

# The Regional Transportation Plan — 2018

## Appendix O Resilience





## May 2018

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# APPENDIX O: Resilience

## Introduction

The topic of resilience has broad implications across all sectors of the economy and communities throughout the region. There is much work going on locally and across the country to address a wide variety of issues such as seismic preparedness, sea level rise and flooding, cybersecurity, aging infrastructure, etc. This appendix discusses the various aspects of resilience in the central Puget Sound region, with a particular focus on the transportation system; outlines the potential impacts to the region from earthquakes, climate change and other hazards; describes the state of the practice and current activities; and discusses next steps to advance the incorporation of resilience in the planning process.

## What is Resilience?

According to the National Academies of Sciences, Engineering and Medicine, resilience is defined as *“The ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse events.”*<sup>1</sup> Resilience encompasses preparing for impacts, mitigating future impacts, and the ability to recover to a “normal,” pre-event state.

While every aspect of a community and an economy can, and should, strive to be resilient, this appendix will focus particularly on resilience of the transportation system. A resilient transportation system can include a variety of factors – for example, ensuring the seamless operation of routes used to deliver food or medical services; fortifying structures to withstand heavy flooding; retrofitting key bridges to prepare for earthquake risk; and planning efforts such as emergency routing plans for key system closures.

## What are the potential impacts in the region from earthquakes, climate change and other hazards?

An in-depth vulnerability assessment of the central Puget Sound region was not within the scope of this report. However, many federal, state and local organizations have conducted, or are in the process of conducting, similar work to identify key risks and vulnerabilities at a variety of scales.

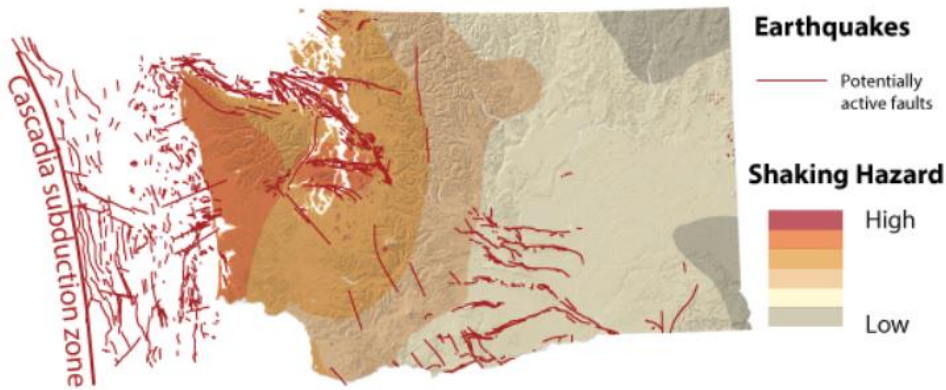
## ***Seismic and other natural hazards risks***

According to the Washington State Department of Natural Resources (DNR), Washington has the second highest risk in the country of large, damaging earthquakes. There are dozens of active faults and fault zones throughout the state, the largest being the Cascadia subduction zone. There are numerous faults in the central Puget Sound region, as illustrated by the figure below.

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<sup>1</sup> Disaster Resilience: A National Imperative; NAS 2012

Figure 1: Seismic Risk in Washington State



Source: Washington State Department of Natural Resources, 2007

According to the United States Geological Survey (USGS), the Pacific Northwest has a 10% chance of a magnitude 8-9 earthquake on the Cascadia subduction zone.<sup>2</sup> *“When the Cascadia fault ruptures, it will likely cause: 1) Severe ground motions along the coast, with shaking in excess of 1 g in many locations (1 g is equal to the acceleration of gravity, 0.5 g is half the acceleration of gravity). The greater Seattle area will see 0.2 to 0.3 g accelerations from a subduction-zone earthquake. 2) Because of the very large fault area involved, slip will produce strong motions that may last for two to four minutes as the earthquake propagates along the fault, and include seismic waves of very long period (20 seconds or more). These long-period waves may particularly effect very tall structures, and long structures such as bridges. 3) Tsunamis generated by sudden uplift of the sea floor above the fault. Effects of past tsunamis are among the evidence observed by geologists to infer the history of earthquakes in the subduction zone. 4) Effects in all of Cascadia’s major population centers, from Vancouver, B.C., to Portland, putting strong stresses on the regional infrastructure.”*<sup>3</sup>

There have been about 15 large earthquakes in Washington state in the last century, with the most recent being the Nisqually earthquake in 2001, which caused damage to numerous buildings and infrastructure. According to a summary report conducted by the Oregon Department of Geology and Mineral Industries, damage in the central Puget Sound region occurred at various scales to SeaTac and Boeing Field Airports, port terminals, and the Alaskan Way and Spokane Viaducts, and there were numerous landslides. Total damage costs were estimated to be up to \$2 billion.

<sup>2</sup> <https://www.shakealert.org/>

<sup>3</sup> <https://geomaps.wr.usgs.gov/pacnw/lifeline/eqhazards.html>

Figure 2: Historic Earthquakes in Washington

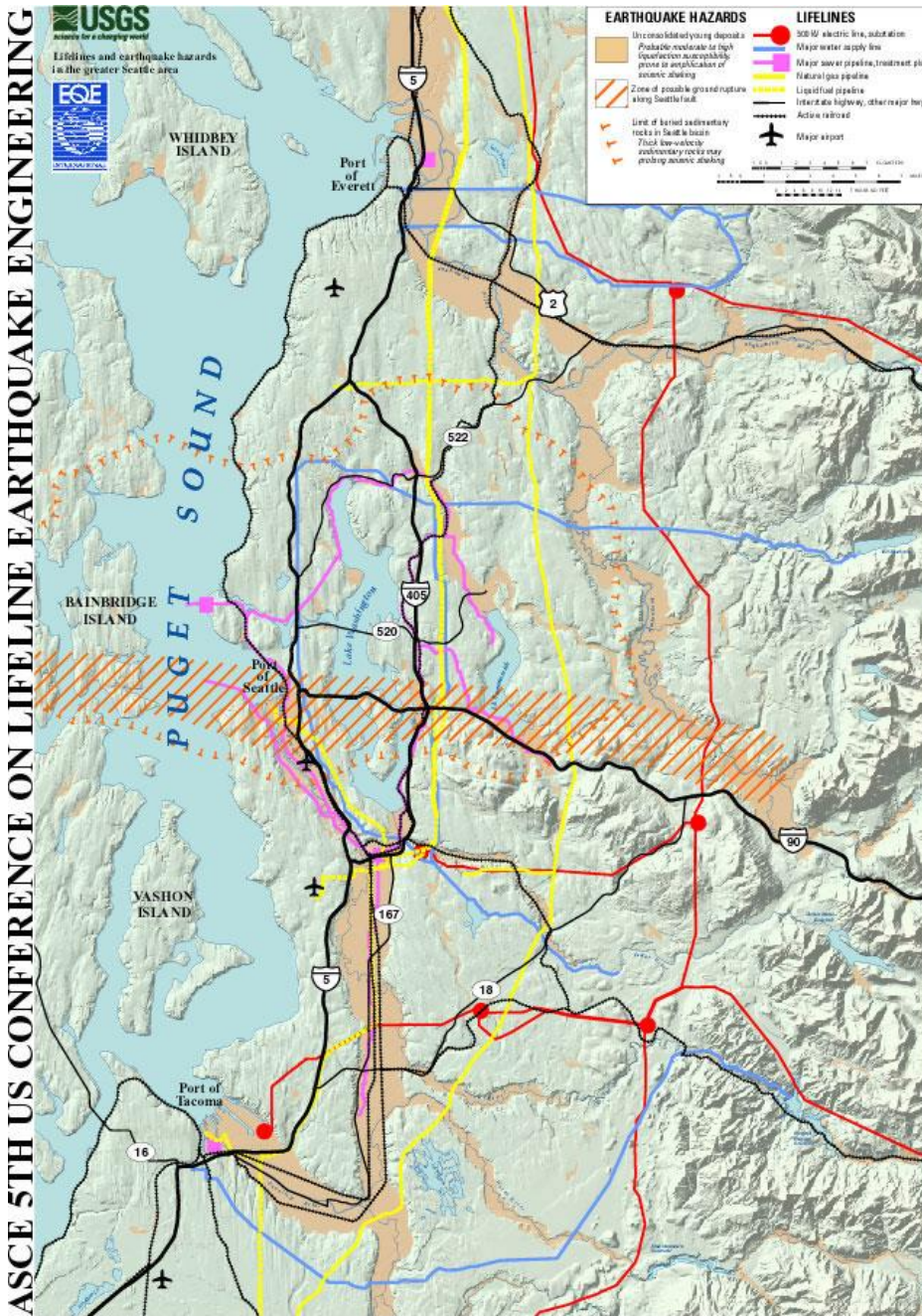


Source: Washington State Department of Natural Resources

While there is uncertainty as to when the next large earthquake will happen in the state, it is expected that most of the populated areas in the state have a 40-80% chance of an earthquake in the next 50 years.<sup>4</sup> The Seattle fault is known to be active, and while it is not known when, it is anticipated to produce a large magnitude (6–7.5) earthquake when it next ruptures. According to the University of Washington, the last major quake on the Seattle fault was estimated to be magnitude 7.4 about 1,100 years ago and generated a Puget Sound tsunami.

<sup>4</sup> <https://www.dnr.wa.gov/programs-and-services/geology/geologic-hazards/earthquakes-and-faults#.5>

Figure 3: Lifelines and earthquake hazards in the greater Seattle area

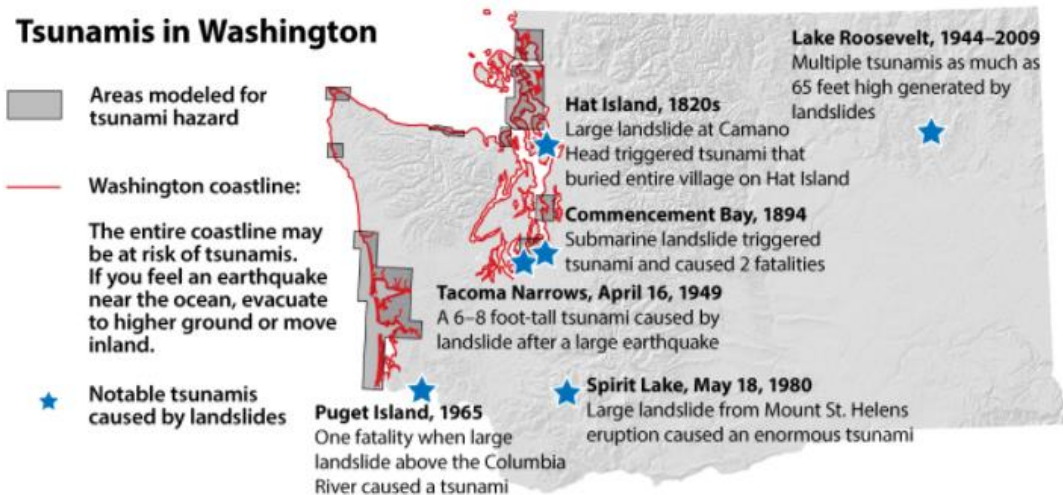


Source: United States Geological Survey

Tsunamis are large, destructive waves caused by earthquakes, landslides or volcanic eruptions. DNR, in partnership with the National Oceanic and Atmospheric Administration (NOAA), has modeled potential inundation of coastal areas in the state, and has worked with the WA Emergency Management Division and local, county, tribal and other partners to prepare community evacuation maps.



Figure 4: Tsunamis in Washington



Source: Washington State Department of Natural Resources

More detailed inundation maps for the state, including the areas of Tacoma, Seattle and Everett, are available on DNR's website at <https://www.dnr.wa.gov/programs-and-services/geology/publications-and-data/publications-and-maps#geologic-hazard-maps.6>.

According to DNR, the state is also one of most landslide-prone stations in the country. Common landslide triggers include, but are not limited to: prolonged or intense rainfall, which is expected to be exacerbated due to climate change; earthquakes; changes in water levels; removal of vegetation on a slope; etc. DNR, in cooperation with NOAA, has developed a shallow landslide hazard forecast map, providing daily forecasts for precipitation-induced shallow landslides in Washington State, using recent and predicted rainfall. This is a beta version, intended to show relative hazards, rather than firm predictions of whether or not a landslide will occur: <https://www.dnr.wa.gov/slhf>.

The most significant landslide in the region's recent history is the Oso Landslide on State Route 530 near Arlington and Darrington in Snohomish County. According to the USGS, the landslide's average speed was 40 miles per hour, covering one half square mile and moving 18 million tons of material. While there were numerous contributing factors, according to the USGS the soil porosity and water content from recent rainfall was one of the factors for the high mobility of the landslide – precipitation in the area in the preceding two months was 150 to 200% of the long-term average.<sup>5</sup> This tragic event resulted in 43 fatalities and the destruction of 40 homes and other structures. The closure of State Route 530 cut off access between the two communities, and it took six months to rebuild the highway and reestablish that connection.<sup>6</sup>

## Climate

According to the *State of Knowledge: Climate Change in Puget Sound*, published by the Climate Impacts Group at the University of Washington, the following are potential key impacts to the region from a changing climate:

<sup>5</sup> [https://www2.usgs.gov/blogs/features/usgs\\_top\\_story/one-year-later-the-oso-landslide-in-washington/](https://www2.usgs.gov/blogs/features/usgs_top_story/one-year-later-the-oso-landslide-in-washington/)

<sup>6</sup> <https://www.wsdot.wa.gov/Projects/SR530/Landslide/>

- Increased temperatures
- Variable precipitation
- More frequent and intense rainfall
- Sea level rise
- Ocean acidification
- Decreased snowpack and higher winter streamflow
- Increased landslide risk and erosion
- More frequent and intense flooding
- Impacts to salmon and other species
- Altered growing seasons

Many agencies have mapped sea level rise scenarios over the last several years. PSRC conducted this work in 2010, but more current efforts reflective of the best available science include NOAA's Office of Coastal Management, which provides a web mapping tool to visualize community-level impacts from coastal flooding and sea level rise up to 6 feet above average high tides.<sup>7</sup>

In addition to exacerbating human health issues and increasing vulnerability, impacts are also expected to the built environment. Specific to transportation infrastructure, examples of potential effects include:

- Accelerated deterioration of roadways
- Flooding of roadways and increased stormwater issues
- Storm surge damage to docks and other facilities
- More frequent landslides
- Rail buckling from higher temperatures
- Reduction in aircraft lift and efficiency due to higher temperatures
- Reduced water levels affecting ships and barges

Transportation is the foundation of a functioning community, providing critical access to jobs, health care, food, and other services. It also serves as an essential underpinning of the economy, from the delivery of goods to serving as the conduit for maintenance of other essential systems such as power and water supply. Planning for potential impacts and preparing a resilient transportation system is therefore crucial to a thriving region.

### **What is being done?**

Described below are some key examples of resilience and preparedness work being conducted around the country and throughout the region. This is by no means an exhaustive list of all activities, and many jurisdictions conduct much of this work as part of their Emergency Management divisions, which prepare for, respond to, and assist in the recovery from emergencies and disasters in each of their communities. Jurisdictions and agencies are incorporating resilience to seismic, climate and other risks in their comprehensive planning and hazard mitigation planning processes; they are addressing impacts and risks in project planning and design; they are adjusting design of capital infrastructure for seismic retrofits as well as withstanding more extreme weather events; and they are pursuing research and data collection for a greater understanding of these impacts at the local scale.

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<sup>7</sup> <https://coast.noaa.gov/digitalcoast/tools/slr>



## Seismic

The Resilient Washington Initiative, spearheaded by the Washington State Emergency Management Council's Seismic Safety Committee, has a primary goal of improving Washington's resilience following earthquakes. The Initiative published "Resilient Washington State: A Framework for Minimizing Loss and Improving Statewide Recovery after an Earthquake."<sup>8</sup> This report contains an assessment of the current recovery capacity of infrastructure in Washington, targets for recommended recovery timeframes, and the top recommendations for improving resilience statewide. The report focuses on four sectors – critical services, transportation, utilities, and housing and economic development. For transportation, the report identified minimal, functional and operational target recovery times for the major highways, bridges, airports, rails, and major/minor arterials in the region. Many of the recommendations are aimed at state agencies, but the report recommends that Regional and Metropolitan Planning Organizations "facilitate coordination between state and local jurisdictions to identify regional lifeline routes and prioritize retrofitting of city and county roads and bridges" and "develop interagency agreements between WSDOT and local jurisdictions to facilitate rerouting of traffic following an earthquake."

The USGS and a coalition of state and university partners, including the University of Washington, is studying an earthquake early warning system called ShakeAlert for the west coast. The system is currently in pilot testing, but the USGS has a goal of beginning public notifications as early as 2018, pending long term funding. In addition, the University of Washington and the University of Oregon cooperatively operate the Pacific Northwest Seismic Network (PNSN), which is the second largest seismic network in the country. PNSN monitors earthquake and volcanic activity across the Pacific Northwest, with over 300 seismograph stations.

The Washington State Department of Transportation (WSDOT) has been actively participating with emergency management agencies and conducting seismic retrofits of bridges throughout the state. According to the State Facilities Action Plan (refer to Appendix I of the Regional Transportation Plan), almost 600 bridges around the state are in need of seismic retrofit, at an estimate of \$1.5 billion (\$1.1 billion of which is in the Puget Sound region). The state is prioritizing this work based on a network of key lifeline routes. In addition, current capital projects are being designed with seismic resiliency in mind: for example, the SR 99 tunnel has been designed to withstand a 9.0 magnitude earthquake, and the SR 520 bridges are designed to withstand a 1,000 year earthquake.

Other local jurisdictions are also addressing vulnerability of assets such as bridges and buildings. For example, the City of Seattle has identified over 800 unreinforced masonry buildings throughout the city, and has sponsored a program to retrofit wood frame homes built prior to current seismic codes. Sound Transit has addressed seismic retrofitting of existing I-90 structures as part of the East Link Light Rail project. Numerous other projects are also addressing earthquake preparedness in the design of their capital projects, particularly during the replacement of key transportation infrastructure such as transit stations and bridges (e.g., King Street Station).

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<sup>8</sup> <https://www.mil.wa.gov/uploads/pdf/seismic-safety-committee/RWS%20final%20report.pdf>, November 2012

## ***Climate and other disaster preparedness***

### National

Over the past decade, several national initiatives have emerged in response to the need for large-scale planning for resilience and climate change preparedness. In response to Executive Orders in 2009 and 2014, many federal agencies have put forward plans and strategies for addressing climate change considerations into their missions and activities, including the incorporation of climate change adaptation plans and vulnerability assessments. A few key examples of federal resilience activities are identified below, specifically relevant to transportation.

In 2012, the Department of Homeland Security (DHS) issued its [Climate Change Adaptation Roadmap](#), which focused on cross-cutting adaptation activities, resilient critical infrastructure and key resources, resilience to disasters, and security and environmental protection in the Arctic. Subsequently, DHS published the [DHS Climate Action Plan](#) and incorporated climate change resiliency into its [Quadrennial Homeland Security Review](#) in 2014. As part of these efforts, the DHS worked with the U.S. Global Change Research Program, the National Oceanic and Atmospheric Administration, and the Environmental Protection Agency to create its [Regional Resiliency Assessment Program](#), a cooperative assessment of a range of critical infrastructure vulnerabilities. The DHS uses this program to produce “Resiliency Assessments” for regions to identify key resilience gaps, and guide strategic investments in equipment, planning, training, and resources.

- *DHS is currently working in partnership with the Washington State Emergency Management Division as part of their Regional Resiliency Assessment Program. This 3-year funded effort is focused on identifying critical transportation infrastructure throughout Western Washington and opportunities to make them more resilient. The specific genesis was the Cascadia Rising Exercise that occurred in 2016, and the effort is focused on an evaluation of potential damage and destruction from an earthquake or tsunami. A draft report with options for consideration is due out in spring 2018.*

The Federal Highway Administration (FHWA) provides technical guidance and funding to help state, regional, and local transportation agencies integrate climate risk considerations into their planning and programming. FHWA funding can be used to address resilience as part of highway vulnerability assessments, asset management plans, project development and design, and construction of projects or features to protect existing assets from climate change associated damage.

In 2014, FHWA published the directive “[FHWA Order 5520](#)” which established FHWA’s efforts to ensure that FHWA programs, policies, and activities integrate consideration of the impacts from climate change and extreme weather events. This directive outlined FHWA’s responsibilities in the delivery and stewardship of federal transportation infrastructure programs, which include:

- Removing administrative, regulatory, and policy barriers to preparedness and resiliency.
- Encouraging transportation agencies to implement strategies for minimizing climate change risks and protecting critical infrastructure.
- Providing technical assistance and developing transportation-specific vulnerability assessment and adaptation tools.
- Informing transportation agencies of funding opportunities for resilience and adaptation activities.

- Updating planning, engineering, and operations guidance to include consideration of climate change and extreme weather event resilience.

As part of these efforts, FHWA developed its [Climate Change and Extreme Weather Vulnerability Assessment Framework](#), a guide for assessing the climate change and extreme weather vulnerability and adaptation options of transportation infrastructure. Between 2013 and 2015, FHWA used this framework to work with state and regional transportation agencies on pilot assessments of 19 transportation systems. These assessments helped the agencies better incorporate climate change into its decisions for engineering design, long range planning, and asset management.

- *WSDOT participated in two pilot projects through this FHWA program: reviewing adaptation options in the Skagit River Basin, and conducting a statewide Climate Impacts Vulnerability Assessment.*

The purpose of FHWA’s ongoing “[Transportation Engineering Approaches to Climate Resiliency \(TEACR\)](#)” study is to develop engineering practices for evaluating project-level vulnerabilities from future climate change and extreme weather events, and design solutions to adapt to those vulnerabilities. This analysis will be used to identify best practices in engineering for different transportation facility types in locations around the United States. Upon completion, the study will provide recommendations for incorporating climate change considerations into the rebuilding, upgrading, and new construction of different types of transportation assets.

Since the early 1990’s, the Department of Defense (DOD) has been researching and developing climate change resilience strategies due to the strong impacts that environmental degradation and climate change events are likely to have on the department’s ability to perform its missions. In 2010, the DOD released its first “[Strategic Sustainability Performance Plan](#),” updated annually thereafter, the goals of which are to identify and assess climate change effects, integrate climate change and risk management considerations, and collaborate with stakeholders on these challenges. Specifically in regards to climate change, in 2013 the DOD issued its first annual “[Climate Change Adaptation Roadmap](#),” a guide for planning and risk mitigation to reduce future adverse impacts of climate change. The DOD’s approach to climate change is to treat it as a “threat multiplier” because climate change events and damage have the potential to exacerbate many of the DOD’s current security functions. In 2016, the DOD issued its [Directive 4715: Climate Change Adaptation and Resilience](#). This directive serves to establish the DOD’s climate change adaptation policies and assigns specific responsibilities to each organizational entity within the DOD for providing the necessary resources necessary for risk assessment and management associated with climate change impacts.

The [National Climate Assessment](#) is a report produced in 2014 by a team of more than 300 climate change experts. The National Climate Assessment comprehensively summarizes the potential current and future impacts of climate change in the United States. Information is provided on how climate change is likely to affect each region of the country, such as drought in the Southwest and coastal flooding in the Northeast. The report was distilled into twelve major research findings, with options for how governments, businesses, and individuals can begin to respond to climate change. As this is mainly an informational rather than a planning document, the report’s main recommendation is a sustained assessment process for measuring and evaluating the nation’s capacity for understanding and responding to the impacts of climate change. Development of the fourth National Climate Assessment is currently underway, with delivery anticipated in late 2018.



The American Association of State Highway Transportation Officials (AASHTO) has also been working on resilience. Their Center for Environmental Excellence, developed in cooperation with FHWA to encourage environmental stewardship and innovation, provides resources on extreme weather and climate impacts in transportation; vulnerability and risk assessment; incorporating climate risk in planning, design and asset management; incorporating resilience in project planning and development; and construction, operations and maintenance activities.

The National Academies of Sciences, Engineering and Medicine developed the Resilient America Roundtable program to convene experts from a variety of sectors to help communities build resilience to extreme events. The region was selected by the Roundtable as one of four pilot communities, with a particular focus on PSRC's Regional Transportation Plan, and community equity within the City of Seattle. A workshop of diverse stakeholders was convened in August 2016, "*Building Resilience in the Puget Sound Region*;" a survey of member jurisdictions was conducted regarding their resilience planning and their technical and policy needs; and selected agency interviews were held between May and July of 2017. A summary of the survey results and these in-depth interviews is contained in Attachment 1. In January 2018, NAS will host another workshop – "*Puget Sound Knowledge Exchange: Resources for Building Resilience*" – which will provide information on local agency activities around the region as well as funding resources to begin incorporating resilience into local and regional planning.

- *Key indications from the survey conducted of PSRC member jurisdictions illustrate the diversity of scales regarding how the topic of resilience is being addressed around the region. Some agencies are actively engaged in this topic, while others have not yet started. Barriers include costs and resources, and it is noted that PSRC can play a role in providing information and technical assistance.*

## State and Region

There are multiple efforts happening at the state and regional level to address resilience. In 2012, the Washington State Department of Ecology published the report, "Preparing for a Changing Climate; Washington State's Integrated Climate Response Strategy." This report describes "*how existing and new state policies and programs can better prepare Washington to respond to the impacts of climate change. It calls on state agencies to make climate adaptation a standard part of agency planning and to make scientific information about climate change impacts readily accessible to decision makers in the public and private sectors. It also recommends that state agencies strengthen existing efforts and build partnerships to help local and tribal governments, private and public organizations, and individuals reduce their vulnerability to climate change impacts.*"<sup>9</sup>

As mentioned previously WSDOT has conducted a statewide vulnerability assessment and has been working to address vulnerability and preparedness in numerous infrastructure projects. Key examples include the Mukilteo Multimodal Terminal, SR 520 bridge, SR 99 tunnel, SR 167 and others.

The Washington State Department of Commerce has published "Building Cities in the Rain: Watershed Prioritization for Stormwater Retrofits," which serves as a tool for local planners to target investments in stormwater retrofits while considering salmon habitat needs and opportunities for redevelopment. The document brings together a number of existing data sources that planners can use in prioritization.

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<sup>9</sup> <https://fortress.wa.gov/ecy/publications/publications/1201004b.pdf>, April 2012

The Center for Regional Disaster Resilience (CRDR) works under the Pacific Northwest Economic Region (a statutory public/private non-profit that coordinates state and provincial policies in the Pacific Northwest and western Canada). CRDR works with states and communities on emergency preparedness and disaster resilience by creating public-private partnerships, hosting conferences and seminars, developing actions plans, and initiating pilot projects. CRDR partners include several US agencies, Pierce County, City of Seattle, King County, WSDOT, Port of Tacoma, Port of Seattle, and several local companies. They have published “Puget Sound Critical Infrastructure Integrated Action Strategy,” which has been informed by several of their programs, including the Blue Cascades exercise series (focused on infrastructure-related issues following a disaster), Puget Sound Maritime Transportation System Recovery Exercise, Green River Regional Resiliency Strategy, and Evergreen Quake exercise series. The Strategy identifies actions for state and local governments, as well as utilities, to address communications and information sharing, transportation and supply chain resilience, lifeline infrastructure systems, community and economic resilience, and governance and policy coordination. The CRDR is currently working to identify important lessons from recent wildfire recovery efforts including impacts to infrastructure, wildlands, and developed areas.

The Northwest Healthcare Response Network (NWHRN) has led efforts in the Puget Sound area to build a disaster-resilient healthcare system. NWHRN formed from the merger of King and Pierce County healthcare coalitions and is a collaboration of regional healthcare providers, emergency services, and public health experts. They have engaged in planning efforts that have established relationships among healthcare facilities and developed tools to plan for emergencies in a coordinated manner. Some of their work has included surge capacity and transportation evacuation planning at hospitals in King and Pierce Counties, developing a plan for a statewide Disaster Medical Control Center that can aid patient movement during a large-scale disaster, and hosting workshops and trainings to build capacity.

Floodplains By Design is public/private partnership led by The Nature Conservancy, Puget Sound Partnership, and the Washington State Department of Ecology with the goal of reducing flood risks and restoring habitat while improving resiliency in the floodplains of the Puget Sound area. Floodplains by Design uses an integrated approach to addressing floodplain challenges by incorporating multiple interests – floodplain planning, salmon recovery, agriculture, and recreation. “Coastal Resilience” is an online interactive map that includes locations of critical facilities in relation to rivers and floodplains, ecosystem components and functions, and flood hazards (<http://maps.coastalresilience.org/washington/#>). Funding has been provided from the Washington State Legislature to provide grants for floodplain projects that further the goals of the program. These grants are awarded on a biennial basis, with the most recent awards being for the 2017-2019 biennium and totaling \$70 million. Several areas in the region have been funded through this program; for example, work is being conducted as part of a 10-year vision for the Puyallup watershed, to safeguard agricultural lands and homes, and restore drainage and fish habitat.

The Central Puget Sound Climate Preparedness Collaborative was launched in 2014, to bring together agencies around the region and work within a common framework to enhance coordination and leverage opportunities. The vision for the Collaborative is to build shared capacity, collaborate with communities, develop consistent communications, coordinate on research projects, jointly pursue funding and other resource opportunities, and ensure climate preparedness and resilience is incorporated in all levels of policy and planning. The Collaborative is actively working to engage new members, and jurisdictions around the region are in varying stages of adopting resolutions or taking other actions as a symbol of commitment to this regional partnership.

## Local

Numerous local jurisdictions and organizations are also addressing resilience, to climate change and other risks, some of which are summarized above. While there may be specific activities related to seismic preparedness or climate change impacts underway, much of the resilience work being done by local agencies is covered under the umbrella of emergency management programs. A few key examples from around the region are provided below.

King County adopted their Strategic Climate Action Plan in 2015, to both mitigate emissions of greenhouse gases and provide goals and strategies to prepare for impacts. Strategies cover the built environment, as well as planning and regional services. In addition, the Plan identifies priority actions by 2020, including science and research, planning and implementation, and partnerships. King County also has a Community Resilience and Equity Program, working collaboratively to build community resilience and ensure no one group is more impacted than another in an emergency.<sup>10</sup>

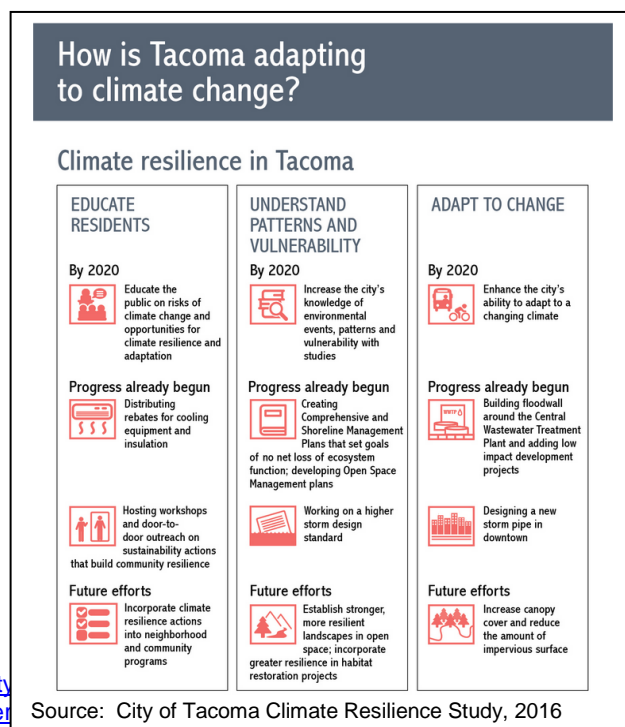
The City of Seattle's Climate Preparedness Strategy (2017) addresses a variety of actions the city will undertake to prepare for a changing climate, with a priority placed on equity. Specific to transportation, assets that have been identified as the most vulnerable include pavement, structures, stormwater conveyance systems and street trees. The Strategy calls for the incorporation of sea level rise in project planning and design, addressing increased temperatures and flooding as part of pavement preservation and maintenance of other structures, and other efforts to address future climate conditions. In addition, Seattle is one of the Rockefeller Foundation's 100 Resilient Cities, a program to help cities around the world become more resilient to a variety of social, environmental and economic challenges. Seattle's resilience work through this partnership will focus on seismic risks, climate change and social and economic inequities.

The City of Tacoma conducted a Climate Resilience Study in 2016, "to better understand and proactively manage climate risks in order to protect local residents, make sound investments, and ensure that the City can prosper, even in a changing climate."<sup>11</sup> Natural systems, social systems and the built infrastructure were considered as part of the study.

The City of Bainbridge Island prepared a Climate Impact Assessment, which guided policies adopted in their 2016 Comprehensive Plan update. The assessment called for three specific actions: the creation of a Climate Change Task Force, which was passed by the City Council in 2017; the development of a Climate Assessment Certification process for projects; and application

<sup>10</sup> [https://your.kingcounty.gov/dnrp/climate/documents/2015\\_King\\_County\\_Climate\\_Action\\_Plan.pdf](https://your.kingcounty.gov/dnrp/climate/documents/2015_King_County_Climate_Action_Plan.pdf)  
<http://www.kingcounty.gov/depts/health/emergency-preparedness/partnerships/>

<sup>11</sup> City of Tacoma Climate Change Resilience Study, 2016, [http://cms.cityoftacoma.org/Sustainability/Environmental\\_Action\\_Plan/Executive\\_Summary\\_TacomaClimate\\_FINAL\\_for\\_web.pdf](http://cms.cityoftacoma.org/Sustainability/Environmental_Action_Plan/Executive_Summary_TacomaClimate_FINAL_for_web.pdf)





elements such as integration of climate information into decision-making processes, mapping of vulnerable areas, and tracking of actions.<sup>12</sup>

The City of Everett conducted a Hazard Inventory and Vulnerability Analysis, and a Hazard Mitigation Plan, in 2011. Climate change was included as a hazard at this time, with high rankings for severe storms and earthquakes, among other risks. A variety of mitigation strategies were identified, addressing a number of critical community elements including transportation.

### **What's next?**

Much work is being done around the region and country to build and maintain resilient communities, across all aspects of the economy. Specific to transportation, many jurisdictions are being proactive in incorporating future climate projections and risk data from earthquakes, flooding and other hazards into project planning and design. There are many examples of best practices around the country and the region from which to learn. However, a key finding from FHWA's "Synthesis of Approaches for Addressing Resilience in Project Development" is that flexible approaches are best, and there is no one-size-fits-all approach.

The work of the Central Puget Sound Climate Preparedness Collaborative will be valuable as a forum for information and knowledge exchange, partnerships, and regional coordination to facilitate resilience across a wide range of sectors. In addition, PSRC will continue to monitor and serve as a resource as more examples of best practices become available – and as federal and state guidance unfolds, particularly as it relates to transportation infrastructure and planning.

In addition to advancing the regional partnerships and leveraging opportunities of the Collaborative, there are a few key upcoming opportunities for regional engagement:

- As mentioned earlier, the outcomes of the Regional Resiliency Assessment being conducted by DHS on transportation facilities in Western Washington should provide useful information on critical facilities facing earthquake and tsunami risk, as well as potential recommendations to enhance the resilience of the regional system. This effort can also be useful in expanding coordination and awareness across a variety of stakeholders. PSRC will monitor the status of this study and provide information to the PSRC Boards regarding possible coordination and next steps.
- PSRC will continue to work with the NAS Resilient America Roundtable, to engage with member organizations on their resiliency needs and activities. The January 2018 workshop, "*Puget Sound Knowledge Exchange: Resources for Building Resilience*," will provide valuable information on best practices and available resources for incorporating resilience into planning and projects.
- In addition, there is continued opportunity to learn from NAS partners on specific issues of critical concern. For example, EPA and FEMA partnered on a project to assist the Association of Bay Area Governments (ABAG) in San Francisco to incorporate resilience to natural hazards and climate change into regional and local land use planning. Implementation of strategies is underway, funded by FEMA Region IX, and a phase two is planned.<sup>13</sup> For example, ABAG has

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<sup>12</sup> <http://www.cakex.org/sites/default/files/documents/BICIA%20Final%2028%20July%202016.pdf>

<sup>13</sup> <https://www.epa.gov/smartgrowth/creating-safe-growth-strategies-san-francisco-bay-area>

several projects related to addressing seismic resilience, including transportation, buildings and utilities. PSRC will continue to engage with our NAS partners on potential learning and collaboration opportunities for the central Puget Sound region.

Another important element to consider as the region advances resilience work is that of equity. Impacts as described in this report are not distributed equally across regional geographies and populations. Equity as it relates to the Regional Transportation Plan is discussed in greater detail in Appendix B, Equity Analysis Report, and as mentioned previously, many jurisdictions are taking an active role in addressing equity within a resilience framework. PSRC will continue to engage and learn more on these issues; one specific project to pursue would be to gather mapping layers of the various hazards and overlay them with the region's demographic data, to provide a more visual illustration of the communities "hit first and worst."

Understanding that there are a variety of challenges to incorporating resilience within planning and project development, including financial considerations, it will become more important for the region to truly plan, and prepare for, emerging risks and events. The costs of recovery are high, and investments to prepare for these impacts and build resilience offer opportunities to address broader inequities in health, mobility, and access to economic opportunity.

# PUGET SOUND CLIMATE RESILIENCY AND ADAPTATION

The Resilient America Roundtable, in collaboration with the Puget Sound Regional Council, met with seven jurisdictions in the Central Puget Sound region in the spring and summer of 2017 to better understand their challenges, goals, priorities, and successes when it comes to community resilience broadly and climate resiliency specifically. This document summarizes those conversations. In addition, this document provides the results from a survey of jurisdictions and organizations across the four counties in the Central Puget Sound Region regarding their primary climate change concerns, their climate resiliency challenges, and whether or not they are incorporating climate change adaptation into their planning documents.

*Input from  
jurisdictions in  
the Central  
Puget Sound  
region*



## Contents

Introduction and Background .....	1
Survey.....	3
List of Survey Questions.....	3
Survey Results .....	3
Respondents .....	3
Climate Impact Concerns .....	4
Community Evaluation of Projected Climate Impacts .....	6
Climate Resiliency Planning and Policies .....	6
How could PSRC help? .....	9
What could be done at the regional level? .....	11
Jurisdiction Meetings .....	13
Common Themes .....	13
Examples of Community Successes .....	13
Next Steps .....	14

## Introduction and Background

The [National Academies of Sciences, Engineering, and Medicine's](#) (NASEM) [Resilient America Roundtable](#) provides venue for current research, science, and evidence-based foundations to inform whole community strategies for building resilience. Through this work, the Roundtable strives to help communities build resilience to extreme events and other disruptions, save lives, and reduce the social and economic costs of disasters. The Roundtable is working in four U.S. communities: Cedar Rapids/Linn County, IA; Charleston, SC; Central Puget Sound, WA; and Tulsa, OK. This community pilot program supports decision makers in their efforts to identify key priorities of the community; tie those priorities to risks that the community faces; and help communities take actions that build resilience to those risks.

The Roundtable is partnering with the [Puget Sound Regional Council](#) (PSRC) to better understand how the PSRC could address future climate impacts in the region. PSRC is the Metropolitan Planning Organization for the Central Puget Sound region, a collaborative body representing cities, counties, transit agencies, ports, tribal governments and the state working to ensure a thriving region through planning for regional transportation, growth management, and economic development. The Central Puget Sound region, is made up of four counties: King, Pierce, Snohomish and Kitsap.

PSRC's long-range metropolitan transportation plan, [Transportation 2040](#), is undergoing an update process, with the new plan scheduled for adoption in spring 2018. The basis of PSRC's transportation plan is the growth strategy in [VISION 2040](#), which focuses on the tremendous growth expected in the region over the next 30 years; plans for a sustainable, multimodal transportation system; and promotion of a healthy environment and continued economic vitality.

When Transportation 2040 was first adopted in 2010, PSRC crafted a four-part greenhouse gas strategy to reduce greenhouse gas emissions, and also developed a white paper outlining the expected impacts to the transportation system from climate change. This white paper represented the first time PSRC initiated a conversation on climate adaptation. For the 2018 plan update, PSRC wants to expand upon this work and engage its 100+ member organizations, agencies, and community partners more fully in the conversation of preparing for climate change.

Through meetings and discussions the Roundtable has had with diverse stakeholders and representatives from multiple sectors in the Puget Sound region, climate adaptation, equity, and transportation were consistently identified as key priorities for building resilience. Based on these priorities, the Roundtable and the PSRC hosted a workshop in August 2016, *Building Resilience in the Puget Sound Region*. Diverse stakeholders from multiple jurisdictions in the Central Puget Sound region came together with representatives from cities and counties in other states to share lessons learned and solutions for building resilience.

Since August 2016, the Roundtable and the PSRC have been working together to better understand how the PSRC could address future climate impacts and help local decision makers identify and integrate actions to build climate resiliency into current plans and efforts. As a starting point, the Roundtable facilitated a survey of the PSRC membership to better understand whether or not PSRC members understand their future climate risks and are considering these risks in their local planning efforts. Data from this online survey was gathered from November 2016 through May 2017.

In order to get a deeper understanding at the local level of the climate risks, challenges, and priorities communities are dealing with, the Roundtable and the PSRC held several meetings with jurisdictions across the region to discuss how they are approaching issues and impacts related to climate change and what their priorities are for building resilience. These conversations included discussions about their successes and challenges in addressing these climate impact issues, how to approach climate resilience from a regional perspective, and ways jurisdictions could work together and leverage resources to address these challenges.



## Survey

A November 2015 report from the University of Washington's Climate Impacts Group, [\*State of Knowledge: Climate Change in Puget Sound\*](#), detailed current and expected future impacts of climate change in the Puget Sound region. Over the past several years, government agencies at the local, regional and state levels have been developing and implementing policies and plans to address these impacts.

The Resilient America Roundtable's partnership with the PSRC focused on better understanding how the PSRC could address future climate impacts in the region. To achieve this, the Roundtable facilitated a survey in the Central Puget Sound Region (King, Pierce, Snohomish, and Kitsap) to learn about local jurisdictions' goals, priorities, and challenges around climate preparedness and resiliency. The information gathered from this survey could help the PSRC:

- determine whether or not PSRC member organizations understand their future climate risks;
- understand what PSRC member organizations are doing to prepare for future climate change; and,
- identify how PSRC could help the region and their member organizations better prepare for future climate risks.

## List of Survey Questions

1. In which county are you located?
2. What town/city/organization do you represent?
3. What climate impacts are of concern to your organization? How do/will these impacts affect your community? Examples of climate impacts could include flooding, landslides, sea level rise, increased temperatures, etc.
4. Has your organization conducted an evaluation of projected climate impacts in your community, such as a climate vulnerability assessment?
5. Does your organization include climate resiliency or adaptation policies in your planning documents, such as the Comprehensive Plan or Hazards Mitigation Plan, or in other planning efforts? If so, what are some examples of these policies?
6. What challenges does your organization face when it comes to incorporating climate resiliency into your planning or implementation efforts?
7. Given PSRC's role in regional planning, what could PSRC do to help local jurisdictions address their future climate risks? This could include providing technical assistance, setting regional policies, providing a forum for peer sharing, etc.
8. What could be done at the regional scale to mitigate climate impacts?

## Survey Results

### Respondents

#### Questions posed:

- *In which county are you located?*
- *What town/city/organization do you represent?*

The survey was sent to the PSRC member jurisdictions in November 2016. Thirty individuals responded to the survey (Figure 1). Of the 75 jurisdictions and organizations the survey was sent to, 24 responded (32% response). There were three responses from organizations not initially contacted. Additionally, three jurisdictions had two representatives answer the survey questions.

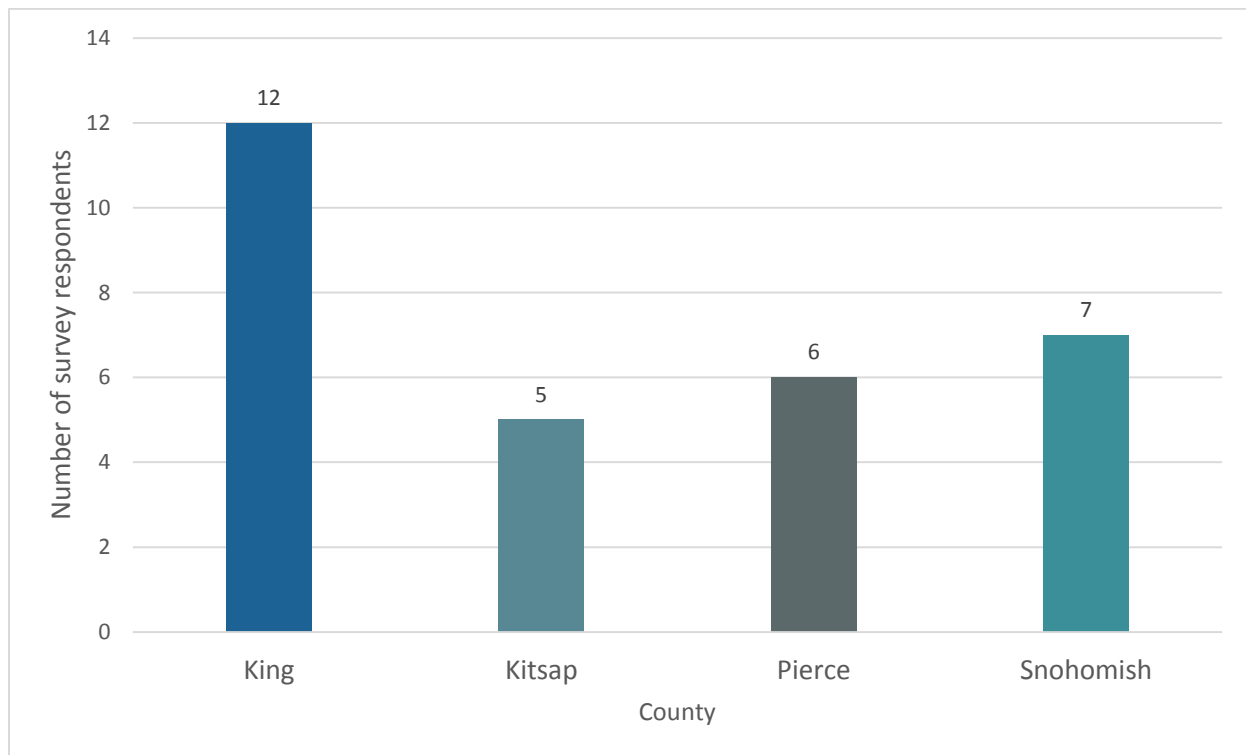


Figure 1. Number of survey respondents by county.

## Climate Impact Concerns

### Questions posed:

- *What climate impacts are of concern to your organization?*
- *How do/will these impacts affect your community? Examples of climate impacts could include flooding, landslides, sea level rise, increased temperatures, etc.*

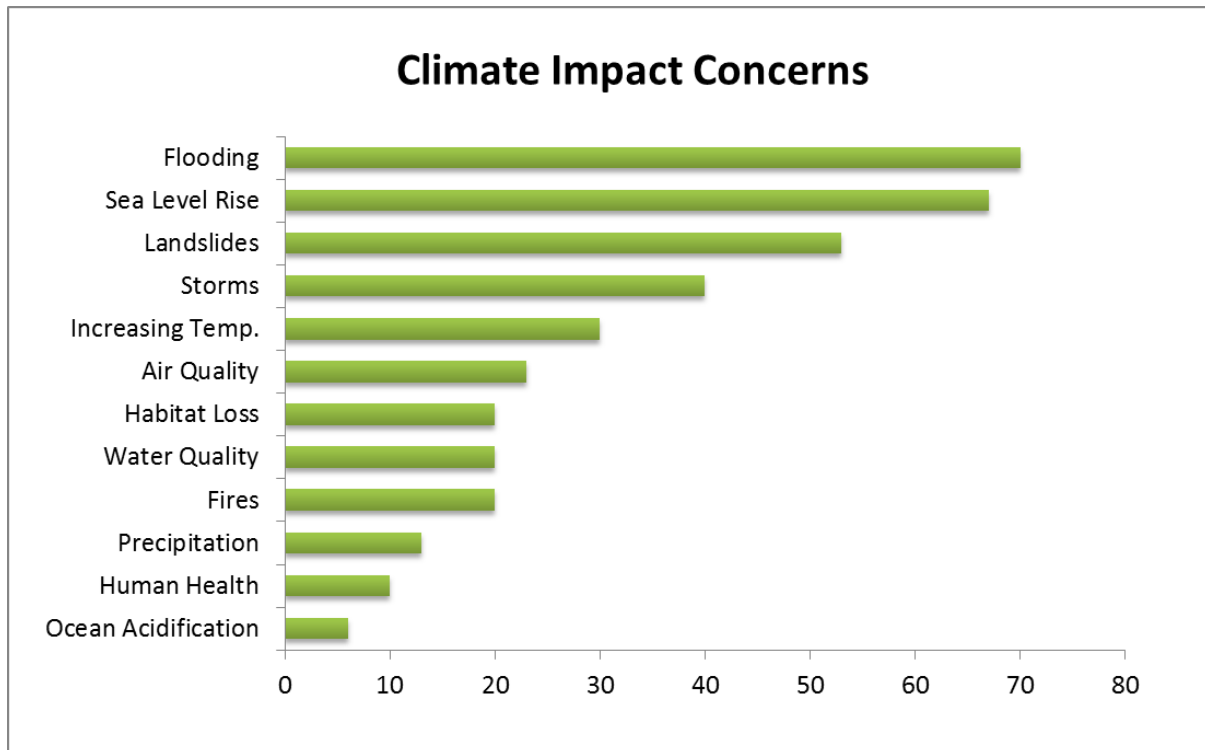


Figure 2. Percent of survey responders (n = 30) who mentioned each climate impact as a primary concern.

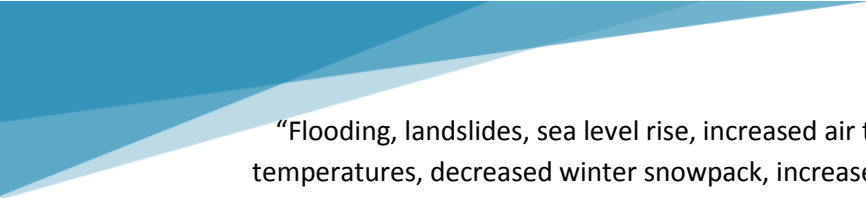
In addition to the most frequently mentioned climate impact concerns listed in Figure 2 (above), other climate impact concerns included:

- decreased winter snowpack
- drought
- higher winter stream flows
- impacts to potable water
- increases in disease
- insect outbreaks
- loss of animal habitats
- lower summer stream flows
- reduced rainfall
- reduced snowfall
- soil erosion

“[Climate change] has not been a topic of overarching concern to past or current city councils. To my knowledge, climate change has not come up at any community meetings.”

“Increased temperatures can be hazardous for the young and elderly, require increased energy consumption and cost to cool indoor temperatures, degrade animal habitat (e.g., salmon), alter precipitation patterns, snowpack levels and runoff periods affecting water supplies and energy costs (due to reliance on hydro-power), and make communities less resilient to wildfire.”





“Flooding, landslides, sea level rise, increased air temperatures, increased stream temperatures, decreased winter snowpack, increased wildfires, ocean acidification, increase in chronic health issues, increase in severe storms, higher winter stream flows, lower summer stream flows, increases in disease and insect outbreaks. These concerns will impact the community in various ways; increased healthcare costs, increased household costs, impacts to recreational opportunities and quality of life, decreased safety, impacts to wildlife and major food sources, decreased access to services, impacts to property and infrastructure and increased need for emergency response.

### **Community Evaluation of Projected Climate Impacts**

#### **Question posed:**

- *Has your organization conducted an evaluation of projected climate impacts in your community, such as a climate vulnerability assessment?*

Of those who responded to the survey, 37% have completed an evaluation of projected climate impacts for their community or organization.

### **Climate Resiliency Planning and Policies**

#### **Questions posed:**

- *Does your organization include climate resiliency or adaptation policies in your planning documents, such as the Comprehensive Plan or Hazards Mitigation Plan, or in other planning efforts? If so, what are some examples of these policies?*
- *What challenges does your organization face when it comes to incorporating climate resiliency into your planning or implementation efforts?*

Forty-six percent of survey respondents indicated that climate change resiliency or adaptation policies are included in their planning documents (Figure 3). Most of these policies were included in their comprehensive plans or hazard mitigation plans.

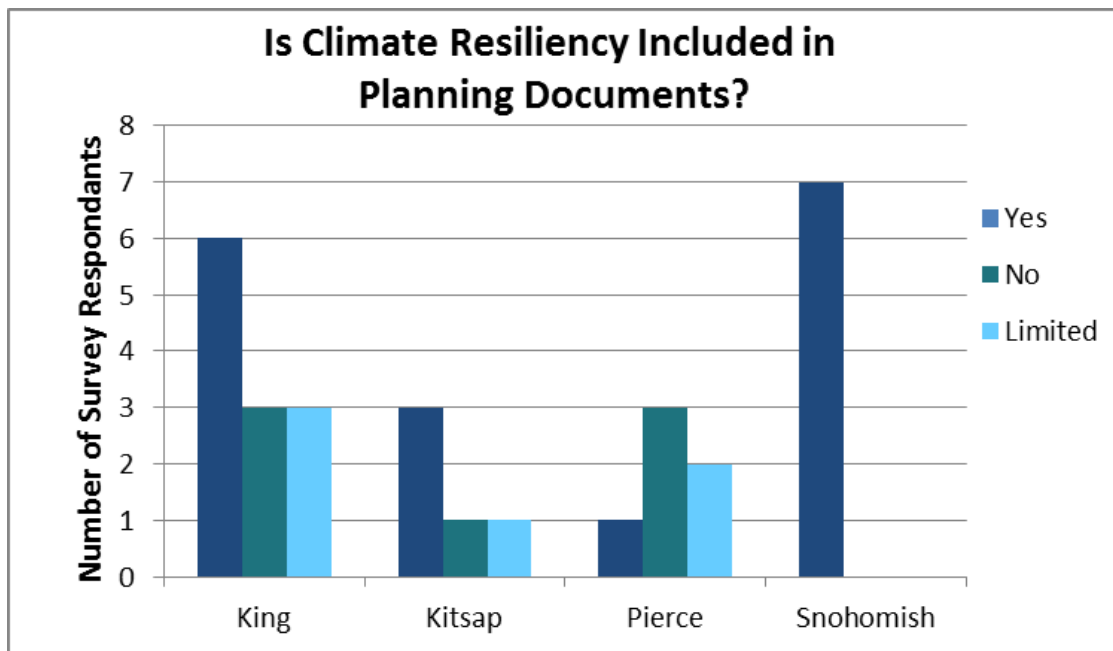


Figure 3. Percent of respondents, from each county, that included climate resiliency or adaptation policies in planning documents (Yes), have not included them (No), or will be soon/have limited inclusion (Limited).

*"One of the City's Comprehensive plan goals is 'Support regional efforts in mitigating and adapting to climate change.' There are seven policies that support this goal, ranging from 'Support multi-jurisdictional efforts to address the impacts of climate change' to 'Assess climate change impacts when conducting review of proposed land use and transportation actions and programs.'"*

*"Policy documents are not specific to "climate change;" however, they do address protection of the environment and sustainable growth that provides housing choices and locates population centers adjacent to transit and services."*

The challenges jurisdictions face when trying to incorporate climate resiliency into planning documents are grouped into two overarching categories (Figure 4).

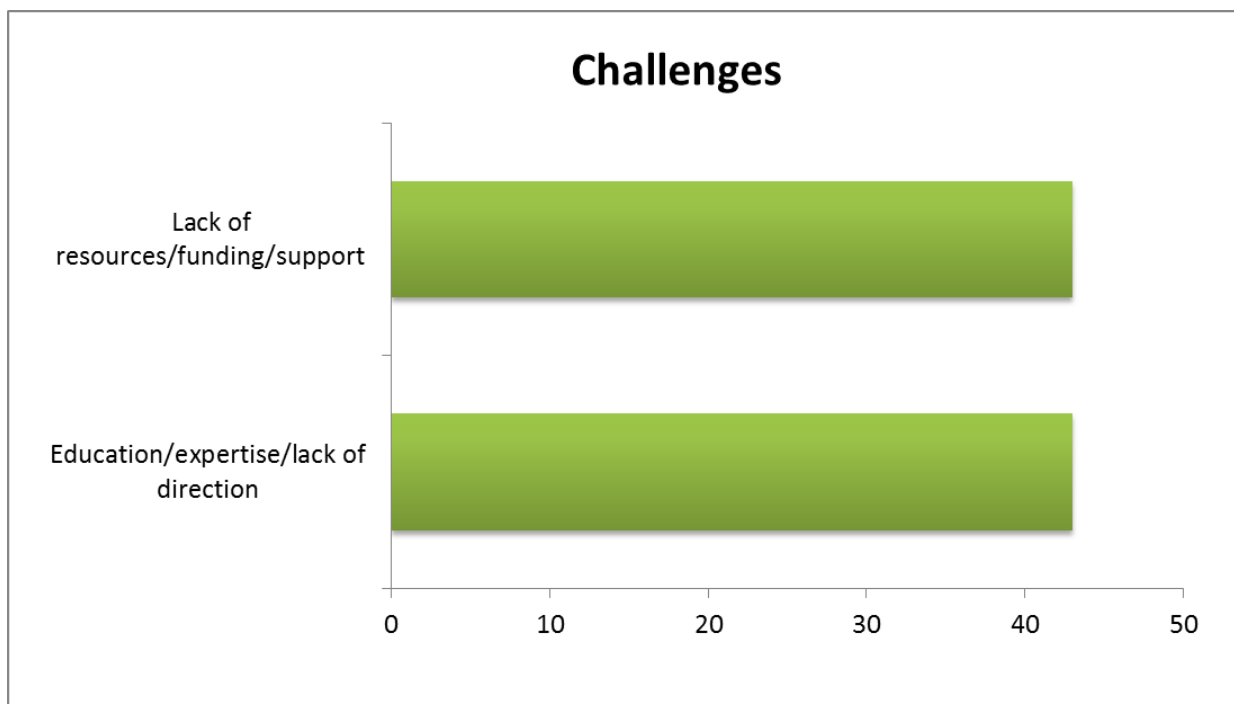


Figure 4. Percent that each topic or item was listed as a challenge to implementing climate resiliency policy into planning documents by survey participants (n=30).

*“Inability to expressly identify impacts that are directly linked to climate issues.”*

*“We have neither the funding, staff, nor elected mandate from our elected officials for such work.”*

*“No incentive to take action, no feeling of urgency.”*

Specific examples of lack of resources, funding, or support mentioned by jurisdictions include a lack of funding and/or staff to conduct vulnerability assessments or undertake climate resiliency planning or implementation efforts. Because of tight budgets, climate resiliency efforts often do not make on the list of a community’s priorities.

Challenges identified by jurisdictions related to education, expertise, or lack of direction include a lack of direction from elected officials; the need to train staff, including elected officials, on climate impacts and planning; lack of technical expertise and knowledge of the “best available science” to address climate impacts; a lack of clear direction, guidance, or tools from regulatory agencies on how best to address many adaptation issues; a lack of understanding of what measures would be helpful to incorporate into plans or strategies; and a lack of consensus on how the community will be impacted by climate change.

Other challenges jurisdictions discussed include how to work within a context where some individuals do not believe climate change is real; lack of coordination and integration across multiple departments, many of whom have their own climate change and adaptation projects; gaining buy-in on the concept

and importance of climate change; moving from planning for climate change to implementation; and communicating climate change to the public.

### How could PSRC help?

#### Question posed:

- *Given PSRC's role in regional planning, what could PSRC do to help local jurisdictions address their future climate risks? This could include providing technical assistance, setting regional policies, providing a forum for peer sharing, etc.*

There were six broad areas where jurisdictions suggested PSRC could help with climate resiliency (see Figure 5).

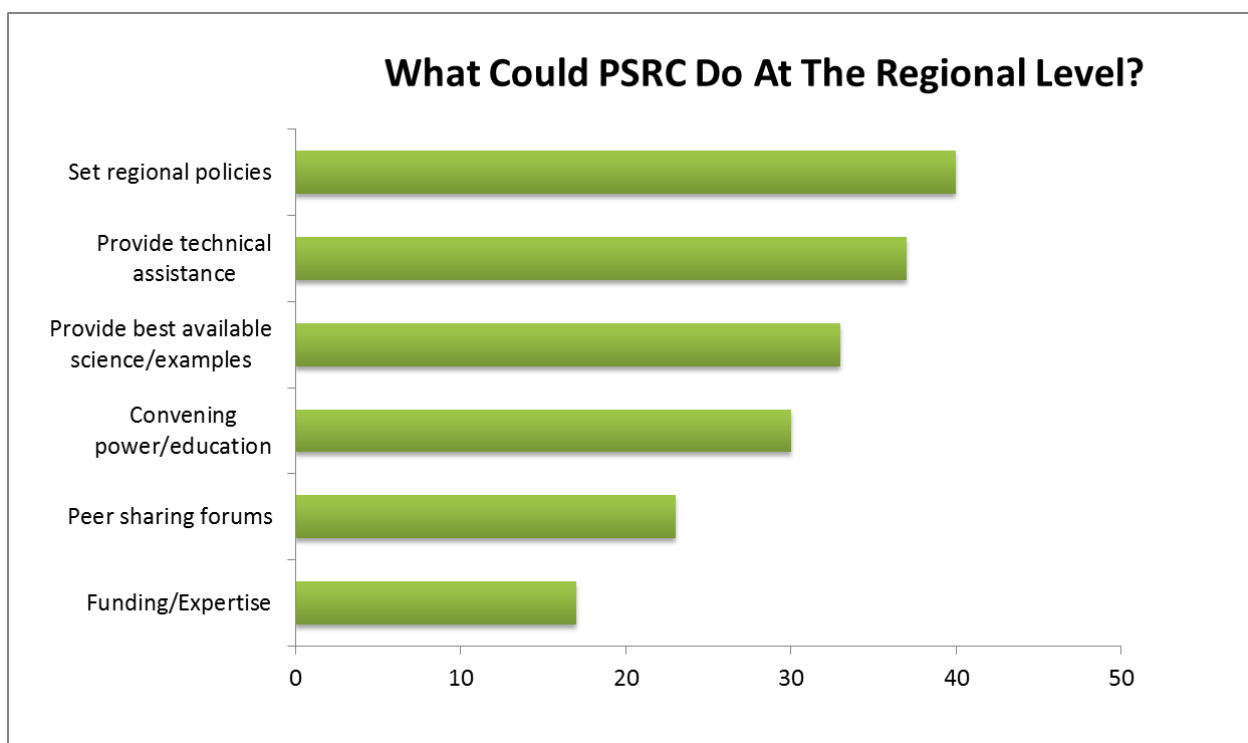


Figure 5. Percent each item or topic was reported by survey participants as something the Puget Sound Regional Council could do to help jurisdictions include climate resiliency into planning documents.

*"Setting climate change policies could be challenging as many jurisdictions do not have the resources to implement."*

*"It would be great for PSRC to come out with the best available science for this region as a guiding document."*

When it comes to setting regional policies, jurisdictions offered several specific examples of how PSRC could help local jurisdictions address their future climate risks such as:



- lead efforts to standardize certain resiliency efforts (e.g., ensuring the region is planning for sea level rise consistently)
- help align regulations such as flood design standards across jurisdictions
- develop policies that would address shared regional infrastructure and shared regional utilities
- provide examples of best practices and policies
- set standards and put in place requirements for addressing climate in comprehensive plans and other related plans (e.g., open space, water supply, stormwater runoff, emergency management)

On the other hand, a few jurisdictions commented that the PSRC should not set regional policies.

In terms of technical assistance, many jurisdictions said there is often a lack of expertise or staff to develop resiliency planning documents/policies or identify and incorporate climate change science into decision making and planning. Jurisdictions would like PSRC to provide suggestions on policy language and policies that could be implemented, climate science risks and impacts, and information about localized adaptation measures that are useful and easy to understand.

When it comes to the best available science, jurisdictions suggested that PSRC could provide:

- climate risk data and mapping
- climate adaptation best practices
- projections on how climate change could impact transportation infrastructure at various intervals (e.g., 20, 40, 80, 100 years), mobility, and modes of transportation in the region under different emission scenarios
- specific guidance on options for planning and public works/transportation departments to address climate impacts

Jurisdictions would also like to see the PSRC act as a convener to bring jurisdictions in the Central Puget Sound region together for peer sharing opportunities, to provide training, and to discuss regional policy setting.

*“Peer sharing is a valuable way to increase the understanding of climate change and foster opportunities to implement climate resiliency.”*

When it comes to funding and expertise, several jurisdictions suggested the PSRC could help jurisdictions with risk assessments; provide grants for vulnerability assessment and action plans; and grants for implementation.

Finally, other suggestions for how the PSRC could help local jurisdictions address their future climate risks include

- provide examples of communication tools for various audiences
- elevate the importance of climate resiliency both regionally and politically
- heighten agency and community awareness of the challenges and needed actions

- require consideration of future climate conditions in regional and local plans, and as a condition for grant funding
- help better allocate federal funding for resiliency projects in the region
- develop incentives for implementing climate resiliency efforts
- create a website where jurisdictions can share their documents, studies, and presentations

*“In general, front line staff are not the ones that need education or convincing. In most cases, you are preaching to the choir. Elected officials, department directors, and managers need to get on board. You need to figure out a way to consistently engage and educate elected officials, directors, and upper level management. If you get them on board, then there is a better shot of staff time and resources being spent on resiliency.”*

### What could be done at the regional level?

#### Question posed:

- *What could be done at the regional scale to mitigate climate impacts?*

Finally, survey participants were asked what could be done at the regional level to mitigate climate impacts (Figure 6). Responses to this question varied widely, but the most frequent response was to develop regional policies and goals, and to align regulations.

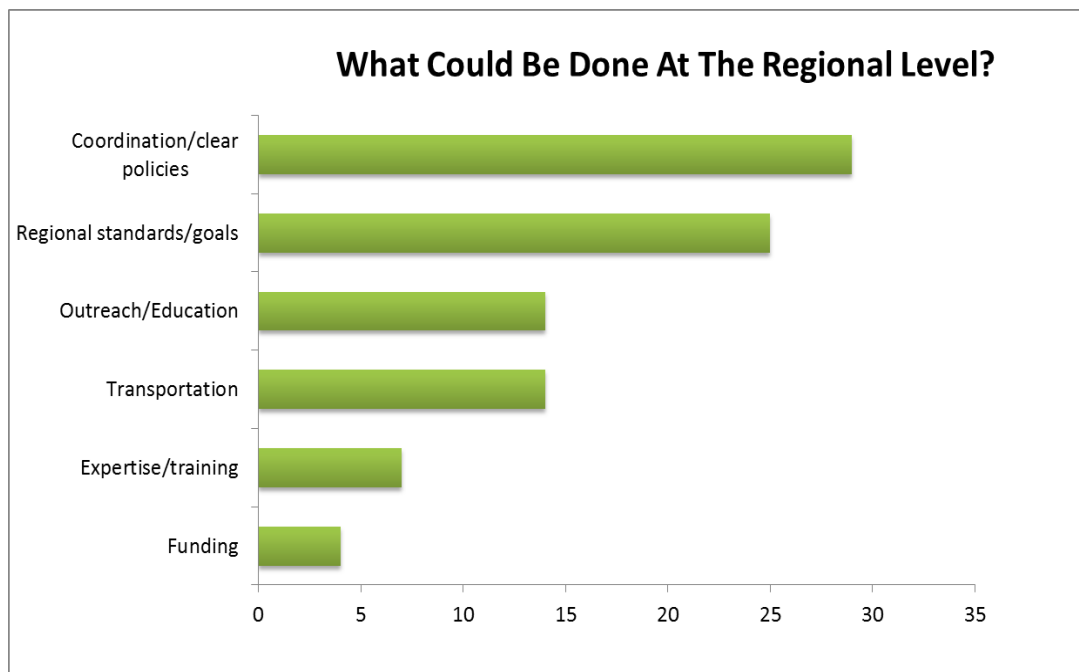


Figure 6. Percent each item or topic was mentioned by a survey participant as something that could be done regionally to help with climate mitigation.

Examples of how the PSRC could help with coordination and regional policies include:

- coordinating regional efforts to reduce local and regional contributions to compounding impacts – such as air quality, urban heat island effect, riverine and beach erosion due to land use, etc. – which would help reduce the Puget Sound's additive impacts to a changing climate and would help to alleviate some localized impacts of climate change
- establishing programs that require regional approaches
- utilizing consistent data across the region to drive decision making
- ensuring climate impacts are assessed in project proposals and that mitigation is included in funding authorization

Jurisdictions suggested that the PSRC develop regional standards, codes, and policies for transportation and building innovation that jurisdictions agree to; establish regional policies that rationalize the protection of shared regional infrastructure and shared regional utilities; and prioritize threats, establish goals to address these threats, and identify ways jurisdictions can work towards these goals collectively.

Jurisdictions had a few suggestions for what the PSRC could do regionally when it comes to transportation:

- identify ways to expedite regional transportation improvement projects
- reduce transportation pollution BAS for steep slopes, development codes, etc.
- reduce fossil fuel use and identify ways to make walking, biking, and transit easy
- identify ways to disincentivize SOV motor travel
- provide jurisdictions with tools to assess transportation impacts

Finally, jurisdictions identified other ways the PSRC could help at the regional level including forecasting sea level rise for 30, 60, and 100 years; providing suggestions for building codes and other public facility projects to control flooding; and supporting regional and state regulations and legislation.

## Jurisdiction Meetings

The PSRC is interested in incorporating climate resiliency into its Transportation 2040 plan update. In order to do this, the PSRC wants to understand what local priorities are for addressing climate risks and impacts and what communities need in order to incorporate climate resiliency into their planning and implement projects. The Resilient America Roundtable facilitated meetings with seven jurisdictions in the region – Arlington, Everett, Kitsap County, Pierce County, Puyallup Tribe, Tulalip Tribes, and University Place – to get a deeper understanding at the local level of the climate risks, challenges, and priorities communities are dealing with.

## Common Themes

There were several common themes that came out of the jurisdiction meetings:

- Communities are concerned about their economic resilience.
- Communities identify a lack of funding as a common challenge.
- Communities are interested in learning about creative and sustainable financing for implementing climate adaptation and resiliency.
- Not all communities are comfortable using the terminology “climate change.”
- Communication, not only with the public but also with leadership, is a challenge.
- Communities want more data to help inform their decision making.
- Communities recognize partnerships and collaboration as important to advancing their disaster resilience related work.

## Examples of Community Successes

- Arlington collaborated with the town of Darrington for the [America’s Best Communities competition](#) and made it to the semi-finalist round. They developed a [Community Revitalization Plan](#) which identified five goals for economic revitalization.
- The Puyallup Tribe undertook a [Climate Change Impact Assessment](#) which brought together multiple stakeholders in the tribal government. The tribe undertook this assessment because they had been dealing with challenges related to floods and the health and safety of youth and elders due to climate change.
- The Tulalip Tribes have successfully implemented climate resilience programs by integrating them into an ongoing [salmon recovery program](#), which is a partnership among several entities. For example, they have successfully restored the [Qwuloolt Estuary](#) to its natural hydrology by partnering with [The Snohomish Basin Salmon Recovery Forum](#) and the [Puget Sound Partnership](#).
- As an example of effectively using data and another example of collaboration, the City of Everett’s Public Works Department is partnering with the Climate Impacts Group at the University of Washington. Specifically, they are looking at how temperature increases relate to storms in order to plan their drainage system.
- The City of Everett is testing a Climate Change Adaptation Planning Tool so consideration of climate science and adaptation measures is available to its employees. The tool currently covers three sectors/topics, and the city hopes to find additional funding and resources to build it out to address adaptation measures for additional topics.
- The Pierce County Council recently adopted a tax to address floods in the [flood control zone district](#).



- Pierce County is working with multiple jurisdictions on a [Floodplains for the Future project](#) which aims to “recover floodplain functions and to protect the health and safety of communities.”

## Next Steps

The Resilient America Roundtable and the Puget Sound Regional Council are planning a peer-to-peer knowledge exchange event to take place in January 2018. This event will bring together representatives from jurisdictions throughout the four counties (Kitsap, King, Pierce, and Snohomish) of the Central Puget Sound to learn and share information about their challenges and successes related to implementing resilience efforts to address climate impacts and other hazards in their communities.

The purpose of this event for the event organizers is to:

- Promote interaction and dialogue among representatives from diverse jurisdictions and organizations around efforts for building resilience
- Provide opportunities for local jurisdictions to learn about and discuss initiatives and approaches happening in the region
- Provide information to jurisdictions about funding opportunities, ways to leverage resources, and creative solutions to funding resilience efforts.

The purpose of these discussions is for local jurisdictions to:

- Share their experiences building resilience to climate risks and other hazards;
- Learn about and discuss initiatives and approaches happening in the region; and,
- Learn about funding opportunities, ways to leverage resources, and creative solutions to funding resilience efforts.

There will be two main sessions:

1. Peer-to-Peer Knowledge Exchange will bring together representatives from local jurisdictions to share their resilience-related initiatives
2. Funding Resilience will bring together representatives from government (federal, state, and local levels) and other organizations to discuss funding opportunities and other resources available to communities for building resilience to impacts related to climate risks and other hazards.