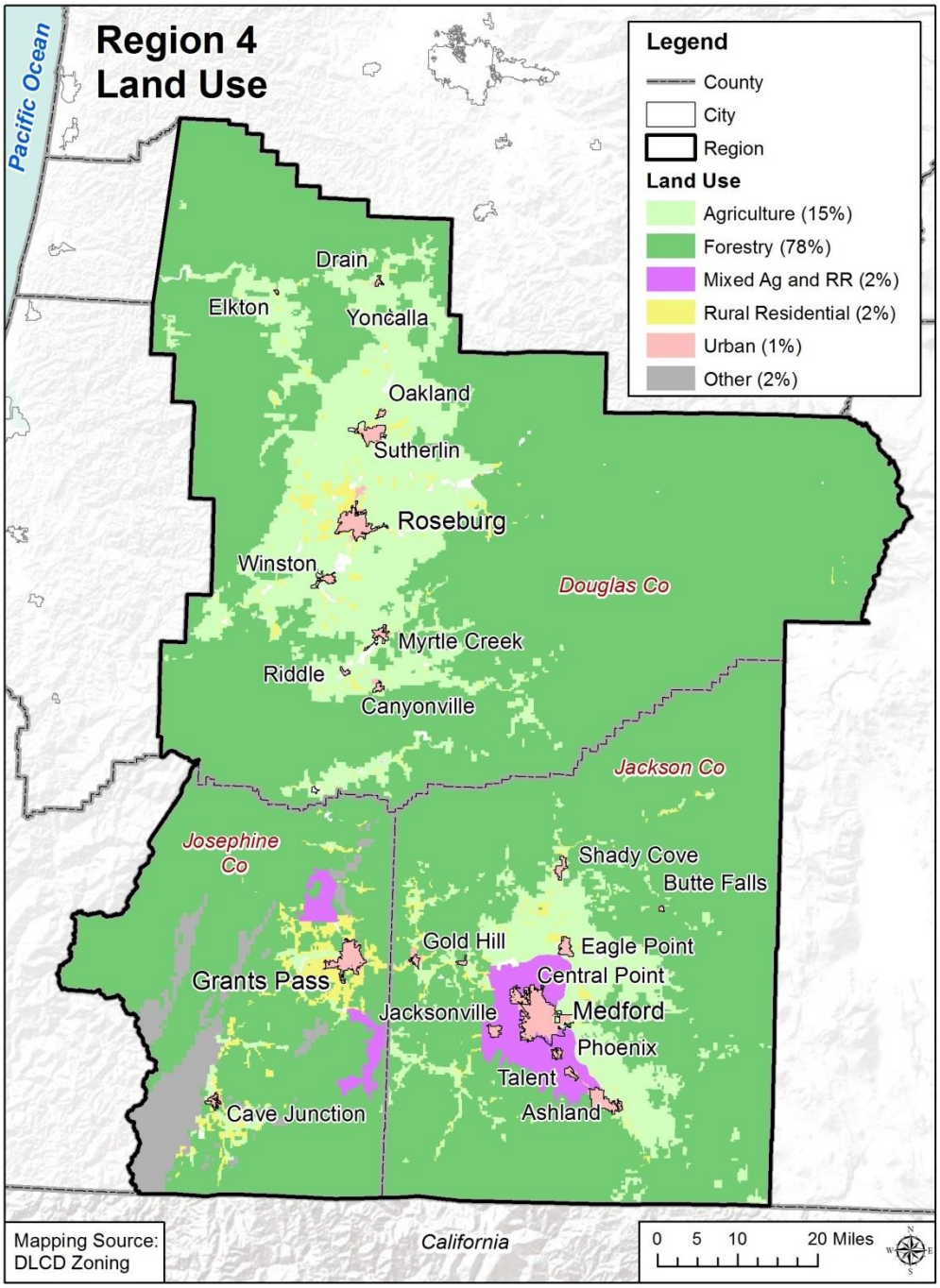
Under Oregon's land use system, each urban area is required to define an Urban Growth Boundary (UGB). Housing tracts, shopping malls, and other kinds of urban development are not allowed to sprawl past that boundary, while agricultural lands and open space outside a UGB are preserved. In Region 4, Roseburg has a significant area to the north along I-5 that can accommodate growth. Grants Pass has room to expand in several directions. Other communities, such as Medford, Central Point, and Jacksonville have little land reserved for urban expansion.

During the 25-year period between 1984 and 2009, Josephine County had a high rate of conversion of private land to developed uses. 14% of the county's 237,000 acres of private land in forest and agricultural uses was converted to low-density residential or urban uses — most of this change occurred between 1974 and 1984. However, the rates of conversion of private land in resource land uses to low-density residential or urban uses declined in the region and almost stopped between 2000 and 2009. Strong farm and forest land protections played a role in this decline. State statutes and rules establish standards for dwellings, uses and land divisions in rural areas to limit incompatible development and land fragmentation and to ensure that newly created farm and forest parcels remain commercially viable for farm and forest use (Lettman, 2011).

These changing land use development patterns and protections contribute to a slowing of the growth in the region's wildland-urban interface and other developed areas. While this does not necessarily lessen the wildfire risk in Region 4, it does provide the communities an opportunity to use tools such as the Josephine and Jackson County Integrated Fire Plans to reach vulnerable communities with wildfire risk assessment, outreach, and education.

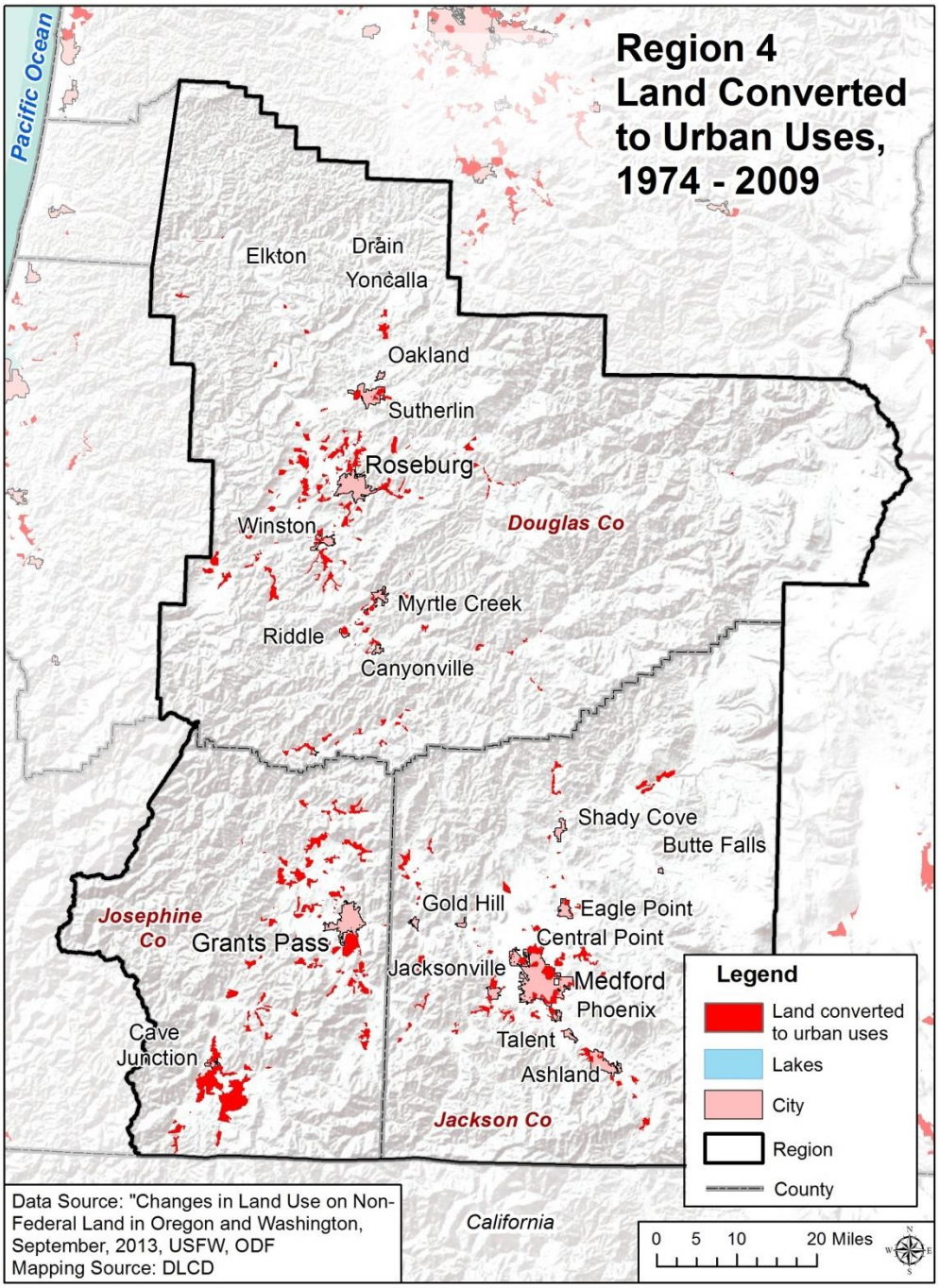
Regional problem solving activities are also addressing land use and development issues and how to guide growth. The "Greater Bear Creek Valley Regional Problem Solving Project" involves Jackson County and six cities in the Rogue Valley in guiding urban growth and development, while preserving priority farmland and floodplain.

Figure 2-198. Region 4 Land Use



Source: Department of Land Conservation and Development

Figure 2-199. Region 4 Land Converted to Urban Uses, 1974-2009



Source: Land Use Change on Non-Federal Land in Oregon and Washington, September, 2013, USFS, ODF

Housing

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. The majority of the region's housing stock is single-family homes. A significant portion of Douglas and Josephine Counties' housing stock is mobile homes. In natural hazard events such as earthquakes and floods, mobile homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor's Office of OES, 1997).

Table 2-364. Housing Profile for Region 4

	Total Housing Units	Single Family			Multi-Family			Mobile Homes		
		Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,733,041	68.1%	☑	0.3%	23.5%	☑	0.3%	8.16%	☑	0.1%
Region 4	182,145	69.5%	☑	0.8%	14.5%	☑	0.7%	15.61%	☑	0.6%
Douglas	49,838	68.6%	☑	1.5%	11.6%	☑	1.3%	19.24%	☑	1.1%
Jackson	93,704	68.9%	☑	1.3%	17.3%	☑	1.0%	13.40%	☑	0.7%
Josephine	38,603	71.9%	☑	1.6%	11.6%	☑	1.4%	16.29%	☑	1.5%

Notes: **Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau. 2013-2017. American Community Survey 5-Year Estimates

APA Citation: U.S. Census Bureau (2018).Table B25024: Units in Structure, 2013-2017 American Community Survey 5-year estimates. Retreived from http://factfinder2.census.gov/

Aside from location and type of housing, the year structures were built (**Table 2-366**) has implications. Seismic building standards were codified in Oregon building code starting in 1974. More rigorous building code standards passed in 1993 accounted for the Cascadia earthquake fault (Judson, 2012). Therefore, homes built before 1994 are more vulnerable to seismic events.

Also in the 1970s, FEMA began assisting communities with floodplain mapping as part of administering the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Upon receipt of floodplain maps, communities started to develop floodplain management ordinances to protect people and property from flood loss and damage. Regionally 32% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. More than one third of the region's housing stock was built after 1990 and the codification of seismic building standards. A larger share of housing in Jackson and Josephine Counties was built after 1990 than does Douglas County.

Table 2-365. Housing Vacancy in Region 4

	Total Housing Units	Vacant^		
		Estimate	CV **	MOE (+/−)
Oregon	1,733,041	5.6%	☑	0.2%
Region 4	182,145	6.4%	☑	0.6%
Douglas	49,838	7.3%	☑	1.1%
Jackson	93,704	5.7%	☑	0.8%
Josephine	38,603	6.8%	☑	1.2%

Notes: ^ Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.
**Green, orange, and red icons indicate the reliability of each Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau (2018), 2013-2017 American Community Survey 5-Year Estimates. http://factfinder2.census.gov/. Table B25004: Vacancy Status

Table 2-366. Age of Housing Stock in Region 4

	Total Housing Units	Pre 1970			1970 to 1989			1990 or Later		
		Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)	Estimate	CV **	MOE (+/−)
Oregon	1,733,041	34.6%	☑	0.3%	30.5%	☑	0.3%	34.9%	☑	0.3%
Region 4	182,145	30.6%	☑	0.9%	33.6%	☑	0.9%	35.8%	☑	0.9%
Douglas	49,838	36.5%	☑	1.9%	33.5%	☑	1.8%	30.0%	☑	1.7%
Jackson	93,704	28.6%	☑	1.2%	31.8%	☑	1.0%	39.6%	☑	1.3%
Josephine	38,603	27.8%	☑	1.9%	38.3%	☑	2.1%	33.8%	☑	2.0%

Notes: **Green, orange, and red icons indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with green checkmark icon, medium reliability (CV 15–30% — be careful) is shown with orange dot icon, and low reliability (CV >30% — use with extreme caution) is shown with red "x" icon. However, there are no absolute rules for acceptable thresholds of reliability. Users should consider the margin of error (MOE) and the need for precision.

Source: U.S. Census Bureau. 2013-2017. American Community Survey 5-Year Estimates. Table B25034

APA Citation: U.S. Census Bureau (2018). Table B25034: Year Structure Built, 2013-2017 American Community Survey 5-Year Estimates. Retreived from http://factfinder2.census.gov/

The National Flood Insurance Program's (NFIP's) Flood Insurance Rate Maps (FIRMs) delineate flood-prone areas. They are used to assess flood insurance premiums and to regulate construction so that in the event of a flood, damage is minimized. **Table 2-367** shows the initial and current FIRM effective dates for Region 4 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

Table 2-367. Community Flood Map History in Region 4

	Initial FIRM	Current FIRM
Douglas County	December 15, 1978	February 17, 2010
Canyonville	November 1, 1978	February 17, 2010
Drain	August 1, 1979	February 17, 2010
Elkton	September 5, 1979	February 17, 2010
Glendale	September 29, 1978	February 17, 2010
Myrtle Creek	February 15, 1978	February 17, 2010
Oakland	June 19, 1985	February 17, 2010
Reedsport	April 3, 1984	February 17, 2010
Riddle	August 1, 1979	February 17, 2010
Roseburg	June 1, 1977	February 17, 2010
Sutherlin	February 17, 2010	February 17, 2010 (M)
Winston	December 31, 1974	February 17, 2010
Yoncalla	February 17, 2010	February 17, 2010 (M)
Jackson County	April 1, 1982	May 3, 2011
Ashland	June 1, 1981	May 3, 2011
Butte Falls	June 30, 1976	June 30, 1976 (M)
Central Point	September 30, 1980	May 3, 2011
Eagle Point	September 30, 1980	May 3, 2011
Gold Hill	September 17, 1980	May 3, 2011
Jacksonville	December 4, 1979	May 3, 2011
Medford	April 15, 1981	May 3, 2011
Phoenix	May 3, 1982	May 3, 2011
Rogue River	January 2, 1980	May 3, 2011
Shady Cove	September 30, 1980	May 3, 2011
Talent	February 1, 1980	May 3, 2011
Josephine County	June 1, 1982	December 3, 2009
Cave Junction	June 1, 1982	December 3, 2009
Grants Pass	April 15, 1981	December 3, 2009

(M) = no elevation determined; all Zone A, C, and X.

Source: Federal Emergency Management Agency, Community Status Book Report

State-Owned/Leased and Critical/Essential Facilities

In 2014 the Department of Geology and Mineral Industries updated the 2012 Oregon NHMP inventory and analysis of state-owned/leased facilities and critical/essential facilities. Results from this report relative to Region 4 can be found in **Table 2-368**. The region contains 2.2% of the total value of state-owned/leased critical/essential facilities.

Table 2-368. Value of State-Owned/Leased Critical and Essential Facilities in Region 4

	Total Property Value (State Facilities)	Percent State Total
Oregon	$7,339,087,023	100%
Region 4	$164,409,632	2.2%
Douglas	$66,660,507	0.9%
Jackson	$60,819,133	0.8%
Josephine	$36,929,992	0.5%

Source: The Department of Geology and Mineral Industries

Built Environment Trends and Issues

The trends within the built environment are critical to understanding the degree to which urban form affects disaster risk. Region 3 is largely urban with development focused around the major cities along I-5 including Ashland, Medford, Grants Pass and Roseburg. Douglas County's urban population is growing at about half the state's rate. The region's housing stock is largely single-family homes. The region has about twice the percentage of mobile homes than the state, with Douglas County having the greatest share of mobile units and Jackson County having the greatest number of units overall. Over 38% of homes in Jackson County were built after 1990 to current seismic building standards. All of the region's FIRMs have been modernized or updated.

2.3.4.3 Hazards and Vulnerability

Droughts

Characteristics

In Region 4, drought conditions can affect commerce, agriculture, fisheries, and overall quality of life. All three counties in Region 4 experienced drought conditions with formal drought declarations in 1992, 1994, 2001, 2002, 2015 and Douglas County again in 2018.

In August 2013, the U.S. Department of Agriculture declared Jackson and Josephine Counties, along with Klamath and Lake Counties in Region 6, as federal primary natural disaster areas due to damages and losses caused by recent drought. This also occurred in Klamath, Josephine, and Jackson Counties in 2015. The lack of snow in the basin forced the Mount Ashland Ski Resort to close the 2013-14 season early on March 13, 2014. For the first time in its 50-year history, Mount Ashland did not open for the 2014-15 season.

Historic Drought Events

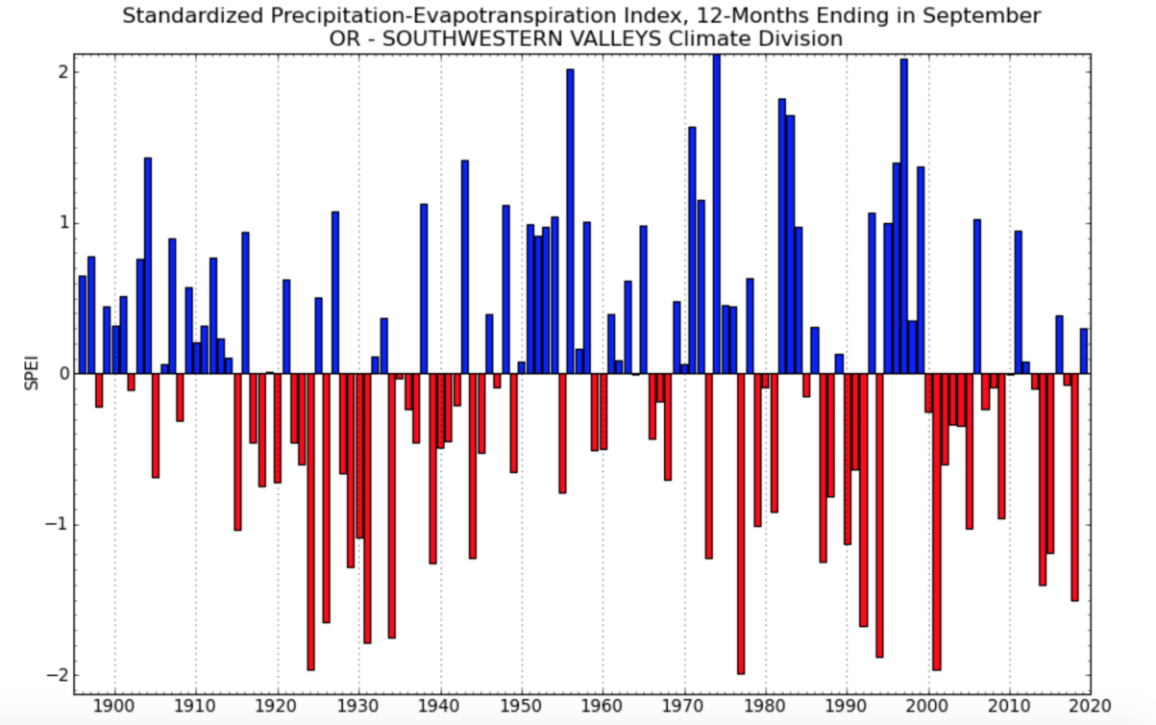
Table 2-369. Historic Droughts in Region 4

Date	Location	Description
1939	statewide	the 1920s and 1930s, known more commonly as the Dust Bowl, were a period of prolonged mostly drier than normal conditions across much of the state and country; water year 1939 was one of the more significant drought years in Region 4 during that period
1976-77	SW Oregon eastern Oregon	despite an insignificant PDSI value, the 1976-77 drought affected agriculture in Region 4; the water year was significantly drier than normal, but temperatures were near normal; the 1976-77 drought is included in this table because of the very large water year precipitation departures
1992	statewide	1992 fell toward the end of a generally dry period, which caused problems throughout the state
1994	SW Oregon eastern Oregon	In 1994, Governor's drought declaration covered 11 counties located within regions 4, 5, 6, 7, and 8
2001	SW Oregon eastern Oregon	Governor-declared drought in effect for all counties in Region 4 during 2001 as well as most counties in Regions 5, 6, 7, and 8
2002	coast; SW Oregon eastern Oregon	2001 Drought Declaration still in effect; five additional counties declared
2014	Regions 4, 6, 7, 8	Governor has declared drought in 10 counties in Oregon, including Region 4's Josephine and Jackson Counties
2015	statewide	Governor-declared drought in 25 counties, including all three Region 4 counties, with federal declarations in all counties.
2018	Regions 4-8, 1	Governor-declared drought in 11 counties, including Douglas County

Sources: Taylor and Hatton (1999); Oregon Secretary of State's Archives Division. NOAA's Climate at a Glance. Western Regional Climate Center's Westwide Drought Tracker http://www.wrcc.dri.edu/wwdt. Personal Communication, Kathie Dello, Oregon Climate Service, Oregon State University.

Region 4, which encompasses Jackson, Josephine, and Douglas Counties, is prone to frequent droughts. Historic drought information can be obtained from the West Wide Drought Tracker, which provides climate data showing wet and dry conditions, using the Standard Precipitation-Evapotranspiration Index (SPEI) that dates back to 1895. During this record, the most extreme drought year in the southwestern valleys was 1977 followed by 1924 and 2001. The index shows moderate to severe drought on several occasions (21 years) in the 1920s and 1930s, the early 1990s, the early 2000s (**Figure 2-200**).

Figure 2-200. Standard Precipitation-Evapotranspiration Index for Region 4



Drought Severity Scale: -1 to -1.49 = moderate drought; -1.5 to -1.99 = severe drought; -2.0 or less = extreme drought.

Source: West Wide Drought Tracker, https://wrcc.dri.edu/wwdt/time/

Table 2-370. Years with Moderate (<-1), Severe (<1.5), and Extreme (<-2) Drought in Oregon Climate Division 3 according to Standard Precipitation-Evapotranspiration Index

Moderate Drought (SPEI < -1.0)	Severe Drought (SPEI < -1.5)	Extreme Drought (SPEI < -2.0)
2014	1977	
1929	1924	
1939	2001	
1987	1994	
1944	1931	
1973	1934	
2015	1992	
1990	1926	
1930	2018	
1915		
2005		
1979		

Note: Within columns, rankings are from more severe to less severe.

Source: West Wide Drought Tracker, https://wrcc.dri.edu/wwdt/time/

Probability

Table 2-371. Probability of Drought in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	M

Source: OWRD, DLCD

Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases.

A comprehensive risk analysis is needed to fully assess the probability and impact of drought to Oregon communities. Such an analysis should be completed statewide to analyze and compare the risk of drought across the state.

Jackson County has received drought declarations in 28% of the years since 1992, Douglas 24% and Josephine 21%. Based on this history, Jackson and Douglas County are considered to have high probability for drought; Josephine County moderate probability.

Climate Change

In southwest Oregon drought is a frequent occurrence and the region has historically been hotter and drier than the statewide average. Region 4 is at higher risk of increased drought frequency than the state overall because it is already drought-prone and future climate projections indicate an exacerbation of the already hot and dry summers. Climate models project warmer, drier summers for Oregon, including Region 4. These summer conditions coupled with projected decreases in mid-to-low elevation mountain snowpack due to warmer winter temperatures increases the likelihood that Region 4 would experience increased frequency of one or more types of drought under future climate change. In Region 4, climate change would result in increased frequency of drought due to low spring snowpack (very likely, >90%), low summer runoff (likely, >66%), and low summer precipitation and low summer soil moisture (more likely than not, >50%). In addition, Region 4, like the rest of Oregon is projected to experience an increase in the frequency of summer drought conditions as summarized by the standard precipitation-evaporation index (SPEI) due largely to projected decreases in summer precipitation and increases in potential evapotranspiration (Dalton et al., 2017).

Vulnerability

Table 2-372. Vulnerability to Drought in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	H	H

Source: OWRD, DLCD

Oregon has not undertaken a comprehensive statewide analysis to identify which communities are most vulnerable to drought.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, vulnerability is similarly high across all three counties in Region 4. Each county's high vulnerability is driven by moderately high scores across the CDC index. Jackson County ranks in the top half of counties for 11 of the 15 index variables. Notably, it is in the 80th percentile for its share of single-parent households and in the 70th percentile for its share of residents that speak English less than "well." Josephine County is in the 80th percentile for its share of residents 65 and older, its unemployment rate, and the share of persons living in poverty. Douglas County has a higher unemployment rate than 80 percent of all counties and ranks in the 60th percentile for 7 of the 15 variables included in the CDC index.

Drought can have wide-ranging economic impacts in Region 4 and all three counties are very vulnerable to drought-induced wildfire. Further, the counties all have high social vulnerability ratings meaning that any natural hazard would significantly impact their populations. Therefore, Region 4's vulnerability to drought is considered high. All three counties are communities most vulnerable to drought.

Risk

Table 2-373. Risk of Drought in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Risk	H	H	H

Source: OWRD, DLCD

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. Based its history of drought declarations and high vulnerability to drought, Region 4's drought risk is considered to be high.

Earthquakes

Characteristics

The geographic position of this region makes it susceptible to earthquakes from four sources: (a) the off-shore Cascadia Fault Zone, (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) shallow crustal events within the North America Plate, and (d) earthquakes associated with renewed volcanic activity.

This part of Oregon has experienced no historic earthquakes of any significance that were centered in the region. However, the region has been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. All considered, there is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region and along the Cascadia Fault Zone. The magnitude 7.3 deep-seated intraplate event centered near Brookings in 1873 was probably felt throughout Southwest Oregon. There have been no known intraplate events in the region's history or pre-history. The 1993 Klamath Falls earthquake was felt in the region, but no damage was reported.

Earthquakes produced through volcanic activity could possibly reach magnitudes of 5.5. The 1980 Mount St. Helens eruption was preceded by a magnitude 5.1 earthquake. Despite the fact that Cascade volcanoes are some distance away from the major population centers in Region 2, earthquake shaking and secondary earthquake-related hazards such as lahars could cause major damage to these centers.

Historic Earthquake Events

Table 2-374. Significant Earthquakes Affecting Region 4

Date	Location	Magnitude (M)	Remarks
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	based on studies of earthquake and tsunami at Willapa Bay, Washington; these are the mid-points of the age ranges for these six events
Jan. 1700	offshore, Cascadia Subduction Zone	approximately 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Nov. 1873	Brookings area	7.3	chimneys fell at Port Orford, Grants Pass, and Jacksonville; no aftershocks; origin probably Gorda block of the Juan de Fuca plate; intraplate event
Apr. 14, 1920	Fort Klamath, Oregon	5.0	three shocks felt at Fort Klamath; center: probably in the vicinity of Crater Lake
Mar. 1993	Scotts Mills	5.6	$28 million in damage; damage to homes, schools, businesses, state buildings (Salem); crustal event (FEMA-985-DR-Oregon)
Sep. 1993	Klamath Falls	5.9 to 6.0	two earthquakes causing two deaths and extensive damage; $7.5 million in damage to homes, commercial, and government buildings; crustal event (FEMA-1004-DR-Oregon)

Note: No significant earthquakes have affected Region 4 since September 1993.

*BCE: Before Common Era.

Sources: Wong and Bott (1995); Pacific Northwest Seismic Network, https://pnsn.org/

Probability

Table 2-375. Assessment of Earthquake Probability in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	VH

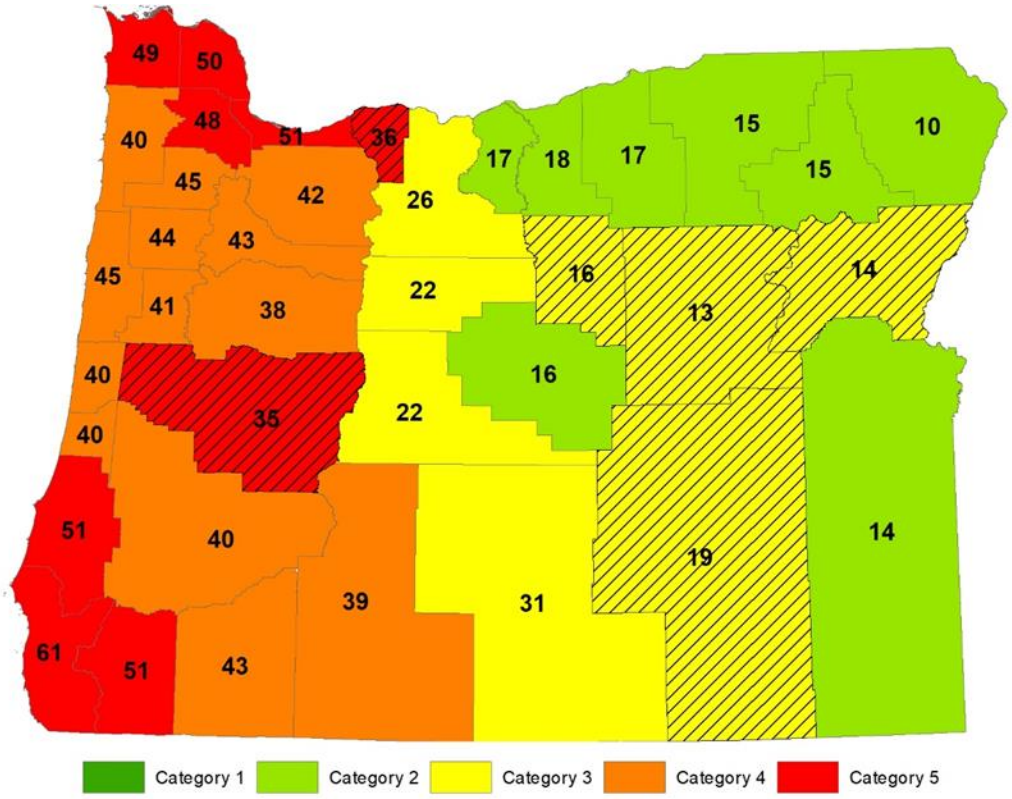
Source: DOGAMI, 2020

DOGAMI has developed a new probability ranking for Oregon counties that is based on the average probability of experiencing damaging shaking during the next 100 years, modified in some cases by the presence of newly discovered lidar faults. If a county had newly discovered faults that were within 10-12 miles of a community, the category defined by the average probability of damaging shaking was increased one step.

- Category 1 100-year probability < 10%
- Category 2 100 year probability 10-20%
- Category 3 100 year probability 21-31%
- Category 4 100 year probability 32-45%
- Category 5 100 year probability > 45%

The probability levels for Baker, Grant, Harney, Hood River, and Wheeler Counties, and the non-coastal portion of Lane County were all increased in this way. The results of this ranking are shown in **Figure 2-201**.

Figure 2-201. 2020 Oregon Earthquake Probability Ranking Based on Mean County Value of the Probability of Damaging Shaking and Presence of Newly Discovered Faults



Source: DOGAMI, 2020

For Oregon west of the crest of the Cascades, the CSZ is responsible for most of the hazard shown in **Figure 2-201**. The paleoseismic record includes 18 magnitude 8.8–9.1 megathrust earthquakes in the last 10,000 years that affected the entire subduction zone. The return period for the largest earthquakes is 530 years, and the probability of the next such event occurring in the next 50 years ranges from 7 to 12%. An additional 10–20 smaller, magnitude 8.3–8.5, earthquakes affected only the southern half of Oregon and northern California. The average return period for these is about 240 years, and the probability of a small or large subduction earthquake occurring in the next 50 years is 37-43%.

Vulnerability

Table 2-376. Assessment of Vulnerability to Earthquakes in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	H	H

Source: DOGAMI and DLCD, 2020

In 2007, DOGAMI (Lewis, 2007) completed a rapid visual screening (RVS) of educational and emergency facilities in communities across Oregon, as directed by the Oregon Legislature in Senate Bill 2 (2005). RVS is a technique used by the Federal Emergency Management Agency (FEMA), known as FEMA 154, to identify, inventory, and rank buildings that are potentially vulnerable to seismic events. DOGAMI surveyed a total of 3,349 buildings, giving each a "low," "moderate," "high," or "very high" potential of collapse in the event of an earthquake. It is important to note that these rankings represent a probability of collapse based on limited observed and analytical data and are therefore approximate rankings (Lewis, 2007). To fully assess a building's potential of collapse, a more detailed engineering study completed by a qualified professional is required, but the RVS study can help prioritize buildings for further study. Table 2-377 shows the number of buildings surveyed in each county with their respective rankings.

Table 2-377. Building Collapse Potential in Region 4

Region 4 Counties	Level of Collapse Potential			
	Low (< 1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Douglas*	74	45	40	10
Jackson	139	13	87	22
Josephine	37	15	16	1

*Does not include the Douglas County coastal communities of Gardiner, Reedsport, and Winchester Bay.

Source: Lewis (2007)

The Oregon Department of Geology and Mineral Industries (DOGAMI) has also developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) a Cascadia Subduction Zone (CSZ) 8.5 event, and (b) combined crustal events (using a 500-year Model). Loss and damage estimates based on these models are founds in Table 2-378 and Table 2-379. For more information on these models, see the State Risk Assessment section.

Table 2-378. Projected Dollar Losses in Region 4, Based on an M8.5 Subduction Event and a 500-Year Model

Region 4 Counties	Economic Base Loss in Thousands (1999)	Greatest Absolute Loss in Thousands (1999) from an 8.5 CSZ Event	Greatest Absolute Loss in Thousands (1999) from a 500-Year (Crustal) Event
Douglas	$4,631,000	$275,000	$546,000
Jackson	$7,829,000	$538,000	$1,191,000
Josephine	$3,240,000	$593,000	$848,000

Source: Wang and Clark (1999)

Table 2-379. Estimated Damages and Losses in Region 4 Associated with Two Earthquake Models

Damage/Loss Type	M8.5 CSZ Event			500-Year Model[1]		
	Douglas	Jackson	Josephine	Douglas	Jackson	Josephine
Injuries	151	428	418	294	930	585
Deaths	2	8	7	4	18	11
Displaced households	255	650	573	534	1,458	872
Economic losses for buildings[2]	$275 m	$538 m	$593 m	$546 m	$1.2 b	$847 m
Operational the "day after" the event[3]:						
Fire stations	66%	75%	22%	N/A	N/A	N/A
Police stations	57%	62%	45%	N/A	N/A	N/A
Schools	44%	70%	34%	N/A	N/A	N/A
Bridges	74%	84%	73%	N/A	N/A	N/A
Economic losses to:						
Highways	$43 m	$10 m	$16 m	$69 m	$34 m	$29 m
Airports	$5 m	$2 m	$5 m	$9 m	$8 m	$10 m
Communications	$7 m	$2 m	$4 m	$12 m	$9 m	$8 m
Debris generated (thousands of tons)	222	434	476	411	889	614

Notes: "b" is billion; "m" is million

[1]Every part of Oregon is subject to earthquakes. The 500-year model is an attempt to quantify the risk across the state. The estimate does not represent a single earthquake. Instead, the 500-year model includes many faults, each with a 10% chance of producing an earthquake in the next 50 years. The model assumes that each fault will produce a single "average" earthquake during this time. More and higher magnitude earthquakes than used in this model may occur (DOGAMI, 1999).

[2]There are numerous unreinforced masonry structures (URMs) in Oregon, the currently available default building data does not include any URMs. Thus, the reported damage and loss estimates may seriously under-represent the actual threat" (Wang, 1998, p. 5)

[3]Because the 500-year model includes several earthquakes, the number of facilities operational the "day after" cannot be calculated.

Source: Wang and Clark (1999)

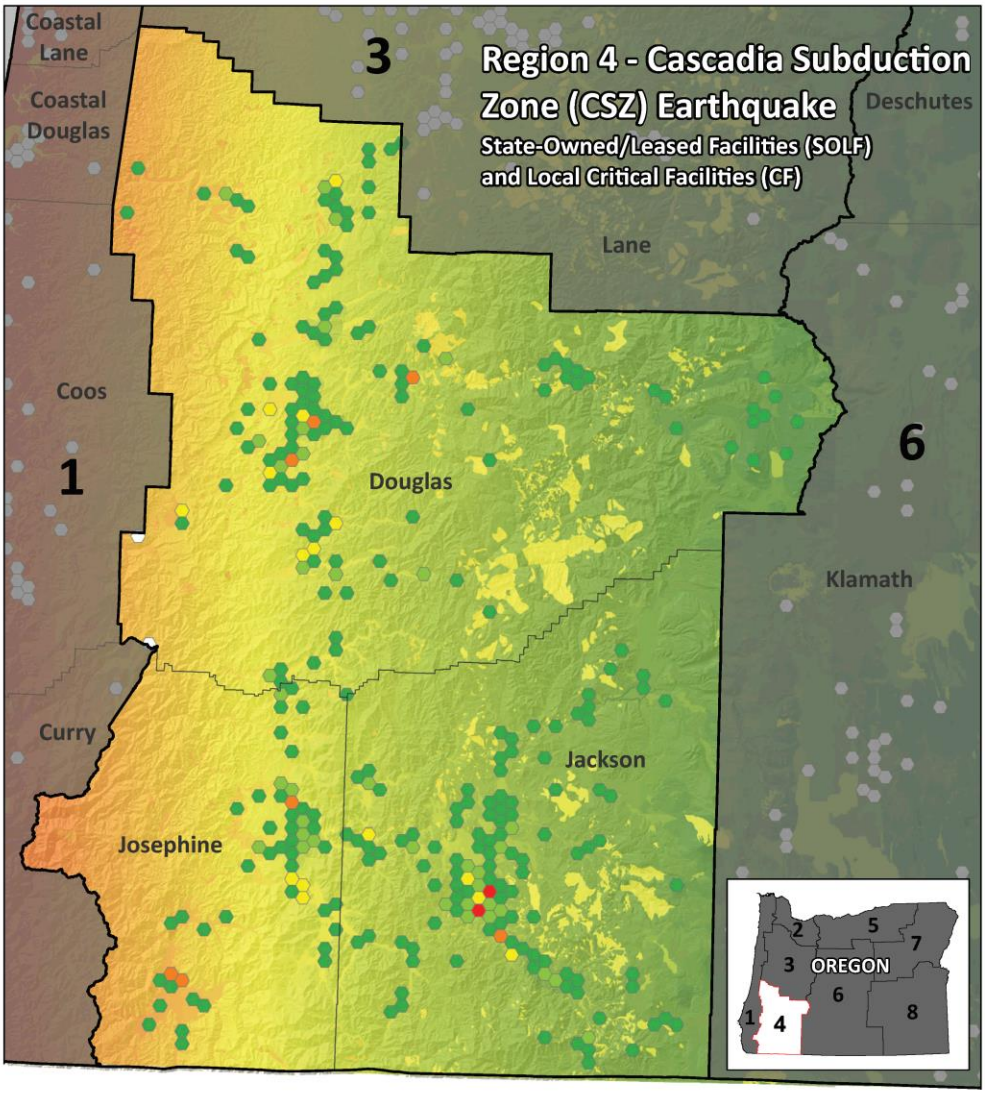
State-Owned/Leased Buildings And Critical Facilities And Local Critical Facilities

For the 2020 vulnerability assessment, DOGAMI used Hazus-MH to estimate potential loss from a Magnitude 9 Cascadia Subduction Zone (CSZ) event in Region 4. The analysis incorporated information about the earthquake scenario (such as coseismic liquefaction and landslide potential), as well as building characteristics (including the seismic building code and building material). The results of the analyses are provided as a loss estimation (the building damage in dollars) and as a loss ratio (the loss estimation divided by the total value of the building) reported as a percentage at the county level.

DOGAMI used the loss ratio to formulate a separate relative vulnerability score for the state buildings, state critical facilities, and local critical facilities data sets. The percentage of loss for each county was statistically distributed into 5 categories (Very Low, Low, Moderate, High, or Very High).

In Region 4, a CSZ event could cause a potential loss of almost $26M in state building and critical facility assets, 40% of it in Jackson County and about 30% each in Douglas and Josephine Counties. The potential loss in local critical facilities is quite a bit greater, over $361M. With 44% of the value of local critical facilities, Jackson County has the greatest potential loss followed by Douglas County with 34%.**Figure 2-202** illustrates the potential loss to state buildings and critical facilities and local critical facilities from a CSZ event.

Figure 2-202. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Cascadia Subduction Zone Earthquake Hazard Zone in Region 4.High-resolution, full-size image linked from Appendix 9.1.22.



Estimated ($) losses to hazard per cell

- Outside of region
- 1 - 1,000,000
- 1,000,001 - 5,000,000
- 5,000,001 - 10,000,000
- 10,000,001 - 20,000,000
- 20,000,001 - 42,000,000

Earthquake peak ground acceleration
(Modified Mercalli Intensity Scale)
Moderate — Severe

Administrative boundary
- Mitigation Planning Region
- County

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet, Horizontal datum: NAD83 HARN, Scale 1:750,000

Source Data:
CSZ Earthquake: Peak ground acceleration from the Oregon Resilience Plan, DOGAMI, 2013
State-owned/lease buildings: Oregon Department of Administrative Services, 2019
Administrative boundaries: Oregon Emergency Management and the Oregon Department of Land Conservation and Development, 2015
Hillshade base map: DOGAMI, Statewide mosaic, 2018, from Oregon Lidar Consortium data

Author: Matt Williams, Oregon Department of Geology and Mineral Industries, January 2020.

REGION 4		Estimated Loss ($) from CSZ Earthquake					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Loss SOLF CF	% Loss SOLF CF	Loss ($) SOLF Non-CF	Loss Total*	Loss Local CF	Total Loss SOLF CF and Local CF
Douglas	985,197,000	2,418,000	9%	4,948,000	7,366,000	124,286,000	126,704,000
Jackson	1,790,356,000	5,362,000	13%	5,165,000	10,527,000	160,832,000	166,194,000
Josephine	528,755,000	1,308,000	3%	7,296,000	8,604,000	76,675,000	77,983,000
Total	3,304,308,000	9,088,000	9%	17,409,000	26,497,000	361,793,000	370,881,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

0 10 20 40 Miles
N

Source: DOGAMI

Historic Resources

None of the 6,265 historic resources in Region 4 are in an area of high or very high liquefaction potential. However, 42% of Region 4's historic resources are located in areas of high or very high potential for ground shaking amplification. Over three quarters of those are in Jackson County.

Archaeological Resources

Three thousand seven hundred six archaeological resources are located in earthquake hazard areas in Region 4. Only eleven are located in an area of high earthquake hazards, and none of them have been evaluated as to their eligibility for listing on the National Register of Historic Places. About 87% of Region 4's archaeological resources in earthquake hazard areas are located in Douglas and Jackson Counties.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, vulnerability is similarly high across all three counties in Region 4. Each county's high vulnerability is driven by moderately high scores across the CDC index. Jackson County ranks in the top half of counties for 11 of the 15 index variables. Notably, it is in the 80th percentile for its share of single-parent households and in the 70th percentile for its share of residents that speak English less than "well." Josephine County is in the 80th percentile for its share of residents 65 and older, its unemployment rate, and the share of persons living in poverty. Douglas County has a higher unemployment rate than 80 percent of all counties and ranks in the 60th percentile for 7 of the 15 variables included in the CDC index.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, all three counties in Region 4 are highly vulnerable to earthquake hazards.

Seismic Lifelines

"Seismic lifelines" are the state highways ODOT has identified as most able to serve response and rescue operations, reaching the most people and best supporting economic recovery. The process, methodology, and criteria used to identify them are described in Section **2.1.6, Seismic Transportation Lifeline Vulnerabilities**, and the full report can be accessed at **Appendix 9.1.14**, *Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification* (OSLR). According to that report, seismic lifelines in Region 4 have the following vulnerabilities.

The following geographic zones identified in the OSLR are located within Region 4:

- *South I-5 Geographic Zone:* Region 4 is primarily in this geographic zone where the only recommended seismic lifeline is I-5 from Eugene to the California border. The entire area is likely to experience sustained ground shaking, with many roadways in areas subject to landslide and rockfall or liquefaction. All of I-5 in this zone was designated a Tier 1 route (highest priority roadway) due to its importance in the region and the lack of alternate corridors.

- *Cascades Geographic Zone:* Region 4 also includes the southerly portion of the Cascades Geographic Zone. The only seismic lifeline in this area is the Tier 2 route (second highest priority roadway) on OR-140 from Medford to US-97 in Klamath County, the southernmost route that can also serve as a connection from Medford to the Klamath Falls area in a seismic event. OR-140 is a mountain road that has risks related to dam failure, landslide, and rockfall and also runs through some high-water-table areas.
- *Coastal Geographic Zone:* Region 4 includes a Tier 3 lifeline (third highest priority) in the Coastal Zone: US-199 from I-5 to the Oregon-California border, connecting with US-101 near Crescent City, California. US-199 has a high risk of rockfall approaching its western end and also runs closely along a riverbed so may be vulnerable to liquefaction damage.

Regional Impact. Routes in Region 4 are vulnerable to ground shaking, landslides, rockfall, and liquefaction.

- Ground Shaking: In Region 4 ground shaking will be the most significant vulnerability in populated areas. Unreinforced structures, roadbeds, and bridges will be damaged to varying extents from either a CSZ or Klamath Falls event.
- Landslides and Rockfall: Many roadways in the foothills within and around the valley include landslide prone features. A major seismic event will increase landslide and rockfall activities and may reactivate ancient slides that are currently inactive.
- Liquefaction: Structures in wetland, alluvial and other saturated areas, including the many Umpqua and Rogue River crossings, may be subject to liquefaction damage; the total area of such impacts will vary with the extent of saturated soils at the time of the event.

Regional Loss Estimates. Economic losses caused by a CSZ event were not calculated for the specific zones of study or for specific highway facilities. The economic loss assessment statewide considered only the losses directly due to highway closures, so for example, it does not include productivity losses due to business site damage. The highway-related losses include disconnection from supplies and replacement inventory and the loss of tourists and other customers who must travel to do business with affected businesses.

Most Vulnerable Jurisdictions. Inland Douglas, Jackson, and Josephine Counties are generally equally vulnerable to ground shaking from a CSZ event. A Klamath Falls event has the potential to affect Ashland and Jackson County more that it would Josephine or Douglas County. All three counties have steep rural areas and to some extent steep developed areas that may experience landslides. All three have some transportation facilities along river beds or river crossings that may be vulnerable to liquefaction. The biggest risk is from a CSZ event with an epicenter off the southern Oregon coast.

Risk

Table 2-380. Risk of Earthquake Hazards in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Risk	VH	VH	VH

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the earthquake probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, all three counties in Region 4 are at very high risk from earthquakes.

Extreme Heat

Characteristics

Extreme temperatures are common in southern Oregon and Region 4 experiences many days above 90°F every year. Medford has an average of about 48 days per year above 90°F

Historic Extreme Heat Events

Table 2-381. Historic Extreme Heat Events in Region 4

Date	Location	Notes
August 1–4, 2017	Region 2–4, 6	Excessive Heat Event: Strong high pressure brought record breaking heat to many parts of southwest, south central, and northwest Oregon. Region 4: Reported high temperatures during this interval ranged from 98 to 112 degrees (Jackson), 95 to 110 degrees (Douglas), 87 to 109 degrees (Josephine, eastern Curry).
July 12–17, 2018	Region 2, 3, 4	Region 4: Strong high pressure coupled with very dry air brought very hot temperatures to the area during this interval. High temperatures ranged from 89 to 105 degrees (Jackson) and from 91 to 104 degrees (Josephine, eastern Curry).
June 11–12, 2019	Region 4 (Jackson, Douglas, Josephine, eastern Curry County)	Strong high pressure and a very dry air mass made for hot conditions over southwest Oregon during this interval. Reported high temperatures ranged from 95 to 101 degrees (Jackson), 89 to 101 degrees (Douglas), 88 to 105 degrees (Josephine, eastern Curry).
August 27-28, 2019	Region 4 (Jackson, Josephine, eastern Curry County)	Excessive Heat Event: High pressure aloft forced a thermal trough near the coast to move inland, bringing hot and dry conditions to the inland west side valleys in southwest Oregon. Reported high temperatures in this zone ranged from 99 to 106 degrees on 08/27 and from 92 to 95 degrees on 08/28. Low temperatures on the morning of 08/28 ranged from 50 to 67 degrees.

Source: https://www.ncdc.noaa.gov/stormevents

Probability

The relative probability of extreme heat was determined by dividing the counties by quintiles based on historic and projected future frequency of days with heat index above 90°F (as shown in **Figure 2-62**). Counties in the bottom quintile had the lowest frequency of days with heat index above 90°F relative to the rest of the state and were given a score of 1 meaning "very low." Region 4 relative probability rankings are shown in **Table 2-382**. Extreme heat frequency relative to the rest of the state is and will continue to be high, especially in Josephine County. The coastal portion of Douglas County is included in Region 4 for this assessment.

Table 2-382. Probability of Extreme Heat in Region 4

	Douglas	Jackson	Josephine
Probability	H	H	VH

Source: Oregon Climate Change Research Institute, https://climatetoolbox.org/

Climate Change

It is *extremely likely* (>95%) that the frequency and severity of extreme heat events will increase over the next several decades across Oregon due to human-induced climate warming (*very high confidence*). Southern Oregon (Region 4) experiences some of the hottest temperatures in the state and is projected to experience greater frequency of extreme temperatures under future climate change. **Table 2-383** lists the number of days exceeding the heat index of 90°F in the historical baseline and future mid-21st century period under RCP 8.5 for counties in Region 4.

Table 2-383. Annual Number of Days Exceeding Heat Index ≥ 90°F for Region 4 Counties

County	Historic Baseline	2050s Future
Douglas	6	28
Jackson	9	33
Josephine	13	40

Note: Numbers represent the multi-model mean from 18 CMIP5 climate models

Source: Oregon Climate Change Research Institute using data from the Northwest Climate Toolbox, https://climatetoolbox.org/.

Vulnerability

Vulnerability of Oregon counties to extreme heat is discussed in Section 2.2.1.3, **Extreme Heat**. Vulnerability is defined as the combination of sensitivity to extreme heat and level of adaptive capacity in response to extreme heat.

For this assessment, sensitivity to extreme heat events was defined using the Center for Disease Control and Prevention (CDC) 2016 Social Vulnerability Index, https://svi.cdc.gov/data-and-tools-download.html.

According to the CDC Social Vulnerability Index, vulnerability is similarly high across all three counties in Region 4. Each county's high vulnerability is driven by moderately high scores across the CDC index. Jackson County ranks in the top half of counties for 11 of the 15 index variables. Notably, it is in the 80th percentile for its share of single-parent households and in the 70th percentile for its share of residents that speak English less than "well." Josephine County is in the 80th percentile for its share of residents 65 and older, its unemployment rate, and the share of persons living in poverty. Douglas County has a higher unemployment rate than 80 percent of all counties and ranks in the 60th percentile for 7 of the 15 variables included in the CDC index.

Adaptive capacity to extreme heat is defined here as percent of homes with air conditioning, however the authors note that this measure has its flaws. First, it assumes that people who have access to cooling systems are able to afford to use them. Second, the data only includes single-family homes, which omits populations living in multi-family housing or who are house-less.

Because extreme heat is common in southern Oregon ("high" probability), most people in Region 4 are accustomed or prepared in terms of air conditioning when an extreme heat event occurs ("high" adaptive capacity). In Cooling Zone 3, which includes Jackson and Josephine counties, 91% of single-family homes have air-conditioning (https://neea.org/img/uploads/Residential-Building-Stock-Assessment-II-Single-Family-Homes-Report-2016-2017.pdf).

The relative vulnerability of Oregon counties to extreme heat was determined by adding the rankings for sensitivity (social vulnerability) and adaptive capacity (air conditioning). The sum of the two components ranged from 1 to 10. Rankings were determined as follows: total vulnerability scores of 1–2 earned a ranking of 1 (very low); scores of 3–4 earned a ranking of 2 (low); scores of 5–6 earned a ranking of 3 (moderate); scores of 7–8 earned a ranking of 4 (high); and scores of 9–10 earned a ranking of 5 (very high). Rankings for NHMP regions are averages of the counties within a region and rounded to the nearest whole number.

Table 2-384 displays the total vulnerability rankings as well as ranking for sensitivity and adaptive capacity for each county in NHMP Region 4. Table 2-385 provides the summary descriptors of Region 4's vulnerability.

Combining sensitivity and adaptive capacity, Region 4's relative vulnerability to extreme heat is "Moderate." Douglas County, with its high vulnerability rating, is the county most vulnerable to extreme heat in Region 4.

Table 2-384. Relative Vulnerability Rankings for Region 4 Counties

County	Sensitivity	Adaptive Capacity	Vulnerability
Region 4	**4**	**2**	**3**
Douglas	4	3	4
Jackson	4	1	3
Josephine	4	1	3

Source: Oregon Climate Change Research Institute

Table 2-385. Vulnerability to Extreme Heat in Region 4

	Douglas	Jackson	Josephine
Vulnerability	H	M	M

Source: Oregon Climate Change Research Institute

Risk

With respect to extreme heat, risk is defined as the combination of the probability of extreme heat events, sensitivity to extreme heat, and level of adaptive capacity in response to extreme heat.

The total relative risk of Oregon counties to extreme heat was determined by adding the rankings for probability and vulnerability (sensitivity and adaptive capacity). The sum of the two components ranged from 1 to 10. Rankings were determined as follows: total risk scores of 1-2 earned a ranking of 1 ("very low"); scores of 3-4 earned a ranking of 2 ("low"); scores of 5-6 earned a ranking of 3 ("moderate"); scores of 7-8 earned a ranking of 4 ("high"); and scores of 9-10 earned a ranking of 5 ("very high"). Rankings for NHMP regions are averages of the counties within a region and rounded to the nearest whole number.

Table 2-386 displays the relative risk ranking as well as rankings for probability and vulnerability for each county in NHMP Region 4. . Table 2-387 provides the summary descriptors of Region 4's risk to extreme heat.

Combining probability and vulnerability, Region 4's relative risk to extreme heat is "High."

Table 2-386. Risk Rankings for Region 4 Counties

County	Probability	Vulnerability	Risk
Region 4	**4**	**3**	**4**
Douglas	4	4	4
Jackson	4	3	4
Josephine	5	3	4

Source: Oregon Climate Change Research Institute

Table 2-387. Risk of Extreme Heat in Region 4

	Douglas	Jackson	Josephine
Risk	H	H	H

Source: Oregon Climate Change Research Institute

Floods

Characteristics

A number of large floods have been recorded in Southwest Oregon, many of which were very destructive. Recurrence is virtually assured, since some areas at risk are rapidly urbanizing. This region has the distinction of having two major rivers the Umpqua and Rogue Rivers that have their origins in the Cascade Mountains and continue to flow through the Coast Range to the Pacific Ocean. Their headwaters receive an abundance of mountain snow. At lower elevations they may receive runoff from intense Pacific storms, which are not uncommon in western Oregon. A combination of rapidly melting snow and intense rain can produce disastrous flood conditions. **Table 2-388** lists some significant floods that affected southwest Oregon communities. **Table 2-389** includes tributary streams that also have produced disastrous floods.

According to the Jackson County Multi-Jurisdictional Hazard Mitigation Plan (2018) the most significant of the FEMA-determined floodplains and floodways surround the Rogue River, Bear Creek, Ashland Creek and Applegate River. Properties in and near the floodplains in the cities of Rogue River and Shady Cove are subject to frequent flooding events.

In Josephine County, the Rogue and Applegate Rivers also are sources of flooding, along with Slate Creek and the Illinois River. Rogue River flooding affects the City of Grants Pass and Illinois River flooding affects the City of Cave.

In Douglas County the highest stream flows in the Umpqua River basin usually occur during November through March as a result of heavy winter rains augmented by snowmelt. Most of the flooding occurs in the valley areas of the South Umpqua and Umpqua Rivers, although the tributary streams of Cow Creek, Calapooya Creek, and Elk Creek also have extensive flood plains. Most of the land subject to flooding along the South Umpqua River is below Days Creek. Because these valleys are the most densely populated and intensively developed in Douglas County, the principal flood problems in the county occur along the South Umpqua River. Flood potential also exists along the Umpqua River between Elkton and the confluence of the North and South Umpqua Rivers. In the Glendale-Azalea valley of Cow Creek, much bank erosion and channel shifting occurs during floods.

The physical beauty of the area has attracted a large number of people to various stream valleys, where they are placed at risk despite National Flood Insurance Program (NFIP) requirements. This is somewhat offset by Oregon's land use program, which generally prohibits the subdivision of farm and forest land for residential purposes.

All of the Region 4 counties have digital Flood Insurance Rate Maps (FIRMs). In Douglas County a countywide update was completed in February 2009 by WEST Consultants, Inc. This update included detailed study area floodplain boundaries for portions of Newton Creek, Deer Creek using new topographic mapping with 2 ft contour intervals.

In 2018 a Physical Map Revision (PMR) was completed by STARR in Jackson County for the City of Ashland and unincorporated areas of Jackson County. The Jackson County-Neil Creek PMR incorporates revised hydraulic analysis based on new hydrologic and topographic data along Clayton and Neil Creeks.

In Josephine County a countywide update was completed in November 2009 by WEST Consultants, Inc. The 1- and 0.2-percent-annual-chance floods were re-delineated on Gilbert Creek and portions of the Rogue River using new topography with a one-foot contour interval provided by the City of Grants Pass.

The effective FIRMs for Region 4 are:

- Douglas, February 2010;
- Jackson, January 2018; and
- Josephine, December 2009.

Douglas County's FIRM has been updated but FEMA has temporarily suspended issuance of Letters of Final Determination due to COVID-19. Lidar updates in Region 4 are planned for fall and winter 2020.

Historic Flood Events

Table 2-388. Significant Historic Flood Events Affecting Region 4

Date	Location	Characteristics	Type of Flood
Mar. 1931	western Oregon	wet, mild weather; bridges and homes destroyed	rain on snow
Oct. 1950	southwest Oregon	severe flooding in Region 4; six fatalities; bridges and roads destroyed	rain on snow
Jan. 1962	western Oregon	heavy rain (3-4 inches in Rogue Valley); 84 people evacuated; great loss of farmland	rain on snow
Dec. 1964	entire state	infamous 1964 flood that has become an Oregon benchmark; record flows on Rogue and Umpqua Rivers	rain on snow
Jan. 1974	western Oregon	series of storms with mild temperatures; large snowmelt with rapid runoff	rain on snow
Jan. 1986	entire state	significant flooding in western Oregon attributable to warm, intense rain	snow melt
Jan. 1990	western Oregon	significant flooding in western Oregon	rain on snow
Nov. 1996	entire state	tropical air mass; intense rain; landslides; power outages (FEMA-1149-DR-Oregon)	rain on snow
Dec. 1996	entire state	mild weather continues; severe flooding in Ashland; FEMA declaration (FEMA-1160-DR-Oregon)	rain on snow
July 2001	Douglas, Deschutes and Lake Counties	A Flash Flood Warning was issued for East Central Douglas county. The Boulder Creek area was of special concern. A heavy slow moving thunderstorm dumped one inch of rain in one hour over Sunriver. Lakeview Police reported rock and/or mudslides on State Highway 140 at mileposts 22, 23.2, and 25.1. They also reported .25 inch hail up to an inch deep and 2 feet of water in spots on the same highway.	flash flood
Dec. 2005	Douglas, Jackson and Josephine Counties	$2,840,000; damage estimate includes areas outside of Region 4	riverine
June 2006	Jackson	heavy rain brought flash flooding to Jacksonville, but no reported damages	riverine
Aug. 2007	Jackson	heavy rains caused flash flooding near Ashland, no major estimated damages	riverine

Date	Location	Characteristics	Type of Flood
Jan. 2011	Clackamas, Clatsop, Crook, Douglas, Lincoln, and Tillamook Counties	severe winter storm, flooding, mudslides, landslides, and debris flows (DR-1956)	
Nov. 2012	Jackson	heavy rains resulted in at least 4 NFIP losses in the area around Central Point	riverine
Jan. 2012	Douglas	heavy rains resulted in at least two NFIP losses in the Roseburg areas	riverine
Feb. 2014	Jackson County	In Jackson County heavy rains caused a brief flood on Little Butte Creek at Eagle Point.	
Dec. 2014	Tillamook, Lincoln, Lane, Polk Clackamas, Benton Coos and Douglas Counties	A slow moving front produced heavy rain over Northwest Oregon which resulted in the flooding of eight rivers. Another impact from the rain were a couple of land/rock slides that both blocked two highways. Heavy rain brought flooding to several rivers in southwest Oregon.	riverine
Feb. 2015	Curry, Coos, Douglas, Josephine and Jackson Counties	Heavy rains caused flooding on the Rogue River at Agness and along the Coquille River at Coquille.	rain on snow
Dec. 2015	Tillamook, Lincoln, Washington, Clackamas, Multnomah, Lane, Columbia, Hood River, Polk, Coos, Douglas, Jackson and Curry Counties	A moist pacific front produced heavy rainfall across Northwest Oregon which resulted in river flooding, urban flooding, small stream flooding, landslides, and a few sink holes. After a wet week (December 5 through Dec 11), several rivers were near bank full ahead of another front on December 12th. Flooding from the Nehalem River and Rock Creek in Vernonia resulted in evacuation of homes and the implementation of the Vernonia Emergency Command Center. Heavy rain resulted in a land slide that closed OR47 at mile marker 8. More than $15 million dollars in property damage reported in these counties combined.	riverine
Jan. 2016	Jackson, Josephine, Curry and Coos Counties	Heavy rain brought flooding to some areas of southwest Oregon. Minor flooding on the Rogue at Agness and moderate flooding on the Coquille River at Coquille.	riverine
Dec. 2016	Josephine, Jackson, Douglas, Coos and Curry Counties	Heavy rain brought some areal flooding to parts of southwest Oregon.	riverine
Feb. 2019	Douglas, Coos and Curry Counties	Very heavy rain along with the melting of recent snowfall caused flooding at several locations in southern Oregon in late February. Deer Creek at Roseburg, South Fork of the Coquille at Myrtle Point, North Fork of the Coquille at Myrtle Point, the Coquille River at Coquille and the Rogue River at Agness all exceeded flood stage.	rain on snow
April 2019	Douglas, Coos and Curry Counties	Two days of very heavy rainfall (compared to April normals) combined with snowmelt led to areal flooding in southwest and south central Oregon	rain on snow

Source: Taylor and Hatton (1999); Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org; 2014 BureauNet; NOAA Storm Event Database, online resource consulted January 2020; Planning for Natural Hazards: Flood TRG (Technical Resource Guide), July 2000, DLCD, Community Planning Workshop

Table 2-389. Principal Flood Sources by County in Region 4

Douglas (Non-Coastal)	Jackson	Josephine
North and South Umpqua Rivers and tributaries	Rogue River and tributaries	Rogue River and tributaries
Tributaries: Scholfield Creek Deer Creek North and South Myrtle Creeks Cow Creek Newton Creek	Tributaries: Jump Off Joe Creek Louse Creek Waters Creek Applegate River Slate Creek Murphy Creek Illinois Creek East and West Forks of the Illinois River Deer Creek	Tributaries: Lazy Creek Larson Creek Griffin Creek Pleasant Creek Foots Creek Little Butte Creek Lone Pine Creek Lassen Creek Crooked Creek Daisy Creek Evans Creek Wagner Creek Ashland Creek Colman Creek Clay Creek Bear Creek

Sources: FEMA, April 21, 1999, Douglas County Flood Insurance Study (FIS); and FEMA, May 15, 2002, Jackson County FIS; and FEMA, Sept 27, 1991, Josephine County FIS

Probability, Vulnerability, and Risk

Different methods are used to assess probability and vulnerability at local and state levels. These methods employ history, probability, and vulnerability data to determine probability and vulnerability scores for each hazard. The challenge with these varied methodologies is that access to, interpretation of, and scale of the data are not necessarily the same at local and state levels. As a result, local and state probability and vulnerability scores for a specific hazard in a specific community are not always the same. In some instances, probability and vulnerability scores are even quite different. A description of the "OEM Hazard Analysis Methodology" used by local governments is provided in Section 2.1, **Local Vulnerability Assessments**. The complete "OEM Hazard Analysis Methodology" is located in **Appendix 9.1.17**.

The purpose of the probability and vulnerability scores is to identify high-priority areas to which local and state governments can target mitigation actions.

Probability

Local Assessment

Participants in each county's Natural Hazard Mitigation Plan update process used the OEM hazard analysis methodology to analyze the probability that Region 4 will experience flooding. The resulting estimates of probability are shown in **Table 2-390**.

Table 2-390. Local Assessment of Flood Probability in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

Source: Douglas County MJNHMP (2016); Jackson County MJNHMP (2018); Josephine County MJNHMP (2017)

State Assessment

Using the methodology described in the Section 2.2.7.1, Floods/Probability, the state assessed the probability of flooding in the counties that comprise Region 4. The results are shown in **Table 2-391**:

Table 2-391. State Assessment of Flood Probability in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	VH	H	VH

Source:

Damaging floods occur approximately every 6-12 years.

Climate Change

It is very likely (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events and extreme river flows (high confidence). The likelihood of increase in extreme precipitation events is greater east of Cascades than west. Extreme river flow, while affected by extreme precipitation, is also driven by antecedent conditions (soil moisture, water table height), snowmelt, river network morphology, and spatial variability in precipitation and snowmelt. Most projections of extreme river flows show increases in flow magnitude at most locations across Oregon. Along the Willamette River and its tributaries (Regions 2, 3, and 4), the largest increases in extreme river flows are more likely to be upstream (towards Cascades headwaters), and less likely as one travels downstream. Overall, it is more likely than not (>50%) that increases in extreme river flows will lead to an increase in the incidence and magnitude of damaging floods (low confidence), although this depends on local conditions (site-dependent river channel and floodplain hydraulics). Increases in extreme river flows leading to damaging floods will be less likely where storm water management (urban) and/or reservoir operations (river) have capacity to offset increases in flood peak.

Vulnerability

Local Assessment

Based on the OEM hazard analysis conducted by participants in the NHMP update process, the region's vulnerability to flooding is shown in in **Table 2-392**.

Table 2-392. Local Vulnerability Assessment of Flood in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	M	M	M

Source: Douglas County MJNHMP (2016); Jackson County MJNHMP (2018); Josephine County MJNHMP (2017

State Assessment

Table 2-393. State Vulnerability Assessment of Flood in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	VH	H

Source: DOGAMI, DLCD

Critical Facilities and Infrastructure

DOGAMI performed a flood loss analysis for the Upper Rogue Watershed in Jackson County. For other portions of Jackson County and both Josephine and Douglas County, participants in the county NHMPs were consulted to evaluate critical facilities and infrastructure vulnerabilities.

The DOGAMI flood loss analysis for the Upper Rogue that encompassed the cities of Eagle Creek, Shady Cove, Butte Falls and the unincorporated community of Prospect determined that 349 buildings were within the flood zone. Of these, 195 buildings are above the height of the 100-year flood. None of the remaining 154 buildings vulnerable to flooding, none are critical facilities.

They identified the following vulnerabilities. Neighborhoods in the cities of Reedsport, Roseburg, Winston, Canyonville, Drain, Elkton and Myrtle Creek were identified as particularly vulnerable to flood damage. The wastewater treatment plants in the Cities of Elkton and Riddle along with portions of the water supply system for the City of Oakland were among the at-risk critical facilities identified in Douglas County.

In Josephine County, the NHMP identified the risk of restricted access to the hospital located in Grants Pass. The City of Grants Pass is bisected by the Rogue River and connectivity of the community is vulnerable to folds that might damage the main transportation routes.

Repetitive Losses

FEMA has identified 42 Repetitive Loss properties in Region 4.

Table 2-394. Flood Severe/Repetitive Losses and Community Rating System Communities by County in Region 4

County	RL/SRL	# of CRS Communities per County
*Douglas (Myrtle Creek=8; Winston=2)	10	2
Jackson (Central Point = 2, Eagle Point = 4, Jackson Co = 11 Jacksonville = 2, Shady Grove = 3)	22	5
Josephine (Grants Pass = 2 Josephine Co = 8)	10	2
Totals	**42**	**9**

* Includes non-coastal sections of Douglas County

Source: FEMA NFIP Community Information System, https://isource.fema.gov/cis/ accessed February 2020

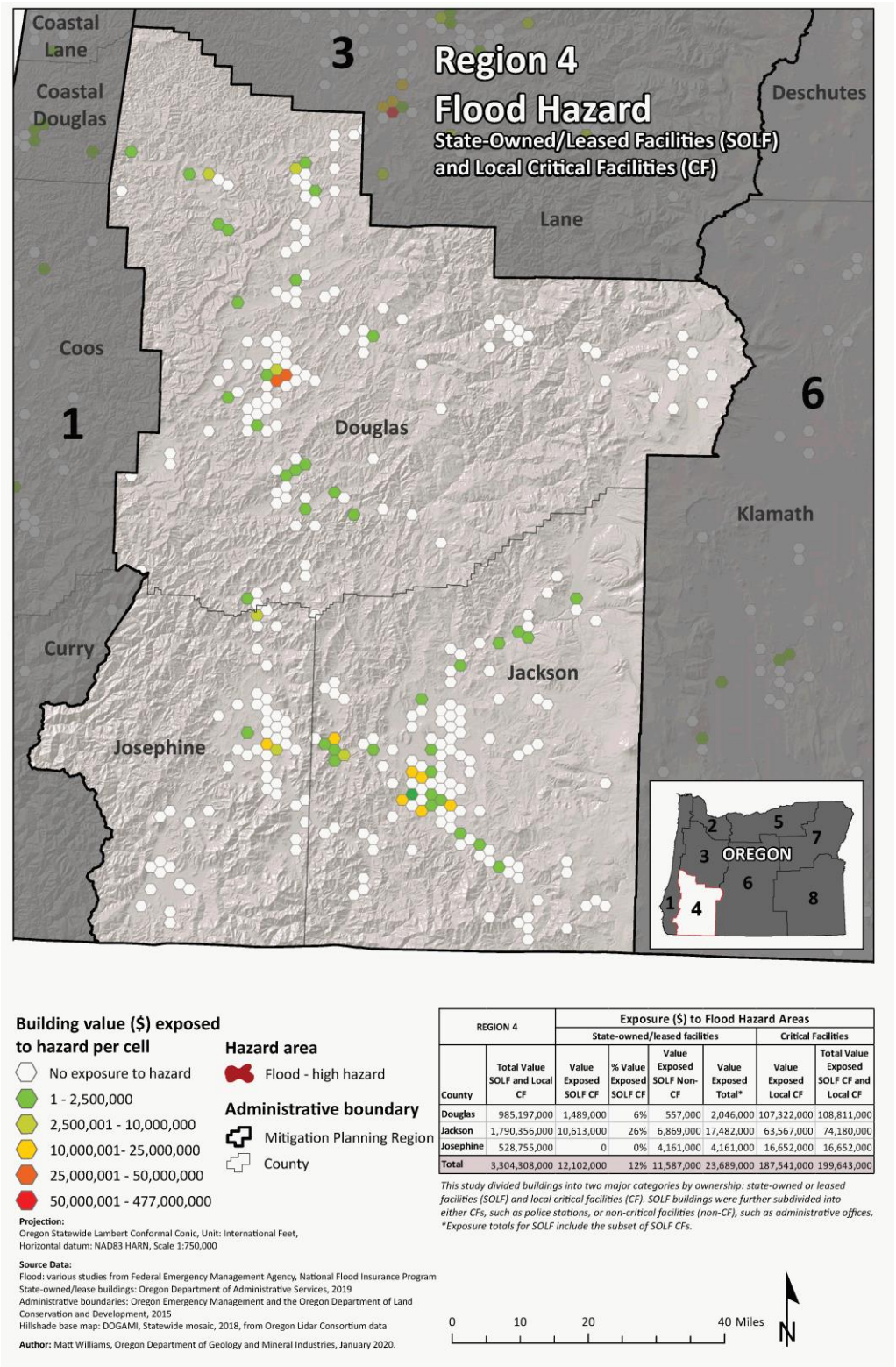
Communities can reduce the likelihood of damaging floods by employing floodplain management practices that exceed NFIP minimum standards. DLCD encourages communities that adopt such standards to participate in FEMA's Community Rating System (CRS), which results in reduced flood insurance costs.

State-Owned/Leased Facilities and Critical/Essential Facilities

For the 2020 Risk Assessment, DOGAMI used a combination of FEMA effective and preliminary flood zone data (FEMA National Flood Hazard Layer, 2019) and FEMA Q3 data (an unpublished digital dataset of paper flood insurance rate maps). All FEMA data that DOGAMI used was current as of 2019. The flood hazard was not divided in to High, Moderate, or Low categories due to the wide variety of flood data, its variable absolute and relative accuracy, and its variable geographic coverage and completeness. Rather, when a building was located within a floodway, 100-year floodplain, or 500-year floodplain, a "High" flood hazard was designated. When there was insufficient information to determine whether a flood hazard exists for a given site, the flood hazard was designated "Other." Sites with "Other" designations could conceivably face relatively high flood hazards or no flood hazard at all.

In Region 4, there is a potential loss from flooding of over $23M in state building and critical facility assets, 74% of it in Jackson County alone. There is a much greater potential loss due to flooding in local critical facilities: over $187M, fifty-seven percent in Douglas County. The next greatest share, 34% is in Jackson County (**Figure 2-203** illustrates the potential loss to state buildings and critical facilities and local critical facilities from flooding in Region 4.

Figure 2-203. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in Region 4.High-resolution, full-size image linked from Appendix 9.1.22.



REGION 4		Exposure ($) to Flood Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Douglas	985,197,000	1,489,000	6%	557,000	2,046,000	107,322,000	108,811,000
Jackson	1,790,356,000	10,613,000	26%	6,869,000	17,482,000	63,567,000	74,180,000
Josephine	528,755,000	0	0%	4,161,000	4,161,000	16,652,000	16,652,000
Total	3,304,308,000	12,102,000	12%	11,587,000	23,689,000	187,541,000	199,643,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

Source: DOGAMI, 2020

Historic Resources

Of the 6,265 historic resources in Region 4, five hundred fifty-two (8%) are located in an area of high flood hazard. Of those, 290 (53%) and214 (39%) are located in Jackson and Douglas Counties, respectively.

Archaeological Resources

Of the 268 archaeological resources located in high flood hazard areas in Region 3, on hundred thirty-nine (52%) are located in Jackson County. The next greatest share, 34% is in Douglas County. Only two are listed on the National Register of Historic Places, one each in Douglas and Jackson Counties. Twenty-five are eligible for listing, 10 in Douglas County, 11 in Jackson County, and four in Josephine County. Fifteen have been determined not eligible and 226 have not been evaluated as to their eligibility.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, vulnerability is similarly high across all three counties in Region 4. Each county's high vulnerability is driven by moderately high scores across the CDC index. Jackson County ranks in the top half of counties for 11 of the 15 index variables. Notably, it is in the 80th percentile for its share of single-parent households and in the 70th percentile for its share of residents that speak English less than "well." Josephine County is in the 80th percentile for its share of residents 65 and older, its unemployment rate, and the share of persons living in poverty. Douglas County has a higher unemployment rate than 80 percent of all counties and ranks in the 60th percentile for 7 of the 15 variables included in the CDC index.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Douglas and Josephine Counties are highly vulnerable to flood events, and Jackson County is very highly vulnerable. All the Region 4 counties have high social vulnerability. Jackson County's very high score was driven by its greater share of the value of state buildings, state critical facilities, and local critical facilities. Jackson County also has the greatest number of repetitive and severe repetitive loss properties in the Region, more than twice as many as each of the other two counties.

Most Vulnerable Communities

While all Region 4 counties are highly vulnerable to flooding, Jackson County is the most vulnerable in Region 4.

Risk

Table 2-395. Risk of Flood Hazards in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Risk	VH	VH	VH

Source: DOGAMI, DLCD

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, all Region 4 counties are at great risk from floods.

Dam Safety

The Oregon Water Resources Department (OWRD) is the state authority for dam safety with specific authorizing laws and implementing regulations. Oregon's dam safety laws were re-written by HB 2085 which passed through the legislature and was signed by Governor Brown in 2019. This law becomes operative on July 1, 2020, with rules and guidance have been drafted and are currently in the public review and comment period.

OWRD coordinates on but does not directly regulate the safety of dams owned by the United States or most dams used to generate hydropower. OWRD is the Oregon Emergency Response System contact in the event of a major emergency involving a state-regulated dam, or any dam in the State if the regulating agency is unknown. The Program also coordinates with the National Weather Service and the Oregon Office of Emergency Management on severe flood potential that could affect dams and other infrastructure.

Analysis and Characterization

Oregon's statutory size threshold for dams to be regulated by OWRD is at least 10 feet high and storing at least 3 million gallons. Many dams that fall below this threshold have water right permits for storage from OWRD.

Under normal loading conditions dams are generally at very low risk of failure. Specific events are associated with most dam failures. Events that might cause dams to fail include:

- An extreme flood that exceeds spillway capacity and causes an earthen dam to fail;
- Extended high water levels in a dam that has no protection against internal erosion;
- Movement of the dam in an earthquake; and
- A large rapidly moving landslide impacting the dam or reservoir.

Most of the largest dams, especially those owned or regulated by the Federal Government are designed to safely withstand these events and have been analyzed to show that they will. However, there are a number of dams where observations, and sometimes analysis indicates a deficiency that may make those dams susceptible to one or more of the events. The large majority of state regulated dams do not have a current risk assessment or analysis, and safe performance in these events is uncertain.

Failures of some dams can result in loss of life, damage to property, infrastructure, and the natural environment. The impacts of dam failures range from local impacts to waters below the dam and the owners property to community destruction with mass fatalities. The 1889 Johnston Flood in Pennsylvania was caused by a dam failure, and resulted in over 2000 lives lost. Oregon's first dam safety laws were developed in response to the St. Francis dam failure in California in 1928. That failure was attributed to unsafe design practice, and because of this about 500 persons perished. In modern times (2006) a dam owner filled in the spillway of a dam on the island of Kauai causing dam failure that killed 7 people. This dam had no recent dam safety inspections because the hazard rating was incorrect.

Where a dam's failure is expected to result in loss of life downstream of the dam, an Emergency Action Plan (EAP) must be developed. The EAP contains a map showing the area that would potentially be inundated by floodwaters from the failed dam. These dams are often monitored

so that conditions that pose a potential for dam failure are identified to allow for emergency evacuations.

Table 2-396. Historic Significant Dam Failures in Region 4

Year	Location	Description
1956	Sams Valley dam east of Gold Hill in Jackson Co.	Landslide related to reservoir filling threatened homes
1961	Woodrat Knob dam near Lake Creek in Jackson Co.	Major landslide on dam with persons evacuated, flooding prevented

Source: Oregon Water Resources Department Dam Safety Program records

Dam Hazard Ratings

Oregon follows national guidance for assigning hazard ratings to dams and for the contents of Emergency Action Plans, which are now required for all dams rated as "high hazard." Each dam is rated according to the anticipated impacts of its potential failure. The state has adopted these definitions (ORS 540.443–491) for state-regulated dams:

- "High Hazard" means loss of life is expected if the dam fails.
- "Significant Hazard" means loss of life is not expected if the dam fails, but extensive damage to property or public infrastructure is.
- "Low Hazard" is assigned to all other state-regulated dams.
- "Emergency Action Plan" means a plan that assists a dam owner or operator, and local emergency management personnel, to perform actions to ensure human safety in the event of a potential or actual dam failure.

Hazard ratings may change for a number of reasons. For example, a dam's original rating may not have been based on current inundation analysis methodologies, or new development may have changed potential downstream impacts.

There are 33 High Hazard dams and 27 Significant Hazard dams in Region 4.

Table 2-397. Summary: High Hazard and Significant Hazard Dams in Region 4

	Hazard Rating		
	State		Federal
	High	Significant	High
Region 4	20	27	13
Douglas	9	10	5
Jackson	9	16	8
Josephine	2	1	0

Source: Oregon Water Resources Department, 2019

Table 2-398. High Hazard and Significant Hazard Dams in Region 4

County	Name	Rating	Regulator
Douglas	Creekside Dam #1	High	Federal
Douglas	Creekside IWR	High	Federal
Douglas	Galesville Reservoir	High	Federal
Douglas	Lemolo Lake Dam	High	Federal
Douglas	Soda Springs Dam	High	Federal
Douglas	Bear Creek 3	High	State
Douglas	Berry Creek	High	State
Douglas	Cooper Creek (Sutherlin)	High	State
Douglas	Hayhurst Road	High	State
Douglas	Paris	High	State
Douglas	Plat I	High	State
Douglas	Updegrave	High	State
Douglas	Wageman	High	State
Douglas	Winchester	High	State
Douglas	Canyonville Reservoir	Significant	State
Douglas	Dillard Lumber Co Dike	Significant	State
Douglas	Dixonville Log Pond	Significant	State
Douglas	Dollar Mill Pond	Significant	State
Douglas	Drain Plywood Log Pond	Significant	State
Douglas	Drain Sewage Lagoon	Significant	State
Douglas	Gardiner	Significant	State
Douglas	Kinnan, Frank Reservoir	Significant	State
Douglas	Sun Studs Log Pond	Significant	State
Douglas	Sutherlin Log Pond	Significant	State
Jackson	Agate Dam	High	Federal
Jackson	Applegate Lake	High	Federal
Jackson	Emigrant	High	Federal
Jackson	Fish Lake (Jackson-USBR)	High	Federal
Jackson	Howard Prairie	High	Federal
Jackson	Hyatt Reservoir	High	Federal
Jackson	Lost Creek Reservoir (COE)	High	Federal
Jackson	Reeder Gulch Reservoir	High	Federal
Jackson	Duggan	High	State
Jackson	Lake Creek	High	State
Jackson	Osborne Creek	High	State
Jackson	Sams Valley	High	State
Jackson	Wade	High	State
Jackson	Walch Dam	High	State
Jackson	Willow Creek	High	State
Jackson	Woodrat Knob	High	State
Jackson	Yankee	High	State
Jackson	Bounds Reservoir	Significant	State
Jackson	Bradshaw	Significant	State
Jackson	Bradshaw 2	Significant	State
Jackson	Frog Pond #1	Significant	State
Jackson	Gardener Reservoir	Significant	State
Jackson	Hammel No. 2	Significant	State

County	Name	Rating	Regulator
Jackson	Harrison	Significant	State
Jackson	Hoover Pond 1	Significant	State
Jackson	Hoover Pond 2	Significant	State
Jackson	Hoover Pond 3	Significant	State
Jackson	Lester James #1	Significant	State
Jackson	Lester James Reservoir 2	Significant	State
Jackson	Lester James Reservoir 3	Significant	State
Jackson	Mccormick Reservoir	Significant	State
Jackson	Skou Reservoir	Significant	State
Jackson	Woolfolk Reservoir	Significant	State
Josephine	Mcmullen Creek	High	State
Josephine	Strong	High	State
Josephine	Sowell Dam	Significant	State

Source: Oregon Water Resources Department, 2019

Probability

Engineering risk assessment and analysis of a dam is the best indicator of the probability of failure. Without that, the condition of a dam as determined by OWRD engineering staff is a helpful indicator OWRD has for of the failure potential of a dam.

Dam safety regulators determine the condition of high hazard rated dams, both state- and federally-regulated. A dam's condition is considered public information for state-regulated dams, but the conditions of federally-regulated dams are generally not subject to disclosure. State-regulated significant hazard dams do not yet have condition ratings.

Oregon uses FEMA's condition classifications. These classifications are subject to change and revisions are being considered at the national level. Currently, FEMA's condition classifications are:

- "Satisfactory" means no existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the applicable regulatory criteria or tolerable risk guidelines.
- "Fair" means no existing dam safety deficiencies are recognized for normal loading conditions. Rare or extreme hydrologic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action.
- "Poor" means a dam safety deficiency is recognized for loading conditions that may realistically occur. Remedial action is necessary. A poor rating may also be used when uncertainties exist as to critical analysis parameters that identify a potential dam safety deficiency. Further investigations and studies are necessary.
- "Unsatisfactory" means a dam safety deficiency is recognized that requires immediate or emergency remedial action for problem resolution.
- "Not Rated" means the dam has not been inspected, is not under State jurisdiction, or has been inspected but, for whatever reason, has not been rated.

Only four of the 20 state-regulated high hazard dams are in satisfactory condition and nine are in fair condition. Seven are in poor or unsatisfactory condition.

Table 2-399. Summary: Condition of High Hazard State-Regulated Dams in Region 4

	Condition of State-Regulated High Hazard Dams				
	Satisfactory	Fair	Poor	Unsatisfactory	Not Rated
Region 4	4	9	5	2	0
Douglas	3	4	2	0	0
Jackson	1	4	3	1	0
Josephine	0	1	0	1	0

Source: Oregon Water Resources Department, 2019

Table 2-400. Condition of High Hazard State-Regulated Dams in Region 4

County	Dam Name	Condition
Douglas	Bear Creek 3	Fair
Douglas	Hayhurst Road	Fair
Douglas	Paris	Fair
Douglas	Wageman	Poor
Douglas	Winchester	Poor
Douglas	Berry Creek	Satisfactory
Douglas	Plat I	Satisfactory
Douglas	Updegrave	Satisfactory
Douglas	Cooper Creek (Sutherlin)	UDA
Jackson	Lake Creek	Fair
Jackson	Sams Valley	Fair
Jackson	Wade	Fair
Jackson	Yankee	Fair
Jackson	Duggan	Poor
Jackson	Osborne Creek	Poor
Jackson	Walch Dam	Poor
Jackson	Willow Creek	Satisfactory
Jackson	Woodrat Knob	Unsatisfactory
Josephine	Strong	Fair
Josephine	Mcmullen Creek	Unsatisfactory

Source: Oregon Water Resources Department, 2019

State-Regulated High Hazard Dams not Meeting Safety Standards

There are seven state-regulated high hazard dams in Region 4 that are currently assessed to be below accepted safety standards (in Poor or Unsatisfactory Condition). These dams and the population at risk, based on a screen using the screening tool DSS-WISE, are shown in **Table 2-401**. As the dam safety program conducts analysis over time, the number of dams in less than satisfactory condition may change. Currently dams that are in poor or unsatisfactory condition are in need of rehabilitation or other action to bring them into a fully safe condition. As of December 2019, these are the dams in Region 4 that are not yet demonstrably unsafe, but that do pose unacceptable risk. When Oregon's new dam safety laws take effect July 1, 2020, the condition of some of these dams may be reclassified as unsafe or potentially unsafe.

It is important to note that many state regulated dams have not received a deep level of risk analysis and review, so the number of dams not meeting minimum standards may increase as additional analyses are performed.

Table 2-401. State-Regulated High Hazard Dams Not Meeting Safety Standards in Region 4

Dam	NID#	Condition Rating	Daytime PAR (number of people)	Nighttime PAR (number of people)	County
Wageman	OR00496	POOR	6	12	Douglas
Winchester		POOR	Small	Small	Douglas
Duggan Dam	OR00475	POOR	6	11	Jackson
Osborne Creek Dam	OR00401	POOR	227	500	Jackson
Walch Dam		POOR	Small	Small	Jackson
Woodrat Knob	OR00357	UNSAT	123	229	Jackson
McMullen Creek	OR00513	UNSAT	85	243	Josephine

Note: "PAR" is number of "Persons At Risk" in the dam failure inundation zone based on a conservative estimate using DSS-Wise dam breach estimator. It includes all persons that normally could be in the inundation area. Actual impacts depend on the velocity and depth of water, and will be determined as part of Oregon's HHPD grant tasks.

Source: DSS-Wise output

Climate Change

Most climate change models indicate there may be more extreme precipitation due to the increased energy in the oceanic and atmospheric systems. Of main concerns for dams is the potential for larger floods than experienced in the past. Almost half of the historical dam failures around the world have been due the floods that exceed the flow capacity of the spillway and overtop the dam. Another issue for the Pacific coast is the shorter record of precipitation and flood events in the data records. Even without climate change there is uncertainty in the extreme storms that could occur in an extreme atmospheric river event (about which there is much to learn). If the actual flood is larger than the design flood, spillway capacity may be exceeded and the dam may overtop, or the spillway may erode so that it can rapidly empty the reservoir. These scenarios can present real risks to some dams in Oregon, risks that depending on the location may be greater than earthquake related risks.

Vulnerability

Table 2-401, State-Regulated High Hazard Dams Not Meeting Safety Standards in Region 4, indicates the number of people currently anticipated to be impacted by potential failure of the state-regulated high hazard dams in poor or unsatisfactory condition. OWRD plans to do more analysis to determine the number and value of structures that may be impacted as well.

Most Vulnerable Communities

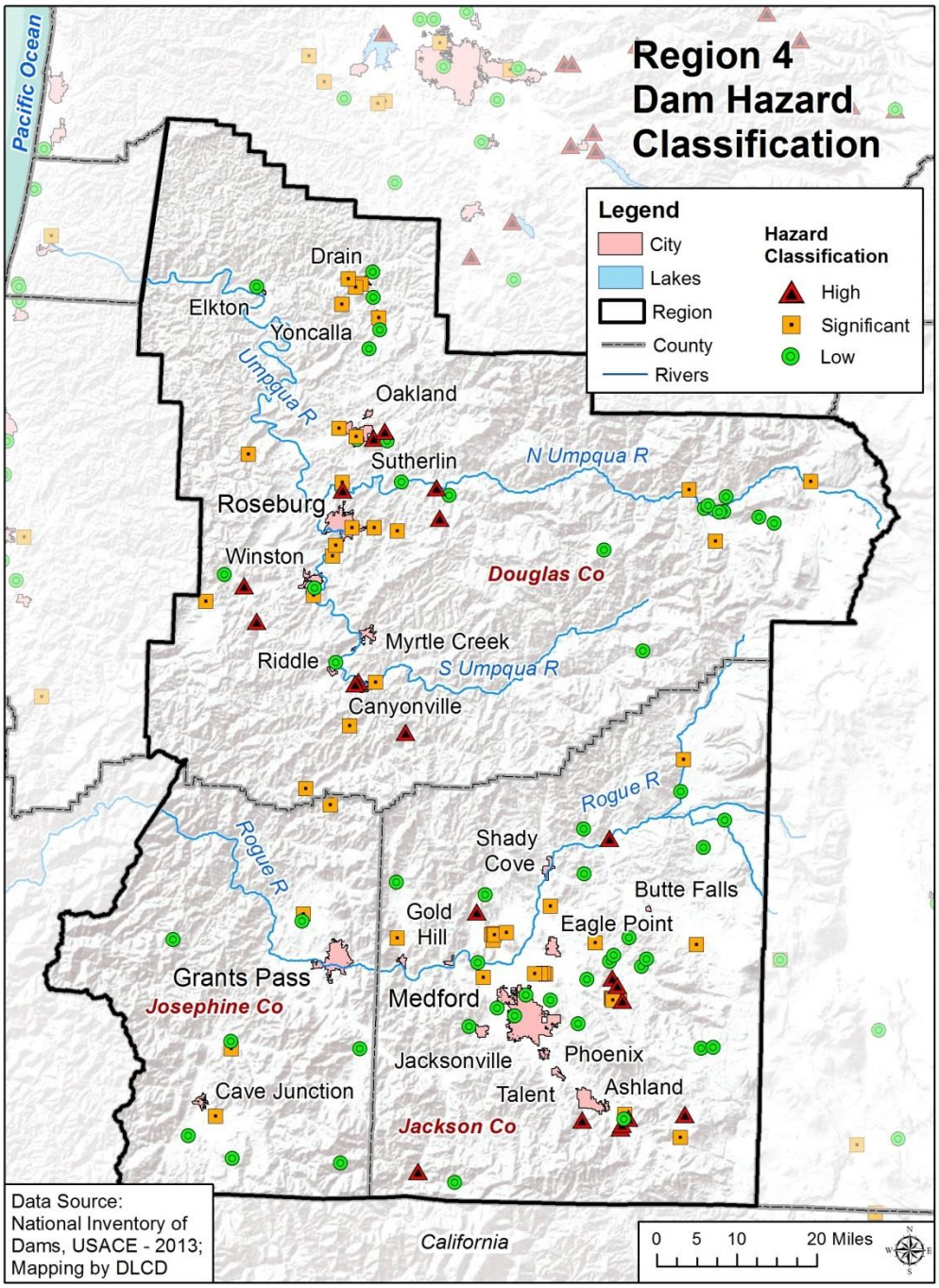
Given the information presented about state-regulated high hazard dams (county and condition; failure expected to result in loss of life) and significant hazard dams (county; failure expected to result in extensive property or infrastructure damage), all the counties in Region 4 have high hazard dams in poor or unsatisfactory condition are therefore considered most vulnerable. Of those, the greatest number of people in potentially dangerous locations if a dam were to fail are in Jackson County followed by Josephine County.

As with high hazard dams, whether counties with significant hazard dams are actually "most vulnerable communities" depends on the conditions of those dams. Since the dams' conditions have not yet been rated, we cannot determine the counties' vulnerability with respect to significant hazard dams. The county with the most state-regulated significant hazard dams is Jackson County (16).

Risk

With FEMA and State funding, OWRD will be completing risk assessments for five of Region 4's state-regulated high hazard dams in poor or unsatisfactory condition over the next several years. For now, the potential for damage to the dam from extreme floods, lack of protection against internal erosion, earthquakes, or landslides and debris indicates greater potential for failure. Coupled with the potential for loss of life and extensive damage to property and public infrastructure, risk is qualitatively determined.

Figure 2-204. Region 4 Dam Hazard Classification



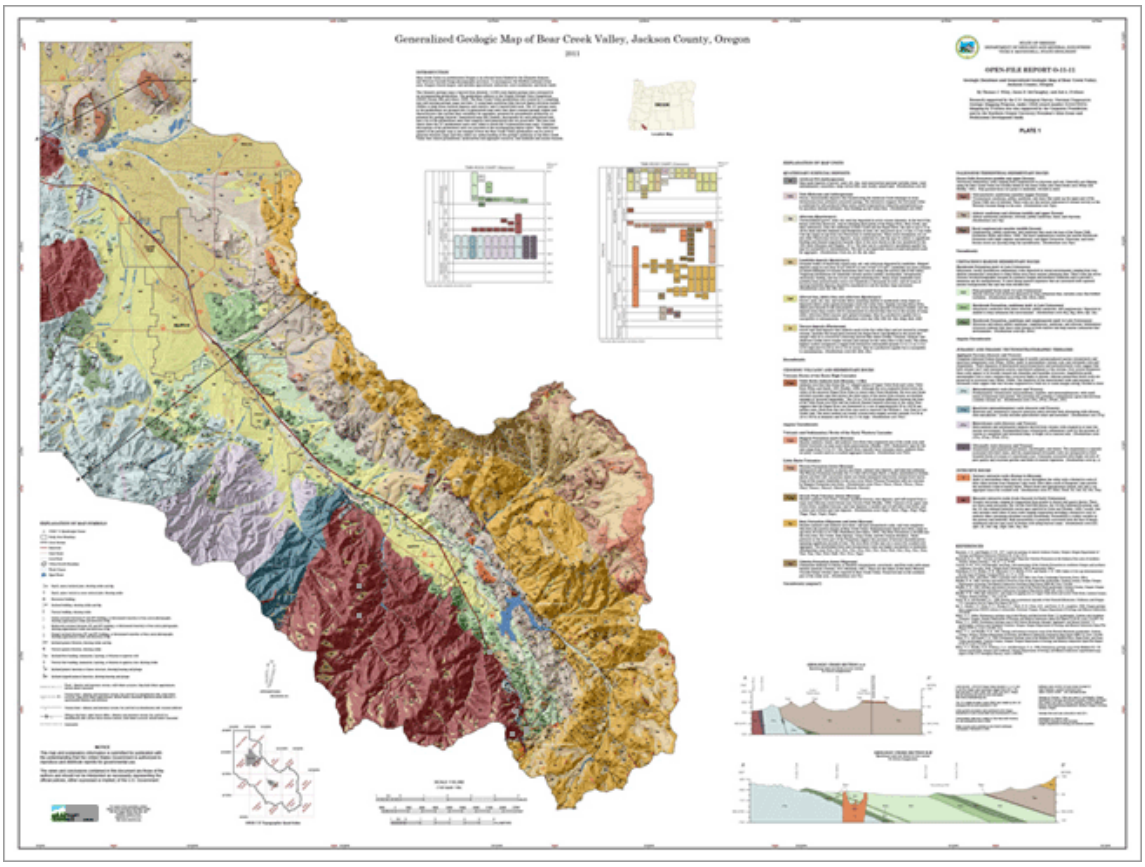
Source: National Inventory of Dams, USACE, 2013

Landslides

Characteristics

Landslides occur throughout this region of the state, although areas with steeper slopes, weaker geology, and higher annual precipitation tend to have more landslides. In general, the Klamath Mountains have a high incidence of landslides. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage. For example, new geologic mapping of the Medford area found 1,734 landslide, debris fan, and colluvium deposits indicating a high level of hazard in this small area (**Figure 2-205**).

Figure 2-205. Generalized Geologic Map of Bear Creek Valley, Jackson County, Oregon



Source: Wiley et al. (2011)

Historic Landslide Events

Table 2-402. Historic Landslide Events in Region 4

Date	Location	Incident
Jan. 1974	near Canyonville, Oregon	nine employees working in a telephone building were killed when the building was pushed by a mudslide into Canyon Creek
Feb. 1996		heavy rains and rapidly melting snow contributed to hundreds of landslides / debris flows across the state; many occurred on clear cuts that damaged logging roads
Nov. 1996	Lane and Douglas Counties	heavy rain triggered mudslides (Lane and Douglas Counties); eight fatalities and several injuries (Douglas County)
Dec. 1996-Jan. 1997	Douglas, Jackson, and Josephine Counties	DR-1160 – Two significant storms caused hundreds of landslides damaging houses and infrastructure
Dec. 2003-Jan. 2004	Douglas	DR-1510
Dec. 2005-Jan. 2006	Douglas, Jackson, and Josephine Counties	DR-1632
Jan. 2011	Douglas	DR-1956
Jan. 2012	Douglas	DR-4055
Dec. 2015	Douglas	DR-4258 – many landslides. Closed roads including Stagecoach Rd (east of Mapleton)
Dec. 2016	Josephine	DR-4296
Jan. 2017	Josephine	DR-4328 – many landslides. Closed roads including OR-36, OR-58, and OR-103
Feb. 2019	Douglas	DR-4432
Apr. 2019	Douglas	DR-4452 – many landslides. Closed roads including OR-58

Source: Taylor and Hatton (1999) https://www.fema.gov/disasters

Probability

Table 2-403. Assessment of Landslide Probability in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	VH	VH	VH

Source: DOGAMI, 2020

Landslides are found in every county in Oregon. There is a 100% probability of landslides occurring in this region in the future. Although we do not know exactly where and when they will occur, they are more likely to happen in the general areas where landslides have occurred in the past. Also, they will likely occur during heavy rainfall events or during a future earthquake.

Climate Change

Landslides are often triggered by heavy rainfall events when the soil becomes saturated. It is *very likely* (>90%) that Oregon will experience an increase in the frequency of extreme precipitation events (*high confidence*). Because landslide risk depends on a variety of site-

specific factors, it is more likely than not (>50%) that climate change, through increasing frequency of extreme precipitation events, will result in increased frequency of landslides.

Vulnerability

Table 2-404. Assessment of Vulnerability to Landslides in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	H	M

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

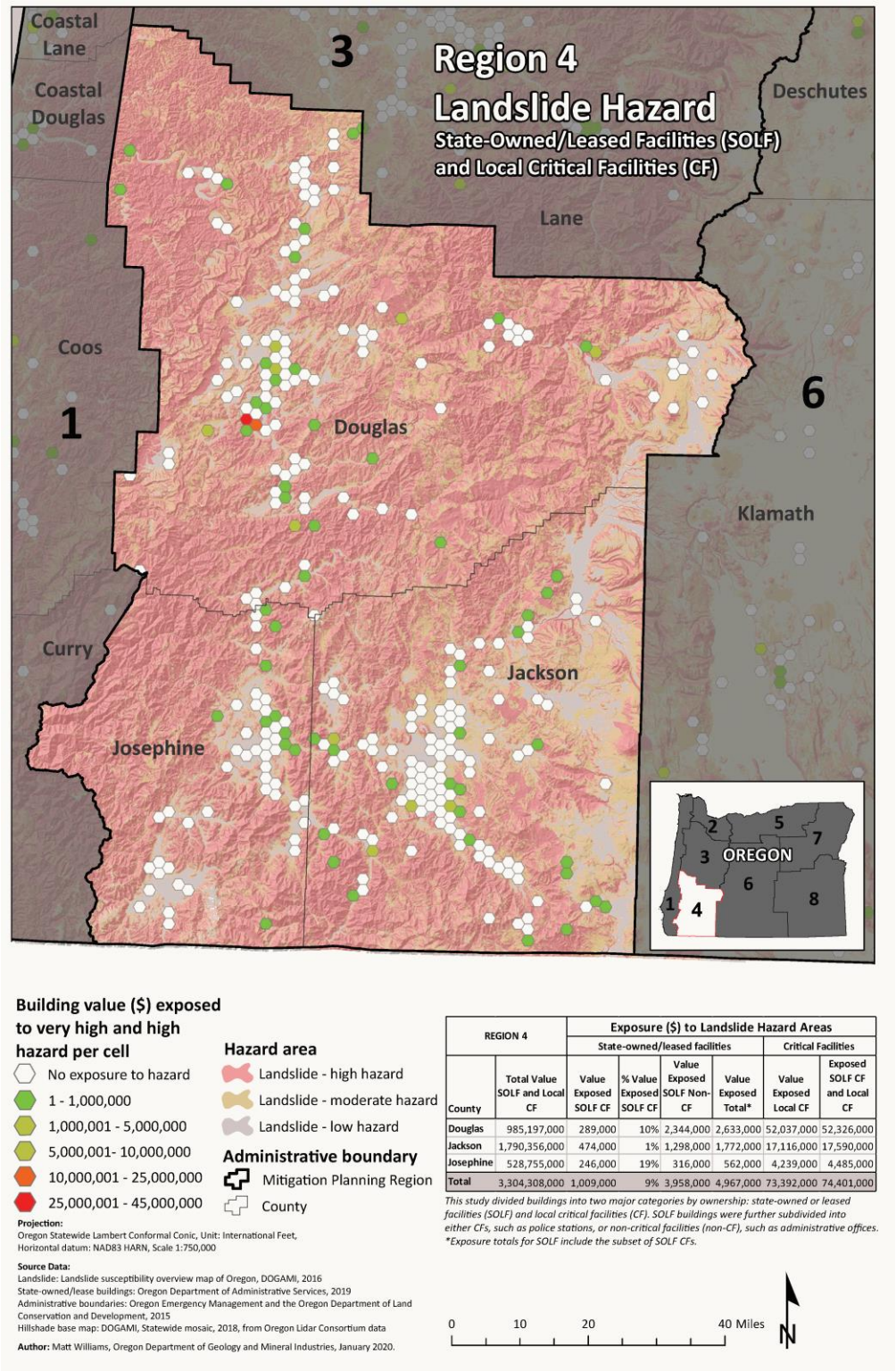
Many of the communities in this region are vulnerable to landslides; for example, the cities of Medford and Ashland have a moderate exposure to landslides.

According to the 2020 risk assessment, the vulnerability scores are driven by high social vulnerability in all three counties. Josephine County's moderate vulnerability rating owes to having fewer state buildings, state and local critical facilities exposed to landslides.

State-Owned/Leased Facilities and Critical and Essential Facilities

DOGAMI analyzed the potential dollar loss from landslide hazards to state buildings and critical facilities as well as to local critical facilities in Region 4. Almost $5M in state building and critical facility assets is exposed to landslide hazards in Region 4, over half of it in Douglas County and over a third in Jackson County. The region has almost 15 times that value in local critical facilities located in landslide hazard areas, 71% of it in Douglas County. **Figure 2-206** illustrates the potential loss to state buildings and critical facilities and local critical facilities from landslide hazards.

Figure 2-206. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Landslide Hazard Zone in Region 4.High-resolution, full-size image linked from Appendix 9.1.22.



REGION 4		Exposure ($) to Landslide Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Exposed SOLF CF and Local CF
Douglas	985,197,000	289,000	10%	2,344,000	2,633,000	52,037,000	52,326,000
Jackson	1,790,356,000	474,000	1%	1,298,000	1,772,000	17,116,000	17,590,000
Josephine	528,755,000	246,000	19%	316,000	562,000	4,239,000	4,485,000
Total	3,304,308,000	1,009,000	9%	3,958,000	4,967,000	73,392,000	74,401,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

Source: DOGAMI **, 2020**

Historic Resources

Of the 6,265 historic resources in Region 4, 265 or about 4% are in areas of very high or high landslide hazard susceptibility; 1,595 are in moderate; and 4,405 in low. Over half of those in high landslide hazard areas are located in Douglas County. However, 67% of all historic resources in landslide hazard areas in Region 4 are located in Jackson County.

Archaeological Resources

Of the 1,988 archaeological resources located in landslide hazard areas in Region 4, eighty-two percent (1,625) are in high landslide hazard areas. Of those, seven are listed on the National Register of Historic Places and 142 are eligible for listing. Two hundred twenty-five have been determined not eligible, and 1,251 have not been evaluated as to their eligibility. Fifty-three percent of the archaeological resources in high landslide hazard areas are located in Douglas County and 51% of all archaeological resources in landslide hazard areas in Region 4 are located in Douglas County.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, vulnerability is similarly high across all three counties in Region 4. Each county's high vulnerability is driven by moderately high scores across the CDC index. Jackson County ranks in the top half of counties for 11 of the 15 index variables. Notably, it is in the 80th percentile for its share of single-parent households and in the 70th percentile for its share of residents that speak English less than "well." Josephine County is in the 80th percentile for its share of residents 65 and older, its unemployment rate, and the share of persons living in poverty. Douglas County has a higher unemployment rate than 80 percent of all counties and ranks in the 60th percentile for 7 of the 15 variables included in the CDC index.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Douglas and Jackson Counties are the most vulnerable to landslides in Region 4.

Risk

Table 2-405. Assessment of Risk to Landslides in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Risk	H	H	M

Source: DOGAMI and DLCD, 2020

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment methodology combined the probability of landslide hazards occurring with the potential cost of damage to exposed state buildings and state and local critical facilities and with an assessment of the social vulnerability of the local population.

According to the 2020 Risk Scores and DOGAMI's expert assessment, all three of the counties are "most vulnerable communities" with very high risk ratings. All communities should be prioritized for mitigation actions.

Volcanoes

Characteristics

The eastern boundaries of Douglas and Jackson Counties coincide with the crest of the Cascade Mountains, a volcanic range. The Cascade Mountains are still active as has been demonstrated by Mount St. Helens in Washington State. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when, remain. Both Douglas and Jackson Counties are at some risk from volcano-associated hazards however remote. Josephine County is west of the Cascade Mountains and is not subject to the same risks.

Southwest Oregon communities are close to several prominent volcanic peaks, one of which is a national park (Crater Lake). The other peaks include Mount Bailey (elevation 8,363 ft), Mount Thielsen (9,182 ft), and Mount McLaughlin (9,495 ft). Of the three, Crater Lake (6,178 ft) may pose the greatest risk. It is a caldera and the remnant of a mountain (Mount Mazama) that probably had an elevation between 10,800 and 12,000 ft. The massive eruption, which produced the caldera, took place about 7,700 years ago. The long history at Mount Mazama strongly suggests that this volcanic center will be active in the future (Bacon et al., 1997). The presence of the lake means that any future eruption likely will be violent; there are many examples of explosive activity brought about by magma coming into contact with water.

Douglas and Jackson Counties should consider the impact of volcano-related activity on small mountain communities, tourist attractions (e.g., Crater Lake) dams, reservoirs, and highways. These counties also should consider probable impacts on the local economy (e.g., wood products, tourism, and recreation).

Historic Volcanic Events

Table 2-406. Historic Volcanic Events in Region 4

Date	Location	Description
about 7,780 to 15,000 YBP	Cinnamon Butte, southern Cascades	basaltic scoria cone and lava flows
about 7,700 YBP	Crater Lake Caldera	formation of Crater Lake caldera, pyroclastic flows, widespread ashfall

Note: YBP is years before present.

Sources: U.S. Geological Survey, Cascades Volcano Observatory: http://volcanoes.usgs.gov/observatories/cvo/; Bacon et al. (1997)

Probability

Table 2-407. Assessment of Volcanic Hazards Probability in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	M	M	VL

Source: DOGAMI, 2020

There is virtually no risk from volcanoes in Josephine County, other than the possibility of ashfall. Ashfall could come from several sources in the Cascade Range, including Mount Shasta in California or Crater Lake in Oregon. The probability of ashfall totaling 1 cm or more in Josephine County, from any Cascade volcano, is about 1 in 10,000.

Douglas and Jackson Counties are at greater risk of volcanic hazards. The probability of a 1 cm or greater ashfall varies from 1 in 5,000 to 1 in 10,000 (Sherrod et al., 1997).

Based on the total number of eruptive episodes in the past 100,000 years, the average recurrence interval in the Crater Lake area is about 10,000 years. The annual probability of an eruption then, is about 1 in 10,000; the 30-year probability is about 1 in 330 (Bacon et al., 1997). The probability of an event is summarized in **Table 2-408** for each of the counties in Region 4.

Table 2-408. Probability of Volcano-Related Hazards in Region 4

Volcano-Related Hazard	Douglas	Josephine	Jackson	Remarks
Volcanic ash (annual probability of 1 cm or more accumulation from eruptions throughout the Cascade Range)	1 in 5,000 to 1 in 10,000	1 in 10,000	1 in 5,000 to 1 in 10,000	Sherrod et al. (1997)
Lahar	Source: Crater Lake	no risk	Source: Crater Lake	Bacon et al. (1997)
Lava flow	no risk	no risk	no risk	Bacon et al. (1997)
Debris flow / avalanche	no risk	no risk	Source: Crater Lake	Bacon et al. (1997)
Pyroclastic flow	Source: Crater Lake	no data available	Source: Crater Lake	Bacon et al. (1997)

Sources: Sherrod et al. (1997); Bacon et al. (1997)

Vulnerability

Table 2-409. Assessment of Vulnerability to Volcanic Hazards in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	M	M	M

Source: DOGAMI and DLCD, 2020

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

DOGAMI analyzed the potential dollar loss from volcanic hazards to state-owned and –leased buildings and critical facilities as well as to local critical facilities in Region 4. No state buildings, state or local critical facilities are exposed to volcanic hazards in Region 4.

Historic Resources

None of the 6,265 historic buildings in Region 4 are exposed to volcanic hazards. See Appendix X for details.

[Insert archaeological vulnerability here.]

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, vulnerability is similarly high across all three counties in Region 4. Each county's high vulnerability is driven by moderately high scores across the CDC index. Jackson County ranks in the top half of counties for 11 of the 15 index variables. Notably, it is in the 80th percentile for its share of single-parent households and in the 70th percentile for its share of residents that speak English less than "well." Josephine County is in the 80th percentile for its share of residents 65 and older, its unemployment rate, and the share of persons living in poverty. Douglas County has a higher unemployment rate than 80 percent of all counties and ranks in the 60th percentile for 7 of the 15 variables included in the CDC index.

According to the 2020 vulnerability scores, all three counties in Region 4 are moderately vulnerable to volcanic hazards. The vulnerability scores are driven primarily by high social vulnerability in all three counties along with low to moderate probability of a volcanic hazard event.

Risk

Table 2-410. Assessment of Risk to Volcanic Hazards in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Risk	M	M	L

Source: DOGAMI and DLCD, 2020

According to the 2020 Risk Scores, Douglas and Jackson Counties are Region 4's "most vulnerable communities" with moderate (M) risk ratings. All three counties' vulnerability scores are driven by their social vulnerability. Douglas and Jackson Counties should be prioritized for mitigation actions. Josephine County has a Low (L) risk rating.

The U.S. Geological Survey has addressed volcanic hazards in the Crater Lake region (Bacon et al., 1997). This report includes maps depicting the areas at greatest risk. The park itself is in the greatest risk category. In Douglas County, the upper reaches of the Umpqua and Clearwater rivers are subject to volcano-associated hazards, as is the OR-62 corridor in Jackson County

(Bacon et al., 1997; http://pubs.usgs.gov/of/1997/0487/). There is virtually no risk from volcanoes in Josephine County, other than the possibility of ashfall.

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Wildfires

Characteristics

While the residents in Region 4 enjoy moderate winters, during the summer residents can expect long drought periods, low humidity with temperatures that sometimes exceed 100 °F, and frequent lightning storms. Some landscapes are affected by autumn east winds that occur when stable air pushes across a mountain range and then descends on the leeward side. The air becomes warmer and drier as it descends and can lead to increased, sometimes extreme, fire behavior in lower lee-side locations.

Summers in Region 4 bring perfect weather conditions for extreme wildfires. Lightning strikes are frequent during the summer months, and the numerous strikes have the potential to ignite numerous fires.

Fire exclusion in Region 4 has created vegetation and fuel conditions for large and catastrophic fires that are more difficult to suppress than smaller fires. Throughout the watersheds, forests present a continuous fuel supply both vertically, in small, thin trees and dead branches (ladder fuels), and horizontally, in an abundance of dead and downed material. When a fire gets started in such a forest, the dead branches, sticks, twigs, and other material increase fire intensity and, with ladder fuels present, provide great opportunity for the fire to reach the forest canopy, resulting in a stand-killing crown fire. These conditions also affect the means in which prescribed fire and fuels treatment are applied to the landscape.

Current climate conditions, especially in drought years, influence the frequency, intensity, duration, and extent of fire. Summers are dry and lightning prone because a Pacific coast high-pressure system typically blocks precipitation for much of the season. In the upper elevations, where temperatures are low and rainfall is high, fires are less frequent than in the valleys. Larger climatic factors such as long-term global variations related to El Niño or to sunspot cycles also influence fire regimes, but this influence is confounded by local climatic variations, recent land management activities, and burns.

Historic Wildfire Events

Table 2-411 describes some of the more noteworthy wildfires in Region 4's history.

Table 2-411. Historic Wildfires Affecting Region 4

Year	Name of Fire	County	Acres Burned	Remarks
1951	Hubbard Creek, Russell Creek, Vincent Creek Fires	Douglas	16,094	the Hubbard Creek Fire burned 15,774 acres and destroyed 18 homes; the Russell Creek Fire burned 350 acres and killed one person; the Vincent Creek Fire burned 23,000 acres near Scottsburg
1966	Oxbow Fire	Douglas	43,368	the Oxbow Fire killed one person
1987	Bland Mountain	Douglas	10,300	near Canyonville; 14 structures lost, 2 people killed
1992	E. Evans Creek	Jackson	10,135	four structures lost
1994	Hull Mountain	Jackson	8,000	one life and 44 structures were lost; the fire was an act of arson
1994	Sprignett Butte	Jackson	1,631	arson
2000	Antioch road	Jackson	376	
2002	Squires Peak/Wall Creek	Jackson	3,125	
2002	Timbered Rock	Jackson	27,111	
2002	Biscuit	Curry, Josephine	500,000	estimated to be one of Oregon's largest in recorded history, the Biscuit Fire encompassed most of the Kalmiopsis Wilderness
2003	Cove Road	Jackson	700	3 miles east of Ashland
2004	Bland Mtn. #2	Douglas	4,700	two homes lost
2008	Doubleday	Jackson	1,244	threatened Butte Falls
2010	Oak Knoll Fire	Jackson County	< 100	Oak Knoll Fire in Ashland destroyed 11 homes in less than 45 minutes
2013	Douglas Complex	Douglas, Josephine, Wasco, Grant	48,324	combined with fires in Region 5, 6, and 7, the most acres burned in since 1951 on lands protected by the Oregon Department of Forestry
2013	Brimstone	Josephine	2,377	part of southern Oregon fire storm that included the Douglas Complex above
2013	Big Windy	Josephine	26,725	part of southern Oregon fire storm that included Brimstone and Douglas Complex; one firefighter death
2018	Klondike	Josephine	175,258	eventually merged into the Taylor Creek Fire that had burned 52,839 acres
2018	Miles	Jackson, Douglas	54,134	combination of merged fires: Sugar Pine, South Umpqua Complex, and the Miles fire
2018	Taylor Creek	Josephine	52,839	started by a lightning strike

Source: 2013 Fire Statistics, Oregon Department of Forestry; ODF, 2020

Probability

Table 2-412. Assessment of Wildfire Probability in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

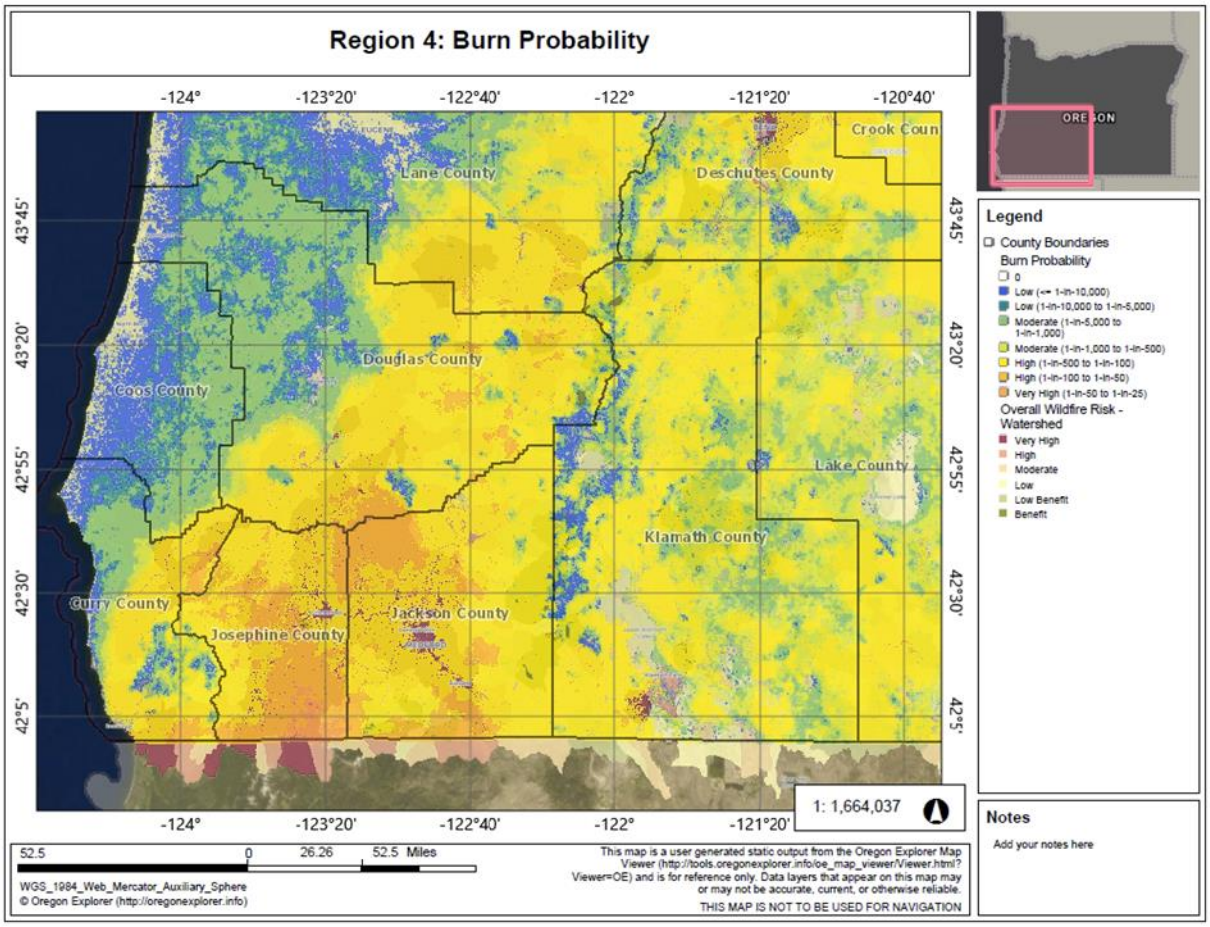
Source: Oregon Wildfire Risk Explorer: Burn Probability layer; PNW Quantitative Wildfire Risk Assessment, 2020

In the PNW Quantitative Wildfire Risk Assessment, Burn Probability was used to assess the likelihood of a large wildfire (>250 acres occurring). In conjunction with that data, examining the number of fire starts reported by ODF for all acreage sizes, gives a full picture of probability of wildfire.

These scores identify high-priority areas to which local and state governments can target mitigation actions. The challenge with these statewide assessments and methodologies is that the scale of the data is not necessarily reflective of the probability at the local and parcel levels, so the fire start data is utilized to help reflect that local level assessment to a certain extent.

Figure 2-207 shows the likelihood of a wildfire >250 acres burning a given location, based on wildfire simulation modeling. This is an annual burn probability, adjusted to be consistent with the historical annual area burned. Be aware that conditions vary widely with local topography, fuels, and weather, especially local winds. In all areas, under warm, dry, windy, and drought conditions, expect higher likelihood of fire starts, higher fire intensities, more ember activity, a wildfire more difficult to control, and more severe fire effects and impacts.

Figure 2-207. Burn Probability

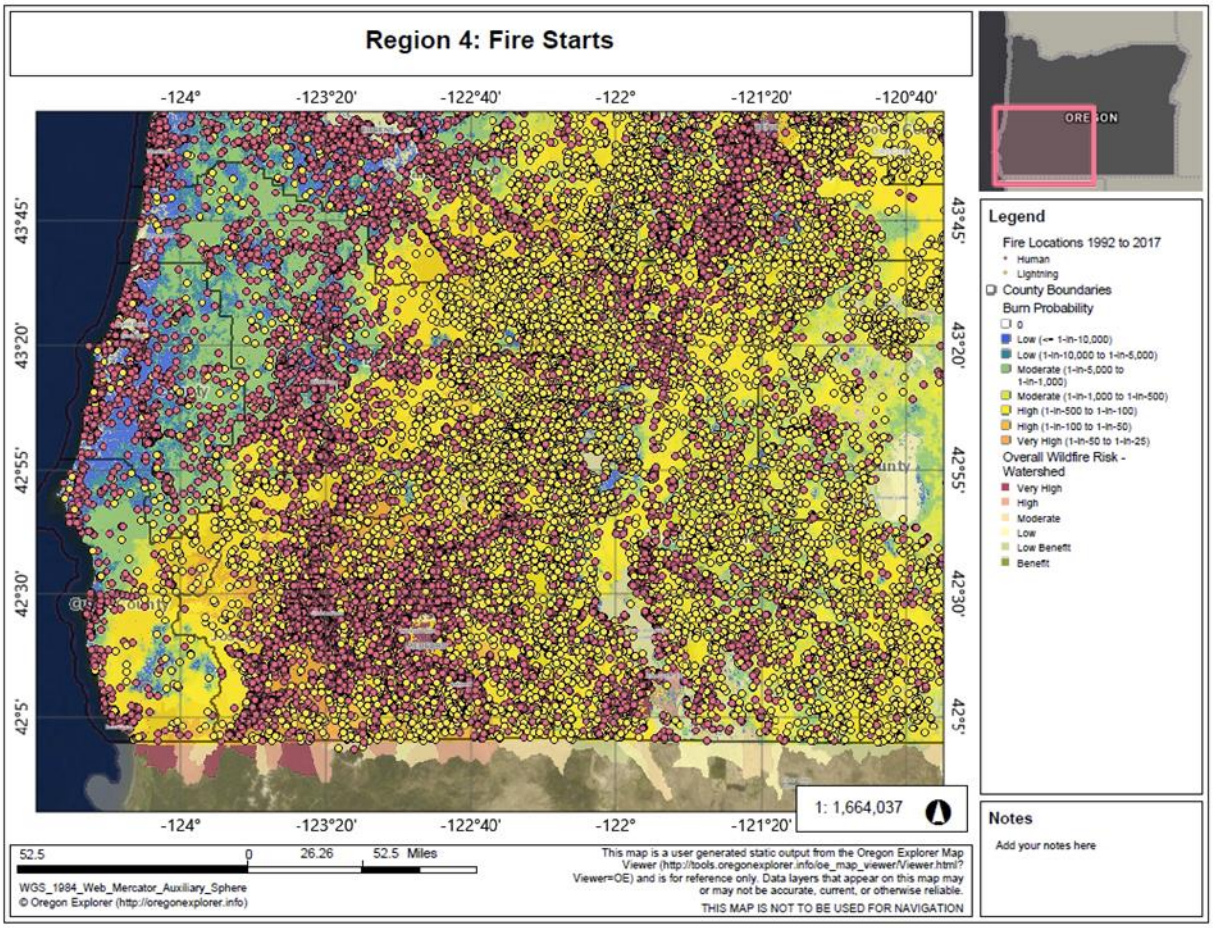


Source: Oregon Wildfire Risk Explorer, March 2020

Wildfire is defined as an uncontrolled burning of forest, brush, or grassland. Wildfires have always been a part of these ecosystems, sometimes with devastating effects. Wildfire may result from natural causes (e.g., lightning strikes), a mechanical failure (Oxbow Fire), or human causes (unattended campfire, debris burning, or arson). Most wildfires can be linked to human carelessness.

Hot and dry summers combined with frequent lightning events, rugged terrain, and an abundance of fuels makes Region 4 a hotbed of fire activity. Historically, some of Region 4's largest fires have been caused by human activity.

Figure 2-208. Human- and Lightning-Caused Wildfires in Region 4, 1992-2017



Source: Oregon Wildfire Risk Explorer, March 2020

Climate Change

Over the last several decades, warmer and drier conditions during the summer months have contributed to an increase in fuel aridity and enabled more frequent large fires, an increase in the total area burned, and a longer fire season across the western United States. Human-cause climate change is partially responsible for these trends, which are expected to continue increasing under continued climate warming (Dalton et al., 2017).

In ignition-limited forest systems, such as those in the southern portions of the state, a long history of fire suppression has resulted in high fuel loads and, forests that have closer canopies and experience greater water competition. These forests experience long, dry fire seasons and are frequently at high fire danger and have a very high potential to burn if exposed to an ignition source. Winter warming will lead to more fine fuels due to greater growth during the cold season; hotter and drier conditions combined with a suppression management regime will lead to large quantity of fuel and closer canopies. Large and severe fires ("unsuppressable megafires") are a result of this large fire debt and climate change combined. It is very likely (>90%) that Region 4 will experience increasing wildfire frequency and intensity under future climate change.

One proxy for future change in wildfire risk is a fire danger index called 100-hour fuel moisture (FM100), which is a measure of the amount of moisture in dead vegetation in the 1–3 inch diameter class available to a fire. A majority of climate models project that FM100 would decline across Oregon under future climate scenarios. This drying of vegetation would lead to greater wildfire risk, especially when coupled with projected decreases in summer soil moisture. The number of "very high" fire danger days—in which fuel moisture is below the 10th percentile—is projected to increase across the state and in Region 4 counties (Table 2-422).

Table 2-413. Projected Increase in Annual Very High Fire Danger Days in Region 4 Counties by 2050 under RCP 8.5

County	# Additional Days	Percent Change
Douglas	12	34%
Josephine	13	35%
Jackson	13	37%

Note: Very High fire danger days are defined as days in which the fuel moisture is below the 10th percentile. By definition, the historical baseline has a 36.5 Very High fire danger days. These numbers represent the multi-model mean change.

Source: Oregon Climate Change Research Institute (OCCRI)

Vulnerability

Table 2-414. Assessment of Vulnerability to Wildfire in Region 4 – Communities at Risk

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	VH	VH	H

Source: ODF Communities at Risk Report, 2020

Table 2-415. Assessment of Vulnerability to Wildfire in Region 4 – 2020 Vulnerability Assessment

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	M	M

Source: DOGAMI and DLCD

According to ODF's assessment of Communities at Risk, Region 4 is one of the state's regions most susceptible to wildfire. It has a high percentage of wildland acres subject to Fire Risk, Wildland Development Areas, Fire Effects, or Fire Threat, making them especially vulnerable.

Douglas, Josephine, and Jackson Counties are made up of several smaller communities that lie within the wildland-urban interface and have a distinct vulnerability to wildfire given their proximity to forestland, high summer temperatures, rugged terrain, and likelihood of summer thunderstorm activity. The human element is a factor as well with several populations intermixed in wildland areas. Arson continues to be a concern in this part of the state as well as the high number of fires caused by debris burning and equipment use.

Each year a significant number of people build homes within or on the edge of the forest (wildland-urban interface), thereby increasing wildfire hazards. These communities have been designated "Wildland-Urban Interface Communities" and include those in **Table 2-425**.

Table 2-416. Region 4 Wildland-Urban Interface Communities

Douglas		Jackson	Josephine
Azalea	Riddle	Antelope Creek	Cave Galice
Camas Valley	Roseburg	Applegate	Murphy
Canyonville	South Umpqua	Ashland	Sunny Valley
Cavitt Creek	Steamboat	Butte Falls	Wilderville
Cow Creek	Susan Creek	Central Point	Junction
Curtin	Sutherlin	Colestin	Grants Pass
Days Creek	Tenmile	Crowfoot Falls	Kerby
Dillard	Tiller	Eagle Point	Merlin
Dixonville	Toketee	Elk Creek	Selma
Drain	Kellogg	Gold Hill	Williams
Drew	Loon Lake	Green Springs	Wolf Creek
Dry Creek	Myrtle Creek	Jackson	
Elkton	Rice Hill	Jacksonville	
Fair Oaks	Riddle Canyonville	Lake Creek	
Fortune Branch Cow Creek	Tri-City	Medford	
Freezeout Creek	Winston	Pioneer Village	
Gardiner	Diamond Lake	Medford	
Glenbrook	North Umpqua	Prospect	
Glendale	Oakland	Rogue River	
Glide	Reedsport	Ruch	
Green Acres	Scottsburg	Sams Valley	
Lemolo	Winchester Bay	Shady Cove	
Lemolo Lake	Yoncalla	Trail	
Little River	Union Gap	Whetstone	
Lookingglass	Wilber	Union Creek	
Milo	Wolf Creek	Phoenix	
Myrtle Creek		White City	
North Umpqua Oakland		Wimer	
Village			

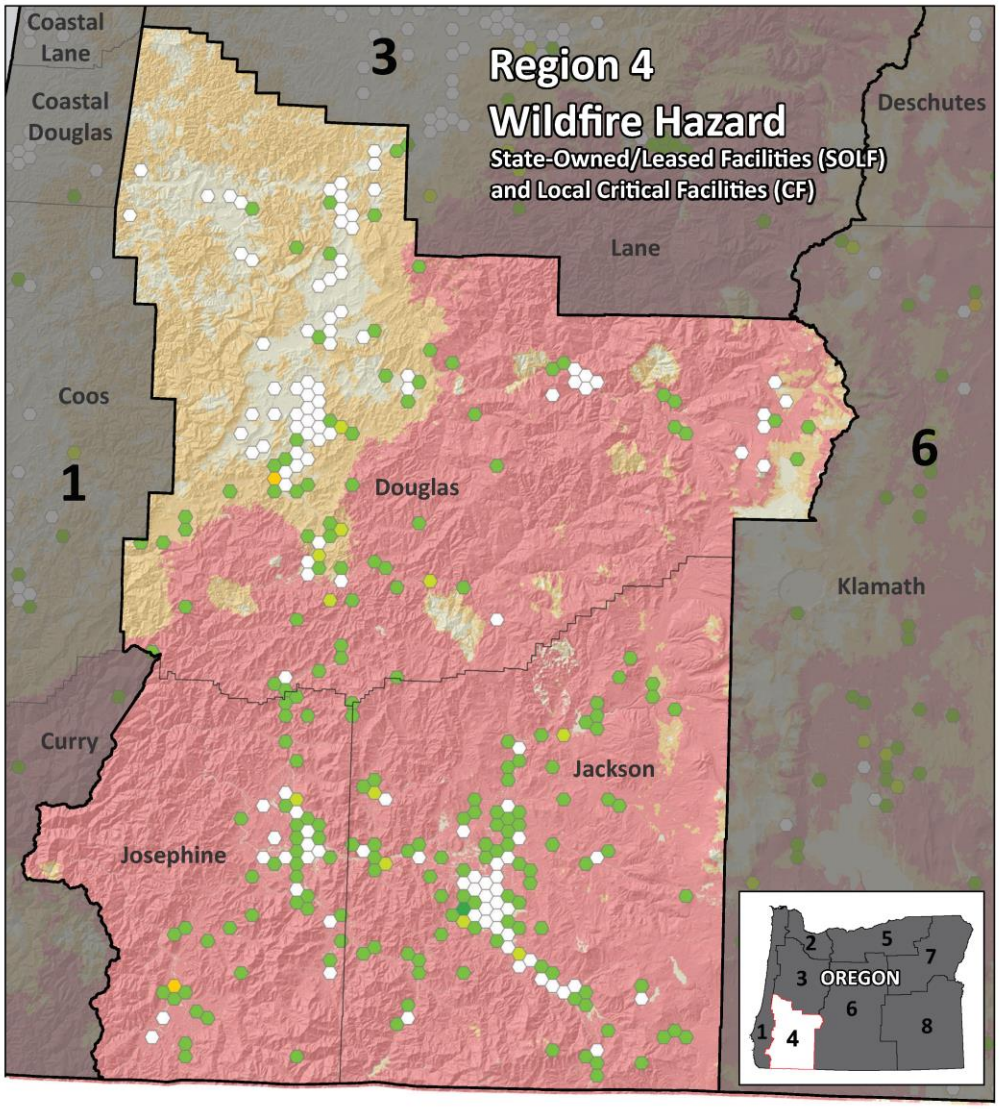
Source: ODF Communities at Risk Report, 2020

State-Owned/Leased Buildings and Critical Facilities and Local Critical Facilities

For the 2020 vulnerability assessment, DOGAMI followed ODF guidance and evaluated building exposure to wildfire using the Burn Probability dataset which was classified by ODF in "High," "Moderate," and "Low" categories. Urban areas, lake surfaces, and areas bare of vegetation do not have fire risk classifications in the data and are represented here as "Low."

In Region 4, there is a potential loss to wildfire of over $32M in state building and critical facility assets, 45% and 40% of it in Jackson and Douglas Counties, respectively, and 15% in Josephine County. There is a much greater potential loss in local critical facilities: over $163M. Thirty-nine and 37% are located in Douglas and Jackson Counties, respectively. Fifteen percent is located in Josephine County.

Figure 2-209. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in Region 4.High-resolution, full-size image linked from Appendix 9.1.22.



Building value ($) exposed to high or moderate hazard per cell

- No exposure to hazard
- 1 - 2,500,000
- 2,500,001 - 10,000,000
- 10,000,001 - 25,000,000
- 25,000,001 - 50,000,000
- 50,000,001 - 290,000,000

Hazard area

- Wildfire - high hazard
- Wildfire - moderate hazard
- Wildfire - low hazard

Administrative boundary

- Mitigation Planning Region
- County

Projection:
Oregon Statewide Lambert Conformal Conic, Unit: International Feet, Horizontal datum: NAD83 HARN, Scale 1:750,000

Source Data:
Wildfire: Burn probability data, Oregon Department of Forestry, 2018
State-owned/lease buildings: Oregon Department of Administrative Services, 2019
Administrative boundaries: Oregon Emergency Management and the Oregon Department of Land Conservation and Development, 2015
Hillshade base map: DOGAMI, Statewide mosaic, 2018, from Oregon Lidar Consortium data

Author: Matt Williams, Oregon Department of Geology and Mineral Industries, January 2020.

REGION 4		Exposure ($) to Wildfire Hazard Areas					
		State-owned/leased facilities				Critical Facilities	
County	Total Value SOLF and Local CF	Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF	Total Value Exposed SOLF CF and Local CF
Douglas	985,197,000	2,090,000	4%	10,996,000	13,086,000	63,550,000	65,640,000
Jackson	1,790,356,000	405,000	0%	14,071,000	14,476,000	61,072,000	61,477,000
Josephine	528,755,000	235,000	0%	4,679,000	4,914,000	38,722,000	38,957,000
Total	3,304,308,000	2,730,000	1%	29,746,000	32,476,000	163,344,000	166,074,000

This study divided buildings into two major categories by ownership: state-owned or leased facilities (SOLF) and local critical facilities (CF). SOLF buildings were further subdivided into either CFs, such as police stations, or non-critical facilities (non-CF), such as administrative offices.
**Exposure totals for SOLF include the subset of SOLF CFs.*

0 10 20 40 Miles

N

Source: DOGAMI, 2020

Historic Resources

Of the 6,265 historic resources in Region 4, six-hundred ninety-two (11%) are located in an area of high wildfire hazard. Of those, 52% are located in Jackson County. Of the 194 (3%) located in a moderate wildfire hazard area, 194 (80%) are located in Douglas County.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

According to the CDC Social Vulnerability Index, vulnerability is similarly high across all three counties in Region 4. Each county's high vulnerability is driven by moderately high scores across the CDC index. Jackson County ranks in the top half of counties for 11 of the 15 index variables. Notably, it is in the 80th percentile for its share of single-parent households and in the 70th percentile for its share of residents that speak English less than "well." Josephine County is in the 80th percentile for its share of residents 65 and older, its unemployment rate, and the share of persons living in poverty. Douglas County has a higher unemployment rate than 80 percent of all counties and ranks in the 60th percentile for 7 of the 15 variables included in the CDC index.

For the 2020 vulnerability assessment, DLCD combined the social vulnerability scores with the vulnerability scores for state buildings, state critical facilities, and local critical facilities to calculate an overall vulnerability score for each county. According to this limited assessment, Douglas County's vulnerability to wildfire is high; Jackson County and Josephine County are moderately vulnerable. This is not consistent with the Communities at Risk assessment.

All three counties in Region 4 are most vulnerable to wildfire.

Risk

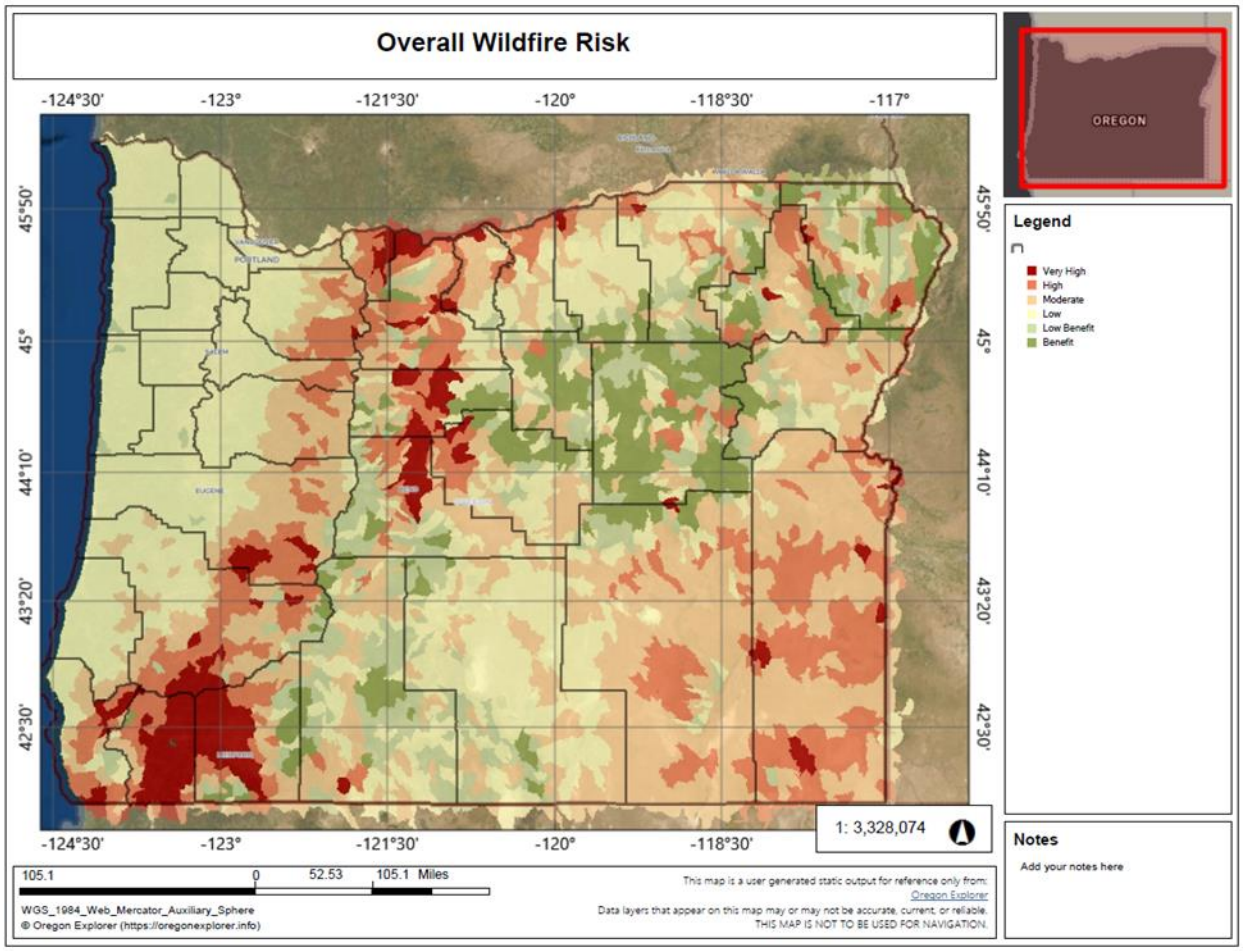
Table 2-417. Risk of Wildfire Hazards in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Risk	VH	VH	H

Source: DOGAMI, DLCD

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life. The 2020 risk assessment combined the wildfire probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, Douglas and Jackson Counties are at very high risk from wildfire; Josephine at high risk. This is fairly consistent with ODF's assessment for the eastern portion of Douglas County, the central and western portions of Jackson County, and all of Josephine County mapped in **Figure 2-210**. The 2020 risk assessment is not granular enough to account for geographic differences in probability, vulnerability, or risk within a county.

Figure 2-210. Overall Wildfire Risk



Source: Oregon Explorer, 2020

Windstorms

Characteristics

Extreme winds (other than tornadoes) are experienced in all of Oregon's eight regions. A majority of the destructive surface winds in Oregon are from the southwest. Under certain conditions, very strong east winds may occur, but these usually are limited to small areas in the vicinity of the Columbia River Gorge or other low mountain passes. The much more frequent and widespread strong winds from the southwest are associated with storms moving onto the coast from the Pacific Ocean. If the winds are from the west, they may be stronger on the coast than in the interior valleys because of the north-south orientation of the Coast Range and Cascades. These mountain ranges obstruct and slow down the westerly surface winds. The most destructive winds are those which blow from the south, parallel to the major mountain ranges. The Columbus Day Storm of 1962 was a classic example of such a storm, and its effects were so

devastating that it has become the benchmark from which other windstorms in Oregon are measured. The storm caused significant damage in Region 4.

There were no documented tornadoes in Jackson, Josephine, or central Douglas Counties until 2013. An EF0 tornado occurred near Roseburg in Douglas County on June 18, 2013. Winds were 65-85 mph and property damage was estimated at $1,000.

Historic Windstorm Events

Table 2-418. Historic Windstorms in Region 4

Date	Affected Area	Characteristics
Apr. 1931	western Oregon	unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	statewide	widespread damage; transmission and utility lines; wind speed 40–60 mph; gusts 75–80 mph
Dec. 1951	statewide	wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec. 1955	statewide	wind speeds 55–65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	statewide	wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	statewide	Columbus Day Storm; Oregon's most destructive storm to date; 116 mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million
Mar. 1971	most of Oregon	greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	most of Oregon	highest winds since Oct. 1962; wind speed 71-mph in Salem; marinas, airports, and bridges severely damaged
Jan. 1990	statewide	heavy rain with winds exceeding 75 mph; significant damage; one fatality
Dec. 1995	statewide	followed path of Columbus Day Storm; wind speeds 62 mph in Willamette Valley; damage to trees (saturated soil a factor) and homes
Nov. 1997	western Oregon	wind speed 52 mph in Willamette Valley; trees uprooted; considerable damage to small airports
Feb. 2002	western Oregon	strongest storm to strike western Oregon in several years; many downed power lines (trees); damage to buildings; water supply problems (lack of power); estimated damage costs: $6.14 million
Feb. 2004	Jackson County	heavy winds caused $4,000 in damages in Jackson County
Dec. 2006	Douglas and Josephine Counties	high winds up to 90 mph caused $150,000 in damages in Douglas and Josephine; the storm also impacted Coos and Curry Counties for a storm damage total of $300,000
Jul. 2007	Josephine and Jackson Counties	severe thunderstorms with winds up to 60 mph down numerous trees damaging vehicles and trailers; $100,000 in damage in Jackson County; lightning struck the steeple of a church in Josephine County, causing $60,000 in damages
Jun. 2013	Douglas County	Winchester; tornado; EF0; $1K in property damage
Apr. 2019	Curry, Douglas, Linn, Wheeler, Grant, and Umatilla	FEMA-4452-DR: Severe storms, straight-line winds, flooding, landslides, and mudslides
Dec. 2015	Regions 1-4	FEMA-4258-DR: severe winter storms, straight-line winds, flooding, landslides, and mudslides

Sources: Taylor and Hatton (1999); Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon, February 7, 2002 (FEMA-1405-DR-OR); Hazards and Vulnerability Research Institute (2007). The Spatial Hazard Events and Losses Database for the United States, Version 5.1 [Online Database]. Columbia, SC: University of South Carolina. Available from http://www.sheldus.org ; National Climatic Data Center, Storm Events, http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms; https://www.ncdc.noaa.gov/stormevents/

Probability

Table 2-419. Assessment of Windstorm Probability in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

Source: Oregon Office of Emergency Management, 2013, County Hazard Analysis Scores

The 100-year event in Region 4 consists of 1-minute average winds of 80 mph. A 50-year event is 70 mph. A 25-year event has average winds of 60 mph.

Climate Change

There is insufficient research on changes in the likelihood of windstorms in the Pacific Northwest as a result of climate change. While climate change has the potential to alter surface winds through changes in the large-scale free atmospheric circulation and storm systems, there is as yet no consensus on whether or not extratropical storms and associated extreme winds will intensify or become more frequent along the Pacific Northwest coast under a warmer climate.

Vulnerability

Table 2-420. Assessment of Vulnerability to Windstorms in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	M	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

Many buildings, utilities, and transportation systems within Region 4 are vulnerable to wind damage. This is especially true in open areas, such as natural grasslands or farmlands. It also is true in forested areas, along tree-lined roads and electrical transmission lines, and on residential parcels where trees have been planted or left for aesthetic purposes. Structures most vulnerable to high winds include insufficiently anchored manufactured homes and older buildings in need of roof repair.

Fallen trees are especially troublesome. They can block roads and rails for long periods and can affect emergency operations. In addition, uprooted or shattered trees can down power and/or utility lines and effectively bring local economic activity and other essential facilities to a standstill. Much of the problem may be attributed to a shallow or weakened root system in saturated ground. Many roofs have been destroyed by uprooted ancient trees growing next to a house. In some situations, strategic pruning may be the answer. Prudent counties will work with utility companies to identify problem areas and establish a tree maintenance and removal program.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard.

The counties with the greatest social vulnerability statewide are Marion, Morrow, Umatilla, Wasco, Jefferson, Klamath, and Malheur.

According to the CDC Social Vulnerability Index, vulnerability is similarly high across all three counties in Region 4. Each county's high vulnerability is driven by moderately high scores across the CDC index. Jackson County ranks in the top half of counties for 11 of the 15 index variables. Notably, it is in the 80th percentile for its share of single-parent households and in the 70th percentile for its share of residents that speak English less than "well." Josephine County is in the 80th percentile for its share of residents 65 and older, its unemployment rate, and the share of persons living in poverty. Douglas County has a higher unemployment rate than 80 percent of all counties and ranks in the 60th percentile for 7 of the 15 variables included in the CDC index.

All the counties in Region 4 are most vulnerable to windstorms.

Risk

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life.

All the counties in Region 4 are at risk of windstorms.

Winter Storms

Characteristics

Severe winter weather in Region 4 can be characterized by extreme cold, snow, ice, and sleet. In higher elevations such as the lower Cascade Range and the Siskiyou Mountains and passes, moderate to heavy snowfall is expected on an annual basis. Some Region 4 communities are unprepared, financially and otherwise, for the impact of severe winter storms. An historical summary of extreme winter conditions in this region is shown in **Table 2-421**.

Historic Winter Storm Events

Table 2-421. Severe Winter Storms in Region 4

Date	Location	Characteristics
Dec. 1861	statewide	snow covered entire Pacific Northwest 1–3 feet
Jan. 1916	statewide	two snow storms, each totaling 5 inches or more
Jan. 1932	SW Oregon mountains	Crater Lake record snowfall: 879 inches
Jan.- Feb. 1937	statewide	heavy snow throughout state
Jan. 1950	statewide	heaviest snowfall since 1890; highway closures; considerable property damage
Jan. 1951	Crater Lake, Oregon	new annual record snowfall at Crater Lake
Jan. 1956	western Oregon	packed snow became ice; automobile accidents throughout region
Mar. 1960	statewide	snowfall: 3–12 inches; over 100 accidents in Marion County
Jan. 1969	statewide	Lane County surpassed old snowfall record; 47 inches in Eugene ; $3 to $4 million in property damage
Jan. 1980	statewide	a series of storms bringing snow, ice, wind, and freezing rain; six fatalities
Feb. 1985	statewide	2-4 inches of snow in western valleys; massive power failures (tree limbs broke power lines)
Feb. 1986	Cascades, Oregon	heavy snowfall
Mar. 1988	statewide	strong winds and heavy snow
Feb. 1989	statewide	heavy snowfall and record low temperatures
Nov. 1989	Siskiyou, Oregon	unusually heavy snowfall
Dec. 1992	western Oregon	heavy snow; interstate highway closed
Feb. 1993	western Oregon	record snowfall at Salem airport
Winter 1998-1999	statewide	series of storms; one of the snowiest winters in Oregon history
Dec. 28, 2003-Jan. 9, 2004	statewide	most significant winter storm in several years brought snowfall to most of Oregon; largest snowstorm in the Siskiyou Pass (Jackson County) in a quarter century; shut down I-5

Date	Location	Characteristics
Dec. 6-23, 2015	Statewide storm events	DR-4258. Douglas County declared in Region 4. Severe winter storms, straight-line winds, flooding, landslides, and mudslides. Several pacific storm systems moved across the region over the Dec 12-13 weekend. Each storm system brought several inches of snow to the mountain areas. Another in a long series of storms brought heavy snow to portions of south central Oregon. Also on the 21st a series of storms made for a long lasting winter storm over southwest and south central Oregon. At first the snow was limited to higher elevations...but lowered with time to some of the west side valley floors. Moist onshore winds produced a steady stream of showers over the foothills of the Cascades with snow levels between 1000 and 2000 feet. This resulted in heavy snow for the Northern Oregon Cascades and Coast Range.
Dec. 14-15, 2016	Josephine County	DR-4296. Josephine County declared in Region 4. Severe winter storm and flooding. East winds ahead of an approaching low pressure system brought temperatures down below freezing across the area ahead of the approaching precipitation. This lead to a mix of freezing rain, sleet, and snow across the area. There was significant damage to trees and power lines, and fairly widespread power outages across the region. 15,000 people were without power.
Jan. 7-8, 2017	Josephine County	DR-4328. Josephine County declared in Region 4. Severe Winter Storms, Flooding, Landslides, And Mudslides. A broad shortwave trough brought multiple rounds of precipitation, including a wintry mix of snow and ice. General snowfall totals of 2-4 inches were reported, with the greatest total being 4.5 inches. Major ice accumulations occurred after the snow, with several locations reporting 0.50-1.00. The combination of snow and ice resulted in significant power outages and closures across the area.
Feb. 22-26, 2019	Douglas County	DR-4432. Douglas County declared in Region 4. Severe Winter Storms, Flooding, Landslides, And Mudslides. Persistent troughing off the coast of the Pacific Northwest focused a stream of mid-level moisture over the Inland Northwest resulting in a long duration snow event as the plume drifted north and south several times between the 22nd and 27th of February. Snowfall rates were greatly enhanced over central Oregon with the proximity of a nearly stationary surface boundary where snowfall rates were in excess of 1 inch per hour.

Source: Taylor and Hatton (1999); Oregon Department of Transportation, 2008; State Natural Hazards Mitigation Plan, Winter Storm chapter; https://www.fema.gov/disaster; https://www.ncdc.noaa.gov/stormevents.

Probability

Table 2-422. Assessment of Winter Storms Probability in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Probability	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

Winter storms occur annually in Region 4. On the basis of historical data, severe winter storms could occur about every 4 years in this region. We can expect to have continued annual storm events in this region. However, there are no solid statistical data available upon which to base these judgments. There is no statewide program to study the past, present, and potential impacts of winter storms in the state of Oregon at this time. Higher elevations through the Siskiyou Mountains and the Cascade Range are expected to have higher annual snowfall amounts and this is planned for at the state and local level.

Climate Change

There is no current research available about changes in the incidence of winter storms in Oregon due to changing climate conditions. However, the warming climate will result in less frequent extreme cold events and high-snowfall years.

Vulnerability

Table 2-423. Assessment of Vulnerability to Winter Storms in Region 4

	Douglas (Non-Coastal)	Jackson	Josephine
Vulnerability	H	H	H

Source: Oregon Office of Emergency Management, November 2013, County Hazard Analysis Scores

All three counties in Region 4 are impacted by severe winter storms. The I-5 corridor passes through the Siskiyou Mountains in this region facilitating commodity flow between Oregon and California. Similarly, US-199 connects Oregon with California from I-5 at Grants Pass to US-101 at Crescent City on the northern California coast. Severe winter storms can shut down these vital links for extended periods and can have a direct adverse impact on Oregon's economy.

Social Vulnerability

The Centers for Disease Control and Prevention (CDC) has calculated a social vulnerability index to assess community resilience to externalities such as natural hazard events. It employs fifteen social vulnerability factors and uses data from the US Census Bureau's American Community Survey. The index is reported in quintiles (1-5). Social vulnerability scores do not vary by hazard. The counties with the greatest social vulnerability statewide are Marion, Morrow, Umatilla, Wasco, Jefferson, Klamath, and Malheur.

According to the CDC Social Vulnerability Index, vulnerability is similarly high across all three counties in Region 4. Each county's high vulnerability is driven by moderately high scores across the CDC index. Jackson County ranks in the top half of counties for 11 of the 15 index variables. Notably, it is in the 80th percentile for its share of single-parent households and in the 70th percentile for its share of residents that speak English less than "well." Josephine County is in the 80th percentile for its share of residents 65 and older, its unemployment rate, and the share of persons living in poverty. Douglas County has a higher unemployment rate than 80 percent of all counties and ranks in the 60th percentile for 7 of the 15 variables included in the CDC index.

All of the counties in Region 4 are vulnerable to the adverse impacts of winter storms, not only because of their high social vulnerabilities, but also because of the important commodity transport routes connecting Oregon with California and the economic costs associated with road closures.

Risk

With respect to natural hazards, risk can be expressed as the probability of a hazard occurring combined with the potential for property damage and loss of life.

All of the counties in Region 4 are similar risk from winter storms.