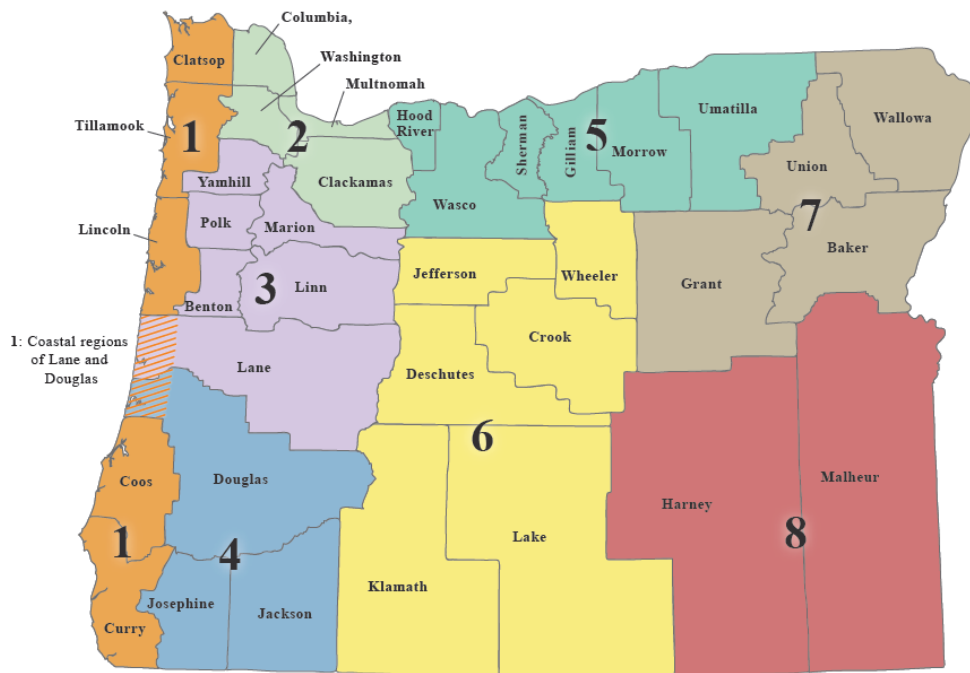


## 2.3 Regional Risk Assessments

The purpose of the Regional Risk Assessment is to assess risks at a regional scale by profiling the characteristics, natural hazards, and vulnerabilities within the eight Oregon NHMP Natural Hazard Regions ([Figure 2-115](#)). Each region has its own Risk Assessment. Together, the eight Regional Risk Assessments combine to describe the State's overall risk to natural hazards.

**Figure 2-115. Oregon NHMP Natural Hazards Regions**



Each Regional Risk Assessment includes three sections:

1. The **Summary** provides a general overview of (a) the Regional Profile, (b) the Regional Hazards and Vulnerability, and (c) how climate change models predict hazards in the region will be impacted based on statewide data.
2. The **Profile** section provides an overview of the region's unique characteristics including profiles of the natural environment, social and demographic situation, economic environment, infrastructure, and built environment.

The research of Susan Cutter, Professor of Geography at the University of South Carolina, Columbia, on vulnerability and environmental hazards provides the framework for discussion of vulnerability in the Regional Profile section. Cutter's framework helps to illustrate the geographic variability of vulnerability and allows policy makers to better understand how to

prepare for, mitigate, and reduce vulnerability (Cutter, Boruff, & Shirley, 2003); (Cutter S. L., 2006).

#### Margin of Error (MOE)

The sociodemographic data in the regional profiles are primarily sourced from the U.S. Census Bureau's American Community Survey (ACS). The ACS's estimates are subject to sampling and nonsampling errors. Nonsampling errors are the product of survey design and measurement flaws, "while sampling error is when the characteristics of the survey group vary from those of the larger population of interest...causing the true value to fall within a range bounded by a margin of error" (Quinterno, 2014).

Through adding and subtracting the MOE from the estimate, users can calculate the 90% confidence interval for that estimate (U.S. Census Bureau, 2018). For example, in [Table 2-81. People with a Disability by Age Group in Region 1](#), data from the 2017 ACS 5-year estimates indicate that 19.1% of all people in Clatsop County have a disability with a MOE of 1.4%. Through adding and subtracting the MOE from the estimate, the user can calculate the 90% confidence interval for that estimate (U.S. Census Bureau, 2018). Doing so indicates that we can be 90 percent confident that the true share of residents in Clatsop County with a disability in the 2013-2017 period falls between 17.7% and 20.5%.

#### Period Estimates

It should also be noted that the ACS estimates in the plan are period estimates, rather than point-in-time or cumulative counts. "A period estimate shows the average value of the variable over a specific reference period" (Quinterno, 2014). The ACS uses period estimates "to compensate for the fact [that] the sampling frame includes too few households to yield reliable annual estimates for small geographies and small population subgroups" (Quinterno, 2014). If the value presented in a table is a period estimate, the period is noted in the table's source data.

#### Coefficient of Variation (CV)

In addition to a MOE, many of the estimates in the plan have a coefficient of variation (CV). "The CV is a relative measure of uncertainty and expresses uncertainty as a percentage of the census estimate" (Jurjevich, et al., 2018). Generally, the lower the CV, the more reliable the data. According to the U.S. Census Bureau, there are "no hard-and-fast rules for determining an acceptable range of error in ACS estimates. Instead, data users must evaluate each application to determine the level of precision that is needed for an ACS estimate to be useful" (U.S. Census Bureau, 2018). This plan adopts CV ranges and data reporting methods recommended by the Population Research Center at Portland State University (Jurjevich, et al., 2018).

Icons are used to indicate the reliability of each estimate using the CV. High reliability (CV <15%) is shown with a green check mark, medium reliability (CV 15–30% — be careful) is shown with a yellow exclamation point, and low reliability (CV >30% — use with extreme caution) is shown with a red cross. However, as mentioned above, there are no precise rules and users should consider the MOE and their need for precision (Jurjevich, et al., 2018).

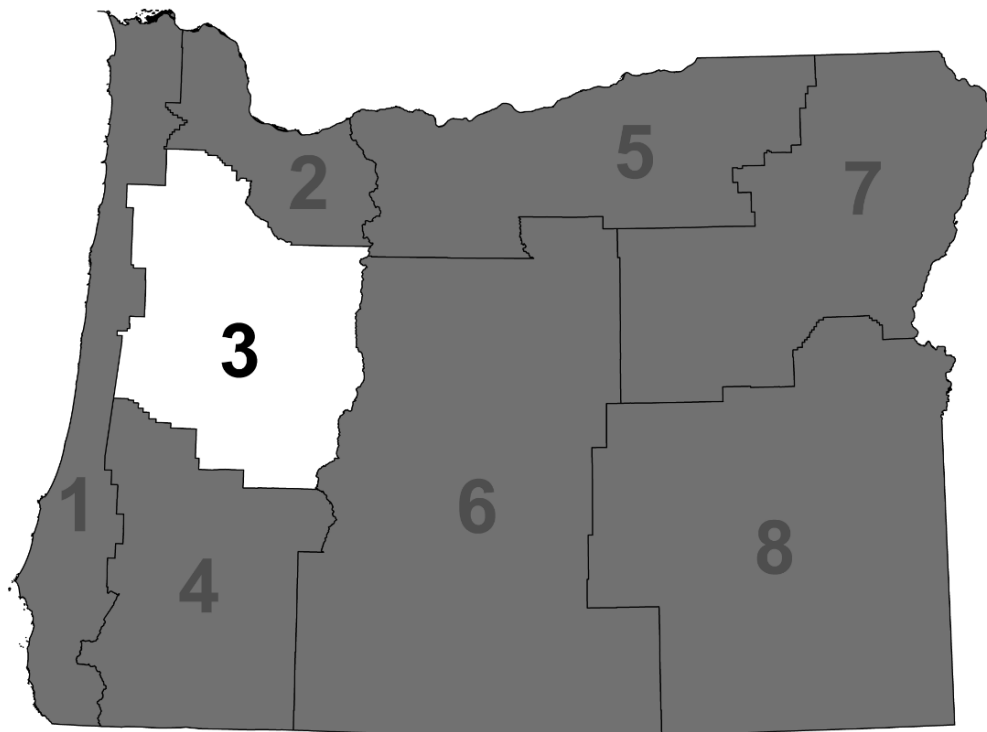
3. The **Hazards and Vulnerability** section first identifies each hazard and its characteristics in the region. Then, the historical events that have impacted the region are listed. Lastly, probabilities and vulnerabilities are discussed as identified by local and state risk assessments. Vulnerabilities

to and potential impacts from each hazard in the region are described including the identification and analysis of the region's State owned/leased facilities and critical/essential facilities located within hazard zones and seismic lifeline vulnerabilities.

Regional Risk Assessments add to the current body of literature and technical resource guides available to Oregon communities. The three levels of government — federal, state, and local — will find the Regional Risk Assessments useful when assessing natural hazards and vulnerabilities and when planning mitigation activities. Local governments can use the Regional Risk Assessments in the development of their jurisdiction's natural hazards mitigation plan. Information from these assessments is intended to be used as a springboard for more detailed community profiles. Likewise, information from local plans helps to inform the Oregon NHMP risk assessment overall.

### 2.3.3 Region 3: Mid/Southern Willamette Valley

Benton, \*Lane (non-coastal), Linn, Marion, Polk, and Yamhill Counties



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



### 2.3.3.1 Summary

#### 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.

According to the CDC Social Vulnerability Index, social vulnerability in the region is highest in Marion County, followed by Linn and Yamhill Counties. Marion and Linn Counties rankings are driven by high numbers of people aged 17 or younger, high percentage of single-parent households, low per capita income, and percentage of occupied housing units with more people than rooms. The Marion County is also in the 90th percentile for its share of residents that speak English less than "well." Vulnerability in Yamhill County is also driven by moderately high scores across the CDC index. The county is in the 80th percentile for its share of multi-unit structures and the percentage of people living in institutionalized group quarters. The region has a number of key industries and employment sectors providing economic stability for the region. The exceptions are Linn and Yamhill Counties, which rely heavily on fewer key industries. Except for in Benton County, wages are lower in Region 3 than statewide. All the counties are contending with the financial impacts of the novel coronavirus pandemic.

Transportation networks across the region are vulnerable to natural hazard events, especially seismic events. Following a Cascadia earthquake event, access across the Willamette River and along I-5 may be limited due to bridge collapse. The Eugene Airport, the state's second largest airport, could become a staging ground after a natural disaster, but is also vulnerable to a catastrophic seismic event.

Energy facilities and conveyance system infrastructure in the region support the regional economy and are vulnerable to natural hazard events. Most state-regulated dams do not generate electricity and the few that do, do not generate large wattage. Some federally-regulated dams in Region 3 may generate power. Liquid Natural Gas is transmitted via pipelines that run through Marion, Linn, and Lane Counties.

Water systems in the region are particularly vulnerable to hazard events because they tend to be older, centralized, lacking in system redundancies and sourced from surface water. Combined sewer overflow (CSO) during high-water events is one such threat. Low impact development (LID) stormwater systems, such as those employed by the City of Eugene, can help communities better manage high-precipitation events.

Urban growth in Region 3 is 4 times rural growth. The majority of growth is occurring in urban areas along I-5, in the region's major cities: Eugene, Albany, Corvallis, Salem, and the Portland Metro Area. Linn County has the highest percentage of manufactured homes, which are inherently more vulnerable to natural hazards events. Almost two thirds of all homes in the region were built before 1990 and seismic building standards. Over one third of all homes in Polk and Yamhill Counties were built before floodplain management standards.



## Hazards and Vulnerability

Region 3 is affected by nine of the 11 natural hazards that affect Oregon communities. Coastal hazards and tsunamis do not directly impact this region.

**Droughts:** Even though drought may not be declared as often in Western Oregon as in counties east of the Cascades, when drought conditions do develop in the Willamette Valley, the impacts are widespread and severe. Reasons for broad and significant impact include insufficient water for crop irrigation; lack of farmworkers when the growing season begins early; and increased frequency of toxic algal blooms in the Willamette system reservoirs, among other reasons.

**Earthquakes:** Four types of earthquakes affect Region 3: (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 the Mid/Southern Willamette Valley. This area 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, five of the 15 counties with highest expected damages and losses are in this region: Lane, Marion, Benton, Linn, and Yamhill. Seismic lifelines will be affected by prolonged ground shaking with several roadways susceptible to landslide, rockfall, or liquefaction. In Region 3, a CSZ event could cause a potential loss of almost \$843M in state building and critical facility assets, 93% of it in Marion County alone. The potential loss in local critical facilities is somewhat greater at almost \$1.2B. Again, Marion County's potential loss is greatest at 48%. Potential losses in Lane Line, Polk, and Yamhill Counties are similar, ranging 9-14%. Benton County's potential loss is significantly less.

**Extreme Heat:** Extreme temperatures aren't as common in western Oregon compared to other parts of the state; however, Region 3 does experience days above 90°F nearly every year. Eugene has an average of about 13 days per year above 90°F. The frequency of prolonged periods of high temperatures is expected to increase. Because extreme heat isn't as common in western Oregon compared to other parts of the state, many people may not be accustomed or prepared when an extreme heat event occurs.

Similar to drought, prolonged elevated temperatures pose risks to agriculture, involving health and welfare to farmers, farm workers, crops and livestock. Some livestock, especially dairy cattle, are sensitive to heat. Milk production decreases and susceptibility to death increases during and for some time after a heat wave. Since risks to human health and welfare are also elevated during heat waves, Oregon and the federal government have regulations and guidelines to help prevent injury to those who work on farms. Impacts of extreme heat on state-owned facilities related to agriculture may include impacts to research conducted in outdoor settings, such as at extension stations and research farms. The value of state-owned and leased buildings and critical facilities in Region 3 is approximately \$3,107,827,000 representing the total potential for loss of state assets due to extreme heat. The value of locally owned critical facilities is \$7,490,014,000.

**Floods:** The most common types of flooding events affecting the Mid/Southern Willamette Valley are riverine and sheet flooding. The most damaging floods are rain-on-snow events and the backing up of tributaries that takes place in December and January in association with La Niña events. While all of the region's counties are considered moderately vulnerable to flooding,



the coastal portion of Lane County and the cities of Eugene-Springfield, Salem, Scio, and Sheridan are considered the most vulnerable. In Region 3, there is a potential loss from flooding of over \$676M in state building and critical facility assets, 93% of it in Marion County alone. The next greatest share is about \$37M, only one-half percent, in Lane County. There is a similar potential loss due to flood in local critical facilities: close to \$677.6M, forty percent and 32% in Lane and Marion Counties, respectively. The next greatest share, 14% is in Benton County.

**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 also trigger landslides. Vulnerability is increased in highly populated areas, such as in the Cities of Corvallis, Eugene, and Salem, and in the Coast and Cascade Mountains. More than \$21.7M in value is exposed to landslide hazards in Region 3, over half of it in Lane County. The potential loss to local critical facilities is more than six times the value of state facilities at over \$140.7M. Yamhill County has 37% of the value of local critical facilities followed by Polk, Lane, and Marion Counties whose shares range from 17% to 24%.

**Volcanoes:** Volcanic activity may occur within the eastern areas of Lane, Linn, and Marion Counties that coincide with the crest of the Cascade mountain range. Most volcanic activity is considered local; however, lahars and ashfall can travel many miles. As such, small mountain communities, dams, reservoirs, energy-generating facilities, and highways in the region may be vulnerable to volcanic activity. Over \$153M in value is exposed to volcanic hazards in Region 3, all of it in Marion, Lane, and Linn Counties.

**Wildfires:** Wildfire risk is low to moderate in the Mid/Southern Willamette Valley. Wildfires that do occur usually happen in the late summer. The areas of greatest vulnerability are wildland-urban interface communities. In Region 3, there is a potential loss to wildfire of about \$45M in state building and critical facility assets, 65% of it in Lane County, 21% in Linn County, and 15% in Marion County. Benton Polk, and Yamhill Counties have no state assets in wildfire hazard areas. There is a similar potential loss in local critical facilities: about \$42.6M. Eighty-three percent of that value is located in Lane County, 9% in Linn County, 6% in Marion County, and 2% in Benton County. Neither Polk nor Yamhill County has local critical facilities located in a wildfire hazard area.

**Windstorms:** Windstorms can occur when winds generated in the Pacific Ocean travel inland in a northeasterly direction. Strong winds from the south are also possible in this region and often cause the most damage. Windstorms affect the region annually. 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. The value of state-owned and leased buildings and critical facilities in Region 3 is approximately \$3,107,827,000 representing the total potential for loss of state assets due to windstorms. The value of locally owned critical facilities is \$7,490,014,000.

**Winter Storms:** Colder weather and higher precipitation and can occur in the region annually. More severe winter storms occur about every 4 years. Due to the infrequent nature of severe storms in Region3, winter storm preparedness is not a priority of most communities. The value of state-owned and leased buildings and critical facilities in Region 3 is approximately \$3,107,827,000 representing the total potential for loss of state assets due to winter storms. The value of locally owned critical facilities is \$7,490,014,000.



## Climate Change

The hazards faced by Region 3 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 3 is expected to be affected by an increased incidence of drought and wildfire. In Region 3, 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 3 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 3, 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](#).





### 2.3.3.2 Profile

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

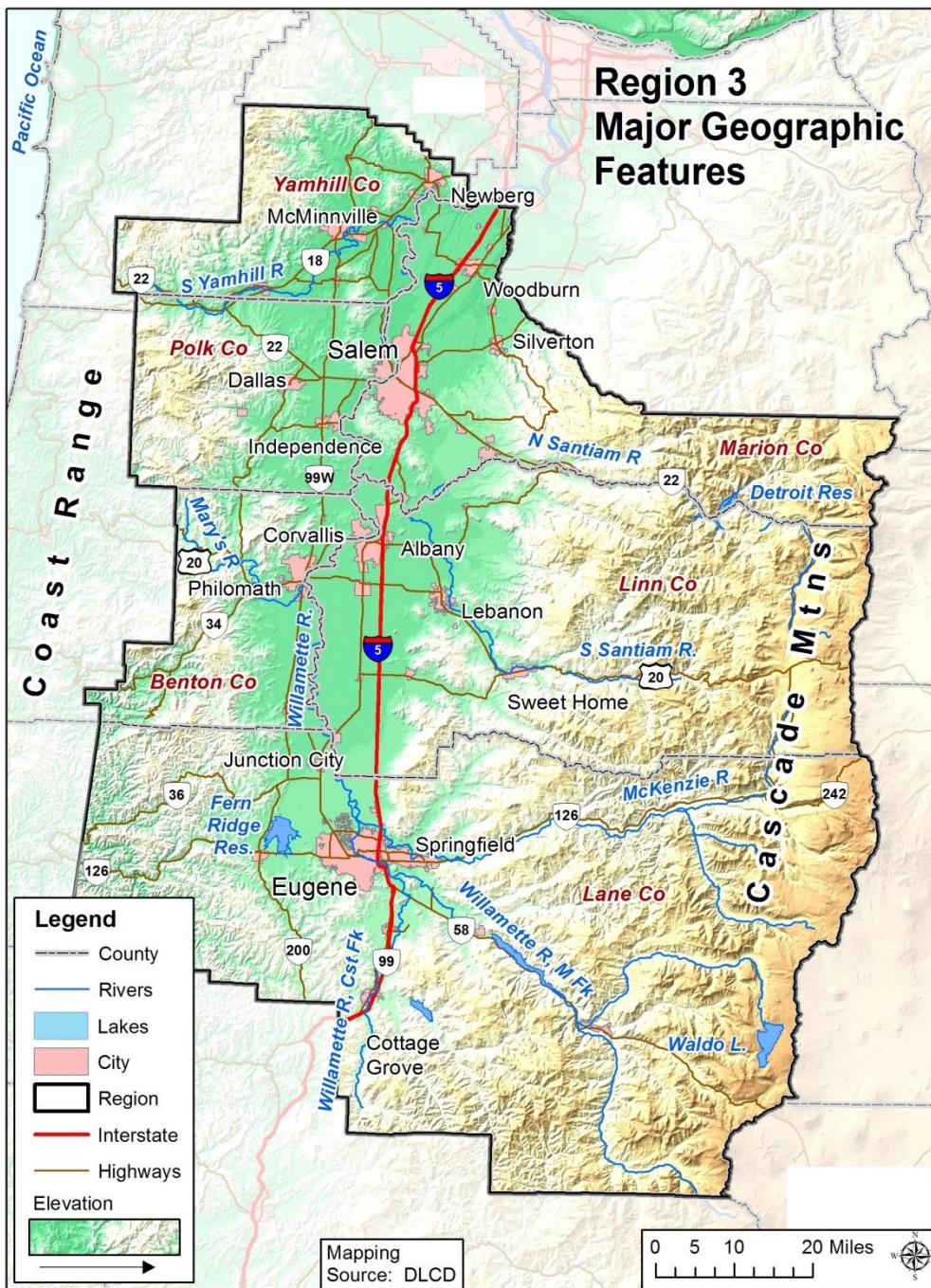
## Natural Environment

### *Geography*

The Mid/Southern Willamette Valley is approximately 10,163 square miles in size, and includes Benton, Lane (non-coastal), Linn, Marion, Polk, and Yamhill Counties. Mountain ranges and watersheds shape the region's topography. Region 3 begins at the Cascades crest in the east, and extends to the Coast Range in the west. It extends from the base of the Calapooya Mountains in the south to the Portland suburbs in the north. The major watershed is the Willamette River with smaller water bodies feeding it as it flows north into the Columbia River. The original Oregon Trail settlers sought out the fertile soil and ample rainfall of the Willamette Valley for their homesteads. The region is still an agriculturally vital area.



Figure 2-167. Region 3 Major Geographic Features



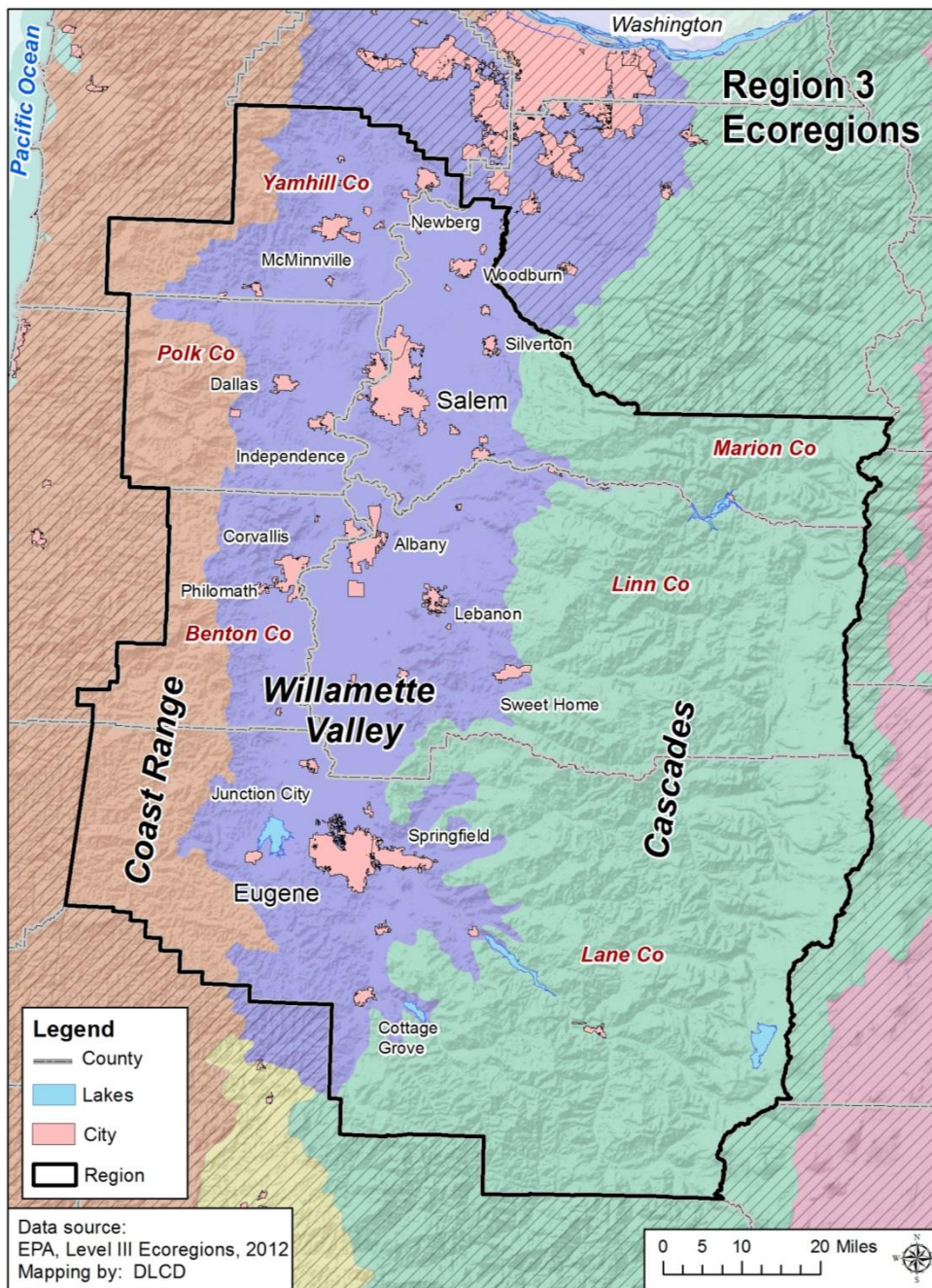
Source: Department of Land Conservation and Development, 2014

The U.S. EPA's ecoregions are used to describe areas of ecosystem similarity. Region 3 is composed of three ecoregions: the Cascades, the Willamette Valley, and the Coast Range.





Figure 2-168. Region 3 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 (Thorson, et al., 2003). 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. Large volcanic peaks, glaciers, and year-round snowfields punctuate the alpine and subalpine areas of the ecoregion (Thorson, et al., 2003).



**Coast Range:** The eastern slope of the Coast Range is located within Region 3. Soils in this ecoregion are a mixture of sedimentary and volcanic composition. Volcanic soils are underlain by basaltic rocks resulting in more consistent summer stream flows and supporting runs of spring Chinook salmon and summer steelhead. 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 (Thorson, et al., 2003).

**Willamette Valley:** Terraces and floodplains dominate the nearly flat central Willamette Valley. The valley floor is dotted with scattered hills and buttes and is bordered by the adjacent foothills. Historically, valley waterways meandered throughout floodplains on the nearly flat valley floor, contributing to the valley’s highly fertile soil and supporting the dominance of oak savannah and prairie ecosystems. Today the Willamette River and its tributaries are highly channelized, helping to protect property, but also restricting the flow of these waterways and threatening stream health. Productive soils and temperate climate make this ecoregion one of the most important agricultural areas in Oregon. The valley’s flat terraces have made urban and suburban development possible (Thorson, et al., 2003).

### *Climate*

This section covers historic climate information only. For estimated future climate conditions and possible impacts refer to the [State Risk Assessment](#).

The Willamette Valley’s mild climate, long growing season, and abundant moisture supports the most diversified agriculture in the state. Precipitation generally occurs in the winter months, falling mostly as rain in the valley, but building snowpack in the mid-elevations of the Cascade foothills. The region’s wet winters can lead to flood, landslide, and winter storm risks while dry summers can lead to drought and wildfire risks. Localized variations in temperature and precipitation exist across the region’s microclimates. [Table 2-274](#) displays 1981–2010 average precipitation and temperature for counties and climate divisions within Region 3 based on data from the NOAA National Centers for Environmental Information.



**Table 2-274. Average Precipitation and Temperature in Region 3 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)
Benton County	58.91" (38.67"–94.51")	Jan: 9.17" Jul: 0.53"	52.1°F	Jan: 34.9°F /46.8°F Jul: 51.6°F /80.2°F
Lane County	64.72" (46.07"–101.5")	Jan: 9.09" Jul: 0.77"	49.9°F	Jan: 33.3°F /44.8°F Jul: 50.8°F /77.0°F
Linn County	70.78" (51.06"–112.43")	Jan: 9.95" Jul: 0.87"	49.2°F	Jan: 32.1°F /43.7°F Jul: 50.1°F /77.4°F
Marion County	64.66" (44.46"–102.94")	Jan: 9.25" Jul: 0.84"	49.8°F	Jan: 32.6°F /44.1°F Jul: 51.1°F /77.3°F
Polk County	66.62" (42.46"–108.27")	Jan: 10.55" Jul: 0.59"	51.6°F	Jan: 34.9°F /46.1°F Jul: 51.7°F /78.9°F
Yamhill County	59.91" (38.41"–97.23")	Jan: 9.39" Jul: 0.59"	51.7°F	Jan: 35.1°F /45.8°F Jul: 52.2°F /78.6°F
Climate Division 2 "Willamette Valley"	58.11" (39.98"–92.22")	Jan: 8.35" Jul: 0.69"	51.5°F	Jan: 34.6°F /45.9°F Jul: 52.2°F /78.6°F
Climate Division 4 "Northern Cascades"	80.7" (59.67"–127.71")	Jan: 11.41" Jul: 1.05"	45.7°F	Jan: 28.5°F/39.8°F Jul: 48.2°F/74.2°F

Source: NOAA National Centers for Environmental Information, Climate at a Glance: County & Divisional Time Series, published August 2019, retrieved on August 15, 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.

Between 2010 and 2018, the region grew less quickly than the state as a whole. Benton County saw the largest percentage increase and Lane County saw the smallest. Over the next decade, all counties in the region are expected to increase in population. Polk and Yamhill Counties are projected to grow most quickly. Net in-migration is expected to increase and be the main driver of population growth in Yamhill County, with the cities of Newberg and McMinnville leading the way (Population Research Center, Portland State University, 2020, Mar. 31). Lane County is projected to continue growing, albeit more slowly than its regional peers. Like many places in Oregon, Lane County has an aging population and the majority of growth is projected to occur from in-migration (Population Research Center, Portland State University, 2019 [Lane County]).



**Table 2-275. Population Estimate and Forecast for Region 3**

	2010	2018	Percent Change (2010 to 2018)	2030 Projected	Percent Change (2018 to 2030)
<b>Oregon</b>	3,831,074	4,195,300	9.5%	4,694,000	11.9%
<b>Region 3</b>	1,043,897	1,127,835	8.0%	1,257,889	11.5%
Benton	85,579	93,590	9.4%	106,498	13.8%
Lane	351,715	375,120	6.7%	396,195	5.6%
Linn	116,672	125,575	7.6%	140,871	12.2%
Marion	315,335	344,035	9.1%	388,420	12.9%
Polk	75,403	82,100	8.9%	98,501	20.0%
Yamhill	99,193	107,415	8.3%	127,404	18.6%

Source: Population Research Center, Portland State University (2018), Certified Population Estimates; Population Research Center, Portland State University (2019), Current Forecast Summaries for All Areas & Oregon Final Forecast Table by Age (2019); U.S. Census Bureau, 2010 Decennial Census. Table DP-1Tourists

### Tourists

Tourists are not counted in population statistics and are therefore considered separately in this analysis. Tourism activities in Region 3 are largely centered on touring (traveling to experience scenic beauty, history, and culture), special events, and outdoor activities (Longwoods International, 2017c). The average travel party contains 2.8 persons, and 81% of their trips originate from California, Oregon, or Washington. In this region, the average trip length is 2.3 nights (Longwoods International, 2017c). Within the region, Lane County has the greatest number of tourists from 2016 to 2018. The presence of the University of Oregon in Eugene is likely a key driver of tourism in Lane County; however, conventions, outdoor recreation and touring has also been cited as important (Omundson, 2019).

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 2-276. Annual Visitor Estimates in Person Nights (x1000) in Region 3**

	2016		2017		2018	
	Number	Percent	Number	Percent	Number	Percent
<b>Region 3</b>	19,743		19,706		20,130	
<b>Benton</b>	1,427	100%	1,432	100%	1,523	100%
Hotel/Motel	451	31.6%	442	31%	495	33%
Private Home	889	62.3%	903	63%	941	62%
Other	87	6.1%	86	6%	87	6%
<b>Lane</b>	8,173	100%	8,042	100%	8,286	100%
Hotel/Motel	2,042	25.0%	1,974	25%	2,057	25%
Private Home	4,766	58.3%	4,713	59%	4,857	59%
Other	1,365	16.7%	1,354	17%	1,372	17%
<b>Linn</b>	1,972	100%	1,965	100%	1,992	100%
Hotel/Motel	393	20%	389	20%	391	20%
Private Home	1,243	63%	1,244	63%	1,264	63%



	2016		2017		2018	
Other	336	17%	332	17%	337	17%
<b>Marion</b>	5,387	100%	5,436	100%	5,408	100%
Hotel/Motel	1,137	21%	1,158	21%	1,124	21%
Private Home	3,701	69%	3,735	69%	3,733	69%
Other	549	10%	544	10%	551	10%
<b>Polk</b>	1,101	100%	1,125	100%	1,148	100%
Hotel/Motel	199	18.1%	196	17.4%	201	17.5%
Private Home	793	72.0%	820	72.9%	837	72.9%
Other	110	10.0%	109	9.7%	110	9.6%
<b>Yamhill</b>	1,683	100%	1,706	100%	1,773	100%
Hotel/Motel	539	32%	551	32%	592	33%
Private Home	1,050	62%	1,061	62%	1,087	61%
Other	95	6%	94	6%	95	5%

Source: Oregon Travel Impacts: 1992–2018, March 2019. (Dean Runyan Associates, 2019),  
[http://www.deanrunyan.com/doc\\_library/ORImp.pdf](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 similar percentage of the people in Region 3 identify as having a disability as do people throughout the state.

The region also has a similar share of younger people (< 18) and older people (≥ 65) with a disability. Within the region, Linn and Lane Counties have the highest percentages of people with a disability. Benton County has the smallest percentage among its overall population and among its younger and older populations.

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 2-277. People with a Disability by Age Group in Region 3**

	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 (+/-)
<b>Oregon</b>	14.6%	✓	0.1%	4.6%	✓	0.2%	37.1%	✓	0.4%
<b>Region 3</b>	15.5%	✓	0.3%	5.3%	✓	0.4%	37.9%	✓	0.7%
Benton	10.5%	✓	0.6%	4.8%	✓	1.1%	30.6%	✓	2.5%
Lane	16.8%	✓	0.5%	5.4%	✓	0.7%	37.7%	✓	1.1%
Linn	17.4%	✓	0.9%	5.4%	✓	1.2%	41.4%	✓	1.9%
Marion	14.8%	✓	0.5%	5.4%	✓	0.7%	37.9%	✓	1.5%
Polk	14.4%	✓	0.9%	4.9%	⊙	1.4%	36.7%	✓	2.7%
Yamhill	15.7%	✓	0.9%	5.7%	✓	1.3%	40.4%	✓	2.6%

\*\*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 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 (PIT), a biennial count of both 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 and Community Services, 2019, Nov. 21). 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 and Community Services, 2019, Nov. 21).

With the exception of Marion County, all counties in the region reported an increase in the overall number of homeless persons between 2017 and 2019. Linn County reported the largest percentage increase during this period (54%), while Lane County reported the greatest increase in the total number of people experiencing homelessness. Lane County also reported an increase in its unsheltered homeless population during this period and has one of the largest homeless populations in the state (Oregon Housing and Community Services, 2019).

People experiencing homelessness are typically more physically and psychologically vulnerable compared to the general population and natural hazard events exacerbate their vulnerability. Disasters that result in damage to the built environment can place additional stress on temporary shelters, a vital service for many people experiencing homelessness (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 2-278. Homeless Population Estimate for Region 3**

	2015	2017	2019	Period Average
<b>Oregon</b>	13,077	13,953	15,800	14,277
<b>Region 3</b>	3,091	3,640	4,575	3,769
Benton	127	287	331	248
Lane	1,473	1,529	2,165	1,722
Linn	222	180	277	226
Marion	732	1,049	974	918
Polk	42	102	121	88
Yamhill	495	493	707	565

Source: Oregon Point in Time Homeless Count, Oregon Housing and Community Services.  
[http://www.oregon.gov/ohcs/pages/ra\\_point\\_in\\_time\\_homeless\\_count.aspx](http://www.oregon.gov/ohcs/pages/ra_point_in_time_homeless_count.aspx)

### *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 slightly more women than men (98.3 men for every 100 women) (U.S. Census Bureau, 2019). The same is true for all counties in the region, except Benton County, which has slightly more men (101.9 men for every 100 women) (U.S. Census Bureau, 2019). Within the region, Polk County has the greatest male to female disparity (94.5 men for every 100 women) (U.S. Census Bureau, 2019).

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 recognized (Enarson, 2017). This is an area deserving of more attention as the field develops

### *Age*

Region 3 has the same proportion of older adults, persons aged 65 and older, as the state as a whole. Within the region, Benton and Marion Counties have the smallest share of older adults (14.6%) and Lane and Linn Counties have the greatest (17%). 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).

Children, persons under the age of 18, also represent a vulnerable segment of the population. Within the region, Benton County has the smallest share (16.7%) of children and Marion County has the greatest (25.3%). Special consideration 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 may lose time from work and money when their children’s childcare facilities and schools are impacted by disasters (Cutter, Boruff, & Shirley, 2003).

**Table 2-279. Population by Vulnerable Age Group, in Region 3**

	Total Population	Under 18 Years Old			65 Years and Older		
	Estimate	Estimate	CV **	MOE (+/-)	Estimate	CV **	MOE (+/-)
<b>Oregon</b>	4,025,127	21.5%	✓	0.1%	16.3%	✓	0.1%
<b>Region 3</b>	1,085,279	21.9%	✓	0.0%	16.3%	✓	0.0%
Benton	88,249	16.7%	✓	0.1%	14.6%	✓	0.1%
Lane	363,471	19.0%	✓	*	17.7%	✓	0.1%
Linn	121,074	23.1%	✓	*	17.6%	✓	0.1%
Marion	330,453	25.3%	✓	*	14.6%	✓	0.1%
Polk	79,666	23.3%	✓	*	16.9%	✓	0.1%
Yamhill	102,366	23.1%	✓	0.1%	15.9%	✓	0.1%

\*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 (2018). Table DP05: ACS Demographics and Housing Estimates, 2013-2017 American Community Survey 5-Year Estimates. Retrieved from <https://data.census.gov/cedsci/>



## Language

Special consideration 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. Similar to the state, almost 94% of the region’s population speaks English “very well”. Notably, approximately 11% of the people in Marion County speak English less than “very well”. Outreach materials used to communicate with and plan for this community should take into consideration their language needs.

**Table 2-280. English Usage in Region 3**

	Speak English Less Than “Very Well”				
	Estimate	CV**	MOE (+/-)	Percent	% MOE (+/-)
<b>Oregon</b>	222,428	✓	4,116	5.9%	0.1%
<b>Region 3</b>	57,156	✓	2,058	5.6%	0.2%
Benton	3,550	✓	466	4.2%	0.6%
Lane	9,080	✓	861	2.6%	0.2%
Linn	2,352	✓	404	2.1%	0.4%
Marion	33,206	✓	1,578	10.8%	0.5%
Polk	3,797	✓	587	5.1%	0.8%
Yamhill	5,171	✓	529	5.4%	0.5%

\*\*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, 2008–2012 American Community Survey 5-Year Estimates, Table DP02

## 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).

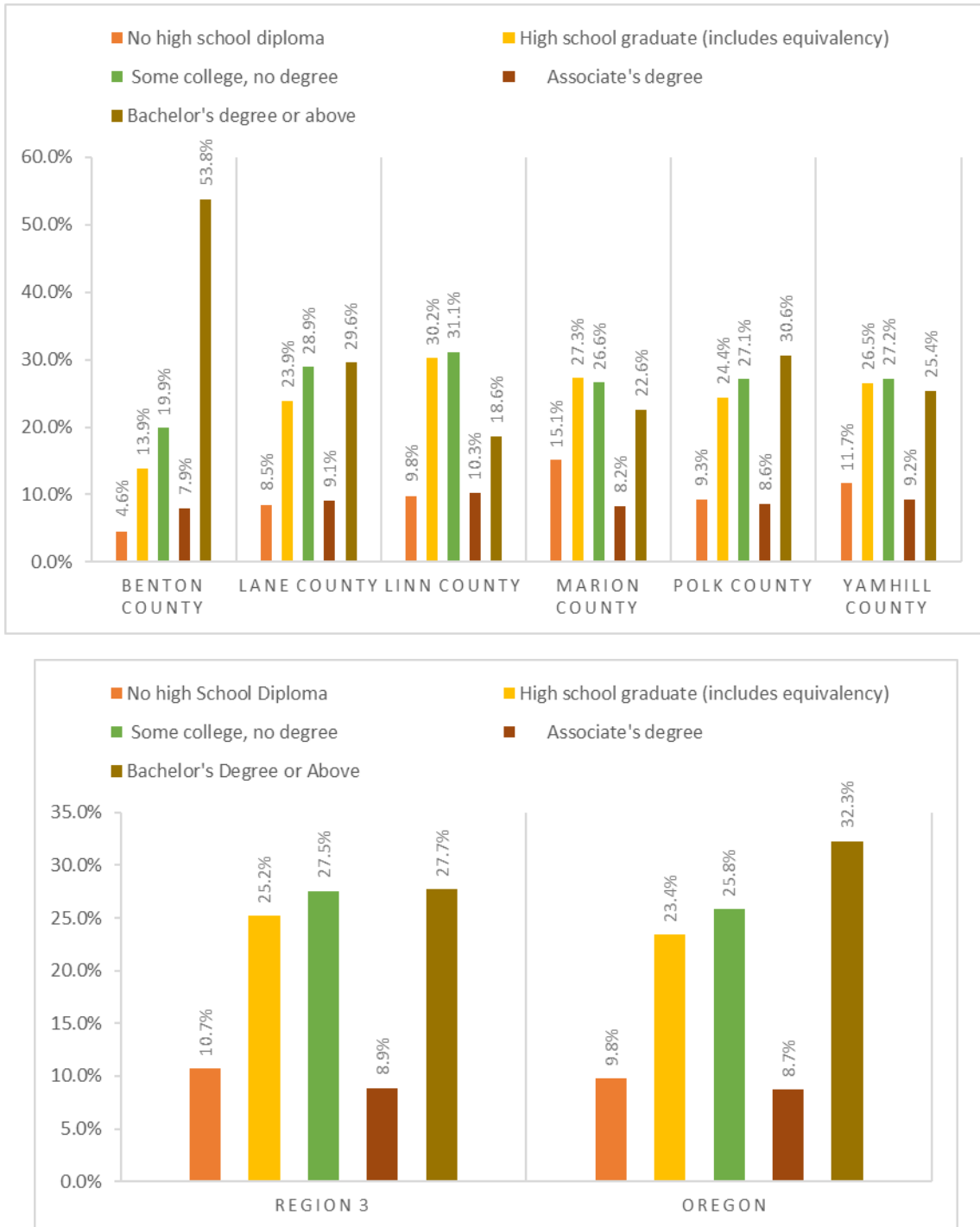
Approximately 28% of residents in Region 3 have a bachelor’s degree or higher, which is approximately five percentage points lower than the statewide estimate. One tenth of residents in the region do not have a high school diploma, which is similar to the statewide share. Approximately one-quarter of the population has received some college credit. Similar to the statewide share, roughly 9% of Region 3 residents, or between 5%-10% in each county, has an associate’s degree.

Benton County is a notable outlier in the region and state, with nearly 54% of residents holding a four-year degree or more. This is likely a result of a relatively small population and the presence of Oregon State University in Corvallis. Within the region, Linn County has the smallest



share of residents with at a bachelor’s degree or more (18.6%) and Marion County has the highest share of residents without a high school diploma (15.1%).

**Figure 2-169. Educational Attainment in Region 3: (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. Retrieved from <https://data.census.gov/cedsci/>



### 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, P., 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 generally declines with distance from the Portland Metropolitan Area. Yamhill County has the highest median household income, approximately \$2,000 above the statewide median. Lane County has the lowest and is approximately \$8,000 below the statewide estimate. From 2012 to 2017, only Lane County and Marion County experienced a statistically significant change in median household income—both increased.

**Table 2-281. Median Household Income in Region 3**

	2008–2012			2013–2017			Statistically Different*
	Estimate	CV **	MOE (+/-)	Estimate	CV **	MOE (+/-)	
<b>Oregon</b>	\$53,427	☑	\$338	\$56,119	☑	\$370	Yes
<b>Region 3</b>	—	—	—	—	—	—	—
Benton	\$51,963	☑	\$2,574	\$54,682	☑	\$2,361	No
Lane	\$45,680	☑	\$858	\$47,710	☑	\$857	Yes
Linn	\$50,518	☑	\$1,304	\$49,515	☑	\$1,904	No
Marion	\$49,750	☑	\$848	\$53,828	☑	\$1,048	Yes
Polk	\$56,343	☑	\$2,001	\$56,032	☑	\$2,412	No
Yamhill	\$57,650	☑	\$2,043	\$58,392	☑	\$2,118	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.

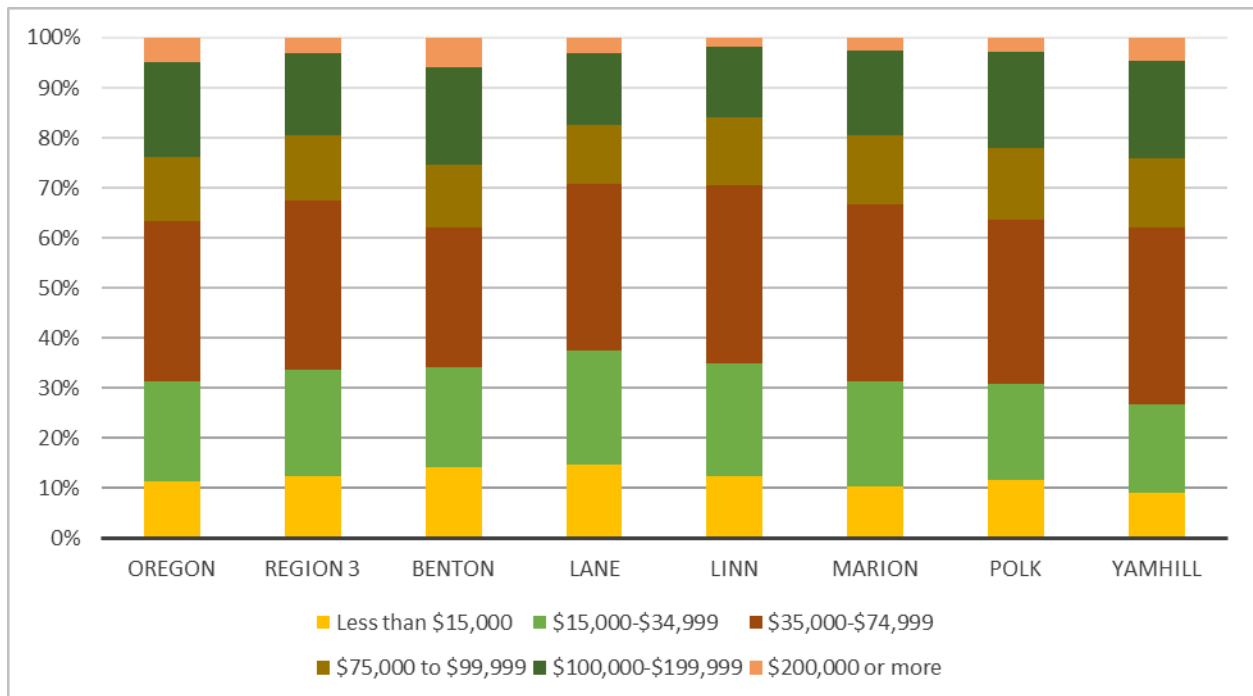
\*\*The circle with a checkmark, circle within a circle, and circle with an x-mark indicate the reliability of each estimate using the coefficient of variation (CV). This table may not contain all these symbols. The lower the CV, the more reliable the data. High reliability (CV <15%) is shown with a 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 its households earning less than \$35,000 per year than the state as a whole. Within the region, Lane County has the highest percentage of people in the lowest income bracket, less than \$15,000 per year, and Yamhill has the smallest share. Benton and Yamhill Counties have a higher percentage of households earning more than \$75,000 per year than the state.



**Figure 2-170. Median Household Income Distribution in Region 3**



Source: U.S. Census Bureau, 2008–2012 American Community Survey 5-Year Estimates, Table DP03

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. Marion County was the only county in the region to experience a statistically significant change—a decrease—in the share of people experiencing poverty from 2012 to 2017. All counties in the region, with the exception of Yamhill County, have a higher percentage of people living in poverty than the state as a whole. Benton County has the largest share of people living in poverty, approximately six percentage points more than the statewide estimate and 3.7 above the regional share. However, it should be noted that poverty rates can be influenced by college students living off-campus. Past U.S. Census Bureau research found that Benton, Lane, and Polk Counties saw statistically significant decreases in poverty rates after the exclusion of off-campus college students (Benson & Bishaw, 2017). The majority of counties in their research saw decreases of five percentage points or less in their poverty rates when college students living off campus were excluded from the sample (Benson & Bishaw, 2017).

A higher percentage of children in Region 3 are living in poverty compared to the statewide share. Although Marion County continues to have the highest percentage of child poverty in the region, it was the only county that experienced a statistically significant decrease from 2012 to 2017. Benton County has the lowest estimate in the region, approximately six percentage points below the regional 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.

**Table 2-282. Poverty Rates in Region 3**

	Total Population in Poverty						Statistical Difference?*
	2008-2012			2013-2017			
	Estimate	CV**	MOE (+/-)	Estimate	CV**	MOE (+/-)	
<b>Oregon</b>	15.5%	☑	0.3%	14.9%	☑	0.3%	No
<b>Region 3</b>	17.8%	☑	0.5%	17.0%	☑	0.4%	No
Benton	21.6%	☑	1.3%	20.7%	☑	1.1%	No
Lane	18.8%	☑	0.7%	18.8%	☑	0.7%	No
Linn	16.7%	☑	1.3%	16.1%	☑	1.5%	No
Marion	18.0%	☑	1.0%	15.9%	☑	0.9%	Yes
Polk	14.6%	☑	1.5%	15.4%	☑	1.5%	No
Yamhill	13.9%	☑	1.4%	13.7%	☑	1.3%	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. 2008-2012 and 2013-2017. American Community Survey – 5-Year Estimates, Table S1701



**Table 2-283. Child Poverty in Region 3**

	Children Under 18 in Poverty						Statistical Difference?*
	2008-2012			2013-2017			
	Estimate	CV**	MOE (+/-)	Estimate	CV**	MOE (+/-)	
<b>Oregon</b>	20.6%	✓	0.5%	19.0%	✓	0.6%	Yes
<b>Region 3</b>	22.7%	✓	1.0%	20.7%	✓	1.0%	Yes
Benton	16.4%	✓	3.4%	12.8%	✓	2.9%	No
Lane	20.3%	✓	1.7%	20.3%	✓	1.8%	No
Linn	25.2%	✓	2.7%	21.6%	✓	3.0%	No
Marion	27.1%	✓	1.8%	23.2%	✓	2.0%	Yes
Polk	18.9%	✓	3.4%	17.5%	✓	3.7%	No
Yamhill	18.8%	✓	2.7%	19.5%	✓	2.9%	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. 2008-2012 and 2013-2017. American Community Survey – 5-Year Estimates, Table S1701

### 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).





The percentage of homeownership exceeds that of the state in Linn, Polk, and Yamhill Counties. Benton County has a higher rate of renter occupied units than other counties in the region. This number is likely driven by rental demand for off campus housing for students attending Oregon State University in Corvallis.

**Table 2-284. Housing Tenure in Region 3**

	Total Occupied Units	Owner Occupied			Renter Occupied		
		Estimate	CV **	MOE (+/-)	Estimate	CV **	MOE (+/-)
<b>Oregon</b>	1,571,631	61.7%	✓	0.3%	38.3%	✓	0.3%
<b>Region 3</b>	410,949	60.7%	✓	0.4%	39.3%	✓	0.5%
Benton	34,775	56.9%	✓	1.5%	43.1%	✓	1.5%
Lane	148,752	58.8%	✓	0.7%	41.2%	✓	0.7%
Linn	46,265	64.1%	✓	1.5%	35.9%	✓	1.5%
Marion	116,077	59.8%	✓	0.8%	40.2%	✓	0.8%
Polk	29,128	64.6%	✓	1.9%	35.4%	✓	1.9%
Yamhill	35,952	67.9%	✓	1.4%	32.1%	✓	1.4%

Source: U.S. Census Bureau, 2013–2017 American Community Survey 5-Year Estimates, Table DP04; <https://data.census.gov/cedsci/>

### *Families and Living Arrangements*

Family care and obligations can create additional hardship during post-disaster recovery, especially for single-parent households (Cutter, Boruff, & Shirley, 2003). 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 3 is predominantly composed of family households. Benton and Lane Counties have higher percentages of non-family households and single-person households, estimates which are likely influenced by the presence of large universities. The region as a whole has approximately the same percentage of households with children as the state, but a greater share of single-parent households. Marion County has the highest percentage of single-parent households, followed closely by Linn and Yamhill Counties.



**Table 2-285. Family vs. Non-family Households in Region 3**

	Total Households	Family Households			Nonfamily Households			Householder Living Alone		
	Estimate	Estimate	CV **	MOE (+/-)	Estimate	CV **	MOE (+/-)	Estimate	CV **	MOE (+/-)
<b>Oregon</b>	1,571,631	63.3%	✓	0.2%	36.7%	✓	0.2%	27.7%	✓	0.2%
<b>Region 3</b>	410,949	64.0%	✓	0.5%	36.0%	✓	0.5%	26.8%	✓	0.4%
Benton	34,775	55.9%	✓	1.5%	44.1%	✓	1.5%	27.9%	✓	1.4%
Lane	148,752	59.1%	✓	0.7%	40.9%	✓	0.7%	29.6%	✓	0.7%
Linn	46,265	68.1%	✓	1.4%	31.9%	✓	1.4%	24.7%	✓	1.2%
Marion	116,077	68.2%	✓	0.8%	31.8%	✓	0.8%	25.5%	✓	0.8%
Polk	29,128	67.9%	✓	1.5%	32.1%	✓	1.5%	24.0%	✓	1.5%
Yamhill	35,952	70.5%	✓	1.6%	29.5%	✓	1.6%	23.2%	✓	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. 2013-2017 American Community Survey. <https://data.census.gov/cedsci/>. Table DP02: Selected Social Characteristics

**Table 2-286. Family Households with Children by Head of Household in Region 3**

	Family Households with Children			Single Parent (Male or Female)		
	Estimate	CV**	MOE (+/-)	Estimate	CV**	MOE (+/-)
<b>Oregon</b>	26.2%	✓	0.2%	8.1%	✓	0.2%
<b>Region 3</b>	26.3%	✓	0.4%	8.5%	✓	0.3%
Benton	21.8%	✓	1.0%	4.6%	✓	0.8%
Lane	22.6%	✓	0.5%	7.8%	✓	0.5%
Linn	27.7%	✓	1.0%	9.6%	✓	1.0%
Marion	30.4%	✓	0.8%	10.2%	✓	0.8%
Polk	27.9%	✓	1.4%	7.4%	✓	1.3%
Yamhill	29.1%	✓	1.2%	9.1%	✓	1.1%

\*\*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. <https://data.census.gov/cedsci/>. Table DP02: Selected Social Characteristics



### *Social and Demographic Trends*

The social and demographic analysis shows that Region 3 is particularly vulnerable during a hazard event in the following categories:

- Except for Marion County, all counties in the region experienced an increase in the overall number of homeless persons between 2015 and 2019.
- Lane County has one of the largest homeless populations in the state and experienced an increase in its unsheltered population during the same period.
- Approximately 11% of the population in Marion County does not speak English "very well".
- A greater share of the regional population is living in poverty compared to the statewide percentage. Moreover, a higher percentage of children are living in poverty in the region compared to the state as a whole. Marion County has the highest child poverty rate.
- Marion, Linn, and Yamhill have a higher share of single-parent households compared to the statewide estimate.



## 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 3 have been steadily declining since they peaked in 2009 during the Great Recession. Within the region, rates are similar to the statewide average and consistently lowest in Benton County and highest in Linn County. Reflecting largest populations, the majority of employment is in Marion and Lane Counties.

**Table 2-287. Civilian Labor Force in Region 3, 2018**

	Civilian Labor Force		Employed Workers		Unemployed	
	Total	Total	Percent	Total	Percent	
<b>Oregon</b>	2,104,516	2,017,155	95.8%	87,361	4.2%	
<b>Region 3</b>	544,552	521,334	95.7%	23,218	4.3%	
Benton	48,345	46,810	96.8%	1,535	3.2%	
Lane	181,761	173,596	95.5%	8,165	4.5%	
Linn	58,551	55,780	95.3%	2,771	4.7%	
Marion	161,676	154,716	95.7%	6,960	4.3%	
Polk	39,695	37,959	95.6%	1,736	4.4%	
Yamhill	54,524	52,473	96.2%	2,051	3.8%	

Source: Oregon Employment Department, 2019



**Table 2-288. Civilian Unemployment Rates in Region 3, 2014-2018**

	2014	2015	2016	2017	2018	Change (2014-2018)
<b>Oregon</b>	6.8%	5.6%	4.8%	4.1%	4.2%	-2.6%
<b>Region 3</b>	6.9%	5.8%	5.0%	4.3%	4.3%	-2.7%
Benton	5.1%	4.2%	3.9%	3.2%	3.2%	-1.9%
Lane	6.9%	5.8%	5.1%	4.4%	4.5%	-2.4%
Linn	8.1%	6.7%	5.7%	4.7%	4.7%	-3.4%
Marion	7.4%	6.0%	5.1%	4.3%	4.3%	-3.1%
Polk	6.8%	5.6%	5.0%	4.3%	4.4%	-2.4%
Yamhill	6.4%	5.3%	4.6%	3.8%	3.8%	-2.6%

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, n.d.). “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, n.d.). 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, Dec. 20). This plan looks at regional economic activity through these supersectors and then through three-digit NAICS subsectors.

In 2018 the five major supersectors by share of employment in Region 1 were:

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

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, Sept. 4). In Region 3, the following supersectors comprise a significant share of all business establishments.

- The Other Services supersector includes the highest number of establishments in Region 3, 17.7% of the share (QCEW, 2018).
- Trade Transportation and Utilities is second largest, with 15.8% of all establishments (QCEW, 2018).



- Professional and Business Services is third with 13.5% of the regional share (QCEW, 2018).
- Professional and Business comprises is fourth, comprising 10.7% of all establishments (QCEW, 2018).
- The Construction supersector is fifth largest, making up 9.9% of all businesses (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 2-289. Covered Employment by Sector in Region 3**

Industry	Region 3		Benton County		Lane County		Linn County	
	%	Employment	%	Employment	%	Employment	%	Employment
<b>Total All Ownerships</b>	100.0%	38,058	100.0%	156,759	100.0%	47,341	100.0%	
<b>Total Private Coverage</b>	81.4%	28,542	75.0%	132,431	84.5%	40,649	85.9%	
Natural Resources & Mining	4.6%	1,083	2.8%	2,360	1.5%	2,447	5.2%	
Construction	5.4%	1,198	3.1%	7,204	4.6%	3,030	6.4%	
Manufacturing	10.0%	3,013	7.9%	14,195	9.1%	8,263	17.5%	
Trade, Transportation & Utilities	17.0%	4,589	12.1%	29,873	19.1%	9,948	21.0%	
Information	1.1%	600	1.6%	2,411	1.5%	393	0.8%	
Financial Activities	3.5%	1,123	3.0%	6,200	4.0%	1,387	2.9%	
Professional & Business Services	9.3%	4,284	11.3%	18,188	11.6%	2,959	6.3%	
Education & Health Services	16.6%	6,760	17.8%	27,763	17.7%	6,438	13.6%	
Leisure & Hospitality	9.9%	4,260	11.2%	17,558	11.2%	3,893	8.2%	
Other Services	4.0%	1,622	4.3%	6,630	4.2%	1,872	4.0%	
Unclassified	0.0%	11	0.0%	48	0.0%	19	0.0%	
<b>Total All Government</b>	18.6%	9,516	25.0%	24,328	15.5%	6,692	14.1%	
Total Federal Government	1.0%	476	1.3%	1,802	1.1%	306	0.6%	
Total State Government	4.9%	216	0.6%	1,680	1.1%	599	1.3%	
Total Local Government	12.7%	8,824	23.2%	20,846	13.3%	5,787	12.2%	

Industry	Region 3		Marion County		Polk County		Yamhill County	
	%	Employment	%	Employment	%	Employment	%	Employment
<b>Total All Ownerships</b>	100.0%	155,949	100.0%	20,442	100.0%	36,339	100.0%	
<b>Total Private Coverage</b>	81.4%	121,028	77.6%	15,536	76.0%	32,155	88.5%	
Natural Resources & Mining	4.6%	9,565	6.1%	1,750	8.6%	3,669	10.1%	
Construction	5.4%	9,993	6.4%	1,031	5.0%	1,977	5.4%	
Manufacturing	10.0%	10,862	7.0%	2,272	11.1%	6,896	19.0%	
Trade, Transportation & Utilities	17.0%	25,739	16.5%	2,467	12.1%	4,844	13.3%	
Information	1.1%	1,288	0.8%	65	0.3%	242	0.7%	
Financial Activities	3.5%	5,714	3.7%	463	2.3%	1,007	2.8%	
Professional & Business Services	9.3%	13,555	8.7%	1,232	6.0%	1,940	5.3%	
Education & Health Services	16.6%	24,704	15.8%	3,325	16.3%	6,392	17.6%	
Leisure & Hospitality	9.9%	13,642	8.7%	1,995	9.8%	3,792	10.4%	
Other Services	4.0%	5,916	3.8%	924	4.5%	1,386	3.8%	
Unclassified	0.0%	51	0.0%	11	0.1%	9	0.0%	
<b>Total All Government</b>	18.6%	34,921	22.4%	4,905	24.0%	4,184	11.5%	
Total Federal Government	1.0%	1,294	0.8%	112	0.5%	440	1.2%	
Total State Government	4.9%	19,350	12.4%	343	1.7%	211	0.6%	
Total Local Government	12.7%	14,277	9.2%	4,450	21.8%	3,532	9.7%	

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 sector 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. Disruption of the transportation system could sever connectivity of people and retail hubs. Retail businesses are concentrated in the larger cities of the region.

**Education and Health Services:** The Health and Social Assistance industries play important roles in emergency response in the event of a disaster. Health care is a relatively stable revenue sector regionally with an abundant distribution of businesses primarily serving a local population.

**Manufacturing:** This supersector 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 often less dependent on local markets for sales, which may contribute to the economic resilience of this sector. The timber manufacturing industry is particularly vulnerable to droughts, landslides, and wildfires.

**Leisure and Hospitality:** This supersector primarily serves regional residents with disposable income and tourists. The behavior of both of these social groups would be disrupted by a natural disaster. Regional residents may have less disposable income and tourists may choose not to visit a region with unstable infrastructure.

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. Notably, in Region 2, three of the largest subsectors by share of employment are healthcare related, Ambulatory—also known as outpatient services—Health Care Services, Nursing and Residential Care Facilities, and Hospitals. 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 6. These subsectors also rank highly in other regions. Conversely, other subsectors, such as Crop Production, are more unique to the region.

**Table 2-290. Industries with Greatest Share of Employment in Region 3, 2018**

Industry	Employment Share	Employment (2018)
Educational Services	9%	49,375
Food Services and Drinking Places	8%	45,386
Administrative and Support Services	6%	30,211
Ambulatory Health Care Services	5%	24,936
Nursing and Residential Care Facilities	4%	19,834
Hospitals	4%	18,981
Specialty Trade Contractors	3%	18,456
Social Assistance	3%	18,306
Professional, Scientific, and Technical Services	3%	18,050
Crop Production	3%	16,292

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 2-291. Most Concentrated Industries and Employment Change in Region 3, 2018**

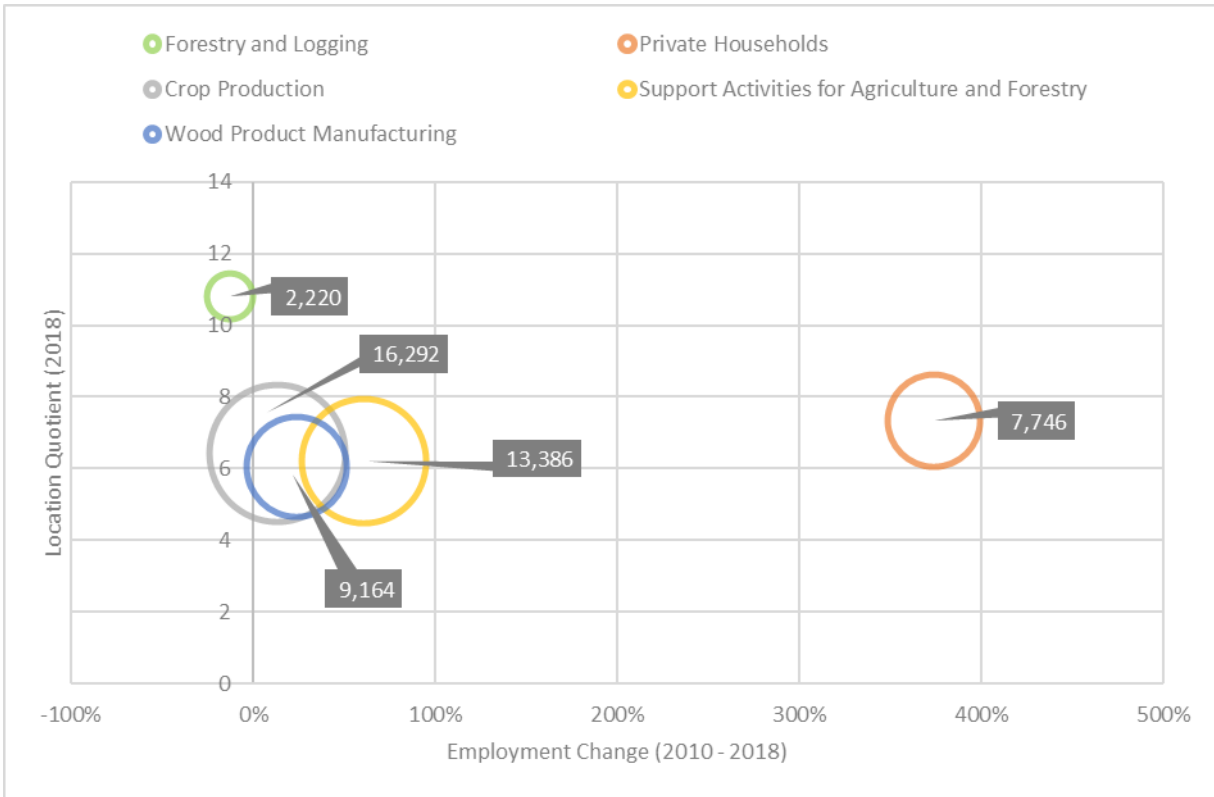
Industry	Location Quotient	Employment (2018)	Employment Change (2010–2018)
Forestry and Logging	10.8	2,220	-13%
Private Households	7.3	7,746	374%
Crop Production	6.4	16,292	13%
Support Activities for Agriculture and Forestry	6.2	13,386	61%
Wood Product Manufacturing	6.1	9,164	24%

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 DLCDD

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 3 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 2-171. Location Quotients, Employment Change, and Total Employment in Region 3, 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

Four of the region’s five most concentrated industries are natural resource based—three have ties to timber. The Forestry and Logging subsector has the highest location quotient, but constitutes a small share of overall employment and shed jobs from 2010 to 2018. The Wood Product Manufacturing subsector has a location quotient over six—a value five-hundred percent higher than would be expected vis-à-vis the nation; the sector increased employment by nearly a quarter during the eight-year period. Employment concentrations in Crop Production and Support Activities of Agriculture and Forestry reflects the rich agricultural economy of the Mid-Willamette Valley and together comprise a significant number of jobs.

***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 3’s fastest growing and declining industries.

**Table 2-292. Fastest Growing and Declining Industries in Region 3, 2010-2018**

Industry	Employment Change	Employment (2010)	Employment (2018)
<b>Fastest Growing</b>			
Private Households	374%	1,636	7,746
Motion Picture and Sound Recording Industries	265%	771	2,811
Other Information Services	208%	224	692
Air Transportation	144%	446	1,086
Construction of Buildings	101%	4,474	9,009
<b>Fastest Declining</b>			
Apparel Manufacturing	-67%	472	155
Paper Manufacturing	-41%	1,344	797
Executive, Legislative, and Other General Government Support	-37%	13,019	8,210
Wholesale Electronic Markets and Agents and Brokers	-31%	1,772	1,227
Publishing Industries (except Internet)	-23%	3,614	2,776

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

Mirroring a statewide trend, employment in the Private Households subsector grew quickly in Oregon from 2010 to 2018 (Wallis, 2019). The Private Households industry employs workers “that work on or about the household premises...such as cooks, maids, butlers, gardeners, personal caretakers, and other maintenance workers” (Wallis, 2019).

While most employment in the Motion Picture and Sound Recording Industries subsector is concentrated in the Portland metro area, Region 3 experienced strong growth in the subsector during the eight-year period. This regional specialty is indicated in the shift-share analysis, which shows the regional-shift as the largest driver of growth. Part of the increase is likely driven by the state’s reputation as a hub for multimedia artists and animators (Starbuck, 2016).

Growth in the Construction of Buildings subsector was strong and 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).

The Air Transportation and Other Information Services subsectors also experienced strong growth during the period. Growth in the Air Transportation subsector was likely driven in part by increased service and passenger travel in Eugene. According to the shift-share analysis, most of the growth in both subsectors was driven by regional factors.

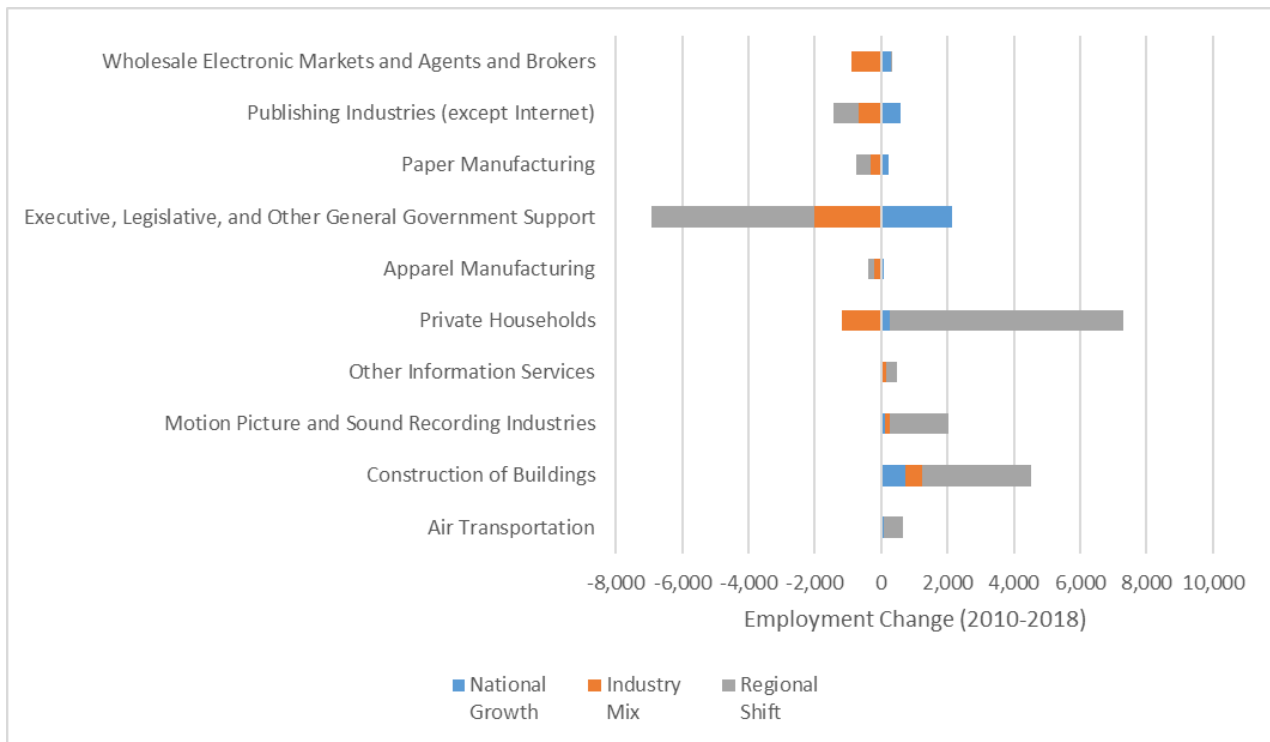
The Wholesale Electronic Markets and Agents and Brokers subsector—which coordinates the sale of goods owned by others, typically for a commission or fee—lost jobs during the 2010 to 2018 period. According to the shift-share analysis, the job loss was not driven by regional factors but forces impacting 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).

The largest decline occurred in the Executive, Legislative, and Other General Government support. While some of the loss can be explained by trends in the subsector nationally, the regional shift suggests something unique happened in the region during the period. The same is true for trends in the Paper Manufacturing, Publishing Industries (Except Internet), and Apparel Manufacturing subsectors. Losses in the Paper Manufacturing subsector represent the continuation of a decade’s long statewide trend (Knoder, Paper cuts: Oregon's declining paper industry, 2018, December 6). Increased competition from abroad is a key driver of employment loss statewide (Knoder, Paper cuts: Oregon's declining paper industry, 2018, December 6). Job loss in Publishing Industries (Except Internet), a subsector comprised of newspaper and periodical businesses, is likely driven by shifts in the media landscape, away from print materials to online platforms.

**Figure 2-172. Shift-Share-Analysis of Fastest Growing and Declining Industries in Region 3, 2010-2018**



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



**Table 2-293. Shift-Share-Analysis of Fastest Growing and Declining Industries in Region 2, 2010-2018**

Industry	Employment Change	National Growth	Industry Mix	Regional Shift
<b>Fastest Growing</b>				
Air Transportation	640	740	-24	591
Construction of Buildings	4,535	732	505	3,298
Motion Picture and Sound Recording Industries	2,040	126	116	1,798
Other Information Services	467	37	114	316
Private Households	6,110	268	-1,200	7,043
<b>Fastest Declining</b>				
Apparel Manufacturing	-317	77	-209	-185
Executive, Legislative, and Other General Government Support	-4,808	2,130	-2,028	-4,910
Paper Manufacturing	-547	220	-304	-464
Publishing Industries (except Internet)	-838	591	-683	-746
Wholesale Electronic Markets and Agents and Brokers	-545	290	-882	48

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

### *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 Region 3’s level of vulnerability to natural hazard events:

- Unemployment in Linn County is consistently higher than its regional counterparts and higher than the statewide average;
- 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 Forestry and Logging subsector, an area of competitive advantage for the region, shed jobs from 2010-2018.

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 highway system in the Region 3 centers on I-5 and the major east-west highways that intersect it. Recent population growth in the region has increased the number of vehicles on the roads. Many trips through the region originate outside the region in the Portland Metropolitan Area. Portland drivers commonly enter the region to reach Salem, The Spirit Mountain Casino, and coastal destinations. Many new residents of Yamhill County commute to Portland for work. [Figure 2-173](#) shows Region 3's highways and population centers.

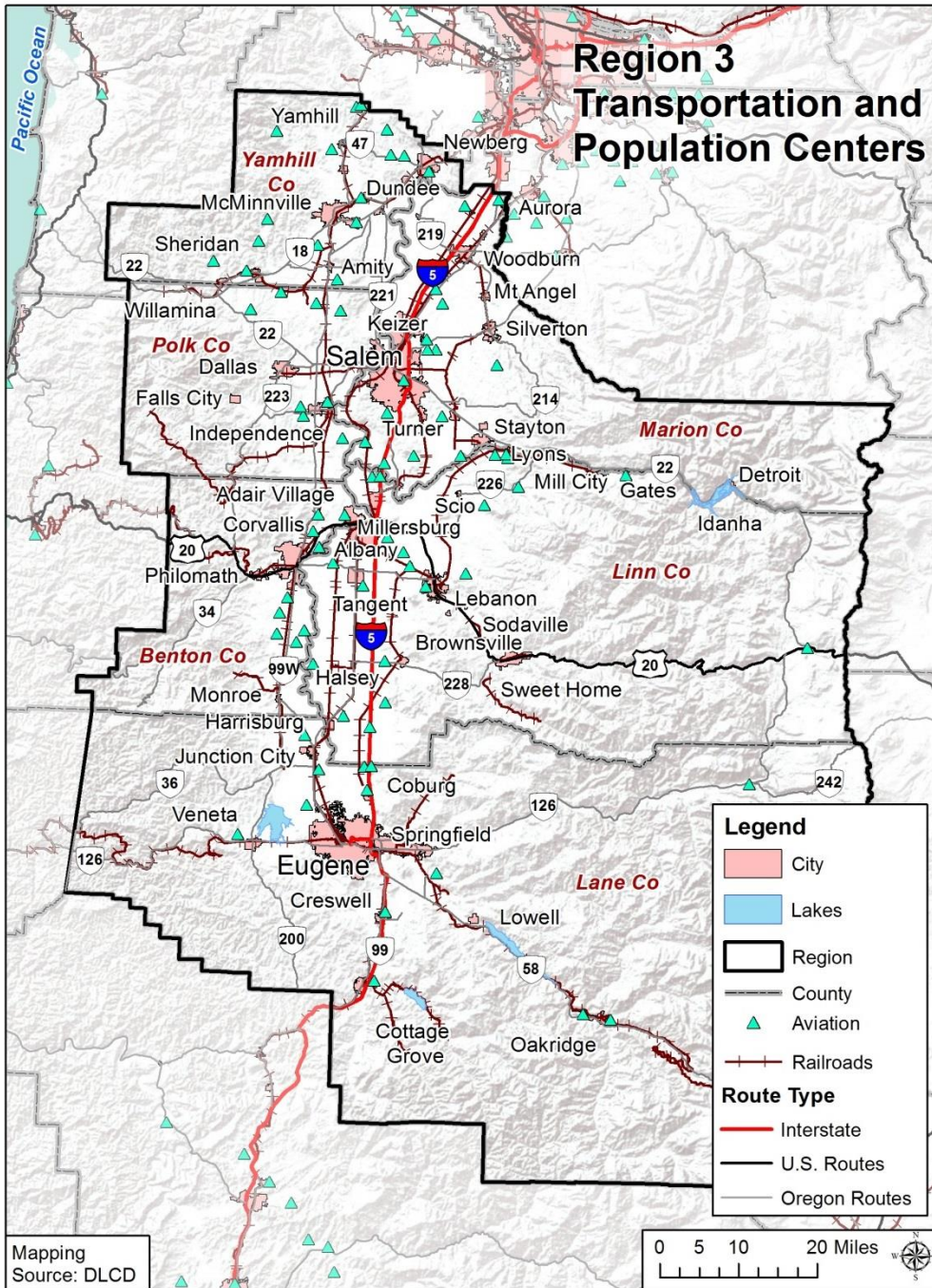
Region 3's growing population centers bring more workers, automobiles and trucks onto roads. A high percentage of workers driving alone to work coupled with interstate and international freight movement on the I-5 corridor create additional stresses on transportation systems. Some of these include added 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 evacuations 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 (2014, October) Seismic Plus Report (Appendix [9.1.13](#)), the region has high 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 3, see [Seismic Lifelines](#).



**Figure 2-173. Region 3 Transportation and Population Centers**



Source: Oregon Department of Transportation, (2014, October)

Bridges

ODOT lists 2,096 bridges in the counties that comprise Region 3.





Because of earthquake risk in Region 3, 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 that are part of regional and local systems that are maintained by the region’s counties and cities.

**Table 2-294** 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. These ratings do not imply that a bridge is unsafe (ODOT, 2020). A significant improvement in the condition of the region’s bridges reduced to 7% (from 29% in 2012 and 2013) the percentage of the region’s bridges that are distressed or deficient. About 2% (from 22% in 2012 and 2013) of the region’s ODOT bridges are distressed. Seventeen percent of all bridges in Linn County are categorized as such, the highest percentage for any county in Oregon. Thirteen percent of city owned bridges in Linn County and 25% of Linn County owned bridges are categorized by ODOT as distressed or deficient.

**Table 2-294. Bridge Inventory for Region 3**

	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
<b>Oregon</b>	42	2,760	2%	258	3,442	7%	30	643	5%	16	121	13%	346	6,966	5%
<b>Region 3</b>	12	717	2%	119	1126	11%	11	227	5%	4	26	15%	146	2096	7%
Benton	0	44	0%	11	93	12%	2	29	7%	0	2	0%	13	168	8%
Lane	7	290	2%	7	410	2%	2	74	3%	2	11	18%	18	785	2%
Linn	2	142	1%	77	306	25%	5	40	13%	0	4	0%	84	492	17%
Marion	0	138	0%	10	139	7%	1	71	1%	0	6	0%	11	354	3%
Polk	0	52	0%	5	89	6%	1	13	8%	2	2	100%	8	156	5%
Yamhill	3	51	6%	9	89	10%	0	0	N/A	0	1	0%	12	141	9%

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 (2020)

### Railroads

Railroads are major providers of regional and national cargo and trade flows. Railroads that run through the Mid/Southern Willamette region primarily run in a north-south direction. The Union Pacific Railroad (UP) is the major freight railroad. An Amtrak passenger train also runs on the UP line. It runs north to Spokane and south to Southern California where the tracks turn east and continue to Texas. Other freight railroads in the region include the Central Oregon and Pacific, the Albany and Eastern, the Portland and Western, the Hampton Railway, the Willamette and Pacific, and the Willamette Valley Railway.

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





products from other states that are shipped to and through Oregon by rail (Cambridge Systematics, 2014).

Rails are sensitive to icing from winter storms that can occur in the Mid/Southern Willamette Valley. Disruptions to the rail system can result in 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

Fifteen public airports, 73 private airports, two public helipads, and 16 private helipads serve Region 3. The Eugene Airport is the largest public airport in the region and the second busiest in Oregon (Federal Aviation Administration [FAA], 2012). The airport is owned, operated, and administered by the City of Eugene. It serves 10 hubs and six air carriers with approximately 56 arriving and departing flights daily (Eugene, Oregon website, Visitors page, <https://www.eugene-or.gov/index.aspx?NID=1715>).

**Table 2-295. Public and Private Airports in Region 3**

	Number of Airports by FAA Designation				Total
	Public Airport	Private Airport	Public Helipad	Private Helipad	
<b>Region 3</b>	15	73	2	16	106
Benton	1	9	0	1	11
Lane	7	9	1	5	22
Linn	3	20	0	2	25
Marion	2	13	1	6	22
Polk	1	7	0	0	8
Yamhill	1	15	0	2	18

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

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.

### *Energy*

#### Electricity

The region is served by several investor-owned, public, cooperative, and municipal utilities. The Bonneville Power Administration is the area’s wholesale electricity distributor. Pacific Power and Light (Pacific Power) is the largest investor-owned utility company serving primarily Linn, Polk, and Marion Counties. Portland General Electric is another investor-owned utility and serves Marion and Yamhill Counties. The Blachly-Lane Electric Cooperative, Lane County Electric Cooperative, and Western Oregon Electric Cooperative each serve a portion of Region 3. Four municipal utility districts serve the region: Eugene Water and Electric Board, Monmouth, McMinnville, and Springfield Utility Board. In addition, the Central Lincoln People’s Utility District, Consumer’s Power, Inc., Emerald People’s Utility District, and Salem serve portions of the region.



The Mid/Southern Willamette Valley has a total of 16 power-generating facilities: 11 hydroelectric power facilities, one natural gas power facility, and four “other” facilities (primarily biomass and solar photovoltaic). In total, the power-generating facilities have the ability to produce up to 668 megawatts (MW) of electricity.

**Table 2-296. Power Plants in Region 3**

	Hydro-electric	Natural Gas	Wind	Coal	Other*	Total
<b>Region 3</b>	11	1	0	0	4	16
Benton	0	0	0	0	0	0
Lane	7	1	0	0	1	9
Linn	4	0	0	0	1	5
Marion	0	0	0	0	0	0
Polk	0	0	0	0	0	0
Yamhill	0	0	0	0	2	2
<b>Energy Production (MW)</b>	585	51	0	0	32	668

\*“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

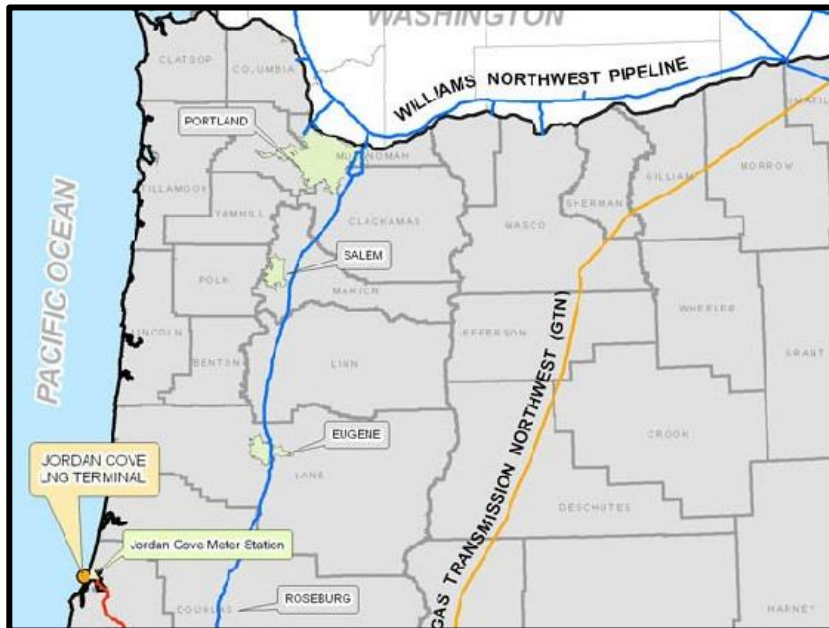
The majority of electrical power in Region 3 is generated hydroelectrically. The Detroit, Carmen-Smith, and Lookout Point dams generate the most power for the region. They are each capable of generating over 100 MW. There are also several power plants that use biomass as their energy source (Loy, 2001). Bonneville Power Administration (BPA) provides hydro-generated electricity to the state’s consumer-owned utilities. BPA’s major dams in Region 3 are located on the following rivers: North Santiam River (Big Cliff and Detroit), South Santiam River (Foster and Green Peter), McKenzie River (Cougar), and Middle Fork of the Willamette River (Dexter, Lookout Point and Hills Creek).

### 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 2-174](#) shows the Williams Northwest Pipeline, which runs through Marion, Linn, and Lane Counties (in blue) (Pipelines International, 2009). LNG pipelines, like other buried pipe infrastructure, are vulnerable to earthquakes and can cause danger to human life and safety, as well as environmental impacts in the case of a spill.



**Figure 2-174. Liquefied Natural Gas Pipelines in Region 3**



Source: Retrieved from [http://gs-press.com.au/images/news\\_articles/cache/Pacific\\_Connector\\_Gas\\_Pipeline\\_Route-0x600.jpg](http://gs-press.com.au/images/news_articles/cache/Pacific_Connector_Gas_Pipeline_Route-0x600.jpg)

### *Utility Lifelines*

The Mid/Southern Willamette Valley is an important thoroughfare for oil and gas pipelines and electrical transmission lines, connecting Oregon to California and Canada. The infrastructure associated with power generation and transmission plays a critical role in supporting the regional economy. These lines may be vulnerable to severe but infrequent natural hazards such as earthquakes. If these lines fail or are disrupted, the essential functions of the community can become severely impaired.

The electric, oil, and gas lines that run through the Mid/Southern Willamette region are both municipally and privately owned. A network of electrical transmission lines running through the region allows Oregon utility companies to exchange electricity with other states and Canada. Most of the natural gas Oregon uses originates in Alberta, Canada. Northwest Natural Gas owns one main natural gas transmission pipeline. An oil pipeline originating in the Puget Sound runs through the region and terminates in Eugene.

### *Telecommunications*

Telecommunications infrastructure includes television, telephone, broadband internet, radio, and amateur radio (ham radio) under the Oregon State Emergency Alert System Plan (Oregon Office of Emergency Management, 2013). Marion, Yamhill, and Polk Counties are part of the Capitol Operational Area. Lane, Benton, Linn, and coastal Douglas Counties are part of the South Valley Operational Area. 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 station identified as the emergency messengers by the Oregon State Emergency Alert System Plan in Region 3 is KWVT-TV Channel 17 in Salem.

### Telephone and Broadband

Landline telephone, mobile wireless telephone, and broadband service providers serve Region 3. 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, OR-99, etc.). The majority of areas that lack access to broadband service are in Coast Range and the Cascades mountains (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 3 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 Capitol Operational Area are:

- KOPB-FM, 91.5 MHZ, Salem; and
- WXL-96.475 MHZ, Salem.

Radio transmitters for the South Valley Operational Area are (Oregon Office of Emergency Management, 2013):

- KWAX-FM, 91.1 MHZ, Eugene; 91.6 MHZ, Florence; 101.9 MHZ, Cottage Grove;
- KKNU-FM, 93.3 MHZ Eugene; 100.9 MHZ, Florence; 101.9 MHZ, Cottage Grove; and
- KOAC-AM, 550 KHZ, Albany, 103.1 MHZ, Corvallis.

### 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 3 is served by ARES District 4. 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 3 include (American Relay Radio League Oregon Chapter, [www.arrloregon.org](http://www.arrloregon.org)) include:

- Benton County: W7DMR;
- Lane County: K7BHB, N7NFS;
- Linn County: W7ACW;
- Marion County: KE70LU, KD7MGF, KC7BRZ, WA7ABU, KE7EXX, W7SDP;
- Polk County: KG7G; and
- Yamhill County: W7IG.

## *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 3 the majority of the municipal drinking water supply is obtained primarily from surface water sources. Surface water is drawn from rivers and smaller tributaries. These surface water sources are often backed up by groundwater that is drawn from an aquifer when surface water levels get low, especially in summer months

Rural residents draw water from surface water, groundwater wells, or springs. 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. In Polk County, saltwater naturally occurs in some aquifers, which presents a challenge during water shortages when aquifers are relied upon for backup water supply. In areas where no new live-flow water rights are available, farmers and ranchers are turning to above-ground storage to help supply water for crop irrigation during dry seasons.

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. DEQ, ODA, and ODF have programs in place to address water quality concerns caused by land management practices that are nonpoint sources of pollution. However, there continue to be on the 303d list and the Pesticide Stewardship Partnerships identified waterbodies that are not meeting water quality standards and pesticide benchmarks. More work is needed to address these. In general ODA's water quality rules and plans and its Confined Animal Feeding Operations (CAFO) program do provide some protection. However, the CAFO program is designed to provide water quality protection for up to a certain design storm, not for a major flood or other natural hazard event. In addition, the data defining the design storm need to be updated to provide the intended protection. Landslides, flood events, and liquefaction from earthquakes can cause increased erosion and sedimentation in waterways.

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 and limit fire suppression. 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 3, 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 3. Low impact development (LID) mitigation strategies can alleviate or lighten the burden to 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 speed, and at lower temperatures. Most cities in Region 3 use the State of Oregon Residential Specialty Code, which does not address the issue of stormwater mitigation on new or existing construction. However, some cities, such as Eugene, require LID stormwater mitigation strategies in their building 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).

Roads, bridges, railroads, and airports are vulnerable to natural hazards. Failures of this infrastructure can be devastating to the economy and health of the region's residents. Bridges are particularly vulnerable to seismic events. Forty-four percent of all state-owned bridges in the region that have been identified as distressed or deficient are within Lane County. Railroads are sensitive to icing from winter storms. The second largest airport in the Oregon is in Region 3, along with several smaller airports and helipads.

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. The majority of power in the region is generated hydroelectrically and there are 16 power-generating facilities in the Mid/Southern Willamette Valley. The majority of dams are in Marion



and Yamhill Counties. The three major dams are Detroit, Carmen-Smith, and Lookout Point. Roughly 14% (53) of all dams in the region are either Significant or High Threat Potential. Liquid Natural Gas is transported through the region via the Williams Northwest Pipeline that runs through Marion, Linn, and Lane Counties.

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 centralized and lacking in system redundancies. Furthermore, because most drinking water is sourced from surface water, the region is at risk of high levels of pollutants entering waterways such as through combined sewers that overflow during high-water events. Older, centralized infrastructure in storm and wastewater infrastructure creates vulnerability in the system during flood events. The City of Eugene employs decentralized, low-impact development (LID) stormwater systems to better manage high-precipitation events.



## Built Environment

### *Settlement and 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 (DLCD, <https://www.oregon.gov/lcd/OP/Pages/Goal-7.aspx>).

### *Urbanization and Population Distribution*

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). Jurisdictions are designated urban or rural after each decennial census. The 2020 Census is currently underway; therefore, the data in [Table 2-297](#) and [Table 2-298](#) remain from the 2010 Census.

Regionally, between 2000 and 2010, urban areas in the Mid/Southern Willamette Valley have grown comparably to other urban areas statewide, with the greatest increases in population occurring in Linn, Polk, and Yamhill Counties. Benton is the only county in the region to experience a more even distribution of population growth in both urban and rural areas, roughly 9%. The most extreme shifts between urban and rural areas occurred in Yamhill County — 28% increase in urban populations and a 10.8% decrease in rural populations.

The percent growth of housing units in urban areas between 2000 and 2010 is almost 4 times that in rural areas. Linn, Polk, and Yamhill Counties have had the greatest increases in urban housing. Rural housing has increased by almost 16% in Benton County.

Unsurprisingly, populations tend to cluster around major road corridors and waterways. This holds true for the major cities of Eugene, Albany, Corvallis, and Salem and for the cities of Portland Metro area. The population distribution in Region 3 is presented in [Figure 2-175](#).





**Table 2-297. Urban and Rural Populations in Region 3, 2010**

	Urban			Rural		
	2000	2010	% Change	2000	2010	% Change
<b>Oregon</b>	2,694,144	3,104,382	15.2%	727,255	726,692	-0.1%
<b>Region 3</b>	738,040	850,560	15.2%	198,347	193,337	-2.5%
Benton	63,378	69,521	9.7%	14,775	16,058	8.7%
Lane	260,514	290,084	11.4%	62,445	61,631	-1.3%
Linn	65,349	79,759	22.1%	37,720	36,913	-2.1%
Marion	241,260	274,046	13.6%	43,574	41,289	-5.2%
Polk	47,672	60,378	26.7%	14,708	15,025	2.2%
Yamhill	59,867	76,772	28.2%	25,125	22,421	-10.8%

Source: U.S. Census Bureau (n.d.). 2010 Decennial Census, Table P2

**Table 2-298. Urban and Rural Housing Units in Region 3, 2010**

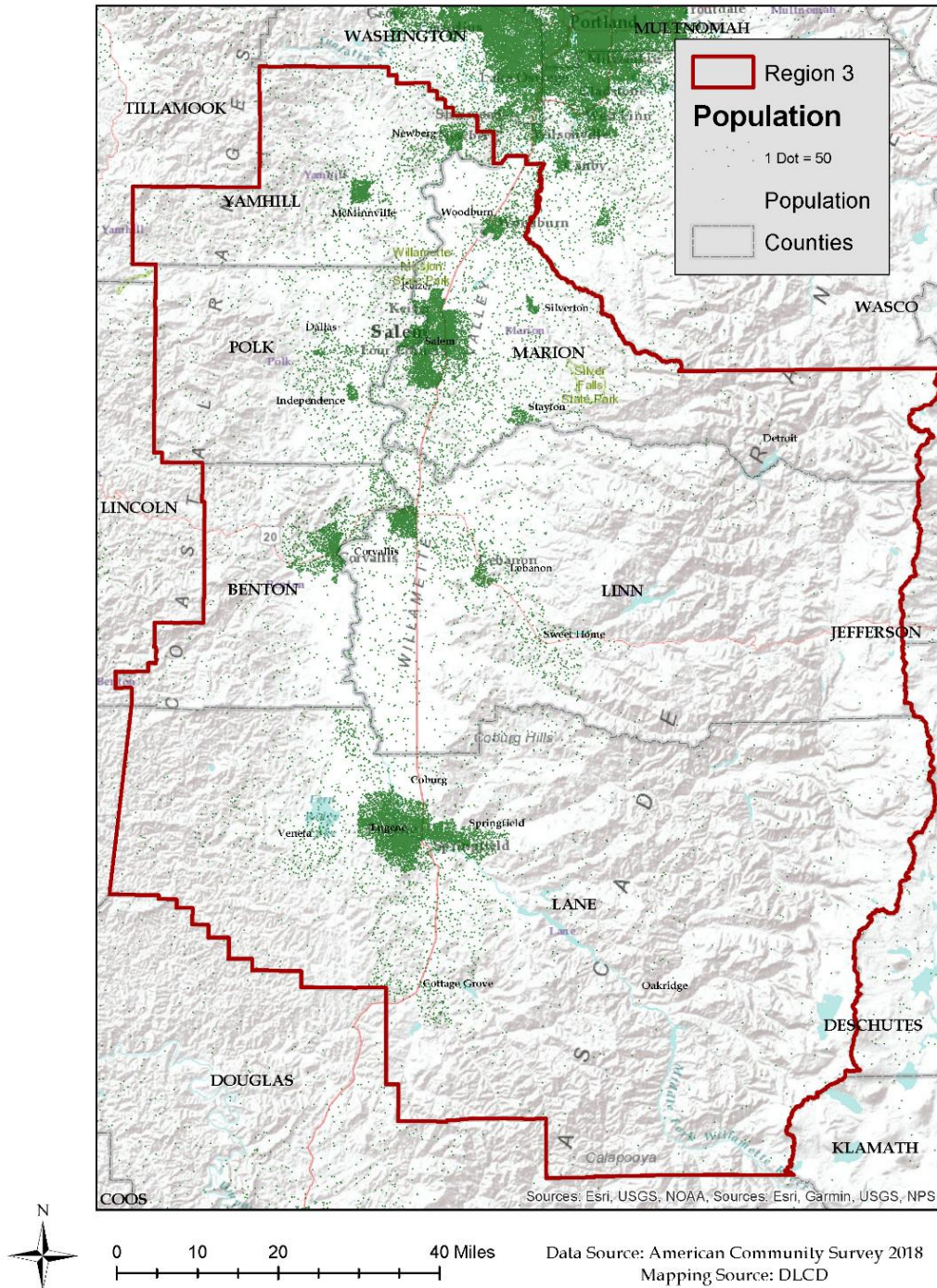
	Urban			Rural		
	2000	2010	% Change	2000	2010	% Change
<b>Oregon</b>	1,131,574	1,328,268	17.4%	321,135	347,294	8.1%
<b>Region 3</b>	298,306	348,148	16.7%	78,046	81,390	4.3%
Benton	26,115	29,459	12.8%	5,865	6,786	15.7%
Lane	112,750	128,267	13.8%	26,196	27,845	6.3%
Linn	27,712	33,467	20.8%	14,809	15,354	3.7%
Marion	91,846	104,590	13.9%	16,328	16,358	0.2%
Polk	18,851	24,204	28.4%	5,610	6,098	8.7%
Yamhill	21,032	28,161	33.9%	9,238	8,949	-3.1%

Source: U.S. Census Bureau (n.d.). 2010 Decennial Census, Table H2.



Figure 2-175. Region 3 Population Distribution

## Region 3 Population Distribution



Source: U.S. Census Bureau, American Community Survey, 2014-2018 5YR



### Housing Development

In addition to location, the character of the housing stock can also affect the level of risk a community faces from natural hazards. [Table 2-299](#) provides a breakdown by county of housing types: single-family, multi-family, and manufactured housing. Note: The total housing units value also includes boats, RVs, vans, etc. that are used as a residence. These homes are not included in the table as a separate category because they represent a small percentage of the overall housing profile. Consequently, adding the percentages horizontally for the state, region, and each county will not equal 100%.

The majority of the region’s housing stock is single-family homes. Manufactured residences make up 9.0% of Region 3’s housing overall. Linn and Yamhill Counties have the highest shares of manufactured homes. In natural hazard events such as earthquakes and floods, manufactured homes are more likely to shift on their foundations and create hazardous conditions for occupants and their neighbors (California Governor’s Office of Emergency Services, 1997).

**Table 2-299. Housing Profile for Region 3**

	Total Housing Units	Single Family			Multi Family			Manufactured Homes		
		Estimate	CV **	MOE (+/-)	Estimate	CV **	MOE (+/-)	Estimate	CV **	MOE (+/-)
<b>Oregon</b>	1,733,041	68.1%	✓	0.3%	23.5%	✓	0.3%	8.2%	✓	0.1%
<b>Region 3</b>	441,923	68.3%	✓	0.5%	22.4%	✓	0.5%	9.0%	✓	0.3%
Benton	37,789	64.7%	✓	1.5%	29.0%	✓	1.9%	6.0%	✓	6.0%
Lane	160,440	67.5%	✓	0.7%	23.2%	✓	0.9%	8.8%	✓	0.4%
Linn	49,688	71.9%	✓	1.3%	16.4%	✓	1.3%	11.5%	✓	0.9%
Marion	124,317	66.4%	✓	1.0%	24.5%	✓	1.0%	8.9%	✓	0.5%
Polk	31,403	72.6%	✓	2.0%	19.7%	✓	1.9%	7.6%	✓	1.0%
Yamhill	38,286	73.6%	✓	1.8%	15.3%	✓	1.5%	10.6%	✓	1.0%

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 (2018). Table B25024: Units in Structure, 2013-2017 American Community Survey 5-year estimates. Retrieved from <https://data.census.gov/cedsci/>



**Table 2-300. Housing Vacancy in Region 3**

	Total Housing Units	Vacant <sup>^</sup>		
		Estimate	CV <sup>**</sup>	MOE (+/-)
<b>Oregon</b>	1,733,041	5.6%	☑	0.2%
<b>Region 3</b>	441,923	5.6%	☑	0.3%
Benton	37,789	7.0%	☑	1.1%
Lane	160,440	5.1%	☑	0.5%
Linn	49,688	5.7%	☑	0.9%
Marion	124,317	5.7%	☑	0.6%
Polk	31,403	6.4%	☑	1.4%
Yamhill	38,286	5.3%	☑	1.1%

Notes: <sup>^</sup> Functional vacant units, computed after removing seasonal, recreational, or occasional housing units from vacant housing units.

<sup>\*\*</sup>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.  
<https://data.census.gov/cedsci/>. Table B25004: Vacancy Status

Aside from location and type of housing, the year structures were built ([Table 2-301](#)) has implications for level of vulnerability to natural hazards. 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. Moreover, the Judson report did not include manufactured housing in its study, but more recent research concludes that manufactured homes installed prior to 2003 lack adequate anchoring and bracing, and are therefore more vulnerable to damage and loss caused by seismic events (Bauer, et al., 2020).

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 34.2% of the housing stock was built prior to 1970, before the implementation of floodplain management ordinances. Just under one third of the region’s housing stock was built after 1990 and the codification of seismic building standards. Additionally, as shown in [Table 2-302](#), many communities did not adopt their initial FIRM—and therefore did not adopt floodplain management ordinances—until the late 1970s or mid-1980s. This means that some structures built after 1970 could still be at increased risk.



**Table 2-301. Age of Housing Stock in Region 3**

Total Housing Units		Pre 1970			1970 to 1989			1990 or Later		
		Estimate	CV **	MOE (+/-)	Estimate	CV **	MOE (+/-)	Estimate	CV **	MOE (+/-)
<b>Oregon</b>	1,733,041	34.6%	✓	0.3%	30.5%	✓	0.3%	34.9%	✓	0.3%
<b>Region 3</b>	441,923	34.2%	✓	0.5%	32.6%	✓	0.5%	33.3%	✓	0.5%
Benton	37,789	34.5%	✓	2.0%	31.2%	✓	1.9%	34.3%	✓	1.8%
Lane	160,440	37.5%	✓	0.9%	32.3%	✓	0.9%	30.2%	✓	0.8%
Linn	49,688	38.7%	✓	1.8%	30.0%	✓	1.6%	31.3%	✓	1.4%
Marion	124,317	31.5%	✓	1.0%	36.4%	✓	1.1%	32.0%	✓	1.0%
Polk	31,403	28.5%	✓	2.0%	26.6%	✓	1.9%	44.9%	✓	2.1%
Yamhill	38,286	27.3%	✓	1.7%	30.4%	✓	1.7%	42.3%	✓	1.9%

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





**Table 2-302** shows the initial and current FIRM effective dates for Region 3 communities. For more information about the flood hazard, NFIP, and FIRMs, please refer to the State Risk Assessment, **Flood** section.

**Table 2-302. Community Flood Map History in Region 3**

	Initial FIRM	Current FIRM		Initial FIRM	Current FIRM
<b>Benton County</b>	Aug. 5, 1986	Dec. 8, 2016	<b>Marion County</b>	Aug. 15, 1979	Oct. 18, 2019
Albany	see Linn County	see Linn County	Aumsville	Mar. 1, 1979	Jan. 19, 2000
Corvallis	Jan. 3, 1985	June 2, 2011	Aurora	June 5, 1979	Jan. 19, 2000
Monroe	Sept. 26, 1975	June 2, 2011	Detroit	June 30, 1976	Jan. 19, 2000
Philomath	June 15, 1982	June 2, 2011	Gates	Dec. 4, 1979	Jan. 19, 2000
<b>Lane County</b>	Dec. 18, 1985	June 2, 1999	Gervais	June 30, 1976	June 30, 1976
Coburg	Jan. 6, 1985	6/2/1999 (M)	Hubbard	Feb. 5, 1986	Jan. 19, 2000
Cottage Grove	Nov. 15, 1985	June 2, 1999	Jefferson	Mar. 1, 1979	Jan. 19, 2000
Creswell	Sept. 18, 1985	June 2, 1999	Keizer	May 1, 1985	Jan. 19, 2000
Dunes City	Mar. 24, 1981	6/2/1999 (M)	Mt. Angel	Jan. 19, 2000	Jan. 19, 2000
Eugene	Sept. 29, 1986	June 2, 1999	Salem	June 15, 1979	Oct. 18, 2019
Florence	May 17, 1982	June 2, 1999	Scotts Mills	Mar. 1, 1979	Jan. 19, 2000
Junction City	June 15, 1982	June 2, 1999	Silverton	Mar. 1, 1979	Jan. 19, 2000
Lowell	June 2, 1999	6/2/1999 (M)	St. Paul	Jan. 19, 2000	Jan. 19, 2000
Oakridge	June 3, 1986	June 2, 1999	Stayton	Mar. 1, 1979	Jan. 19, 2000
Springfield	Sept. 27, 1985	June 2, 1999	Turner	Apr. 2, 1979	Oct. 18, 2019
Veneta	Feb. 1, 1984	June 2, 1999	Woodburn	Mar. 1, 1979	Jan. 19, 2000
Westfir	Aug. 19, 1985	June 2, 1999	<b>Polk County</b>	Feb. 15, 1978	Dec. 19, 2006
<b>Linn County</b>	Sept. 29, 1986	Dec. 8, 2016	Dallas	Apr. 5, 1988	Dec. 19, 2006
Albany	Apr. 3, 1985	Dec. 8, 2016	Falls City	July 7, 1981	Dec. 19, 2006
Brownsville	Aug. 17, 1981	Sept. 29, 2010	Independence	Apr. 5, 1988	Dec. 19, 2006
Halsey	Sept. 29, 2010	Sept. 29, 2010	Monmouth	Apr. 5, 1988	Dec. 19, 2006
Harrisburg	Feb. 3, 1982	Sept. 29, 2010	Salem	see Marion County	see Marion County
Idanha	Mar. 1, 1979	Jan. 19, 2000	<b>Yamhill County</b>	Sept. 30, 1983	Mar. 2, 2010
Lebanon	July 2, 1981	Sept. 29, 2010	Amity	Dec. 1, 1981	Mar. 2, 2010
Lyons	Dec. 15, 1981	Sept. 29, 2010	Carlton	June 30, 1976	Mar. 2, 2010
Mill City	Mar. 1, 1979	Sept. 29, 2010	Dayton	June 1, 1982	Mar. 2, 2010
Millersburg	June 15, 1982	Dec. 8, 2016	Dundee	Mar. 1, 1982	Mar. 2, 2010
Scio	Aug. 1, 1984	Sept. 29, 2010	Lafayette	June 15, 1982	Mar. 2, 2010
Sweet Home	Mar. 1, 1982	Sept. 29, 2010	McMinnville	Dec. 1, 1982	Mar. 2, 2010
Tangent	May 17, 1982	Sept. 29, 2010	Newberg	Mar. 1, 1982	Mar. 2, 2010
Waterloo	Sept. 29, 2010	Sept. 29, 2010	Sheridan	Aug. 1, 1990	Mar. 2, 2010
			Willamina	Mar. 15, 1982	Mar. 2, 2010
			Yamhill, City	Mar. 1, 1982	Mar. 2, 2010

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

Source: Federal Emergency Management Agency (2019), Community Status Book Report, <https://www.fema.gov/cis/OR.pdf>



State-Owned/Leased and Critical/Essential Facilities

In 2020 the Department of Geology and Mineral Industries updated the 2015 Oregon NHMP inventory and analysis of state-owned and –leased buildings, state-owned and –leased critical facilities, and local critical facilities. Results from this report relative to Region 3 can be found in [Table 2-303](#). The region contains just under one-third of the total value of all local critical facilities and state-owned and –leased critical and non-critical facilities in the state. These assets have a combined value of over ten billion dollars. Many of the facilities are associated with the universities in Eugene and Corvallis and with state offices in Salem.

**Table 2-303. Value of State-Owned/Leased Critical and Essential Facilities in Region 3**

	Value of Local and State-Owned/Leased Facilities				Percent of Total
	State Non-Critical	State Critical	Local Critical	State + Local Total	
<b>Oregon</b>	\$2,630,306,288	\$4,622,433,011	\$ 26,285,277,425	\$ 33,538,016,724	100%
<b>Region 3</b>	\$1,647,256,264	\$1,460,570,293	\$ 7,490,014,345	\$ 10,597,840,902	31.6%
Benton	\$ 19,658,758	\$ 21,711,757	\$ 601,049,400	\$ 642,419,915	1.9%
Lane	\$ 255,204,883	\$ 104,069,324	\$ 2,601,296,095	\$ 2,960,570,302	8.8%
Linn	\$ 84,722,101	\$ 55,424,803	\$ 794,175,900	\$ 934,322,804	2.8%
Marion	\$1,269,221,291	\$1,238,287,979	\$ 2,193,334,800	\$ 4,700,844,070	14.0%
Polk	\$ 15,437,309	\$ 27,230,661	\$ 465,625,050	\$ 508,293,020	1.5%
Yamhill	\$ 3,011,922	\$ 13,845,769	\$ 834,533,100	\$ 851,390,791	2.5%

Source: DOGAMI, 2020

*Land Use Patterns*

Region 3 has a larger percentage of private land, 57.7%, than federal land, 39.1%, with most of the federal holdings ranging up the slopes of the Cascades. However, the northern portion is dominated by agricultural activities, while the southern end has a much larger share of BLM and Forest Service timberland.

The South Willamette Region is a land of contrasts, with urban areas nestled within productive farmland, bordered by the Cascade and Coast Range timberlands. I-5 runs the length of the region, and this area’s economy is shaped by the transportation system. With 61 incorporated communities in the region, there is continued pressure on area ecosystems from population growth, land use conversion, and altered habitat, fire regimes, and floodplain development.

Oregon Department of Forestry data show that in the 25-year period between 1984 and 2009, approximately 147,000 acres of farm and range land in the state transitioned from land use classes more conducive to commercial farm or forest practices into more developed land classes. Almost half of all farm land conversion occurred in central Oregon, while nearly one quarter took place in the Metro area and one quarter in the general area of Region 3 (Lettman G. J., 2011).



According to the Oregon Department of Forestry’s most recent land use study., “development of resource lands hit a record low between 2009 and 2014...with roughly 3,000 acres per year of Oregon’s farms, forests, and rangeland shifted to low-density residential or urban uses” (Lettman G. J., Gray, Hubner, McKay, & Thompson, 2016). In Region 2, approximately 5,312 acres of resource lands were converted to more urban uses during the six-year period. [Table 2-304](#) shows that during the six-year period, the percentage of resource lands converted in each county in Region 3 was less than one percent of each county’s total acreage. Lane County led the region in terms of total acres converted.

This region of the state is often subject to major flooding events, and communities have experienced major floods in 1861, 1890, 1945, 1956, 1964, 1996, and 2011. Generally, they have responded by keeping their flood ordinances current as well as going beyond minimum standards. For example, Corvallis, Albany, and Benton County integrate natural hazard information into their Comprehensive Plan, assuring that proper planning, such as determining if enough buildable land is available for future growth, and policies that regulate and prohibit development in natural hazard areas, will help minimize the extent of damage from future hazard events.

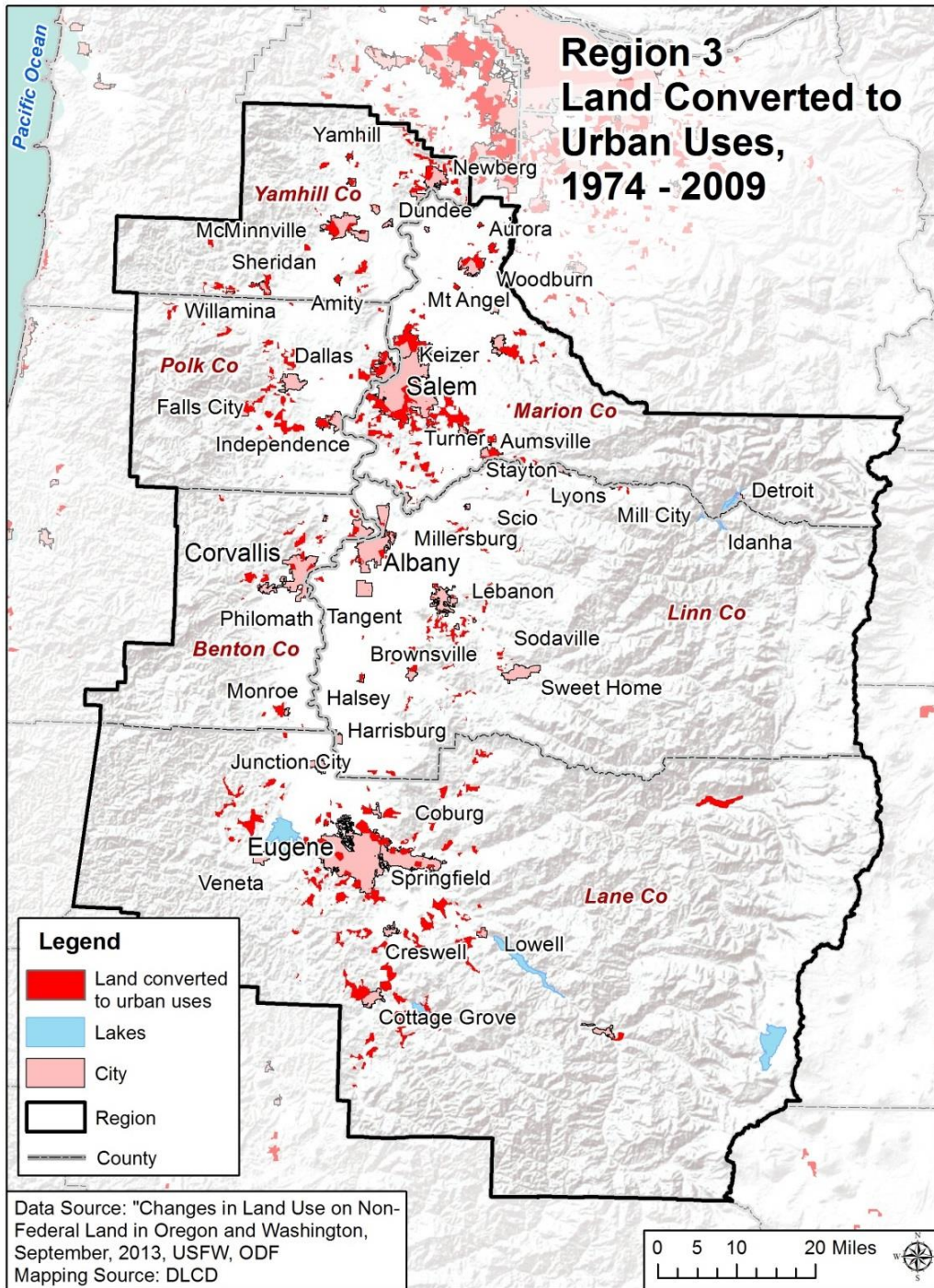
Eugene-Springfield is the third largest metropolitan area in Oregon, but expansion options are restricted by potential landslide and flood hazard areas. These communities are doing what they can to accommodate growth inside existing UGBs while minimizing encroachment into known hazard areas. One strategy they are using is to allow increased intensity of development outside of hazard areas, reducing the need to develop within them. For example, Eugene minimizes residential development on steep slopes by requiring larger lot sizes, and using floodplain areas as parks and open spaces. Overall, Eugene’s average density has increased, and the mix of housing types is shifting toward more multi-family (DLCD, internal communication, 2014).







**Figure 2-177. Region 3 Land Converted to Urban Uses, 1974–2009**



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



**Table 2-304. Region 3 Resource Lands Converted to Urban Uses, 2009-2014**

	Lost Resource Lands 2009-2014		
	Total Resource Acres (2009)	Acres Converted to Urban Use	Percent Converted
<b>Region 3</b>	3,346,514	5,314	0.16%
Yamhill	360,084	825	0.23%
Polk	402,291	829	0.20%
Marion	447,948	998	0.22%
Linn	863,818	747	0.09%
Benton	317,707	414	0.13%
Lane	954,666	1,575	0.16%

### *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 an urban county with urban development focused around the major cities along I-5. Population growth in the region was slightly below the statewide rate of growth from 2010-2018. From 2018-2030, the region is projected to continue growing at a rate commensurate with the statewide rate of growth. Please refer to the Region 3 Risk Assessment [Demography](#) section for more information on population trends and forecast. The results of the 2020 U.S. Census will better illustrate what has happened in the region over the last decade in terms of urbanization and population dispersion.

In terms of housing composition and hazard risk, the region has a slightly higher percentage of manufactured homes than the state as a whole — the highest percentage being in Linn County 11.5%. Nearly 40% of housing in Linn and Lane Counties was built before 1970 and floodplain management standards. Furthermore, roughly two thirds of the region’s homes were built before 1990 and seismic building standards. All of the region’s FIRMs have been modernized or updated.





### 2.3.3.3 Hazards and Vulnerability

#### Droughts

##### *Characteristics*

Droughts are not common in Region 3. In 1992, the Governor declared a drought for all 36 counties in Oregon. However, since 1992, no Governor-declared droughts have occurred in Region 3 until 2015 when the Governor declared drought in Marion, Linn, and Lane counties. Federal drought declarations were given to all 36 Oregon counties in 2015. Nonetheless, a dry winter or spring can have an effect on water supplies within the Mid/Southern Willamette Valley.

Even though drought may not be declared as often in Western Oregon as in counties east of the Cascades, when drought conditions do develop in the Willamette Valley, the impacts are widespread and severe when both winter snow and spring/summer rain are low. Reasons for broad and significant impact include:

- Higher population density and growing population in the Willamette Valley;
- Dependence on surface water supplies for many municipalities, agriculture and industries from large flood control reservoirs in the Willamette river system;
- Agriculture is a major industry becoming increasingly dependent on irrigation;
- Increased frequency of toxic algal blooms in the Willamette system reservoirs, resulting in restrictions on use of water from reservoirs for drinking (i.e., for human and animals). Affected waters may not be safe for agricultural irrigation, and other uses; necessitating purchasing and transporting water from alternative sources;
- Since drought is typically accompanied by earlier onset of snowmelt (e.g., during flood control or early storage season), little or no snowmelt runoff is stored until later;
- Earlier start to growing season, before the start of the irrigation season, means that crops may not be irrigated until the irrigation season begins;
- Insufficient number of farm workers available because the growing season began before the workers were scheduled to arrive; and
- Responsibilities to recovering anadromous fish.

These are relatively recent and developing concerns, in particular on livestock and some other agricultural operations, and therefore there is no single comprehensive source or other sources for information to assess economic impacts. Impacts of drought on state-owned facilities related to agriculture would include impacts to research conducted in outdoor settings, such as at extension stations and research farms.



## Historic Drought Events

**Table 2-305. Historic Droughts in Region 3**

Date	Location	Description
1923-1924	statewide	prolonged statewide drought that caused major problems for agriculture
1928-1930	Regions 1–3, 5–7	moderate to severe drought affected much of the state; the worst years in Region 2 were 1928–1930, which initiated an era of many drier than normal years
1938-1939	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 during that period
1991-1992	statewide, especially Regions 1–4, 8	1992 fell toward the end of a generally dry period, which caused problems throughout the state; the 1992 drought was most intense in eastern Oregon, with severe drought occurring in Region 1
2000-2001	Regions 2–4, 6, 7	the driest water year on record in the Willamette Valley (NOAA Climate Division 2); warmer than normal temperatures combined with dry conditions
2015	statewide	Governor-declared drought in 25 counties, including Marion, Linn, and Lane, with federal declarations in all counties.

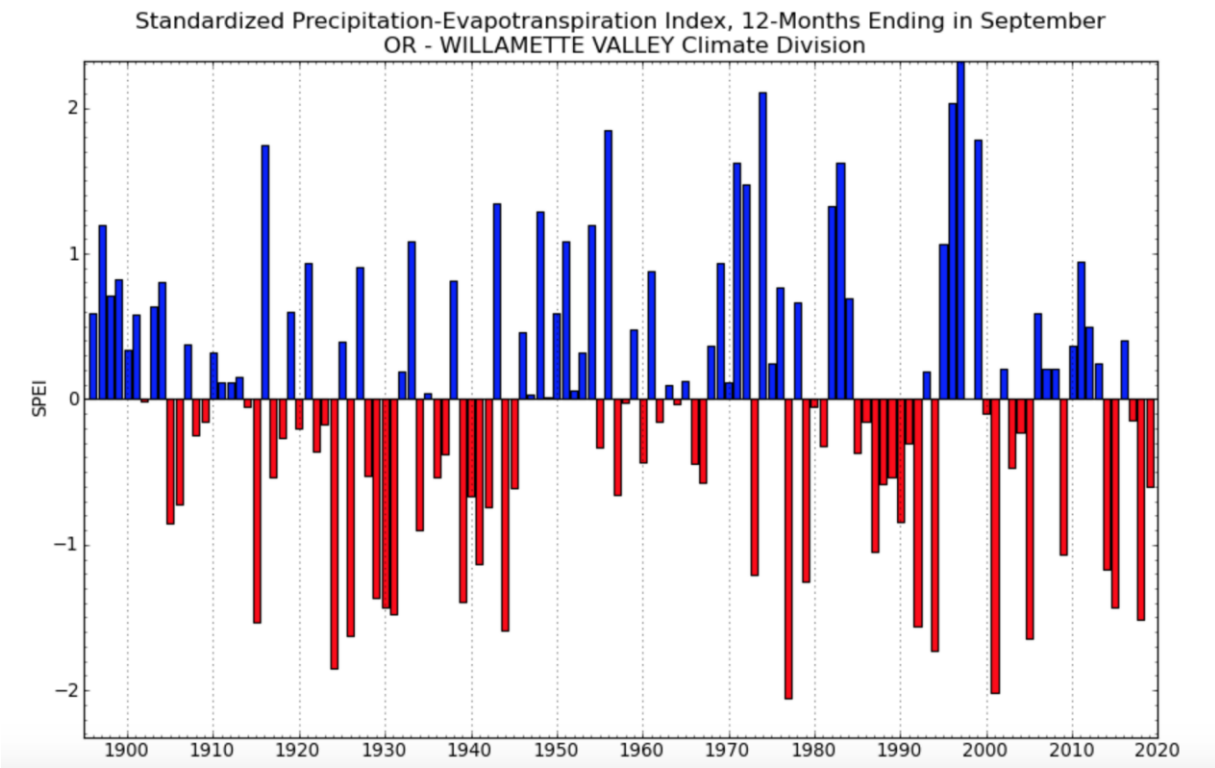
Sources: Taylor and Hatton (1999); Oregon Secretary of State’s Archives Division. NOAA’s Climate at a Glance. Western Regional Climate Center’s Westwide Drought Tracker <http://www.wrcc.dri.edu/wwdt>. Personal Communication, Kathie Dello, Oregon Climate Service, Oregon State University.

Historical drought information can also 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. [Figure 2-178](#) shows years where drought or dry conditions affected the Willamette Valley (Climate Division 2). Based on this index, Water Years 1977 and 2001 were extreme drought years for the Willamette Valley. Years with at least moderate drought have occurred 21 times during 1895–2019 ([Table 2-306](#)).





**Figure 2-178. Standard Precipitation-Evapotranspiration Index for Region 3**



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 2-306. Years with Moderate (<-1), Severe (<-1.5), and Extreme (<-2) Drought in Oregon Climate Division 2 according to Standard Precipitation-Evapotranspiration Index**

Moderate Drought (SPEI < -1.0)	Severe Drought (SPEI < -1.5)	Extreme Drought (SPEI < -2.0)
1931	1924	1977
1930	1994	2001
2015	2005	
1939	1926	
1929	1944	
1979	1992	
1973	1915	
2014	2018	
1941		
2009		
1987		

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

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

Although not shown here, drought data from Climate Division 4, “the High Cascades,” could also be analyzed to show a broader picture of drought impacts in Hazard Regions 2 and 3.



## Probability

**Table 2-307. Probability of Drought in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	VL	L	L	L	VL	VL

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 could be completed statewide to analyze and compare the risk of drought across the state.

Benton, Polk, and Yamhill Counties have received drought declarations in only 3% of the years since 1992, Marion and Linn in 7%, and Lane in 10%. This accounts for their very low and low probability, respectively, of experiencing drought.

## Climate Change

Even though drought is infrequent in the mid-southern Willamette Valley, climate models project warmer, drier summers for Oregon, including Region 3. These summer conditions coupled with projected decreases in mid-to-low elevation mountain snowpack due to warmer winter temperatures increases the likelihood that Region 3 would experience increased frequency of one or more types of drought under future climate change. In Region 3, 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 3, 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, Dello, Hawkins, Mote, & Rupp, 2017).

## Vulnerability

**Table 2-308. Local Assessment of Vulnerability to Drought in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	L	L	H	—	M

Source: Most recent local hazard vulnerability analyses ([Table 2-4](#))

**Table 2-309. State Assessment of Vulnerability to Drought in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	M	H	VH	M	H

Source: OWRD, DLCD



Although long-term drought conditions are uncommon in the mid-Willamette Valley, a dry winter or spring could affect many communities and water users throughout the Basin. Recreation, particularly at the reservoirs owned and operated by the U.S. Army Corps of Engineers, contributes greatly to the valley's economy. Communities, such as Detroit in Marion County, can be economically impacted by low reservoir levels. The Willamette Valley is also home to one of the most productive and diverse agricultural regions in the United States. Drought, especially a long drought, could significantly impact agricultural production.

Impacts of drought on state-owned facilities related to agriculture would include impacts to research conducted in outdoor settings, such as at extension stations and research farms.

Because drought impacts are relatively recent in Region 3, there is no single comprehensive source or other sources for information to assess economic impacts.

Oregon has yet to undertake 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, social vulnerability in the region is highest in Marion County, followed by Linn and Yamhill Counties. Marion County ranks in the 90th percentile for its share of persons aged 17 or younger, percentage of single-parent households, and percentage of occupied housing units with more people than rooms. The county is also the 90th percentile for its share of residents that speak English less than "well." Linn County's high vulnerability is driven by moderately high scores across the CDC index. Notably, however, the county is in the 80th percentile for its share of single-parent households and has a smaller per-capita income and a higher percentage of persons aged 17 and younger than 70 percent of all counties. Vulnerability in Yamhill County is also driven by moderately high scores across the CDC index. The county is in the 80th percentile for its share of multi-unit structures and the percentage of people living in institutionalized group quarters.

Marion County's social vulnerability score is very high, Linn and Yamhill Counties' high. Lane and Polk Counties' social vulnerability score is moderate, Benton County's low. The social vulnerability score indicates the extent of impact of any natural hazard, including drought, on a county's population. Marion, Linn, and Yamhill are the communities most vulnerable to drought in Region 3.

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

The value of state-owned and leased buildings and critical facilities in Region 3 is approximately \$3,107,827,000 representing the total potential for loss of state assets due to drought. The value of locally owned critical facilities is \$7,490,014,000. Because drought, while uncommon in Region 3, could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to drought. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. According to Department of Administrative Services records, three losses totaling almost





\$39,000 state facilities were recorded in Region 3 since the beginning of 2015. None were caused by drought.

*Risk*

**Table 2-310. Risk of Drought in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Risk	L	M	H	H	M	M

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 on social vulnerability, a review of Governor-declared drought declarations since 1992, and the potential for drought to impact Region 3’s agricultural productivity and other economic drivers, Region 3 is considered to generally be at moderate to high risk from drought.



## Earthquakes

### *Characteristics*

The geographic position of Region 3 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.

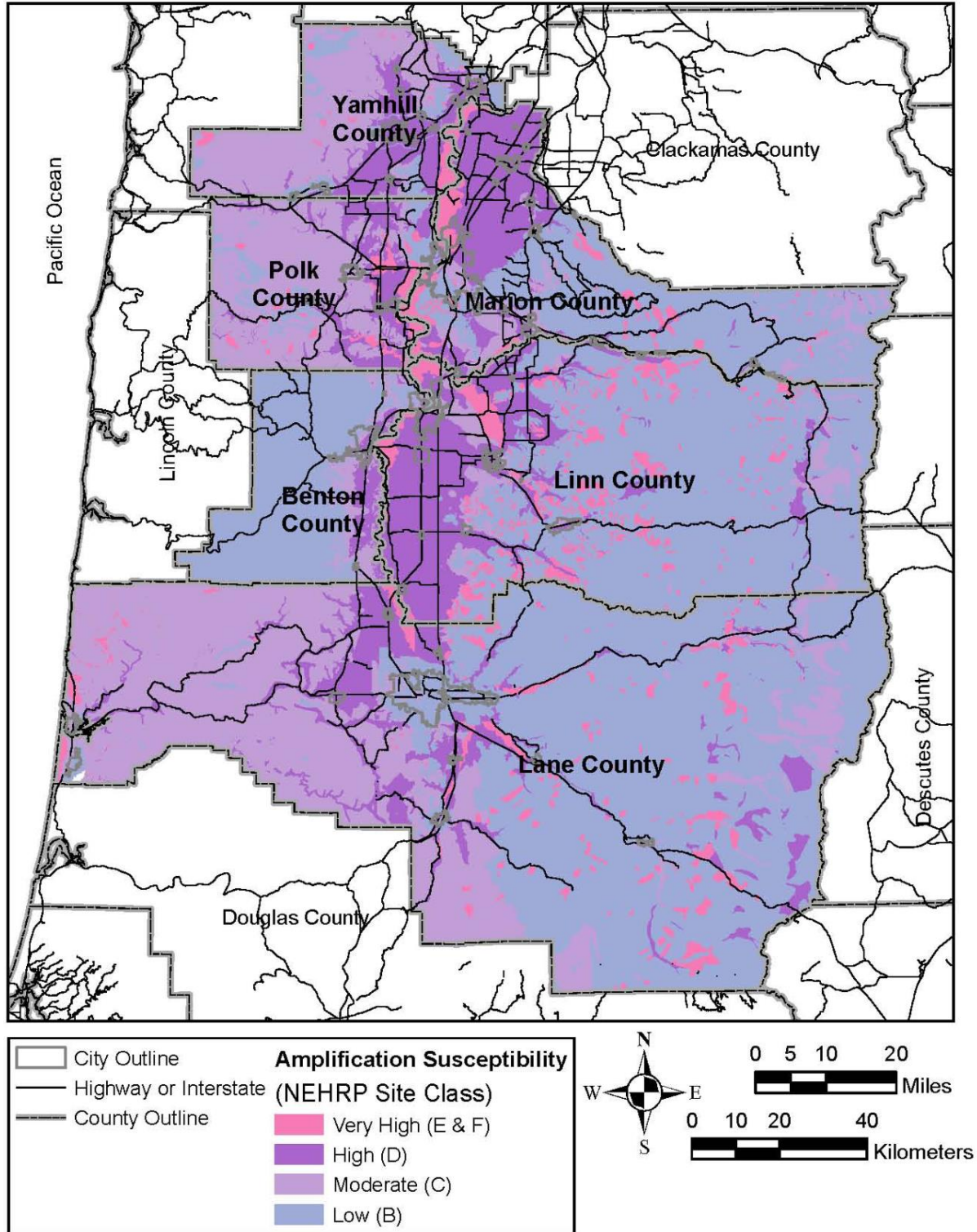
Region 3 has experienced a few historic earthquakes centered in the region. In addition, the region has been shaken historically by crustal and intraplate earthquakes and prehistorically by subduction zone earthquakes centered outside the area. All considered, there is good reason to believe that the most devastating future earthquakes would probably originate along shallow crustal faults in the region and along the Cascadia Fault Zone. Deep-seated intra-plate events have been discovered by scientists in the region's historic and pre-historic record, as occurred near Olympia, Washington in 1949 and 2001, could generate magnitudes as large as M7.5.

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 3, earthquake shaking and secondary earthquake-related hazards such as lahars could cause major damage to these centers.

Earthquake-associated hazards include severe ground shaking, liquefaction of fine-grained soils, and landsliding. The severity of these effects depends on several factors, including the distance from the earthquake source, the ability of soil and rock to conduct seismic energy, and the degree and composition of slope materials. As seismic waves travel through bedrock, some energy propagates through surface soils to the ground surface. Soil deposits can either deamplify or amplify the shaking based on the characteristics of the deposit. This phenomenon is generally referred to as ground shaking amplification (GSA). [Figure 2-179](#) displays the areas in Region 3 with greater and lesser ground shaking amplification hazard.



Figure 2-179. Amplification Susceptibility for Region 3



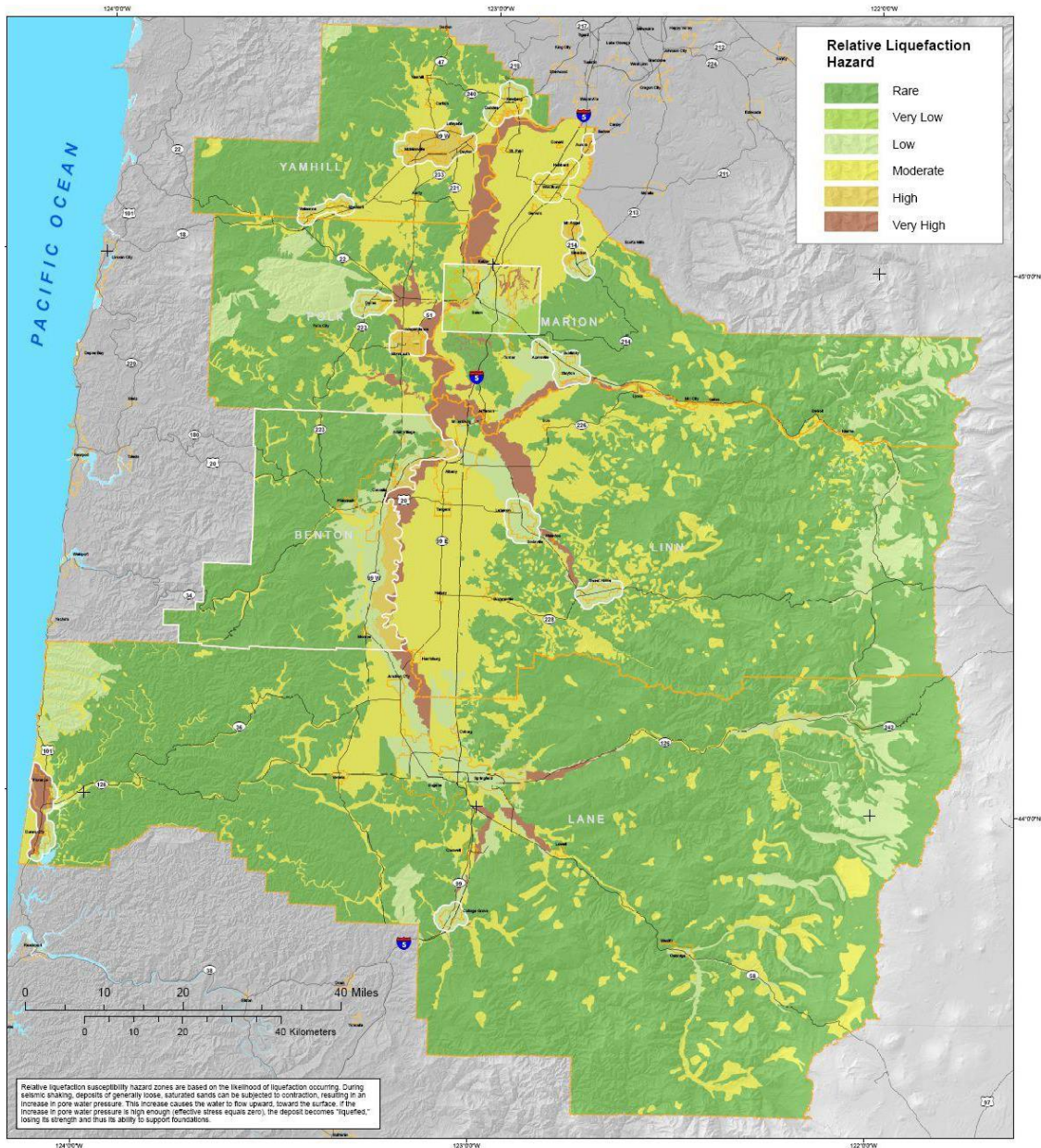
Source: Burns, et al. (2008)





During seismic shaking, deposits of loose saturated sands can be subjected to contraction resulting in an increase in pore water pressure. If the increase in pore water pressure is high enough, the deposit becomes “liquefied,” losing its strength and thus its ability to hold and support loads. [Figure 2-180](#) displays the areas in the region with greater and lesser liquefaction hazard.

**Figure 2-180. Relative Liquefaction Hazard for Region 3**

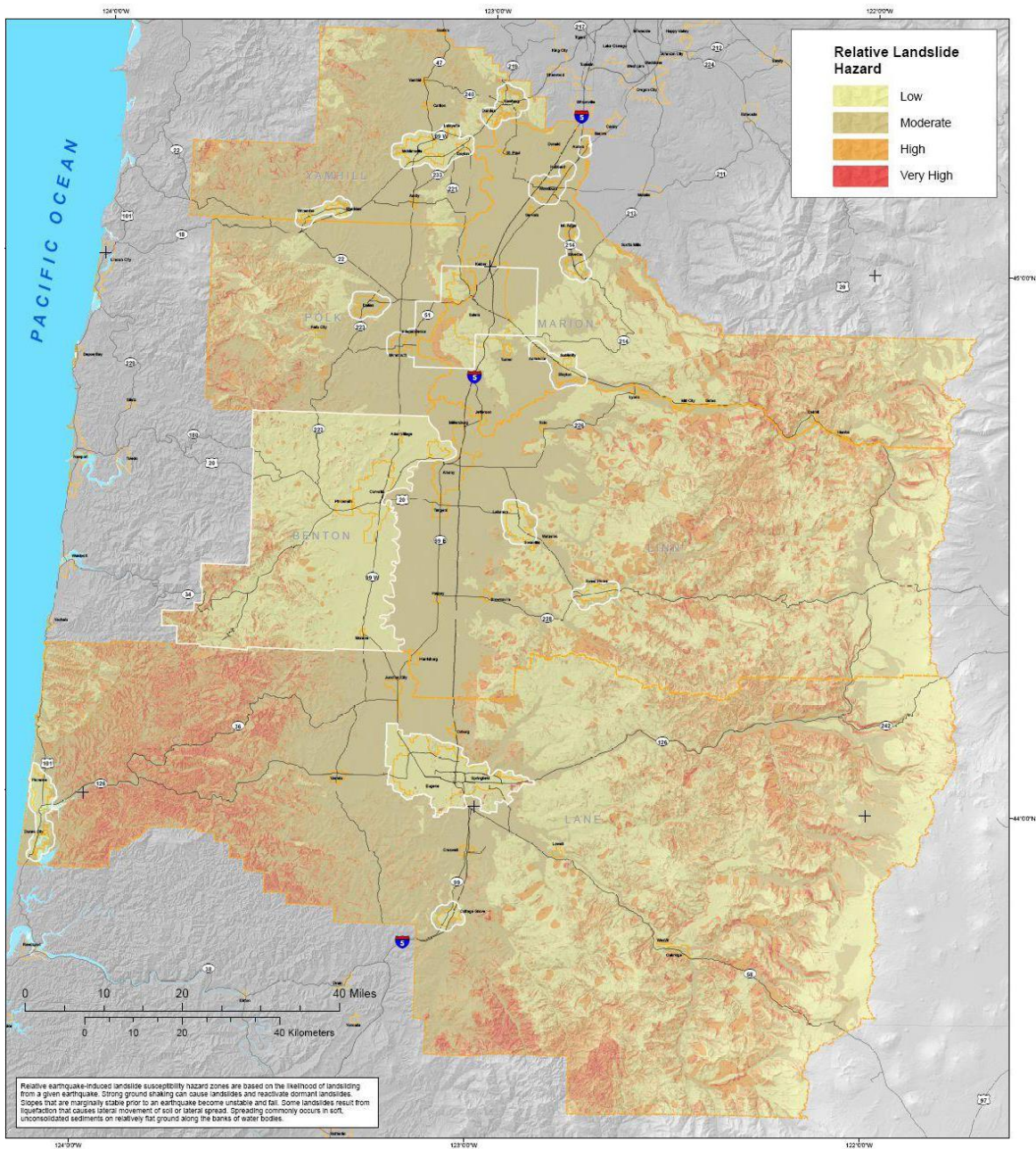


Source: Burns, et al. (2008)





Figure 2-181. Earthquake Induced Landslide Hazards for Region 3



Source: Burns, et al. (2008)



## Historic Earthquake Events

**Table 2-311. Significant Earthquakes Affecting Region 3**

Date	Location	Magnitude (M)	Comments
Approximate Years: 1400 BCE*, 1050 BCE, 600 BCE, 400, 750, 900	offshore, Cascadia Subduction Zone	probably 8-9	mid-points of the age ranges for these six events
Jan. 1700	offshore, Cascadia Subduction Zone	about 9.0	generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast
Apr. 1896	McMinnville, Oregon	4	also felt in Portland
July 1930	Perrydale, Oregon	4	cracked plaster
Apr. 1949	Olympia, Washington	7.1	Intraplate event. Damage: significant (Washington); minor (NW Oregon)
Aug. 1961	Albany, Oregon	4.5	damage: minor (Albany)
Nov. 1962	Portland area, Oregon	5.5	shaking up to 30 seconds; chimneys cracked; windows broken; furniture moved
Mar. 1963	Salem, Oregon	4.6	damage: minor (Salem)
Mar. 1993	Scotts Mills, Oregon	5.6	FEMA-985-DR-Oregon; center: Mt. Angel-Gales Creek fault; damage: \$30 million (including Oregon State Capitol in Salem)
Feb. 2001	Nisqually, Washington	6.8	felt in the region; damage: none reported
Jul. 4, 2015	East of Springfield, OR	4.0	

\*BCE: Before Common Era.

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

## Probability

**Table 2-312. Assessment of Earthquake Probability in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	VH	H	H	H	H

Source: DOGAMI, 2020

The probability of damaging earthquakes varies widely across the state. In Region 3 the hazard is dominated by Cascadia subduction earthquakes originating from a single fault with a well-understood recurrence history.

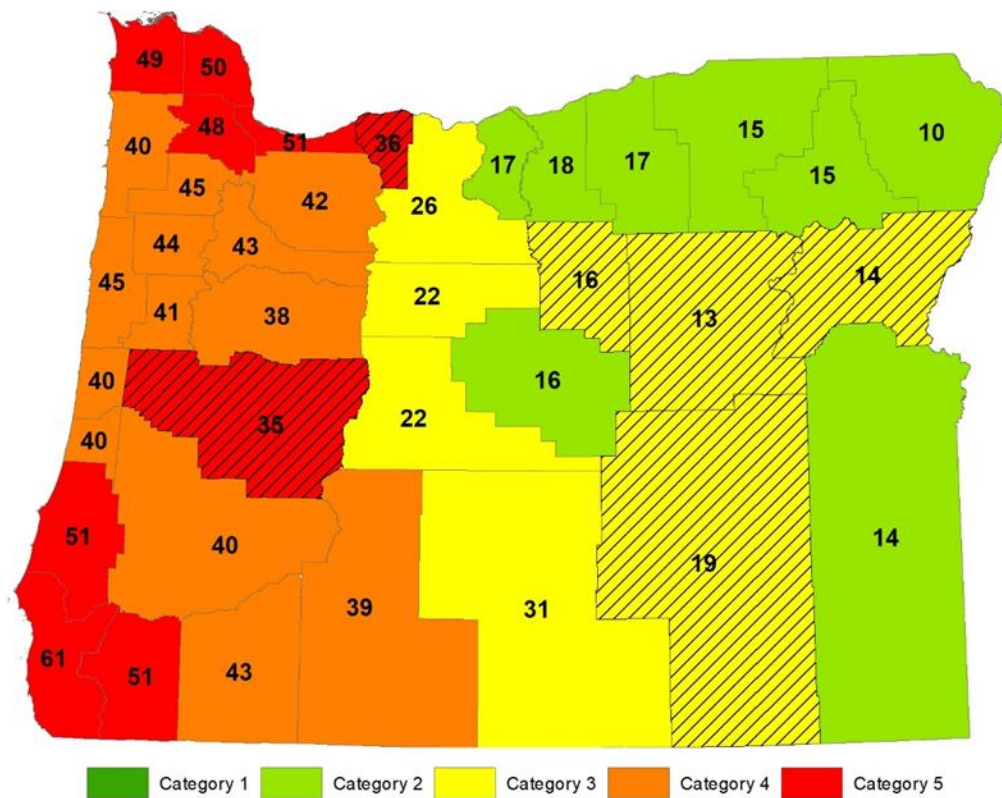
DOGAMI has developed a new probability ranking for Oregon counties that is based on the average probability of experiencing damaging shaking during the next 100 years, modified in some cases by the presence of newly discovered faults. If a county had newly discovered faults that were within 10-12 miles 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 2-182](#).

**Figure 2-182. 2020 Oregon Earthquake Probability Ranking Based on Mean County Value of the Probability of Damaging Shaking and Presence of Newly Discovered Faults**



Note: Counties with hatching had their probability category increased one step due to newly discovered faults.  
 Source: DOGAMI, 2020)

The Cascadia subduction zone is responsible for most of the hazard shown in [Figure 2-182](#). 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 to 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 2-313. Local Assessment of Vulnerability to Earthquakes in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	H	M	H	H	M	H

Source: Most recent local hazard vulnerability analyses ([Table 2-4](#))

**Table 2-314. State Assessment of Vulnerability to Earthquakes in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	L	VH	VH	M	VH

Source: DOGAMI and DLCD, 2020

### State Assessment

Region 3 is especially vulnerable to earthquake hazards because much of the area is susceptible to earthquake-induced landslides, liquefaction, and strong ground shaking.

Of the 15 counties in the state with the highest expected damages and losses based on the 500 year model, the following counties are located in Region 3:

- Lane,
- Marion,
- Benton,
- Linn, and
- Yamhill.

The Oregon Department of Geology and Mineral Industries (DOGAMI) developed two earthquake loss models for Oregon based on the two most likely sources of seismic events: (a) the Cascadia Subduction Zone (CSZ), and (b) combined crustal events (500-year model). Both models use Hazus, a software program developed by the Federal Emergency Management Agency (FEMA) as a means of determining potential losses from earthquakes. The CSZ event is based on a potential M8.5 earthquake generated off the Oregon coast. The model does not take into account a tsunami, which probably would develop from such an event. The 500-year crustal model does not look at a single earthquake (as in the CSZ model); it encompasses many faults. Neither model takes unreinforced masonry buildings into consideration.

DOGAMI investigators caution that the models contain a high degree of uncertainty and should be used only for general planning and policy making purposes. Despite their limitations, the models do provide some approximate estimates of damage and are useful to understand the relative relationships between the counties.

[Table 2-315](#), [Table 2-316](#), [Table 2-317](#), and [Table 2-318](#) show estimated losses in each county, including building collapse potential and damages based on three model scenarios.





**Table 2-315. Building Collapse Potential in Region 3**

County	Level of Collapse Potential			
	Low (<1%)	Moderate (>1%)	High (>10%)	Very High (100%)
Benton	13	5	22	3
Lane*	126	69	68	8
Linn	74	15	30	23
Marion	94	34	88	30
Polk	13	11	17	4
Yamhill	30	20	22	5

\*Does not include the Lane County coastal communities of Deadwood, Florence, Mapleton, and Swisshome, which are addressed in the Region 1 Profile.

Source: Lewis (2007)

**Table 2-316. Estimated Losses in Region 3 from a M9 CSZ and Local Crustal Event**

County	Building Value (Billions)	Total Building Related Losses from an M9.0 CSZ Event (Billions)	Total Building Related Losses from a Crustal Earthquake (Billions)
Benton	\$4.85	\$1.1	\$0.8
Lane	\$21.055	\$5.0	\$3.4
Linn	\$5.669	\$1.2	\$1.3
Marion	\$15.86	\$2.6	\$3.9
Polk	\$3.467	\$0.6	\$0.4
Yamhill	\$4.597	\$1.2	\$1.5

Source: Burns, et al. (2008)

**Table 2-317. Estimated Losses in Region 3 Associated with an M8.5-9.0 Subduction Event**

Category	Benton	Lane	Linn	Marion	Polk	Yamhill
Injuries (5 pm time period)	1,356	3,945	1,049	2,492	678	1,190
Deaths (5 pm time period)	96	264	67	157	43	74
Displaced Households	2,375	7,633	2,563	5,787	1,822	3,082
Economic losses for buildings	\$1,049.51 m	\$4,652 m	\$1,150.68 m	\$2,604.95m	\$624.43 m	\$1198.48 m
Operational after Day 1						
Fire station	100%	100%	100%	100%	100%	100%
Police Station	100%	100%	100%	100%	100%	100%
Schools	91%	100%	100%	99%	100%	98%
Bridges	91%	84%	100%	89%	82%	85%
Economic loss to infrastructure						
Highways	\$ 33.5 m	\$211 m	\$4.4 m	\$127.7 m	\$59.4 m	\$60.2 m
Airports	\$0 m	\$13.3 m	\$23.10 m	\$13 m	\$14 m	\$21.4 m
Communications	\$0 m	\$0.33 m	\$0.07 m	\$0.03 m	\$0.05 m	\$0.03 m
Debris generated (thousands of tons)	0	2,000	0	1,000	0	0

Source: Burns, et al. (2008)



**Table 2-318. Estimated Losses in Region 3 Associated with an Arbitrary M6.5-6.9 Crustal Event**

Mitigation Factors	Benton	Lane	Linn	Marion	Polk	Yamhill
Injuries (5 pm time period)	557	1,821	993	3,249	321	1,178
Deaths (5 pm time period)	33	96	59	189	18	67
Displaced households	1,755	7,716	3,683	10,701	1,412	4,256
Economic losses from buildings	\$762.25 m	\$3,351.03 m	\$1,315.72 m	\$3979.57 m	\$409.43 m	\$1,525.35 m
Operational the day after the event:						
Fire station	75%	100%	77%	61%	100%	
Police Station	75%	91%	40%	65%	100%	
Schools	91%	99%	70%	74%	100%	
Bridges	100%	97%	91%	86%	93%	
Economic losses to infrastructure:						
Highways	\$18.7 m	\$106 m	\$129.70 m	\$271.5 m	\$35.7 m	\$71.3 m
Airports	\$19.3 m	\$16 m	\$38.3 m	\$38 m	\$11 m	\$43.9 m
Communications	\$ 0.24 m	\$0.63 m	\$0.11 m	\$0.18 m	\$0.05 m	\$0.10 m
Debris generated (in thousands of tons)	0	1,000	0	1,000	0	0

Source: Burns, et al. (2008)

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

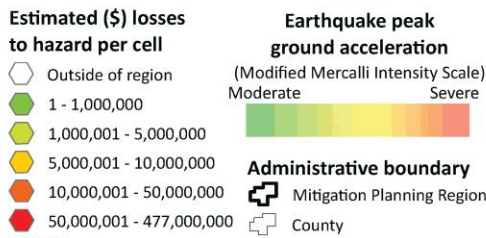
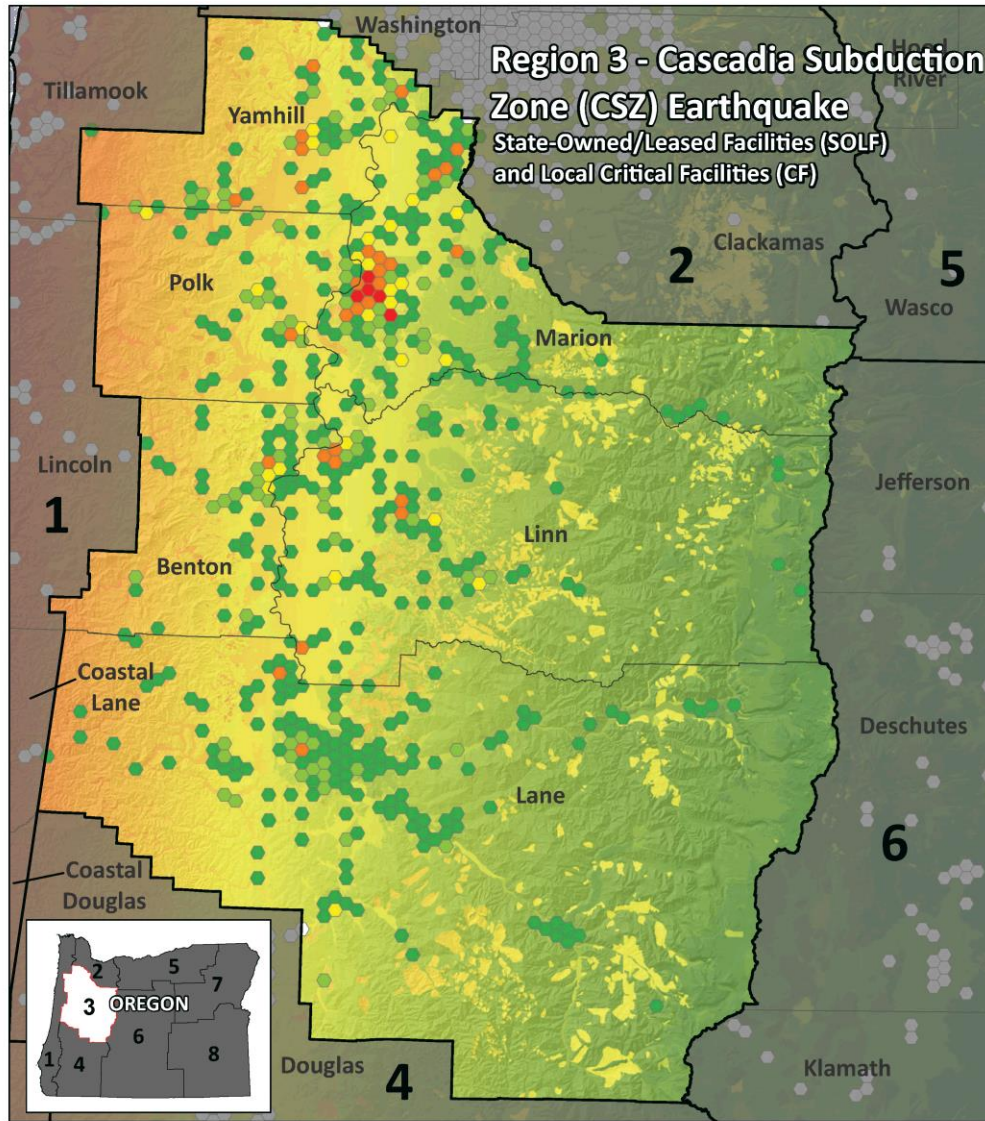
For the 2020 vulnerability assessment, DOGAMI used Hazus-MH to estimate potential loss from a magnitude 9 Cascadia Subduction Zone (CSZ) event in Region 3. The analysis incorporated information about the earthquake scenario (such as coseismic liquefaction and landslide potential), as well as building 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 3, a CSZ event could cause a potential loss of almost \$843M in state building and critical facility assets, 93% of it in Marion County alone. The potential loss in local critical facilities is somewhat greater at almost \$1.2B. Again, Marion County’s potential loss is greatest at 48%. Potential losses in Lane Line, Polk, and Yamhill Counties are similar, ranging 9-14%. Benton County’s potential loss is significantly less. [Figure 2-183](#) illustrates the potential loss to state buildings and critical facilities and local critical facilities from a CSZ event.



**Figure 2-183. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Cascadia Subduction Zone Earthquake Hazard Zone in Region 3.** High-resolution, full-size image linked from Appendix 9.1.26.

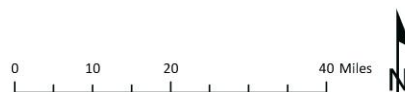


**Projection:**  
 Oregon Statewide Lambert Conformal Conic, Unit: International Feet,  
 Horizontal datum: NAD83 HARN, Scale 1:750,000

**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 3	Estimated Loss (\$) from CSZ Earthquake						
	County	Total Value SOLF and Local CF	State-owned/leased facilities			Critical Facilities	
Loss SOLF			% Loss SOLF	Loss (\$) SOLF	Loss Total*	Loss Local CF	Total Loss SOLF CF and Local CF
Benton	642,420,000	2,268,000	11%	4,976,000	7,244,000	76,996,000	79,264,000
Lane	2,960,570,000	1,133,000	0%	18,348,000	19,481,000	104,898,000	106,031,000
Linn	934,323,000	11,744,000	21%	5,250,000	16,994,000	165,778,000	177,522,000
Marion	4,700,844,000	341,971,000	28%	449,154,000	791,125,000	570,657,000	912,628,000
Polk	508,293,000	1,827,000	1%	1,366,000	3,193,000	115,000,000	116,827,000
Yamhill	851,391,000	3,951,000	29%	801,000	4,752,000	148,163,000	152,114,000
<b>Total</b>	<b>10,597,841,000</b>	<b>362,894,000</b>	<b>25%</b>	<b>479,895,000</b>	<b>842,789,000</b>	<b>1,181,492,000</b>	<b>1,544,386,000</b>

*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

### Historic Resources

Of the 19,731 historic resources in Region 3, only 10% are in an area of high or very high liquefaction potential. Almost three quarters of those, 74%, are located in Linn County. Another 20% are located in Marion and Polk Counties. Many more (44%) of Region 3's historic resources are located in areas of high or very high potential for ground shaking amplification. Of those, 27% are located in Marion County. Benton, Linn, and Yamhill Counties have sizable shares of historic resources at risk of ground shaking amplification as well, ranging from 14 to 24%.

### Archaeological Resources

Three thousand five hundred thirty-four archaeological resources are located in earthquake hazard areas in Region 3. Only three archaeological resources listed on the National Register of Historic Places and six eligible for listing are located in areas of high earthquake hazards. Eleven have been determined not eligible, and 200 have not been evaluated. All of the listed and eligible resources in areas of high earthquake hazards are located in Lane, Linn, and Marion Counties. Overall, the majority archaeological resources in earthquake hazard areas in Region 3 are in Lane County (55%) followed by Linn County (24%).

### 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, social vulnerability in Region 3 is highest in Marion County, followed by Linn and Yamhill Counties. Marion County ranks in the 90th percentile for its share of persons aged 17 or younger, percentage of single-parent households, and percentage of occupied housing units with more people than rooms. The county is also the 90th percentile for its share of residents that speak English less than "well". Linn County's high vulnerability is driven by moderately high scores across the CDC index. Notably, however, the county is in the 80th percentile for its share of single-parent households and has a smaller per-capita income and a higher percentage of persons aged 17 and younger than 70 percent of all counties. Vulnerability in Yamhill County is also driven by moderately high scores across the CDC index. The county is in the 80th percentile for its share of multi-unit structures and the percentage of people living in institutionalized group quarters.

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, Linn, Marion, and Yamhill Counties are most vulnerable, each with a very high rating. Polk County has a moderate rating and Benton and Lane Counties both have a low rating.

### 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 [9.1.16, Statewide Loss Estimates: Seismic Lifelines Evaluation, Vulnerability Synthesis, and Identification \(OSLR\)](#). According to that report, seismic lifelines in Region 3 have the following vulnerabilities.

Regional delineations for this Plan and for the OSLR are slightly different. Regions in the OSLR that correspond to Region 3 include sections of the Valley and Cascades Geographic Zones.

*VALLEY GEOGRAPHIC ZONE (OSLR)*. The Valley Geographic Zone generally consists of two or three north-south routes through the Willamette Valley and a variety of east-west connectors between those routes. The entire area is likely to experience sustained ground shaking, with many roadways in areas subject to landslide and rockfall or liquefaction. Seismic lifeline routes that provide redundant north-south movement were designated.

The Tier 1 system in the Valley Geographic Zone consists of the following corridors:

- I-5,
- OR-99W from I-5 to OR-18 near Dayton,
- OR-18 from OR-99W near Dayton to McMinnville, and
- OR-22 from I-5 to OR-99E in Salem.

The Tier 2 system in the Valley Geographic Zone consists of the following corridors:

- US-26 from OR-47 to OR-217,
- OR-99W from McMinnville to Junction City,
- OR-99 from Junction City to I-5 in Eugene,
- OR-99E from Oregon City to I-5 in Salem, and
- OR-214 in Woodburn from I-5 to OR-99E.

The Tier 3 system in the Valley Geographic Zone consists of the following corridors:

- OR-219 from Newberg to Woodburn,
- OR-99E in Salem from I-5 to OR-22,
- OR-22 from OR-99W to Salem, and
- OR-34 from Corvallis to I-5.

Region 3 includes the central area of the Cascades Geographic Zone. These routes connect the highly seismically impacted western portion of the state to the less seismically impacted central portion of the state. The Tier 1 system in this region consists of OR-58. The Tier 2 system in the Cascades Geographic Zone in Region 3 consists of OR-22 from Salem to Santiam Junction and US-20 from Santiam Junction to Bend. There are no corridors designated as Tier 3 in the Region 3 Cascades Geographic Zone.

*REGIONAL IMPACT.*

- Ground shaking: In Region 3, ground shaking will be of a magnitude and duration to cause property damage, possibly severe. Unreinforced structures, roadbeds, and bridges will be damaged to varying extents, and there will be damaged areas on lifelines that will be impassable without at least temporary repairs.
- Landslides and rockfall: Many rural and some developed area roadways in Region 3 are cut into or along 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 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.* 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.* Benton, Lane, Linn, Marion, Polk, and Yamhill Counties are generally equally vulnerable to ground shaking from a CSZ event. Each county has some steep roads in rural and developed areas that may experience landslides. All three have some transportation facilities along river beds or crossing rivers that may be vulnerable to liquefaction.

### Risk

**Table 2-319. Risk of Earthquake Hazards in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Risk	M	H	VH	VH	H	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, Linn, Marion, and Yamhill Counties are at very high risk from earthquakes; Lane and Polk are at high risk. Only Benton County has a moderate risk. Its very high probability and high vulnerability of local critical facilities are moderated by the very low vulnerability of state buildings and critical facilities as well as its low social vulnerability





## Extreme Heat

### Characteristics

Climate conditions in the Willamette Valley are described as Mediterranean, with rainy winters and warm dry summers. Extreme temperatures aren't as common in western Oregon compared to other parts of the state; however, Region 3 does experience days above 90°F nearly every year. Eugene has an average of about 13 days per year above 90°F. The frequency of prolonged periods of high temperatures is expected to increase.

### Historic Extreme Heat Events

**Table 2-320. Historic Extreme Heat Events in Region 3**

Date	Location	Notes
June 24–26, 2006	Region 1–3, 5	A broad upper ridge of unusually high height coupled with a thermally induced surface trough of low pressure lingered over the Pacific Northwest for several days. This pattern resulted in persistent offshore flow, and therefore many days of record-smashing high temperatures. Portland International Airport had 101 degrees on June 26 breaking the old record at 94 degrees in 1987.
July 20–24, 2006	Region 1–3, 5, 7	An unusually strong ridge of high pressure brought several days of record breaking hot and humid weather to NW Oregon. Many cities in Oregon saw record-breaking daily high temperatures for multiple days in a row. On July 21, Portland reported 104°F.
June 28–30, 2008	Region 2, 3, 5, 7	An upper level ridge and thermal trough across the Pacific Northwest produced temperatures above 100 degrees for two consecutive days breaking records in many locations. Two people died of heat-related illness.
July 1, 2014	Region 3	An upper level ridge combined with a surface thermal trough and low level offshore winds resulted in a hot day across Northwest Oregon where inland temperatures peaked in the upper 90s.
Summer 2015	Region 2, 3	A series of heat waves struck western Oregon in the summer of 2015, Oregon's hottest year on record, driven by a strong, persistent upper level ridge over the region. Heat waves occurred June 7–9, June 26–28, July 1–5, July 28–30, and August 18–19. Heat-related illnesses and deaths were markedly greater during these heat wave periods and cooling shelters were opened. High temperatures were 10–20°F above normal and overnight low temperatures were also unseasonably warm. Many locations broke both daytime high temperature records as well as warm overnight low temperature records.
June 2–5, 2016	Region 3	Excessive Heat Event: Unseasonably strong ridge of high pressure resulted in a period of early-season hot temperatures across Northwest Oregon. Temperatures of 95 to 100 in early June lead to people seeking relief at local rivers. Three drownings were reported.
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 2–3: The record-breaking heat led people to seek relief at local rivers. Two people drowned while swimming.
July 12–17, 2018	Region 2, 3, 4	Region 2–3: High pressure over the region led to a stretch of hot day July 12 through July 17th. Hot temperatures led people to cool off in local rivers. There were two drownings recorded on July 16 and July 18. Temperatures on July 16th near the Sandy River in Troutdale got up to 98 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 3 relative probability rankings are shown in [Table 2-321](#). Most of the region is in the center quintile of extreme heat frequency meaning relative probability is moderate compared to the rest of the state. The coastal portion of Lane County is included in Region 3 for this assessment.

**Table 2-321. Probability of Extreme Heat in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	M	M	M	L	M	M

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*). Extreme temperatures are relatively rare in Region 3, but are projected to increase under future climate change. [Table 2-322](#) 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 3.

**Table 2-322. Annual Number of Days Exceeding Heat Index ≥ 90°F for Region 3 Counties**

County	Historic Baseline	2050s Future
Benton	4	25
Lane	4	24
Linn	3	22
Marion	3	20
Polk	4	23
Yamhill	5	24

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, social vulnerability in the region is highest in Marion County, followed by Linn and Yamhill Counties. Marion County ranks in the 90th percentile for its share of persons aged 17 or younger, percentage of single-parent households, and percentage of occupied housing units with more people than rooms. The county is also the 90th percentile for its share of residents that speak English less than “well.” Linn County’s high





vulnerability is driven by moderately high scores across the CDC index. Notably, however, the county is in the 80th percentile for its share of single-parent households and has a smaller per-capita income and a higher percentage of persons aged 17 and younger than 70 percent of all counties. Vulnerability in Yamhill County is also driven by moderately high scores across the CDC index. The county is in the 80th percentile for its share of multi-unit structures and the percentage of people living in institutionalized group quarters.

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 houseless.

Because extreme heat isn't as common in western Oregon ("moderate" probability) compared to other parts of the state, many people may not be accustomed or prepared when an extreme heat event occurs ("moderate" adaptive capacity). In Cooling Zone 1, which includes Region 3, 58% 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 2-323** displays the total vulnerability rankings as well as ranking for sensitivity and adaptive capacity for each county in NHMP Region 3. **Table 2-324** provides the summary descriptors of Region 3's vulnerability.

Combining sensitivity and adaptive capacity, Region 3's relative vulnerability to extreme heat is "High." With their high vulnerability ratings, Linn, Marion, and Yamhill Counties are the most vulnerable to extreme heat in Region 3.

**Table 2-323. Relative Vulnerability Rankings for Region 3 Counties**

County	Sensitivity	Adaptive Capacity	Vulnerability
<b>Region 3</b>	<b>4</b>	<b>3</b>	<b>4</b>
Benton	2	3	3
Lane	3	3	3
Linn	4	3	4
Marion	5	3	4
Polk	3	3	3
Yamhill	4	3	4

Source: Oregon Climate Change Research Institute



**Table 2-324. State Assessment of Vulnerability to Extreme Heat in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	H	H	H	H	H

Source: Oregon Climate Change Research Institute

**Table 2-325. Local Assessment of Vulnerability to Extreme Heat in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	—	—	—	M	—	—

Source: Most recent local hazard vulnerability analyses ([Table 2-4](#))

Similar to drought, prolonged elevated temperatures pose risks to agriculture, involving health and welfare to farmers, farm workers, crops and livestock. Higher temperatures, crops, livestock and humans require more water. For example, on average, for each degree Fahrenheit increase in temperature, plants use 2.5% - 5% more water. High temperature and insufficient water stunt plant growth and cause areas of crops to wither.

Some livestock, especially dairy cattle, are sensitive to heat. Milk production decreases and susceptibility to death increases during and for some time after a heat wave. Since risks to human health and welfare are also elevated during heat waves, Oregon and the federal government have regulations and guidelines to help prevent injury to those who work on farms.

Also similar to drought, impacts of extreme heat on state-owned facilities related to agriculture may include impacts to research conducted in outdoor settings, such as at extension stations and research farms. Since heat waves are more recent to the Willamette Valley, appropriate data have not been collected to assess economic impacts to the state.

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

The value of state-owned and leased buildings and critical facilities in Region 3 is approximately \$3,107,827,000 representing the total potential for loss of state assets due to extreme heat. The value of locally owned critical facilities is \$7,490,014,000. Because extreme heat, while relatively uncommon in Region 3, could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to extreme heat. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. According to Department of Administrative Services records, three losses totaling almost \$39,000 state facilities were recorded in Region 3 since the beginning of 2015. None were caused by extreme heat.

*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 2-326** displays the relative risk ranking as well as rankings for probability and vulnerability for each county in NHMP Region 3. **Table 2-327** provides the summary descriptors of Region 3’s risk to extreme heat.

Combining probability and vulnerability, Region 3’s relative risk to extreme heat is “Moderate.” Linn and Yamhill Counties are at high risk.

**Table 2-326. Risk Rankings for Region 3 Counties**

County	Probability	Vulnerability	Risk
<b>Region 3</b>	<b>3</b>	<b>4</b>	<b>3</b>
Benton	3	3	3
Lane	3	3	3
Linn	3	4	4
Marion	2	4	3
Polk	3	3	3
Yamhill	3	4	4

Source: Oregon Climate Change Research Institute

**Table 2-327. Risk of Extreme Heat in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Risk	M	M	H	M	M	H

Source: Oregon Climate Change Research Institute



## Floods

### *Characteristics*

Region 3 has a lengthy flood history. Notable floods affecting Region 3 are shown in [Table 2-328](#). [Table 2-329](#) describes flood sources for each of the counties in the region. Additionally, sheet flooding occurs on agricultural land. Because this occurs far from a source river or stream, however, such flood areas are not depicted on federal Flood Insurance Rate Maps.

Most of the serious flooding experienced in Region 3 occurs in December and January. These events are usually associated with La Niña conditions, which result in prolonged rain and rapid snowmelt on saturated or frozen ground. This sudden influx of water causes rivers to swell, forcing tributary streams to back up and flood communities.

Region 3 is protected by several flood control dams.

A very large 1964 flood was a result of unusually intense precipitation on frozen topsoil, augmented by snowmelt in the mountains and valley. Without upstream flood control structures, the 1964 flood would have been the largest flood of the 20th century, with a peak discharge of 320,000 cubic feet per second (cfs) at the Albany gage. However, upstream dams reduced the peak discharge to 186,000 cfs.

The unincorporated areas of Region 3 are nearly all agricultural lands or timberlands. Flood damage in those areas would be limited to farm crops, farm buildings and residences, and erosion of croplands.

The Federal Emergency Management Agency (FEMA) has mapped most flood-prone streams in Oregon. The maps depict the 1% flood (100 year) upon which the National Flood Insurance Program is based. All of the Region 2 counties have Flood Insurance Rate Maps (FIRM). The FIRMs were issued at the following times:

- Benton, June 6, 2011 with some panels issued on December 8, 2016;
- Lane, June 2, 1999;
- Linn, September 29, 2010 with some panels issued on December 8, 2016;
- Marion, January 19, 2000 with some panels issued October 18, 2019;
- Polk, December 19, 2006 with some panels issued October 18, 2019; and
- Yamhill, March 2, 2010.

FEMA is working through the Risk MAP process in Lane County to update the FIRMs. Preliminary FIRMs are anticipated in February 2020 to be followed with CCO meetings with local officials and eventual public review of the updated FIRMs.

The Risk MAP project for the Upper Willamette anticipates draft maps to be issued in summer 2020.



## Historic Flood Events

**Table 2-328. Significant Historic Floods Affecting Region 3**

Date	Location	Characteristics	Type of Flood
Dec. 1861	Willamette Basin and coastal rivers	preceded by two weeks of heavy rain; every town on the Willamette was flooded or washed away; 635,000 cfs at Portland	rain on snow; snow melt
Jan. 1881	Willamette Basin	Lane, Linn, Benton, Marion, Polk, Yamhill, Clackamas, Multnomah Counties	
Feb. 1890	Willamette Basin and coastal rivers	second largest known flood in the Willamette Basin; almost every large bridge washed downstream	rain on snow
Dec. 1937	western Oregon	flooding followed heavy rains; considerable highway flooding; landslides	rain on snow
Jan. 1953	western Oregon	widespread flooding in western Oregon accompanied by windstorm	rain on snow
Dec. 1964- Jan. 1965	Willamette Basin	record flooding throughout Willamette Basin; two intense storms; near-record early season snow depths; largest flood in Oregon since dam construction on upper Willamette (1940s–50s; \$34 million in damages)	rain on snow
Jan. 1974	western Oregon	flooding followed heavy wet snow and freezing rain; nine counties received Disaster Declaration	rain on snow
Dec. 1978	western Oregon	intense heavy rain, snowmelt, saturated ground; one fatality in Region 3 (Benton County)	rain on snow
Feb. 1986	entire state	severe statewide flooding; rain and melting snow; numerous homes flooded and highways closed	snow melt
Feb. 1987	western Oregon	Willamette River and tributaries; mudslides; damaged highways and homes	rain on snow
Feb. 1996	entire state	deep snowpack, warm temperatures, record-breaking rains; flooding, landslides, power-outages (FEMA-1099-DR-Oregon)	rain on snow
Nov. 1996	entire state	record-breaking precipitation; local flooding/landslides (FEMA-1149-DR-Oregon)	rain on snow
Dec. 2005	Polk, Marion, Linn, Lane and Benton Counties	heavy rains causing rivers to crest above flood stage in Polk, Marion, Linn, Lane, and Benton Counties, as well as other counties in the Willamette Valley	riverine
Jan. 2006	Willamette Valley	heavy rains caused many rivers to crest above flood stage in the Willamette Valley, causing road closures and damage to agricultural lands	riverine
Dec. 2007	Yamhill	South Yamhill River flooded near McMinnville, causing damage to roads and bridges, 120 homes in Sheridan along with a few businesses and churches, and causing minor damage in Willamina; total county-wide damage estimates at \$9.6 million	riverine
Dec. 2007	Polk	major flooding in Suver and other areas in Polk County; total losses equal \$1 million for entire county	riverine
Jan. 2012	Polk, Marion, Yamhill, Lincoln, Benton, Linn and Lane Counties	heavy rain and wind; ice (DR-4055); flooding in the Willamette Valley; 130 homes and seven businesses were damaged in the City of Turner; 29 streets were closed in the City of Salem; the state motor pool lost 150 vehicles and thousands of gallons of fuel; Thomas Creek in the City of Scio overtopped, damaging several buildings	riverine





Date	Location	Characteristics	Type of Flood
Nov. 2012	Curry, Josephine, and Lane Counties	heavy precipitation; the Curry Coastal Pilot reported over 2 million dollars in infrastructure damage in Brookings and another 2 million in Curry County due to recent heavy rains; sinkholes and overflowing sewage facilities were also reported; according to KVAL news, Eugene Public Works has opened its emergency command center to deal with numerous flooding incidents, including two flooded intersections	riverine
Feb. 2014	Lane, Coos, Marion and Tillamook and Counties	A series of fronts resulted in a prolonged period of rain for Northwest Oregon, and minor flooding of several of the area's rivers from February 12th through February 17th. Heavy rains caused the Coquille River at Coquille to flood. The flood was categorized as a moderate flood. The Nehalem River near Foss in Tillamook County exceeded flood stage on February 18th, 2014.	riverine
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
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.	
Nov. 2016	Columbia, Tillamook, Lincoln, Benton, Washington, Polk, and Yamhill Counties	A moist Pacific front moving slowly across the area produced heavy rainfall, resulting in flooding of several rivers across Northwest Oregon and at least two landslides.	riverine
Feb. 2017	Marion, Polk, Yamhill, Washington, Columbia, Benton, Tillamook, Lane, Coos, Curry, Klamath, Wheeler and Malheur Counties	High river flows combined with high tide to flood some areas near the southern Oregon coast. Heavy rain combined with snow melt caused flooding along the Coquille River and the Rogue River twice this month in southwest Oregon. Heavy rain combined with snow melt caused flooding along the Sprague River in south central Oregon. Flows on the John Day river reached flood levels downstream of Monument due to the breaking up of an ice jam.	riverine and coastal flooding
Oct. 2017	Tillamook, Benton, and Clackamas Counties	A very potent atmospheric river brought strong winds to the north Oregon Coast and Coast Range on October 21st. What followed was a tremendous amount of rain for some locations along the north Oregon Coast and in the Coast Range, with Lees Camp receiving upwards of 9 inches of rain. All this heavy rain brought the earliest significant Wilson River Flood on record, as well as flooding on several other rivers around the area.	riverine
June 2018	Lane County	In Lane County an upper-level trough moved across the area from the southwest, generating strong thunderstorms which produced locally heavy rainfall, lightning, hail, and gusty winds.	
April 2019	Lane, Benton, Marion, Clackamas and Linn Counties		

Sources: Taylor and Hatton (1999); National Climatic Data Center Storm Events, located at <http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwEvent~Storms>



**Table 2-329. Principal Riverine Flood Sources by County in Region 3**

Benton	Lane	Linn	Marion	Polk	Yamhill
Willamette River, N. Fork Alsea, and tributaries, especially:	Willamette River and tributaries, especially:	Willamette River and tributaries, especially:	Willamette River and tributaries, especially:	Willamette River and tributaries, especially:	Willamette River and tributaries, especially:
Marys River	Amazon Creek	Calapooia River	Santiam River	S. Yamhill River	Yamhill River
Newton Creek	Berkshire Slough	Calapooia River	Pudding River	Ash Creek (all forks)	Yamhill Creek
Mill Race	Blue River	Santiam (N and S)	Battle Creek	Agency Creek	Baker Creek
Frazier Creek	Cedar Creek	Thomas Creek	Butte Creek	Ellendale Creek	Chehalem Creek
Soap Creek	Coast Fork	Ames Creek	Beaver Creek	Gibson Creek	Cozine Creek
Oak Creek	Dedrick Slough	Oak Creek	Claggett Creek	Rickreall Creek	Hess Creek
Jackson Creek	Fall Creek	Peters Ditch	Croisan Creek	Rock Creek	Palmer Creek
	Long Tom River	Truax Creek	Gibson Creek	Rowell Creek	
	McKenzie River		Lake Labish Creek		
	Mohawk River		Mill Creek		
	Oxley Slough		Pringle Creek		
	Row River		Senecal Creek		
	Salmon Creek		Silver Creek		
	Silk Creek		Shelton Ditch		

Sources: FEMA, Benton County Flood Insurance Study (FIS), Aug. 15, 1996; FEMA, Lane County FIS, June 2, 1999; FEMA, Linn County FIS, Sept. 29, 1986; FEMA, Marion County FIS, July 13, 2001; FEMA, Polk County FIS, Dec. 19, 1995; FEMA, Yamhill County FIS, Sept. 30, 1983

### *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 [9.1.19](#).

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 3 will experience flooding. The resulting estimates of probability are shown in [Table 2-330](#).

**Table 2-330. Local Assessment of Flood Probability in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	H	H	H	H	H

Source: Benton County MJNHMP (2016; [https://www.co.benton.or.us/sites/default/files/fileattachments/sheriff039s\\_office/page/6029/natural\\_hazard\\_mitigation\\_plan\\_2016.pdf](https://www.co.benton.or.us/sites/default/files/fileattachments/sheriff039s_office/page/6029/natural_hazard_mitigation_plan_2016.pdf)), Lane County MJNHMP (2018; [https://lanecounty.org/UserFiles/Servers/Server\\_3585797/File/Government/County%20Departments/Emergency%20Management/Hazard%20Mitigation%20Plan/20180828\\_MASTER\\_MJ-NHMPUpdate\\_Final.pdf](https://lanecounty.org/UserFiles/Servers/Server_3585797/File/Government/County%20Departments/Emergency%20Management/Hazard%20Mitigation%20Plan/20180828_MASTER_MJ-NHMPUpdate_Final.pdf)), Linn County MJNHMP (2017; <http://www.co.linn.or.us/Planning/HazardPlan/NHMP%202018.pdf>); Marion County MJNHMP (2017; [https://www.co.marion.or.us/PW/EmergencyManagement/Documents/120116\\_MarionNHMP\\_Volume%20I\\_Draft.pdf](https://www.co.marion.or.us/PW/EmergencyManagement/Documents/120116_MarionNHMP_Volume%20I_Draft.pdf)), Polk County MJNHMP (2017; <https://cpb-us-e1.wpmucdn.com/blogs.uoregon.edu/dist/3/4943/files/2017/11/Volume-I-Polk-NHMP-Update-2f51ktm.pdf>), Yamhill County Multi-Jurisdictional Hazard Mitigation Plan Update (2014; [https://www.co.yamhill.or.us/sites/default/files/Yamhill\\_County\\_Natural\\_Hazard\\_Mitigation\\_Plan2014.pdf](https://www.co.yamhill.or.us/sites/default/files/Yamhill_County_Natural_Hazard_Mitigation_Plan2014.pdf))

*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 3. The results are shown in [Table 2-331](#).

**Table 2-331. State Assessment of Flood Probability in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	VH	VH	VH	H	H	H

Source: DOGAMI

*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 (toward 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

**Table 2-332. Local Assessment of Vulnerability to Flood in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	H	M	H	M	H

Source: Benton County MJNHMP (2016; [https://www.co.benton.or.us/sites/default/files/fileattachments/sheriff039s\\_office/page/6029/natural\\_hazard\\_mitigation\\_plan\\_2016.pdf](https://www.co.benton.or.us/sites/default/files/fileattachments/sheriff039s_office/page/6029/natural_hazard_mitigation_plan_2016.pdf)), Lane County MJNHMP (2018; [https://lanecounty.org/UserFiles/Servers/Server\\_3585797/File/Government/County%20Departments/Emergency%20Management/Hazard%20Mitigation%20Plan/20180828\\_MASTER\\_MJ-NHMPUpdate\\_Final.pdf](https://lanecounty.org/UserFiles/Servers/Server_3585797/File/Government/County%20Departments/Emergency%20Management/Hazard%20Mitigation%20Plan/20180828_MASTER_MJ-NHMPUpdate_Final.pdf)), Linn County MJNHMP (2017; <http://www.co.linn.or.us/Planning/HazardPlan/NHMP%202018.pdf>); Marion County MJNHMP (2017; [https://www.co.marion.or.us/PW/EmergencyManagement/Documents/120116\\_MarionNHMP\\_Volume%20I\\_Draft.pdf](https://www.co.marion.or.us/PW/EmergencyManagement/Documents/120116_MarionNHMP_Volume%20I_Draft.pdf)), Polk County MJNHMP (2017; <https://cpb-us-e1.wpmucdn.com/blogs.uoregon.edu/dist/3/4943/files/2017/11/Volume-I-Polk-NHMP-Update-2f51ktm.pdf>), Yamhill County Multi-Jurisdictional Hazard Mitigation Plan Update (2014; [https://www.co.yamhill.or.us/sites/default/files/Yamhill\\_County\\_Natural\\_Hazard\\_Mitigation\\_Plan2014.pdf](https://www.co.yamhill.or.us/sites/default/files/Yamhill_County_Natural_Hazard_Mitigation_Plan2014.pdf))

**Table 2-333. State Assessment of Vulnerability to Flood in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	M	H	VH	M	M

Source: DOGAMI, DLCD

Participants in the county NHMPs were consulted to evaluate critical facilities and infrastructure vulnerabilities. Most counties in Region 3 have not yet catalogued critical facilities and infrastructure and therefore have not yet analyzed the hazards to which these facilities are subject. These counties have begun to consider that analysis by establishing mitigation actions such as developing a list of hazard types to be mapped and then identifying, locating and obtaining the necessary data to plot critical facilities and infrastructure to show their location within the hazard areas. Benton County did catalogue those critical facilities located in the floodplain, but was not able to analyze whether these facilities might be damaged by flooding. Among these facilities were the wastewater/sewage treatment plants in Alsea, Corvallis, Monroe and Philomath, and Corvallis High School.

Repetitive Losses

FEMA has identified 46 Repetitive Loss buildings in Region 3, four of which are Severe Repetitive Loss properties. This region has the third most repetitive flood losses of the Oregon NHMP Natural Hazard Regions, reflecting its downstream location in or near the Willamette Valley, often flat topography, and population density.



**Table 2-334. Flood Severe/Repetitive Losses and Community Rating System Communities by County in Region 3**

County	RL/SRL	Number of CRS Communities per County
Benton	3	2
*Lane	30	3
** Linn	7	1
***Marion	15	2
Polk	1	1
Yamhill	5	1
<b>Totals</b>	<b>61</b>	<b>10</b>

\*Includes non-coastal sections of Lane County.

\*\*Albany is a CRS community located in both Benton and Linn Counties. For the purposes of this table, Albany is counted as being in Linn County.

\*\*\*Salem is located in both Marion and Polk Counties. For the purposes of this table, Salem is counted as being in Marion County due to the way FEMA categorizes the City of Salem.

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. DLCDC encourages communities that adopt such standards to participate in FEMA’s Community Rating System (CRS), which results in reduced flood insurance costs. Benton, Lane, Marion, and Polk Counties participate in CRS, as do the cities of Albany, Corvallis, Eugene, Salem, and Sheridan.

*State-Owned/Leased Facilities and Critical/Essential Facilities*

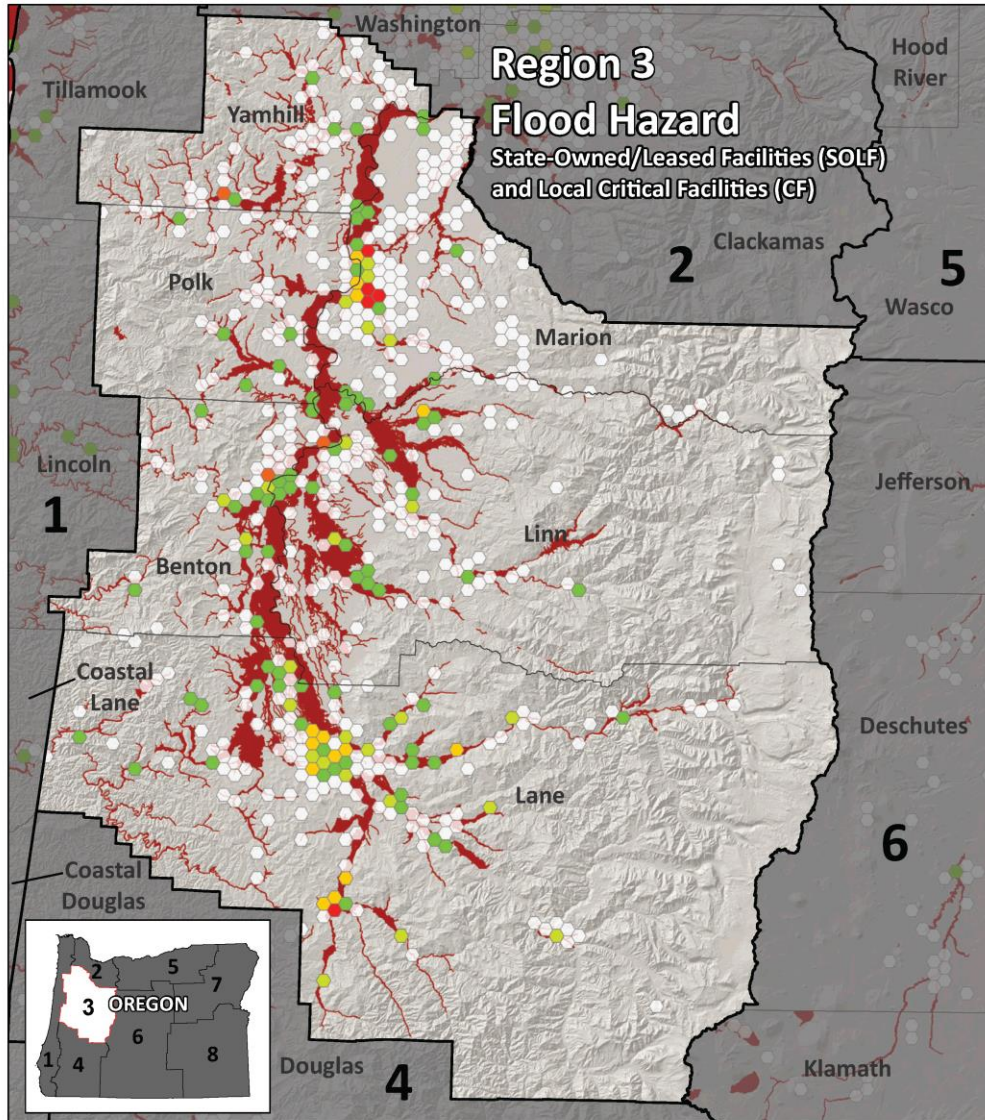
For the 2020 Risk Assessment, DOGAMI used a combination of FEMA effective and preliminary flood zone data (FEMA National Flood Hazard Layer, 2019) and FEMA Q3 data (an unpublished digital dataset of paper flood insurance rate maps). All FEMA data that DOGAMI used was current as of 2019. The flood hazard 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 3, there is a potential loss from flooding of over \$676M in state building and critical facility assets, 93% of it in Marion County alone. The next greatest share is about \$37M, only one-half percent, in Lane County. There is a similar potential loss due to flood in local critical facilities: close to \$677.6M, forty percent and 32% in Lane and Marion Counties, respectively. The next greatest share, 14% is in Benton County. [Figure 2-184](#) illustrates the potential loss to state buildings and critical facilities and local critical facilities from flooding.





**Figure 2-184. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Flood Hazard Zone in Region 3.** High-resolution, full-size image linked from Appendix 9.1.26.



**Building value (\$) exposed to 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 - 477,000,000

**Hazard area**

- Flood - high hazard

**Administrative boundary**

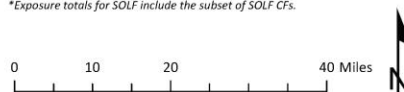
- ▭ Mitigation Planning Region
- ▭ County

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

**Source Data:**  
 Flood: various studies from Federal Emergency Management Agency, National Flood Insurance Program  
 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 3	Exposure (\$) to Flood Hazard Areas						
	Total Value SOLF and Local CF	State-owned/leased facilities			Critical Facilities		
County	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	
Benton	642,420,000	347,000	2%	692,000	1,039,000	92,350,000	92,697,000
Lane	2,960,570,000	6,321,000	5%	30,669,000	36,990,000	274,029,000	280,350,000
Linn	934,323,000	0	0%	7,582,000	7,582,000	41,873,000	41,873,000
Marion	4,700,844,000	305,263,000	24%	323,025,000	628,288,000	216,685,000	521,948,000
Polk	508,293,000	0	0%	2,126,000	2,126,000	24,735,000	24,735,000
Yamhill	851,391,000	0	0%	59,000	59,000	27,886,000	27,886,000
<b>Total</b>	<b>10,597,841,000</b>	<b>311,931,000</b>	<b>22%</b>	<b>364,153,000</b>	<b>676,084,000</b>	<b>677,558,000</b>	<b>989,489,000</b>

*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 19,731 historic resources in Region 3, two thousand three hundred seventy-seven (12%) are located in an area of high flood hazard. Of those, 1,480 (62%) are located in Lane County. The next greatest share, 17%, is in Marion County.

### *Archaeological Resources*

Of the 854 archaeological resources located in high flood hazard areas in Region 3, fifty-two percent are located in Lane County. The next greatest share, 24% is in Linn County. Twenty-two are listed on the National Register of Historic Places and 37 are eligible for listing. Twenty have been determined not eligible and 775 have not been evaluated as to their eligibility. The listed resources are located in Lane (15), Marion (6), and Yamhill (1) Counties. Thirteen and 14 of the eligible resources are located in Lane and Marion Counties, respectively; the rest are spread throughout Region 3.

### *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, social vulnerability in the region is highest in Marion County, followed by Linn and Yamhill Counties. Marion County ranks in the 90th percentile for its share of persons aged 17 or younger, percentage of single-parent households, and percentage of occupied housing units with more people than rooms. The county is also the 90th percentile for its share of residents that speak English less than “well.” Linn County's high vulnerability is driven by moderately high scores across the CDC index. Notably, however, the county is in the 80th percentile for its share of single-parent households and has a smaller per-capita income and a higher percentage of persons aged 17 and younger than 70 percent of all counties. Vulnerability in Yamhill County is also driven by moderately high scores across the CDC index. The county is in the 80th percentile for its share of multi-unit structures and the percentage of people living in institutionalized group quarters.

For the 2020 vulnerability assessment, DLCDC 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, Marion County is very highly vulnerable and Linn County is highly vulnerable to the impacts of flood. Marion County's very high vulnerability score is driven by the high value of state buildings, state critical facilities, and local critical facilities in the county as well as its very high social vulnerability. Linn County's high score is driven primarily by its high social vulnerability. While Lane County has twice as many repetitive or severe repetitive loss properties, Marion County still has a significant number. Lane County has significantly more historic and archaeological resources than Marion or Linn Counties.

### *Most Vulnerable Jurisdictions*

Marion, Lane, and Linn Counties are the most vulnerable to flood hazards in Region 3.



Risk

**Table 2-335. Risk of Flood Hazards in Region 3**

	<b>Benton</b>	<b>Lane</b>	<b>Linn</b>	<b>Marion</b>	<b>Polk</b>	<b>Yamhill</b>
Risk	H	VH	VH	VH	H	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 probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, all Region 3 counties are at great risk from floods; Lane, Linn, and Marion Counties face the greatest risk



## *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.

Landslides are a significant hazard in many parts of Oregon, and some dams are constructed on landslide deposits. Though not common, a large and rapidly moving landslide or debris flow may generate a wave that can overtop a dam, causing significant flooding, especially if it causes a dam to fail.

Wildfires may increase the risk of debris flows (though wildfire generated debris flows are typically on the smaller size scale). Wildfires and windstorms can also result in large woody debris that can block spillways, also a risk to dam integrity. Oregon will be evaluating both landslide and wildfire risks during its HHPD grant funded risk assessments of dams currently eligible for the program.

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 owner's 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 2-336. Historic Significant Dam Failures in Region 3**

Year	Location	Description
1982	Mann creek dam near Sweet Home in Linn Co.	Washed out multiple forest roads
2016	Heater Reservoir near Sublimity in Marion Co.	Flooded area occupied by Christmas tree packers, flooded paved road

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 28 High Hazard dams and 38 Significant Hazard dams in Region 3.



**Table 2-337. Summary: High Hazard and Significant Hazard Dams in Region 3**

	Hazard Rating		
	State		Federal
	High	Significant	High
Region 3	9	38	19
Benton	1	1	0
Lane	1	5	13
Linn	1	0	6
Marion	2	13	0
Polk	2	8	0
Yamhill	2	11	0

Source: Oregon Water Resources Department, 2019

**Table 2-338. High Hazard and Significant Hazard Dams in Region 3**

County	Name	Rating	Regulator
Benton	North Fork	High	State
Benton	Thompson (Benton)	Significant	State
Lane	Blue River Dam	High	Federal
Lane	Cottage Grove	High	Federal
Lane	Cougar Reservoir	High	Federal
Lane	Dexter	High	Federal
Lane	Dorena	High	Federal
Lane	Fall Creek Reservoir	High	Federal
Lane	Fern Ridge	High	Federal
Lane	Hills Creek Reservoir	High	Federal
Lane	Hult Log Storage Pond	High	Federal
Lane	Leaburg Dam	High	Federal
Lane	Lookout	High	Federal
Lane	Walterville Power Intake	High	Federal
Lane	Walterville Pumped S. Pond	High	Federal
Lane	Santa Clara	High	State
Lane	Farnam Creek Reservoir	Significant	State
Lane	Forcia And Larsen Log Pond	Significant	State
Lane	Ford Farms Reservoir	Significant	State
Lane	Schwartz Reservoir	Significant	State
Lane	Vaughn Log Pond	Significant	State
Linn	Big Cliff Dam	High	Federal
Linn	Detroit Reservoir	High	Federal
Linn	Foster Reservoir	High	Federal
Linn	Green Peter Reservoir	High	Federal
Linn	Smith River	High	Federal
Linn	Trail Bridge Reg. Reservoir	High	Federal
Linn	Foster Log Pond	High	State
Marion	Franzen	High	State
Marion	Silver Creek	High	State



County	Name	Rating	Regulator
Marion	Barnes Bros. Reservoir	Significant	State
Marion	Berger Lake	Significant	State
Marion	Fredericks Pond	Significant	State
Marion	Funrue	Significant	State
Marion	Heater Dam	Significant	State
Marion	Heater Reservoir #2	Significant	State
Marion	Koinenia Lake Dam	Significant	State
Marion	Lorence Lake	Significant	State
Marion	Neil Creek Reservoir	Significant	State
Marion	Peterson, Floyd	Significant	State
Marion	Pettit Reservoir	Significant	State
Marion	Spring Lake Estates	Significant	State
Marion	Waldo Lake	Significant	State
Polk	Croft	High	State
Polk	Mercer	High	State
Polk	Deraeve Reservoir #1 (Lower)	Significant	State
Polk	Eola Hills Reservoir	Significant	State
Polk	Fern Creek	Significant	State
Polk	Kennel Reservoir	Significant	State
Polk	Koning "E" Reservoir	Significant	State
Polk	Mt. Springs Ranch Dam	Significant	State
Polk	Olson Reservoir (Mark)	Significant	State
Polk	Shaffer Reservoir	Significant	State
Yamhill	Baker, Er	High	State
Yamhill	Mcguire	High	State
Yamhill	Amity Hills Dam	Significant	State
Yamhill	Haskins Creek Dam	Significant	State
Yamhill	Hickory Hill Farm	Significant	State
Yamhill	Jensen (Yamhill Farm)	Significant	State
Yamhill	Katz Farm	Significant	State
Yamhill	Kuehne Dam	Significant	State
Yamhill	Muhs Quarry Dam	Significant	State
Yamhill	Olson Flashboard Dam	Significant	State
Yamhill	Panther Creek Reservoir	Significant	State
Yamhill	Walker (Bryan Creek)	Significant	State
Yamhill	Yamhill Vista Dam #5	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.

Five of the nine state-regulated high hazard dams are in satisfactory condition and four are in fair condition.

**Table 2-339. Summary: Condition of High Hazard State-Regulated Dams in Region 3**

	Condition of State-Regulated High Hazard Dams				
	Satisfactory	Fair	Poor	Unsatisfactory	Not Rated
Region 3	5	4	0	0	0
Benton	1	0	0	0	0
Lane	1	0	0	0	0
Linn	0	1	0	0	0
Marion	1	1	0	0	0
Polk	1	1	0	0	0
Yamhill	1	1	0	0	0

Source: Oregon Water Resources Department, 2019

**Table 2-340. Condition of High Hazard State-Regulated Dams in Region 3**

County	Dam Name	Condition
Benton	North Fork	Satisfactory
Lane	Santa Clara	Satisfactory
Linn	Foster Log Pond	Fair
Marion	Silver Creek	Fair
Marion	Franzen	Satisfactory
Polk	Mercer	Fair
Polk	Croft	Satisfactory
Yamhill	Baker, Er	Fair
Yamhill	Mcguire	Satisfactory

Source: Oregon Water Resources Department, 2019





*State-Regulated High Hazard Dams not Meeting Safety Standards*

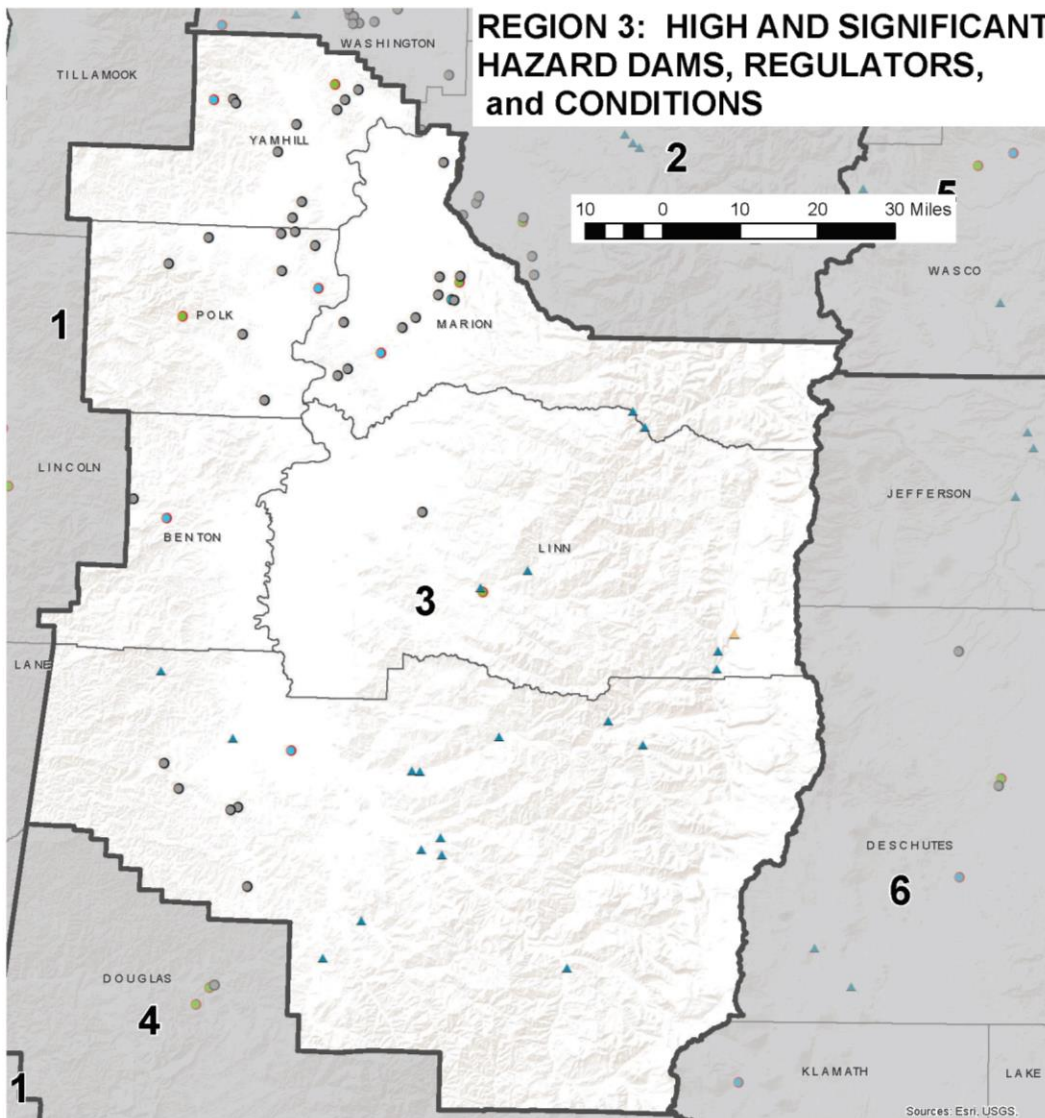
There are no state-regulated high hazard dams in Region 3 that are currently assessed to be below accepted safety standards (in Poor or Unsatisfactory Condition). When Oregon’s new dam safety laws take effect July 1, 2020, the condition of some of these dams may be reclassified as unsafe or potentially 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.

[Figure 2-185](#) shows state- and federally regulated high and significant hazard dams as well as the condition of state-regulated dams in Region 3. The table on the map shows the total number of these dams in each of the seven mapped hazard areas.



Figure 2-185. High- and Significant-Hazard Dams, Regulators, and Conditions in Region 3



	Coastal	Earthquake	Flood	Landslide	Volcanic	Tsunami	Wildfire
Region 3	0	31 *		22	3	0	0
Benton	0	2 *		0	0	0	0
Lane	0	14 *		6	1	0	0
Linn	0	3 *		6	2	0	0
Marion	0	2 *		3	0	0	0
Polk	0	3 *		1	0	0	0
Yamhill	0	7 *		6	0	0	0

\* - flood risk affected by function and condition of dam, not by presence in mapped flood prone location

**State regulated dams\*\***

**Condition assessment**

- Poor
- Unsatisfactory
- Fair
- Satisfactory
- No assessment

**Federal regulated dams**

**Hazard**

- ▲ High
- ▲ Significant

- ⊕ Mitigation Planning Regions
- ⊕ Counties

\*\* - Significant hazard dam symbols have a black outline.  
 High hazard dam symbols have a red outline.

**Projection:**  
 Oregon Lambert Coordinate Reference System, Unit: International Feet, Horizontal datum: NAD83, EPSG #2992

**Source Data:**  
 State regulated dams: Oregon Water Resources Dept., July 2020  
 Mitigation Planning Regions: Oregon Emergency Management  
 Counties: U.S. Bureau of Land Management (BLM)  
 Base map: Esri, World Terrain Base

**Author:** Robert Hamon, GISP, Oregon Water Resources Dept. (July 2020)





### 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

State-regulated high hazard dams in Region 3 are currently meeting safety standards.

Dams in the western portions of Region 3 can have high risks from earthquakes. Outside of valley locations, some dams have a moderately increased risk from landslide and wildfire, with some risk of large woody debris from wildfire. State-regulated dams in this region are not close to volcanic hazards; some federally regulated dams are closer.

No dams in Region 3 meet FEMA HHPD eligibility criteria.

### *Most Vulnerable Jurisdictions*

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), no Region 3 counties are considered “most vulnerable jurisdictions” because none have high hazard dams in poor or unsatisfactory condition.

As with high hazard dams, whether counties with significant hazard dams are actually “most vulnerable jurisdictions” 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 counties with the most state-regulated significant hazard dams are Marion (13) and Yamhill (11).

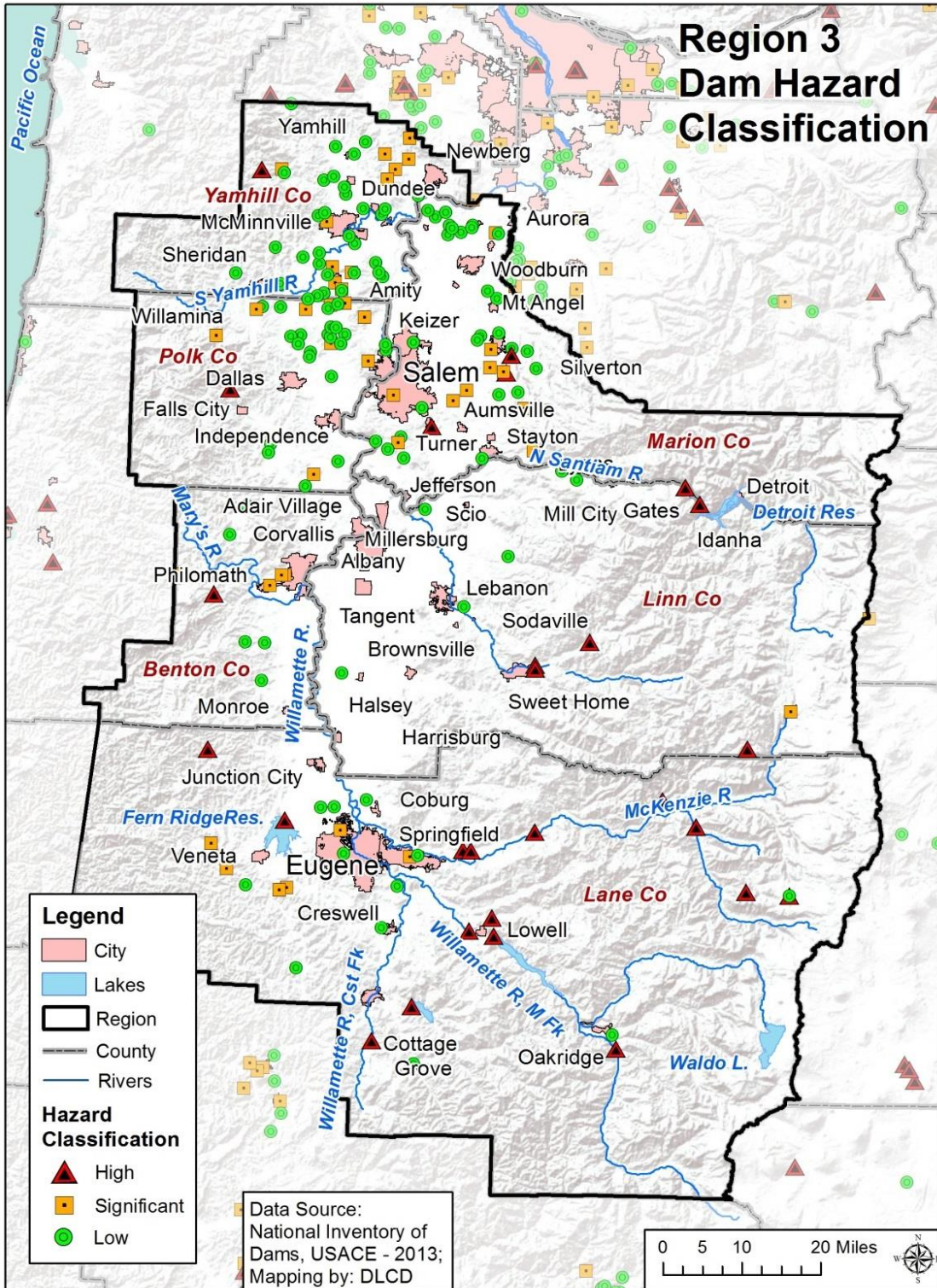
### Risk

The potential for damage to a 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 2-186. Region 3 Dam Hazard Classification



Source: National Inventory of Dams, USACE, 2013

Note: Federally regulated significant hazard dams are not shown.



## 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 Coast Range and Cascade Mountains have a very high incidence of landslides. For example, the Vineyard Mountain area near Corvallis, which is in the Coast Range foothills, experienced at least half a dozen landslides during the January 2009 storm. On occasion, major landslides sever major transportation routes such as U.S. or state highways and rail lines, causing temporary but significant economic damage.

### Historic Landslide Events

**Table 2-341. Historic Landslides in Region 3**

Date	Location	Incident
Aug. 1957	near Westfir, Oregon	rock slide; fatalities: two workers
Feb. 1996		FEMA-1099-DR-Oregon; heavy rains and rapidly melting snow contributed to thousands of landslides/debris flows across the state; many on clear cuts that damaged logging roads
Nov. 1996	Benton, Lane, Lincoln, and Yamhill Counties	DR-1107; hundreds of landslides
Nov. 1996	Lane and Douglas Counties	FEMA-1149-DR-Oregon; heavy rain triggered mudslides (Lane and Douglas Counties); fatalities: eight; injuries: several (Douglas County)
Feb. 2002	Lane and Linn Counties	DR-1405, Feb 2002
Dec. 2005-Jan. 2006	Benton, Linn, Polk, and Yamhill Counties	DR-1632; several debris flows in the Oregon coast range
Dec 2006	Benton, Polk, and Yamhill Counties	DR-1683
Dec. 2007	Polk and Yamhill Counties	DR-1733; hundreds of landslides
Dec. 2008	Marion, Polk, and Yamhill Counties	DR-1824
Jan. 2012	Benton, Lane, Linn, Marion, and Polk Counties	DR-4055
Feb. 2014	Benton, Lane, and Linn Counties	DR-4169
Dec. 2015	Linn, Lane, Polk, and Yamhill Counties	DR-4258
Dec. 2016	Lane County	DR-4296; several roads closed from landslides
Feb. 2019	Lane County	DR-4432; Highway 224 closed from rockfall
Apr. 2019	Linn County	DR-4452

Sources: Taylor and Hatton (1999); Oregon Department of Transportation Emergency Operations Plan, October 7, 2002; <https://www.fema.gov/disasters>



## Probability

**Table 2-342. Assessment of Landslide Probability in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	VH	H	H	H	VH

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

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 2-343. Local Assessment of Vulnerability to Landslides in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	M	—	H	L	L

Source: Most recent local hazard vulnerability analyses ([Table 2-4](#))

**Table 2-344. State Assessment of Vulnerability to Landslides in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	M	M	H	L	M

Source: DOGAMI and DLCD, 2020

Many of the communities in this region are vulnerable to landslides; for example, the cities of Salem, Corvallis, and Eugene all have moderate exposure to landslides. As previously mentioned, the Vineyard Mountain area near Corvallis had landslides during the January 2009 storm. Many of these landslides caused significant damage to homes, roads, and the environment.

## State-Owned/Leased Buildings And Critical Facilities And Local Critical 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 3. More than \$21.7M in value is exposed to landslide hazards in Region 3, over half of it in Lane County. The potential loss to local critical facilities is more than six times the value of state facilities at over \$140.7M. Yamhill County has 37% of the value of local critical facilities followed by Polk, Lane, and Marion Counties whose

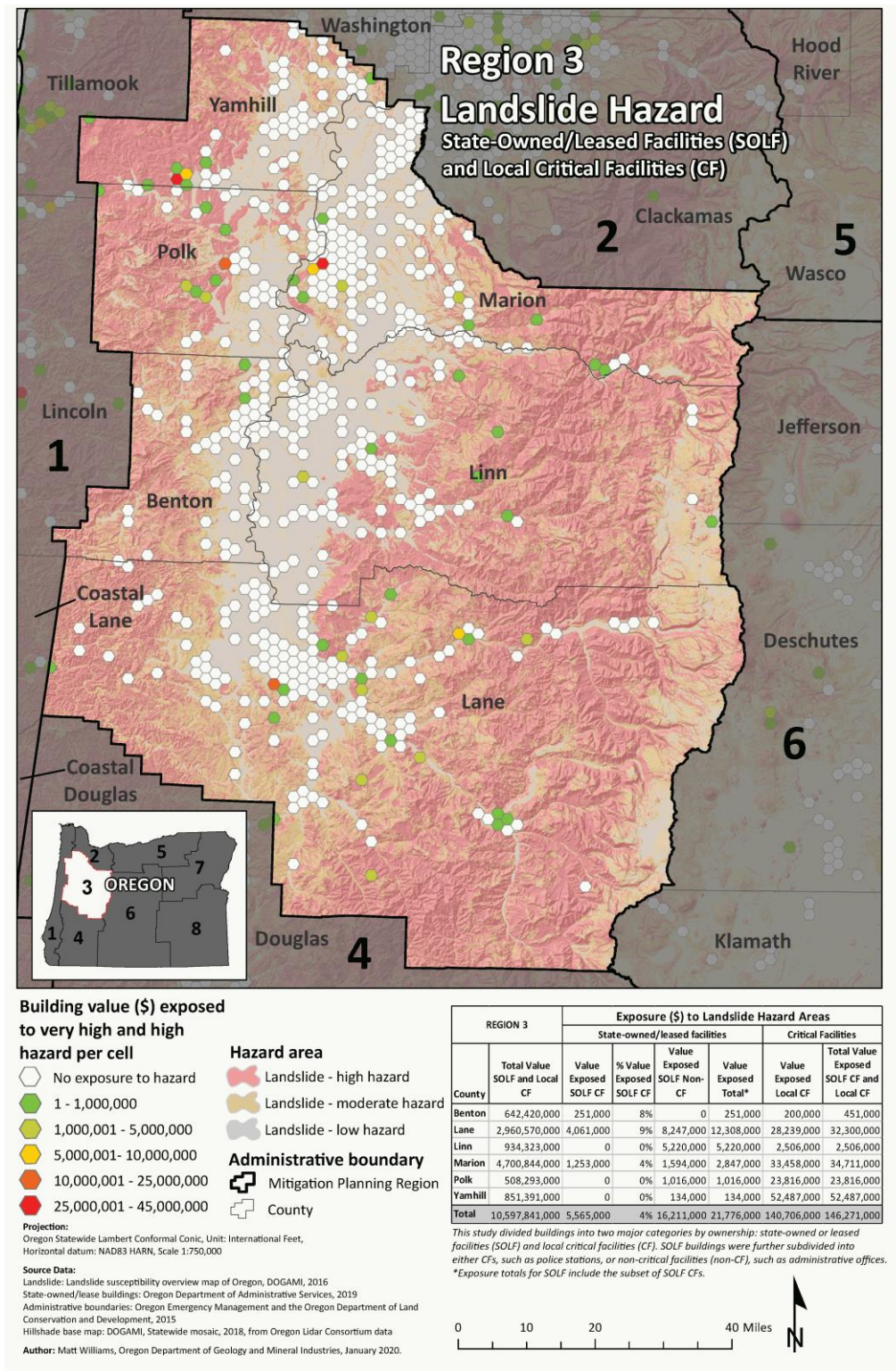


shares range from 17% to 24%. [Figure 2-187](#) illustrates the potential loss to state buildings and critical facilities and local critical facilities from a CSZ event.





**Figure 2-187. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Landslide Hazard Zone in Region 3.** High-resolution, full-size image linked from Appendix 9.1.26.



Source: DOGAMI, 2020



Historic Resources

Of the 19,731 historic resources in Region 3, two hundred sixty-five or about 1.5% are in an area of very high or high landslide hazard susceptibility; 2,446 or about 12% in moderate; and 16,999 or about 86% in low. The greatest number of historic resources exposed to landslide hazards is in Lane County.

Archaeological Resources

Of the 1,854 archaeological resources located in landslide hazard areas in Region 3, seventy percent (1,293) are in high landslide hazard areas. Of those, 21 are listed on the National Register of Historic Places and 47 are eligible for listing. Thirty-two have been determined not eligible, and 1,193 have not been evaluated as to their eligibility. Fifty-seven percent of both the archaeological resources in high landslide hazard areas and those in landslide areas in Region 3 overall are located in Lane County. The resources that are listed and eligible for listing are located in all counties except Yamhill 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, social vulnerability in Region 3 is highest in Marion County, followed by Linn and Yamhill Counties. Marion County ranks in the 90th percentile for its share of persons aged 17 or younger, percentage of single-parent households, and percentage of occupied housing units with more people than rooms. The county is also the 90th percentile for its share of residents that speak English less than “well.” Linn County’s high vulnerability is driven by moderately high scores across the CDC index. Notably, however, the county is in the 80th percentile for its share of single-parent households and has a smaller per-capita income and a higher percentage of persons aged 17 and younger than 70 percent of all counties. Vulnerability in Yamhill County is also driven by moderately high scores across the CDC index. The county is in the 80th percentile for its share of multi-unit structures and the percentage of people living in institutionalized group quarters.

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, Marion County is the most vulnerable to landslides in Region 3.

*Risk*

**Table 2-345. Assessment of Risk to Landslides in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Risk	M	VH	H	VH	M	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 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, Lane, Linn, Marion, and Yamhill counties are "most vulnerable jurisdictions" with either very high or high risk ratings. All communities should be prioritized for mitigation actions.



## Volcanoes

### Characteristics

The eastern boundaries of Lane, Linn, and Marion Counties coincide with the crest of the Cascade Mountains. Volcanic activity in the Cascades will continue, but questions regarding how, to what extent, and when remain unanswered. Most volcano-associated hazards are local (e.g., explosions, debris, lava, and pyroclastic flows). However, lahars can travel considerable distances downstream, and wind-borne ash can blanket areas many miles from the source.

### Historic Volcanic Events

**Table 2-346. Historic Volcanic Events Affecting Region 3**

Date	Location	Description
about 10,000 to <7,700 YBP	cones south of Mount Jefferson; Forked Butte and South Cinder Peak	lava flows
about 4,000 to 3,000 YBP	Sand Mountain, central Cascades	lava flows and cinder cones in Sand Mountain field
about 3,000 to 1,500 YBP	Belknap Volcano, central Cascades	lava flows, tephra
about 2,000 YBP	South Sister Volcano	rhyolite lava flow
about 1,300 YBP	Blue Lake Crater, central Cascades	spatter cones and tephra

Note: YBP is years before present.

Source: U.S. Geological Survey, Cascades Volcano Observatory: <http://volcanoes.usgs.gov/observatories/cvo/> Scott, et al. (2001); Walder, et al. (1999)

### Probability

**Table 2-347. Assessment of Volcanic Hazards Probability in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	L	M	M	M	L	L

Source: DOGAMI, 2020

Region 3 communities are closest to the Three Sisters and Mount Jefferson. Middle and South Sisters are the most active of the group. Because geologic history is fragmentary for these volcanoes, the probability of future explosive eruptions is difficult to estimate. Only two explosive episodes have occurred at the South Sister since the end of the ice age (about 12,000 years ago). Given the fragmentary record, the annual probability of the South and Middle Sister entering a new period of eruptive activity has been estimated from 1 in several thousand to 1 in 10,000 (Schilling, et al., 1997). Similar difficulties complicate predictions of future eruptions at Mount Jefferson. There have been four episodes of lava flow eruptions around Mount Jefferson since the end of the Ice Age (about 12,000 years ago). Such a frequency suggests an annual probability of lava flow eruptions of 1 in 4,000 to 1 in 3,000 Walder, et al. (1999).

**Table 2-348** provides further information about probability of volcanic eruptions in Region 3.



**Table 2-348. Probability of Volcano-Related Hazards in Region 3**

Volcano-Related Hazards	Benton	Lane	Linn	Marion	Polk	Yamhill	Remarks
Volcanic ash (annual probability of 1 cm or more accumulation from eruptions throughout the Cascade Range)	1 in 1,000 to 1 in 5,000	1 in 1,000	1 in 1,000	1 in 1,000	1 in 1,000 to 1 in 5,000	1 in 1,000 to 1 in 5,000	Sherrod, et al. (1997)
Lahar	no risk	source: Three Sisters McKenzie River: 3 scenarios: source to Thurston	Source: Mt. Jefferson S. Santiam R. from Mt. Jefferson to Detroit	source: Mt. Jefferson, N. and S. Santiam rivers from Mt. Jefferson to Detroit	no risk	no risk	if the Detroit Lake dam is breached, lahars could reach Mill City, Lyons, and Stayton in Marion County: Walder, et al. (1999) (maps); Lane County: Scott, et al. (2001) (map)
Lava flow	no risk	source: Three Sisters immediate vicinity	Source: Mt. Jefferson Immediate vicinity	source: Mt. Jefferson immediate vicinity	no risk	no risk	Mt. Jefferson: Walder, et al. (1999) (maps); Three Sisters: Scott, et al. (2001) (maps)
Debris flow / avalanche	no risk	source: Three Sisters Proximity	Source: Mt. Jefferson Proximity	source: Mt. Jefferson proximity	no risk	no risk	Mt. Jefferson: Walder, et al. (1999) (maps); Three Sisters: Scott, et al. (2001) (maps)
Pyroclastic flow	no risk	source: Three Sisters Proximity	Source: Mt. Jefferson Pamela and Minto Creeks	source: Mt. Jefferson Whitewater Cr and S. Fork Santiam	no risk	no risk	Mt. Jefferson: Walder, et al. (1999) (maps); Three Sisters: Scott, et al. (2001) (maps)

Sources: Sherrod, et al. (1997), Walder, et al. (1999), Scott, et al. (2001)

### Vulnerability

**Table 2-349. Local Assessment of Vulnerability to Volcanic Hazards in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	L	M	L	M	L

Source: Most recent local hazard vulnerability analyses ([Table 2-4](#))

**Table 2-350. State Assessment of Vulnerability to Volcanic Hazards in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	H	H	VH	L	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 3 (Figure 2-XX). Over \$153M in value is exposed to volcanic hazards in Region 3, all of it in Marion, Lane, and Linn Counties.

Historic Resources

Of the 19,731 historic buildings in Region 3, 154 are exposed to moderate volcanic hazards, all in the same three counties. See Appendix 9.1.12 for details.

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, social vulnerability in the region is highest in Marion County, followed by Linn and Yamhill Counties. Marion County ranks in the 90th percentile for its share of persons aged 17 or younger, percentage of single-parent households, and percentage of occupied housing units with more people than rooms. The county is also the 90th percentile for its share of residents that speak English less than “well.” Linn County’s high vulnerability is driven by moderately high scores across the CDC index. Notably, however, the county is in the 80th percentile for its share of single-parent households and has a smaller per-capita income and a higher percentage of persons aged 17 and younger than 70 percent of all counties. Vulnerability in Yamhill County is also driven by moderately high scores across the CDC index. The county is in the 80th percentile for its share of multi-unit structures and the percentage of people living in institutionalized group quarters.

According to the 2020 vulnerability scores, Marion County is the most vulnerable to volcanic hazards in Region 3 followed by Lane and Linn Counties. Marion County’s vulnerability is driven somewhat by the presence of state and local critical facilities, but primarily by social vulnerability. Lane County’s vulnerability is driven by the presence of state buildings and state and local critical facilities. Linn County’s vulnerability is driven by both the presence of local critical facilities and social vulnerability. Yamhill County has a very low vulnerability score for state buildings and state and local critical facilities, but high social vulnerability accounting for its moderate vulnerability score.

**Risk**

**Table 2-351. Assessment of Risk to Volcanic Hazards in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Risk	VL	H	H	VH	VL	L

Source: DOGAMI and DLCD, 2020

According to the 2020 risk scores, Marion, Lane, and Linn Counties are the most at risk of volcanic hazards in Region 3 with either very high (VH) or high (H) risk ratings. These





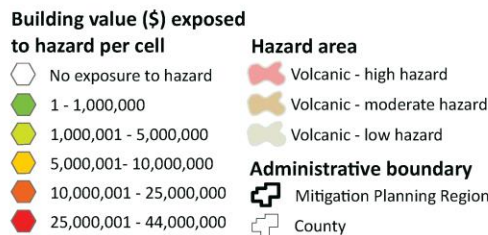
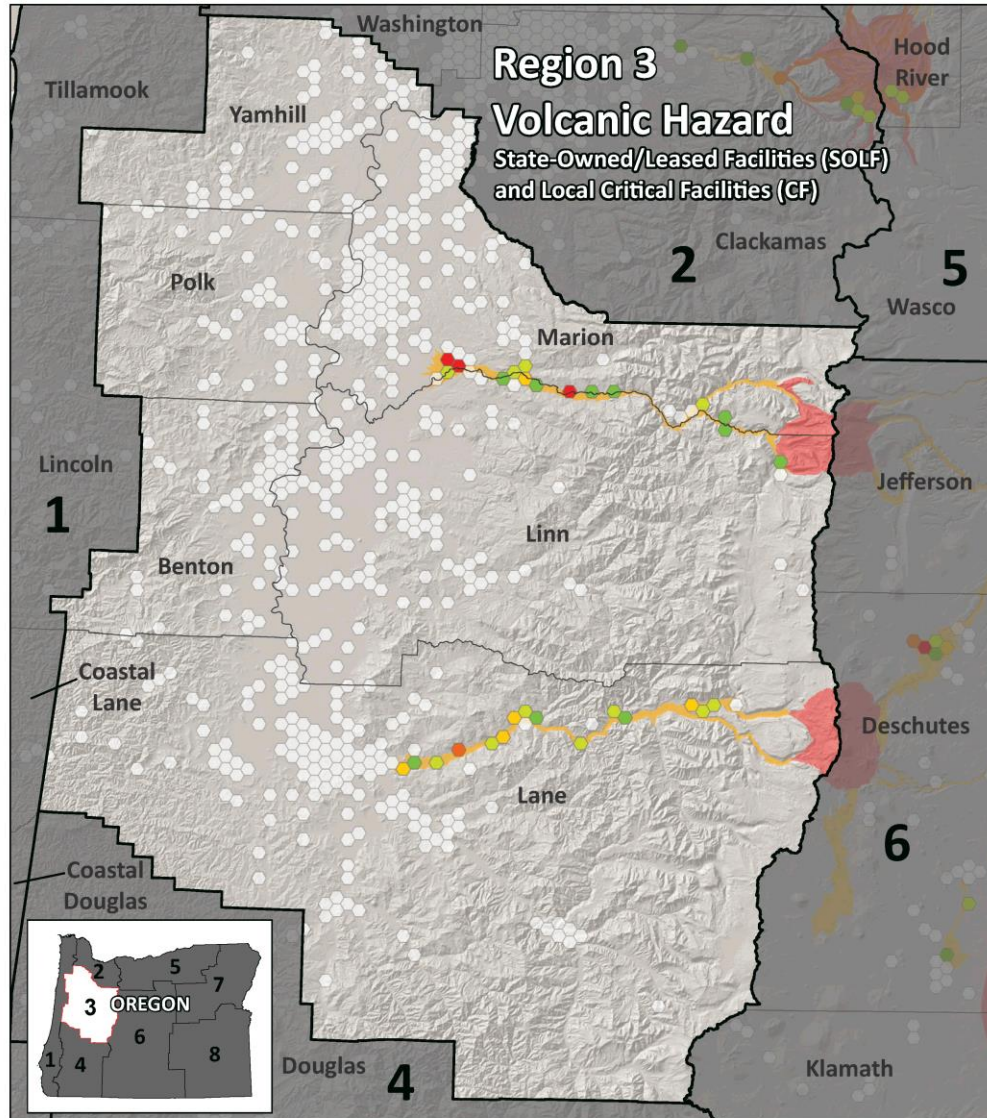
communities should be prioritized for mitigation actions. While these three counties all face moderate probability for volcanic hazards, they are more vulnerable than the other counties. Benton, Polk, and Yamhill Counties have either very low (VL) or Low (L) risk ratings.

The U.S. Geological Survey has addressed volcanic hazards at Mount Jefferson (Walder, Gardner, Conrey, Fisher, & Schilling, 1999) and the Three Sisters (Scott, Iverson, Schilling, & Fisher, 2001). These reports include maps depicting the areas at greatest risk. Lane, Linn, and Marion Counties are at risk and should consider the impact of volcano-related activity, such as lahars, on small mountain communities, dams, reservoirs, energy-generating facilities, and highways. These counties also should consider probable impacts on the local economy (e.g., wood products and recreation). There is virtually no risk from volcanoes in Benton, Polk, and Yamhill Counties, although normal prevailing winds could shift and carry ash into those areas.





**Figure 2-188. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Volcanic Hazard Zone in Region 3. High-resolution, full-size image linked from Appendix 9.1.26.**

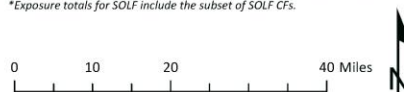


**Projection:**  
 Oregon Statewide Lambert Conformal Conic, Unit: International Feet.  
 Horizontal datum: NAD83 HARN, Scale 1:750,000

**Source Data:**  
 Volcanic: various studies of proximal and distal volcanic hazards from United States Geological Survey  
 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 3	Exposure (\$) to Volcanic Hazard Areas						
	County	Total Value SOLF and Local CF	State-owned/leased facilities			Critical Facilities	
			Value Exposed SOLF CF	% Value Exposed SOLF CF	Value Exposed SOLF Non-CF	Value Exposed Total*	Value Exposed Local CF
Benton	642,420,000	0	0%	0	0	0	0
Lane	2,960,570,000	1,693,000	0%	27,156,000	28,849,000	27,991,000	29,684,000
Linn	934,323,000	0	0%	153,000	153,000	35,879,000	35,879,000
Marion	4,700,844,000	2,865,000	0%	4,851,000	7,716,000	84,748,000	87,613,000
Polk	508,293,000	0	0%	0	0	0	0
Yamhill	851,391,000	0	0%	0	0	0	0
<b>Total</b>	<b>10,597,841,000</b>	<b>4,558,000</b>	<b>0%</b>	<b>32,160,000</b>	<b>36,718,000</b>	<b>148,618,000</b>	<b>153,176,000</b>

*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



## Wildfires

### Characteristics

Forests in Region 3 are quite productive due to the mild temperatures, amount of precipitation, and deep, rich, fertile soils. Historically, this landscape was dominated by oak woodland and savanna with an understory consisting of grasses and forbs. These landscapes tended to burn on a regular basis with low intensity surface fires. This area was also heavily influenced by the Kalapuya Indians. The Kalapuyas frequently burned this area to make the landscape more favorable to elk and deer, which they hunted for food. As Euro-Americans moved in, native tribes moved on. Without prescribed burns, conifer trees have established and have overtopped the oak trees. The understory has changed from grasses and forbs to an understory with more woody shrubs and dead and downed wood. These forests are similar to those of the Oregon Coast Range and have historic fire return intervals of 150-300 years. These fires also tend to be large, stand-replacing fires, rather than the low-intensity, frequent fires of the oak woodland forest type.

Because wildland fires are being effectively suppressed, the patterns and characteristics of fires are changing. Vegetation that historically would have been minimized by frequent fires has become more dominant. Over time, some species have also become more susceptible to disease and insect damage, which leads to an increase in mortality. The resulting accumulation of dead wood and debris creates the types of fuels that promote intense, rapidly spreading fires

### Historic Wildfire Events

**Table 2-352. Historic Wildfires Affecting Region 3**

Year	Name of Fire	Counties	Acres Burned	Remarks
1853	Nestucca	Tillamook/Yamhill	320,000	
1849	Siletz	Lincoln/Polk	800,000	
1865	Silverton	Marion	988,000	
1933	Tillamook	Tillamook, Yamhill	240,000	Human caused. Between 1933 and 1951, the Tillamook forest burned every 6 years. Fires followed drought conditions. Total Tillamook Burn: 350,000 acres (George Taylor, <i>The Oregon Weather Book</i> , p.202)
1972	Yamhill	Yamhill		
1977		Yamhill		west of Carlton
1987	Shady Lane	Polk		

Note: This list is representative of a lengthy wildfire history. There have been many fires, named and unnamed. Statistics differ, depending on the source. There have been no large, historic wildfires in Region 3 in recent years.

Source: Brian Ballou, August 2002, A Short History of Oregon Wildfires, Oregon Department of Forestry, unpublished; 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.



## Probability

**Table 2-353. Assessment of Wildfire Probability in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	L	M	H	H	L	L

Source: PNW Quantitative Wildfire Risk Assessment and Oregon Wildfire Risk Explorer, 2020

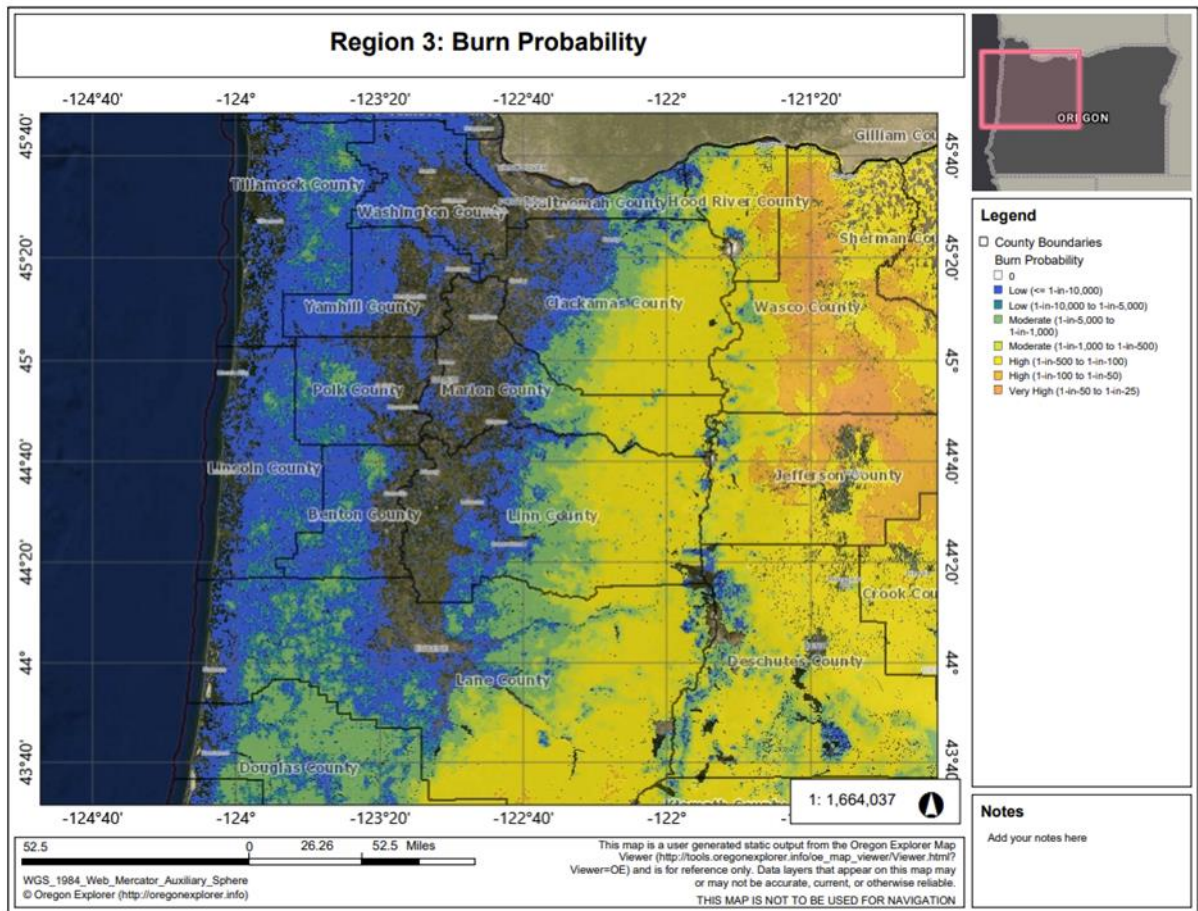
In the PNW Quantitative Wildfire Risk Assessment, Burn Probability was used to assess the likelihood of a large wildfire (>250 acres occurring). In conjunction with that data, examining the number of fire starts reported by ODF for all acreage sizes, gives a full picture of probability of wildfire.

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 2-189](#) 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 2-189. Burn Probability



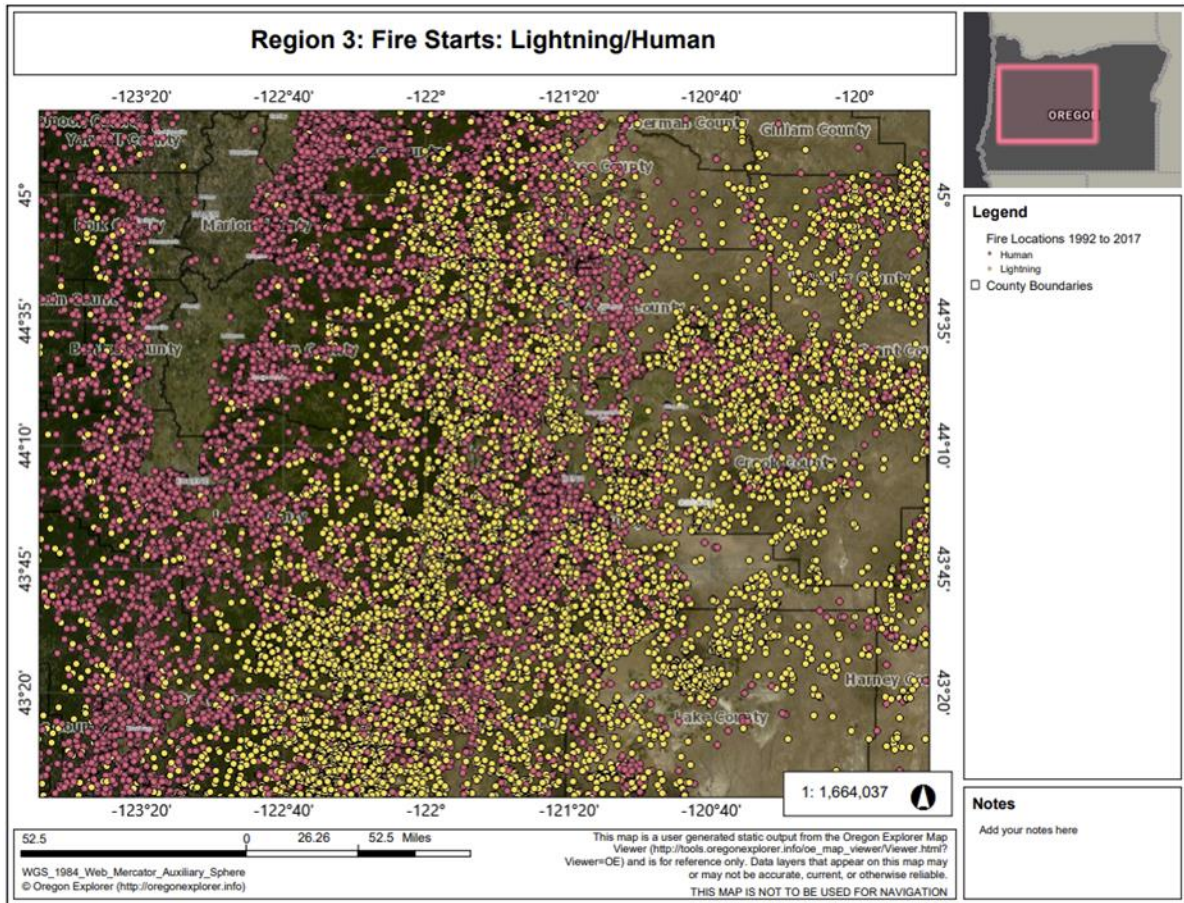
Source: Oregon Wildfire Risk Explorer, March 2020

Wildfire always has been a part of the ecosystems in Oregon, sometimes with devastating effects. Some of the state’s most devastating wildfires have been in counties within Region 3 (e.g., Marion, Polk, and Yamhill). Wildfire results from natural causes (e.g., lightning strikes), mechanical failure (Oxbow Fire), or human activity (unattended campfire, debris burning, or arson).





**Figure 2-190. Human- and Lightning-Caused Wildfires in Region 3, 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, Dello, Hawkins, Mote, & Rupp, 2017).

In moisture-limited forest systems, such as those in the Coast and Cascade Ranges, warming winters will lead to more fine fuels from greater cold season growth. Hotter and drier conditions will lead to large fuel quantities, which lead to large and severe fires. It is very likely (>90%) that the Coast Range and lower elevations of the Cascade Range in Region 3 will experience increasing wildfire frequency and intensity under future climate change. Modeled projections of future fire frequency indicate more frequent fires for the Pacific Northwest, particularly west of the Cascade Mountains where fires have been infrequent historically. In coastal areas, fire frequency is projected to change from approximately every 100 years to every 60 years.

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 3 counties ([Table 2-354](#)).

**Table 2-354. Projected Increase in Annual Very High Fire Danger Days in Region 3 Counties by 2050 under RCP 8.5**

County	# Additional Days	Percent Change
Benton	11	30%
Lane	12	32%
Linn	12	33%
Marion	13	35%
Polk	11	31%
Yamhill	12	33%

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 2-355. Local Assessment of Vulnerability to Wildfire in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	M	M	M	M	L

Source: Most recent local hazard vulnerability analyses ([Table 2-4](#))

**Table 2-356. Assessment of Vulnerability to Wildfire in Region 3 – Communities at Risk**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	L	M	L	L	VL	L

Source: 2020 ODF Communities at Risk Report

**Table 2-357. Assessment of Vulnerability to Wildfire in Region 3 – 2020 Vulnerability Assessment**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	VL	L	M	H	L	M

Source: DOGAMI and DLCDC, 2020

According to ODF’s assessment of Communities at Risk, wildfire vulnerability is generally low to moderate in Region 3. Jurisdictions most vulnerable to wildfire are the result of a dispersed population in close proximity to abundant vegetative fuels. These forestlands contain extensive fuels composed of flammable grasses, brush, slash and timber.



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 2-358](#).

**Table 2-358. Wildland-Urban Interface Communities in Region 3**

Benton	Lane (Non-Coastal)	Linn	Marion	Polk	Yamhill
Adair	Bohemia City	Albany	Aumsville	Airlie	Amity
Alsea	Coburg	Brownsville	Aurora	Buell	Carlton
Blodgett	Cottage Grove	Clear Lake Resort	Drakes	Dallas	Dayton
Corvallis	Creswell	Halsey	Crossing	Falls City	Dundee
Dawson	Dexter	Harrisburg	Gates	Fort Hill	Grand Ronde
Hoskins	Dorena	Lebanon	Stayton	Grand Ronde	Agency
Mary's River Estates	Eugene	Lost Prairie	Hubbard	Independence	Lafayette
Monroe	Glenwood	Lower Willamette	Idanha	Pedee	McMinnville
Philomath	Goshen	Lyons	Jefferson	West Valley	Midway
Summit	Hazeldell	Marion Forks	Keizer		Nestucca
Vineyard Mountain	London Springs	Mill City	Lyons		Orchard View
	Lorane	New Idanha	Marion		Sheridan
	Lowell	Scio	Mehama		Trask
	Lower McKenzie	South Shore	Mill City		Willamina
	McKenzie	Sweet Home	Mill Creek		Yamhill
	Mohawk	Tadmor	Monitor		
	Oakridge	Tangent	Mt Angel		
	Pleasant Hill		Orchard View		
	Rainbow		Salem		
	Santa Clara, Eugene		Scotts Mills		
	Springfield		Silverton		
	Upper McKenzie		St Paul		
	Upper Willamette		Sublimity		
	Waldon		Turner		
	West Valley		Woodburn		
	Veneta				
	Walker				
	Westfir				

Source: Oregon Department of Forestry 2020 Communities at Risk Report

*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 3, there is a potential loss to wildfire of about \$45M in state building and critical facility assets, 65% of it in Lane County, 21% in Linn County, and 15% in Marion County. Benton Polk, and Yamhill Counties have no state assets in wildfire hazard areas. There is a similar potential loss in local critical facilities: about \$42.6M. Eighty-three percent of that value is

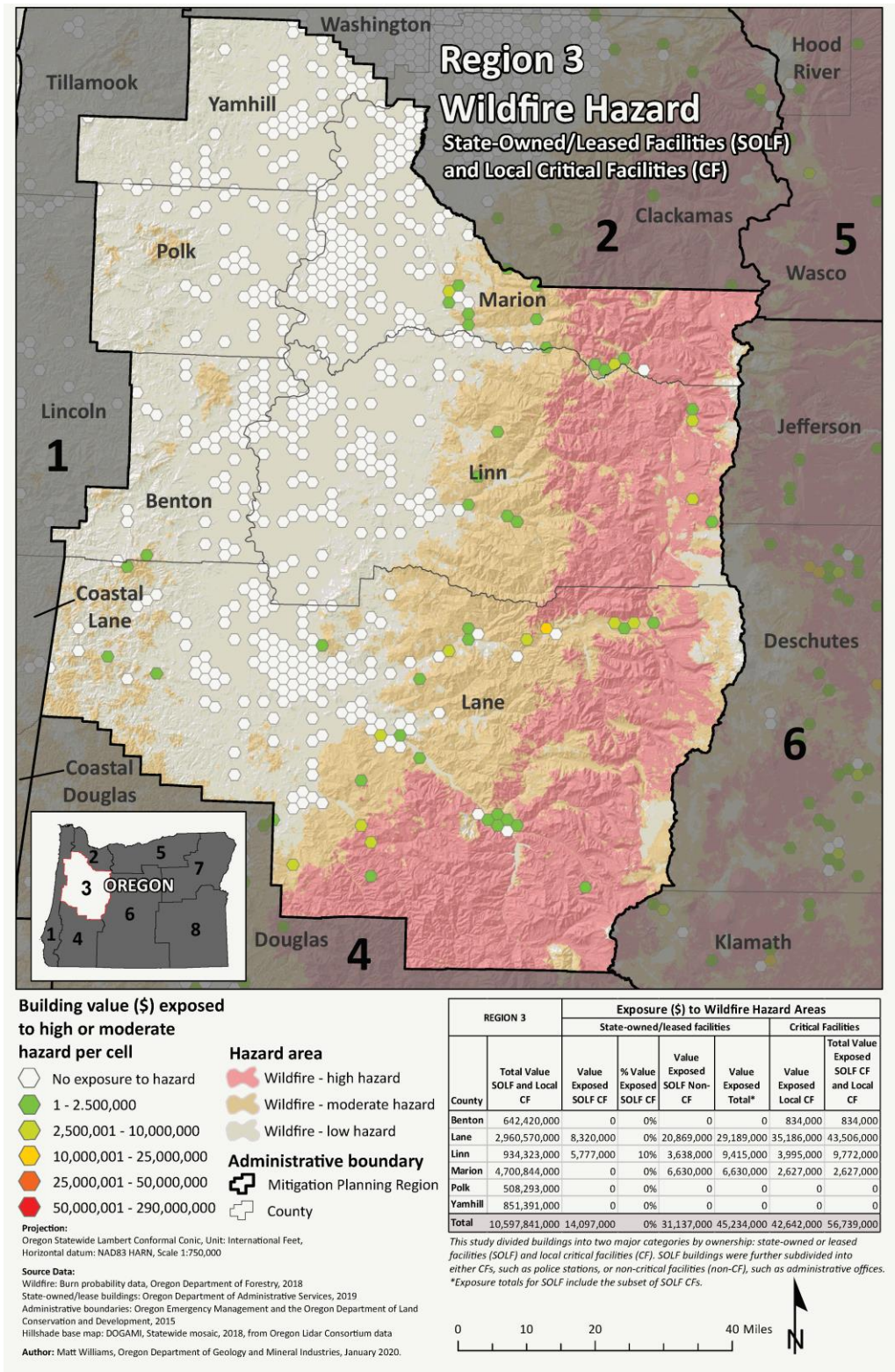




located in Lane County, 9% in Linn County, 6% in Marion County, and 2% in Benton County. Neither Polk nor Yamhill County has local critical facilities located in a wildfire hazard area.



**Figure 2-191. State-Owned/Leased Facilities (SOLF) and Local Critical Facilities (CF) in a Wildfire Hazard Zone in Region 3.** High-resolution, full-size image linked from Appendix 9.1.26.



Source: DOGAMI, 2020



Historic Resources

Of the 19,731 historic resources in Region 2, eleven are located in an area of high wildfire hazard in Lane, Linn, and Marion Counties. Forty-three are located in an area of moderate wildfire hazard. Again, all are in Lane, Linn, and Marion Counties. The rest are in areas of low wildfire hazard in all the counties, with 50% in Lane County alone

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, social vulnerability in the region is highest in Marion County, followed by Linn and Yamhill Counties. Marion County ranks in the 90th percentile for its share of persons aged 17 or younger, percentage of single-parent households, and percentage of occupied housing units with more people than rooms. The county is also the 90th percentile for its share of residents that speak English less than “well.” Linn County’s high vulnerability is driven by moderately high scores across the CDC index. Notably, however, the county is in the 80th percentile for its share of single-parent households and has a smaller per-capita income and a higher percentage of persons aged 17 and younger than 70 percent of all counties. Vulnerability in Yamhill County is also driven by moderately high scores across the CDC index. The county is in the 80th percentile for its share of multi-unit structures and the percentage of people living in institutionalized group quarters.

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, vulnerability to wildfire varies from very low to high, but overall it is low to moderate. While the individual county scores differ, this assessment is in general agreement with the scores based on Communities at Risk. The exception is Marion County whose very high social vulnerability drove its vulnerability score higher than that of the other counties.

Marion County is the most vulnerable to wildfire in Region 3.

*Risk*

**Table 2-359. Risk of Wildfire Hazards in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Risk	VL	M	M	M	VL	M

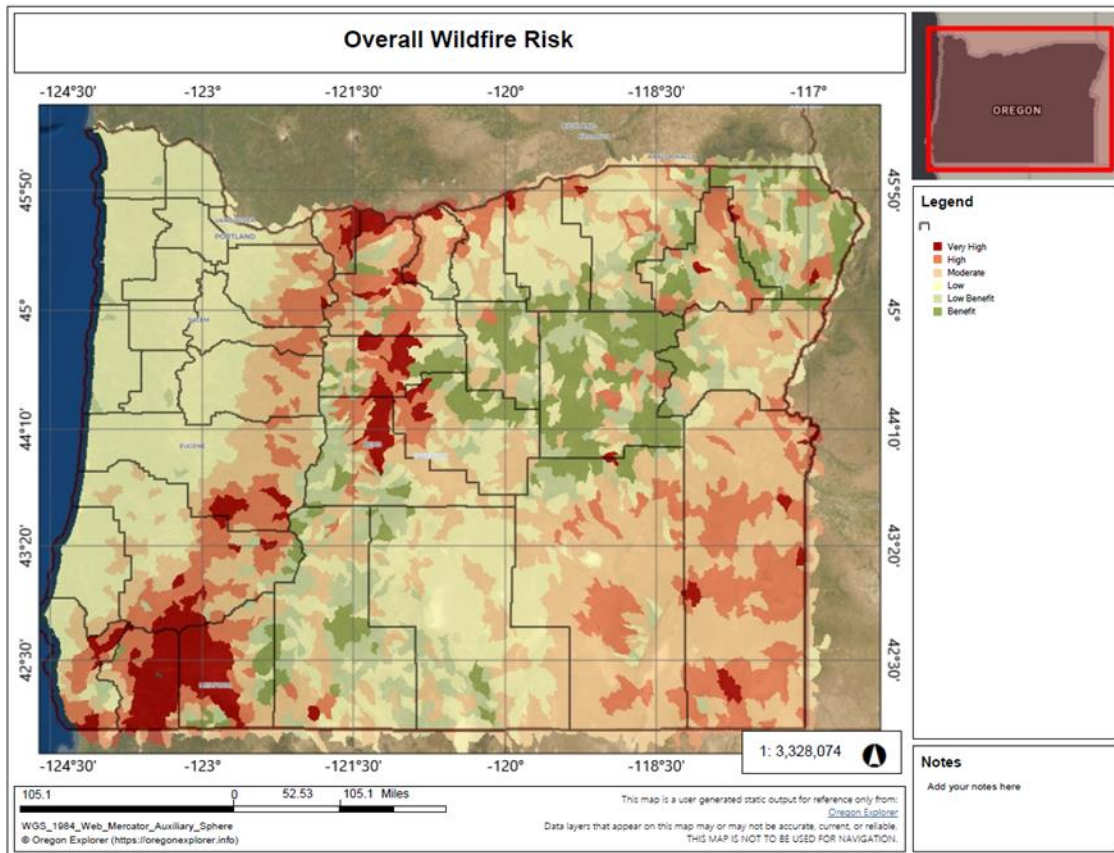
Source: DOGAMI and DLCD, 2020

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 combined the wildfire probability with the vulnerability assessment to arrive at a composite risk score. According to the 2020 risk assessment, overall the risk from wildfire in Region three is low to moderate. In Benton and Polk Counties it is very low. Yamhill County’s risk would be lower save for its high social vulnerability. These scores, then, are in agreement with ODF’s assessment



mapped in [Figure 2-192](#). In addition, the moderate scores of the 2020 risk assessment are in general agreement with that map as the western portions of Lane, Linn, and Marion Counties are shown with low risk and the eastern portions with high or very high risk. The 2020 risk assessment is not granular enough to account for geographic differences in probability, vulnerability, or risk within a county.

**Figure 2-192. Overall Wildfire Risk**



Source: Oregon Explorer, 2020



## Windstorms

### *Characteristics*

High winds are not uncommon in the Willamette Valley. Tornadoes and thunderstorms are increasing in frequency in the Willamette Valley. A majority of the destructive surface winds in the region are from the southwest, similar to Region 2. 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 3.

In addition to windstorms, tornadoes have been recorded in Region 3 since 1887. The storms have occurred during all seasons, as described in [Table 2-360](#). Fortunately, damage has been slight, and has mostly affected individual farm buildings, orchards, telephone poles and trees.



## Historic Windstorm Events

**Table 2-360. Historic Windstorms Affecting Region 3**

Date	Location	Description
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 (FEMA-1107-DR-Oregon)
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 (FEMA-1405-DR-Oregon)
July 2003	Marion County	\$15,000 in property damage
Dec. 2004	Marion, Lane, and Polk Counties	\$6,250 in property damage — property damage estimate includes counties outside of Region 3
Dec. 2005	Mario and Linn Counties	\$3,000 in property damage
Apr. 2004	Lane County	\$5,000 in property damage
Jan. 2005	Linn and Marion Counties	windstorms cause \$6,000 of damage in Linn and Marion Counties; a storm total of \$15,000 in damages spread out among, Linn, Marion, Clackamas, Multnomah, and Washington Counties
Jan. 2006	Yamhill, Marion, and Polk Counties	wind storm with winds up to 58 mph causes a total of \$500,000 in damages spread out over all four counties and includes Clackamas, Columbia, Washington, and Multnomah Counties as well
Feb. 2006	Linn, Marion, Lane, Benton, Polk, and Yamhill Counties	windstorms with gusts up to 77 mph cause \$227,000 in damages in Linn, Lane, Marion, Benton, Polk, and Yamhill Counties; storm causes damages in region 2 and region 1 as well for a total storm damage of \$575,000
May 2006	Lane County	\$5,000 in property damage in Eugene, approximately 13,000 customers out of power
May 2007	Marion County	hail storm causes \$5,000 in damages
Mar. 2008	Marion County	heavy winds measured at 40 mph cause \$15,000 in damage near Woodburn
Dec. 2015	Regions 1-4	FEMA-4258-DR: severe winter storms, straight-line winds, flooding, landslides, and mudslides
Apr. 2019	Curry, Douglas, Linn, Wheeler, Grant, and Umatilla	FEMA-4452-DR: Severe storms, straight-line winds, flooding, landslides, and mudslides





Sources: Taylor and Hatton (1999); FEMA-1405-DR-OR: February 7, 2002, Hazard Mitigation Team Survey Report, Severe Windstorm in Western Oregon; 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>

U.S. Department of Commerce. National Climatic Data Center. Available from <http://www4.ncdc.noaa.gov/cgi-win/wwwcgi.dll?wwevent~storms>; <https://www.fema.gov/disaster/>

**Table 2-361. Recorded Tornadoes in Region 3**

Date	County	Damage Description
Jan. 1887	Lane	fences damaged; livestock losses; trees uprooted
Nov. 1925	Polk	buildings, barns, and fruit trees damaged
Feb. 1926	Polk	house and trees damaged
Sep. 1938	Linn	observed in Brownsville; no damage
Dec. 1951	Lane	barn destroyed
Jan. 1953	Benton	observed; no damage
Mar. 1960	Marion	several farms damaged near Aumsville; trees uprooted
May 1971	Yamhill	house and barn damaged near McMinnville
Aug. 1975	Lane	metal building destroyed near Eugene
Aug. 1978	Yamhill	minor damage near Amity
Apr. 1984	Yamhill	barn roof destroyed
May 1984	Lane	barn and shelter damaged near Junction City
Nov. 1989	Lane	telephone poles and trees uprooted near Eugene
Nov. 1991	Marion	barn damaged near Silverton
Sep. 2007	Linn	a tornado rated at F0 near Albany and Lebanon causes \$20,000 in damage to buildings and \$22,000 to crops
Dec. 2010	Marion	a tornado rated at F2 damaged 50 buildings in the community of Aumsville, causing a total of \$1.2 million in property damage
Jun. 2013	Yamhill	McMinnville; tornado took ¼ mile path through town, some structural damage; \$100K in crop damage
Apr. 2015	Lane	Eugene; EF0; \$25K in property damage
Sep. 2017	Linn	Lacomb; EF1; \$240K in property damage
Oct. 2017	Marion	Aurora Airport; EF0; \$40K in property damage
Oct. 2018	Marion	Jefferson; EF0; \$200 in property damage

Sources: Taylor and Hatton (1999), pp. 130-137; U.S. Department of Commerce. National Climatic Data Center. Available from <http://www.ncdc.noaa.gov/stormevents/>; <https://www.ncdc.noaa.gov/stormevents/>

### Probability

**Table 2-362. Assessment of Windstorm Probability in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	H	H	H	H	H

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

The 100-year event for a windstorm in Region 3 is 1-minute average winds of 75 mph. A 50-year event has average winds of 68 mph. A 25-year event has average winds speeds 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 2-363. Local Assessment of Vulnerability to Windstorms in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	H	M	L	H	M

Source: Most recent local hazard vulnerability analyses ([Table 2-4](#))

**Table 2-364. State Assessment of Vulnerability to Windstorms in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	M	M	H	H	M

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

Many buildings, utilities, and transportation systems within Region 3 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. Benton, Lane, Marion, and Polk Counties are listed by PUC as being most vulnerable to wind damage in this region.

Fallen trees are especially troublesome. They can block roads and rails for long periods, which can affect emergency operations. In addition, uprooted or shattered trees can down power and other 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.

Bridges, which may be closed during periods of high wind, are an additional consideration.

Impacts to agriculture related to windstorms, or related to windstorms with heavy and/or freezing precipitation, include crop damage or loss (e.g., grain crops, orchards), and impacts to buildings and infrastructure important for supporting agriculture, for example, Oregon State University Extension and USDA Agricultural Research stations that provide services and support to agricultural communities and conduct valuable research on pest control, irrigation efficiency, soil health, crop research, livestock raising and health, and other topics.



Data have not yet been collected to assess the economic impacts to the state as a consequence of wind-related damage to agriculture and associated infrastructure.

### 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, social vulnerability in the region is highest in Marion County, followed by Linn and Yamhill Counties.

Marion County ranks in the 90th percentile for its share of persons aged 17 or younger, percentage of single-parent households, and percentage of occupied housing units with more people than rooms. The county is also the 90th percentile for its share of residents that speak English less than “well.”

Linn County's high vulnerability is driven by moderately high scores across the CDC index. Notably, however, the county is in the 80th percentile for its share of single-parent households and has a smaller per-capita income and a higher percentage of persons aged 17 and younger than 70 percent of all counties.

Vulnerability in Yamhill County is also driven by moderately high scores across the CDC index. The county is in the 80th percentile for its share of multi-unit structures and the percentage of people living in institutionalized group quarters.

Marion County's very high social vulnerability indicates that the effects of windstorms will be felt more intensely by its population than by the populations of the other Region 3 counties and will require more resources for preparation, mitigation, and response. Social vulnerability in Linn and Yamhill Counties is high. Marion, Linn, and Yamhill Counties are the most vulnerable to windstorms in Region 3.

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

The value of state-owned and leased buildings and critical facilities in Region 3 is approximately \$3,107,827,000 representing the total potential for loss of state assets due to windstorms. The value of locally owned critical facilities is \$7,490,014,000. Because windstorms could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to windstorms. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. According to Department of Administrative Services records, three losses totaling almost \$39,000 state facilities were recorded in Region 3 since the beginning of 2015. One with a net claim value of a little over \$11,000 was caused by a windstorm.

### **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.



Due to their greater vulnerability, Marion, Linn, and Yamhill Counties are at greater risk from windstorms than the other counties in Region 3. Marion County is the most at risk in Region 3 and with Morrow County in the state overall.



## Winter Storms

### Characteristics

Severe winter weather in Region 3 is characterized by extreme cold, snow, ice, and sleet. Although such conditions may be expected in the Cascade Mountains and eastern Oregon, they are considered to be unusual in the Willamette Valley. Some Region 3 communities are unprepared, financially and otherwise, to handle severe winter storms. There are more moderate annual winter storms in the region; severe winter storms occur approximately every 4 years in the Valley. Severe weather conditions do not last long in Region 3, and winter-preparedness is a moderate priority.

### Historic Winter Storm Events

**Table 2-365. Severe Winter Storms in Region 3**

Date	Location	Description
Dec. 1861	statewide	snowfall varied between 1 and 3 feet; did not leave Willamette Valley floor until late February
Dec. 1864	Willamette Valley and Columbia Basin	heavy snowfall; Albany (Linn County) received 16 inches in one day
Jan. 1916	statewide	two snow storms, each totaling 5 inches or more
Dec. 1919	Corvallis (Benton County)	Corvallis received 22 inches of snow and set an all-time low temperature record of 14°F
Jan.- Feb. 1937	statewide	heavy snow throughout the Willamette Valley; Dallas (Polk County) had 24 inches; Salem (Marion County) had 25 inches
Jan. 1950	statewide	heaviest snowfall since 1890; many highway closures; considerable property damage
Jan. 1956	western Oregon	packed snow became ice; many automobile accidents throughout the region
Mar. 1960	statewide	snowfall: 3–12 inches, depending on location; more than 100 snow-related accidents in Marion County
Jan. 1969	statewide	Lane County surpassed old snowfall record; Eugene (Lane County) had a total snow depth of 47 inches; three 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	western valleys received 2–4 inches of snow; massive power failures (tree limbs broke power lines)
Dec. 1985	Willamette Valley	heavy snowfall throughout valley
Mar. 1988	statewide	strong winds and heavy snow
Feb. 1989	statewide	heavy snowfall and record low temperatures; Salem (Marion County) received 9 inches
Feb. 1990	statewide	average snowfall from one storm about 4 inches (Willamette Valley)
Dec. 1992	western Oregon	heavy snow; interstate highway closed
Feb. 1993	western Oregon	record snowfall at Salem airport
Winter 1998-99	statewide	series of storms; one of the snowiest winters in Oregon history
Dec. 2003 -Jan. 2004	statewide	DR-1510. Benton, Lane, Linn, Marion, Polk, and Yamhill declared in Region 3. Wet snow blanketed highways in the Willamette Valley, causing power lines and trees to topple; Oregon 34 east of Philomath was closed for 30 hours January 5 and 6 while crews removed trees; Presidential disaster declaration for 30 of Oregon’s 36 counties
Mar. 8–10, 2006	Lane, Linn, Benton, Marion, Polk, Yamhill Counties	snow fell up to a few inches at the coast and through the Willamette Valley; many school closures



Date	Location	Description
Jan.-Feb. 2008	Marion County	a series of vigorous winter storms brought record setting snow accumulation to Detroit, Oregon; three dozen Oregon National Guard personnel were called in to help with snow removal in Detroit and Idanha; the towns received over 12 feet of snow in several weeks
Dec. 9–11, 2009	Marion, Linn, Lane Counties	freezing rain covered the central valley with a coating of ice; south of Salem, numerous road closures due to accidents caused by icy roadway; I-84 from Troutdale to Hood River closed for 22 hours
Feb. 6–10, 2014	Lane, Benton, Polk, Yamhill, Linn, and Marion Counties	DR-4169. Linn, Lane, and Benton Counties declared in Region 3. A strong winter storm system affected the Pacific Northwest during the February 6–10, 2014 time period bringing a mixture of arctic air, strong east winds, significant snowfall and freezing rain to several counties in northwest Oregon; a much warmer and moisture-laden storm moved across northwest Oregon after the snow and ice storm (Feb. 11-14), which produced heavy rainfall and significant rises on area rivers from rain and snowmelt runoff; during the 5-day period Feb. 6–10, 5 to 16 inches of snow fell in many valley locations and 2 to 10 inches in the coastal region of northwest Oregon; freezing rain accumulations generally were 0.25 to 0.75 inches; the snowfall combined with the freezing rain had a tremendous impact on the region
Feb. 11–14, 2014	Lane, Benton, Polk, Yamhill, Linn, and Marion Counties	DR-4169 Linn, Lane, Benton and Lincoln Counties declared. Another weather system moved across northwest Oregon during the February 11–14 time frame; this storm was distinctly different from the storm that produced the snow and ice the week prior and brought abundant moisture and warm air from the sub-tropics into the region; as this storm moved across the area, 2 to 7 inches of rain fell across many counties in western Oregon; the heavy rainfall combined with warm temperatures led to snowmelt and rainfall runoff that produced rapid rises on several rivers, which included flooding on three rivers in northwest Oregon
Nov. 13, 2014	Marion, and Linn Counties (North Cascade foothills)	An early cold snap hit the Pacific Northwest before moist Pacific air moved in and resulted in one of the earliest snow, sleet, and freezing rain events in northwestern Oregon. Farther south, 1/2 of freezing rain accumulated on trees in the coast range foothills outside of Corvallis and Dallas, Oregon. Upwards of a quarter of an inch of ice fell around Dallas, Oregon. Some snow fell, but accumulations were primarily restricted to the Cascade valleys and the central Columbia River Gorge. Spotters reported around 6 to 8 inches of snow for the Cascade Foothills followed by a quarter of an inch of ice.
Dec. 6-23, 2015	Statewide storm events	DR-4258. Yamhill, Polk, Linn, and Lane Counties declared in Region 3. 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. 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.
Mar. 13, 2016	Marion, Linn and Lane Counties (North Oregon Cascades and Cascades in Lane County)	A strong low pressure system generated frequent and persistent snow showers over the northern and central Oregon Cascades. Several SNOTEL stations measured 16 to 24 inches of snow over a 24 to 30 hour period above 3500 feet.
Dec. 14-15, 2016	Lane, Benton, Marion, and Linn Counties (Southern Willamette Valley, Cascade foothills in Lane County, Northern Cascade foothills)	DR-4296. Lane County declared in Region 3. 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 led to a mix of freezing rain, sleet, and snow across the area. While areas farther north saw more of a snow/sleet mix before a changeover to freezing rain then rain, areas in Lane County saw freezing rain for most of this event, causing power outages, damage to trees, and many car accidents around Eugene and Springfield. Snow followed by sleet and freezing rain. The freezing rain turned into a major ice storm occurred in Eugene and the vicinity with 0.5 to 1.0 inch of ice accumulation observed. There was significant damage to trees and power lines, and fairly widespread power outages across the region. 15,000 people were without power. There was a report of 0.4 inch of ice accumulation near Sodaville.





Date	Location	Description
Dec. 26-27, 2016	Linn and Marion, Counties (North Oregon Cascades)	A frontal system brought high winds to the Central Oregon Coast, heavy snow to the Cascades and a mix of ice and snow in the Columbia River Gorge and Hood River Valley. SNOTELs and other stations reported a range of 12 to 25 inches of snow in the Cascades. Some specific reports include 25 inches at Mt Hood Meadows, 22 inches at Timberline, 14 inches at Government Camp and 12 inches at McKenzie Snotel.
Jan. 7-8, 2017	Lane, Benton, Polk, Yamhill, Linn, and Marion Counties (Central and Southern Willamette Valley, North Cascades foothills)	DR-4328. No counties in Region 3 declared. Severe Winter Storms, Flooding, Landslides, And Mudslides. A broad shortwave trough brought multiple rounds of precipitation, including a wintry mix of snow and ice for many locations across Northwest Oregon. Strong easterly pressure gradients generated high winds through the Columbia River Gorge as well on January 8. 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.

Source: Taylor and Hatton (1999); unknown sources; <https://www.fema.gov/disaster>; <https://www.ncdc.noaa.gov/stormevents>

### Probability

**Table 2-366. Assessment of Winter Storms Probability in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Probability	H	H	H	H	—	H

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

Winter storms occur annually in Region 3. 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.

### 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 2-367. Local Assessment of Vulnerability to Winter Storms in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	H	H	H	H	H

Source: Most recent local hazard vulnerability analyses ([Table 2-4](#))

**Table 2-368. State Assessment of Vulnerability to Winter Storms in Region 3**

	Benton	Lane	Linn	Marion	Polk	Yamhill
Vulnerability	M	H	H	H	—	H

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



The I-5 corridor through this region is key to intermodal transportation; severe winter storms can have an adverse impact on the economy if the interstate has to be closed for any extended period of time.

### 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, social vulnerability in the region is highest in Marion County, followed by Linn and Yamhill Counties. Marion County ranks in the 90th percentile for its share of persons aged 17 or younger, percentage of single-parent households, and percentage of occupied housing units with more people than rooms. The county is also the 90th percentile for its share of residents that speak English less than “well.”

Linn County's high vulnerability is driven by moderately high scores across the CDC index. Notably, however, the county is in the 80th percentile for its share of single-parent households and has a smaller per-capita income and a higher percentage of persons aged 17 and younger than 70 percent of all counties.

Vulnerability in Yamhill County is also driven by moderately high scores across the CDC index. The county is in the 80th percentile for its share of multi-unit structures and the percentage of people living in institutionalized group quarters.

Marion County's very high social vulnerability, indeed among the highest in the state, coupled with its vulnerability to closure of Interstate 5 make it the county most vulnerable to the adverse impacts of winter storms in Region 3. Linn and Yamhill's high social vulnerability make them relatively more vulnerable than the other counties in the region.

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

The value of state-owned and leased buildings and critical facilities in Region 3 is approximately \$3,107,827,000 representing the total potential for loss of state assets due to winter storms. The value of locally owned critical facilities is \$7,490,014,000. Because winter storms could impact the entire region, these figures together represent the maximum potential loss to state assets and local critical facilities due to winter storms. Because the state is self-insured, FEMA funds are rarely used to cover damage to state assets from natural hazards. According to Department of Administrative Services records, three losses totaling almost \$39,000 state facilities were recorded in Region 3 since the beginning of 2015. None was caused by a winter storm.

### 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.



Marion County is at the greatest risk from winter storms in Region 3 followed by Linn and Yamhill Counties.