Climate Change in the Northwest

Ongoing research on the regional implications of global climate change largely confirms observations, projections and analyses made over the last decade while providing more information about how climate impacts are likely to vary from place to place within the region.

Climate

Updated research, including improved climate models, has refined descriptions of climate change. During 1895-2011, the Northwest warmed 1.3°F while precipitation fluctuated with no consistent trend. Over the period from 1970-99 to 2041-70, new models project NW warming of 2.0°F to 8.5°F, with the lower end possible only if greenhouse gas emissions are significantly reduced (RCP4.5 scenario; Fig 1). Annual average precipitation is projected

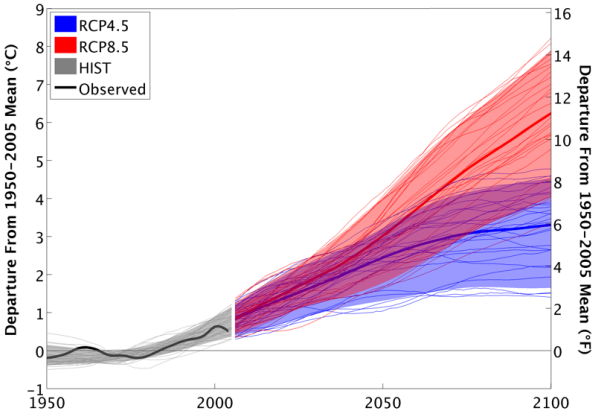

Fig. 1 Observed (1950-2011, black) and simulated (1950-2100) regional mean temperature for selected global models for the low-growth RCP4.5 and high-growth RCP8.5 scenarios.

to change by –5% to +14% for 2041-70. For every season, some models project decreases and some project increases; most models project lower summer rainfall by as much as 34%.

Water

Changes in precipitation and air temperature have already affected hydrology and water resources in the Northwest. In most watersheds (except those with little snow), as snow accumulation diminishes, spring peak flows shift earlier, winter flow increases, and late-summer flow decreases. Dry years are becoming drier everywhere (Fig. 2). Some basins are likely to be buffered by groundwater.

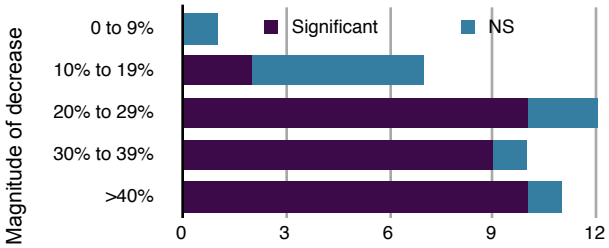

Fig. 2 Number of NW stream gauges with decreasing trends in 25th percentile annual flow that do (purple) and do not (blue) pass a significance test (α <0.10) over the 1948-2006 period. None have increased.

Irrigated agriculture is the largest consumptive water user in the Columbia River Basin and poses the greatest extractive demands on reservoir systems. Warmer, drier summers and longer growing seasons may increase those demands. Competing reservoir water demands could create summer water shortages and reduce the proportion of irrigable cropland and/or reduce the production and value of agricultural goods.

Hydropower production, which provides two thirds of the region's electricity, will also be affected by snowmelt-driven shifts in streamflow. By the 2040s, summer production is projected to decrease by about 15% and winter production to increase by about 4% compared with the period from 1917-2006. Further reductions in hydropower may also result from climate change adaptation; for example, flood control and instream flow augmentation for fish.

Changes in flood risk depend on the type of basin, with mixed rain-snow basins in Washington and Oregon already seeing increases in flood risk. Floodplain development has increased vulnerability in many areas.

Continued warming of rivers, lakes, and wetlands will affect the health of aquatic species and the extent of suitable habitat for many species, especially salmonids and other species already near their upper thermal tolerance.

Water-dependent recreational activities may be affected by dry conditions, reduced snowpack, lower summer flows, impaired water quality, and reduced reservoir storage. Difficulties for native fish including Pacific salmon could hamper sport fishing, while ski resorts near the freezing elevation will encounter less snow and more rain.

Coasts

Climate driven changes will likely be profound for Northwest coasts and associated ecosystems. Sea levels are projected to rise 4-56" by 2100 relative to 2000, with some local variations. Coastal marshes that cannot move upslope will shrink, affecting shorebirds and other species. Increased wave heights in recent decades have been a significant factor in the observed increased frequency of coastal flooding. About 2800 miles of roads in WA and OR are in the 100-year floodplain; some highways may face increased inundation with 2 feet of sea level rise.

In Northwest marine waters, elevated levels of absorbed CO_2 combine with seasonal coastal upwelling and nutrient runoff to produce some of the world's most acidified conditions, hindering some marine organisms' ability to build shells; some sea grasses may benefit. Warm years already bring non-native southern species. Higher sea surface temperature may boost harmful algal blooms. Economic effects, both positive and negative, will stem from changes in productivity and distribution of commercially valuable marine species, such as shellfish.

Forests and other vegetation

About half the land area in the Northwest is forested. Climate directly affects tree growth in forests through temperature and moisture controls, and indirectly through its influence on disturbances -- wildfires, insects, and diseases. The spatial distribution of suitable climate for many important NW tree species and vegetation types may change considerably by the end of the 21st century, and

some vegetation types, such as subalpine forests, will become extremely limited. Affected habitats will in turn affect the species that depend on them, notably wolverines and pika at higher elevations, while some species like the northern flicker and hairy woodpecker may thrive with more frequent fires.

Large areas have been affected by disturbances in recent years (Fig. 3), and climate change is probably one major factor. One study estimated area burned will rise by roughly 900 sq mi by the 2040s, or a factor of 2.5 from the 1980-2006 average. Climate is a major driver of insect outbreaks that affect millions of forest acres. Insect life stage development and mortality rates are influenced by temperature, and drought can cause host trees to be more vulnerable to insects. Recent mountain pine beetle and other insect outbreaks were facilitated by higher temperatures and drought stress, and the frequency of such outbreaks is projected to increase, particularly in high-elevation forests.

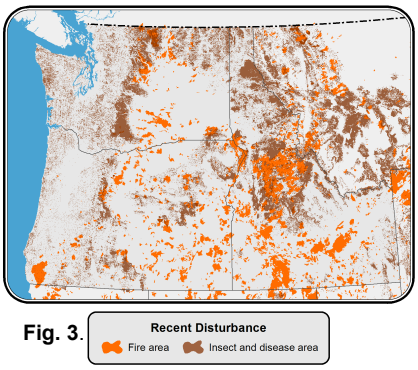

Fig. 3.

Federal and state policies governing management and harvest may impact the economy as much as any effect attributable to climate change. Increased productivity in a milder climate with higher CO_2 may be offset by insect and disease outbreaks (e.g. Swiss needle cast affecting the commercially important Douglas-fir), and wildfires.

Agriculture

The Northwest's diverse crops depend on adequate water supplies and specific temperature ranges, which are projected to change during the 21st century. Warmer winters and longer growing seasons could increase growth for some crops while adversely affecting other crops dependent on chilling periods. Warmer, drier summers could result in yield reductions due to heat and drought stress. More rainfall in the winter could mean wetter soils in the spring, which could benefit some crops while hampering planting of others. These climate changes could also result in changes in pressures from pests, weeds, diseases, and invasive species.

commodity	value ($b)	pathways
milk, dairy, cattle	6.0	heat stress, forage quality/availability
vegetables, hay	3.8	CO_2 fertilization, Irr.
fruits, nuts, berries	2.6	CO_2, Irr., heat, precip, chilling, pests
grains, oilseed	2.1	CO_2, Irr., heat, precip

Northwest agricultural commodites with 2007 market values and potential pathways for impacts of climate change on each sector. Irr=irrigation water availability.

Projected yield losses due to warming and drought are expected to be offset to varying degrees by CO_2 fertilization for many crops. In a study with one climate scenario, winter wheat yields were projected to increase 13%-25% while spring wheat yields were projected to change by -7% to +2% by the 2040s across several locations in Washington, relative to 1975-2005. Yields of irrigated apples are projected to increase by 9%. Availability of water for irrigation is crucial and will depend on hydrological, structural, and policy (seniority of water rights) factors.

Warming may reduce productivity and nutritional value of forage on grazing lands. Alfalfa production may increase as long as water is available. Higher temperatures can affect animal health, and can reduce milk production and beef cattle growth.

Human Health

Effects of climate change on human health will depend on specific attributes of climate change and on exposure to climate-related risks. While vulnerability remains relatively low in the Northwest, adverse impacts of climate change outweigh any positive ones. Concerns include increased morbidity and mortality from heat-related illness, air pollution and allergenic disease, and emergence of infectious diseases. A changing climate is also expected to impact mental health.

Heat-related deaths in the US have increased over the past few decades. In Oregon, analysis of hospitalization and climate data showed that each 10°F increase in daily maximum temperature was associated with a nearly 3-fold increase in the incidence of heat-related illness. Wildfires, especially east of the Cascades, lead to days or weeks of poor air quality and respiratory disease. In Puget Sound, rising water temperatures promote longer harmful algal blooms which can cause paralytic shellfish and domoic acid poisoning in humans who consume infected shellfish.

Tribal communities

Tribes have always been intimately connected to the land and natural resources. In ceding their lands and resources to the US, tribes were guaranteed the rights to continue to hunt, fish, and gather in all their usual and accustomed places both on and off reservation lands. By altering the distribution and timing of traditional resources, climate change could affect these treaty-protected rights. Treaty-protected fish and shellfish populations may become less accessible to tribes. Changes in salmon abundance and tree species distribution, and risks to infrastructure, can affect the cultural, medicinal, economic, and community health of tribes.

Tribes are tied to their homelands by law and culture, yet the impacts of climate change will not recognize geographic or political boundaries. Tribal vulnerability and adaptation strategies require explicit attention because of the unique social, legal, and regulatory context for tribes. Tribal climate change efforts in the region are strengthened by strong government-to-government relationships, informed by traditional knowledge, and are resulting in strategies to address climate impacts on tribal resources and traditional ways of life.

This is a summary of *Climate Change in the Northwest: Implications for our Landscapes, Waters, and Communities*. Dalton, M.M., P.W. Mote, and A.K. Snover, eds., Island Press, 270pp. and available from www.occri.net/reports. Citations for statements made herein, and complete author list, are available in the full report.
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