

Hi Todd —

Here are  
the first regional  
vignettes. . . .

Rosina

We would want to give <sup>Regional /</sup> very specific examples <sup>Impact</sup> under each "likely impact".

## Alaska: Climate Change Vulnerabilities and Impacts

Alaska's dependence on natural resources makes it highly vulnerable to climate change. Global warming is most pronounced in northern regions, and probable consequences include drying of Alaska's interior, inundation of fragile coastal delta areas, and, most seriously, melting of permafrost, which is already underway. The Fisheries, Petroleum, Forestry, and Tourism industries together make up ?? of the Alaskan economy; all are likely to be significantly affected by climate change.

- The value of Alaska fisheries in 1995 was over \$1.4 billion, excluding processing.
- Petroleum production and infrastructure taxes account for about 85% of state revenue.
- 70% of US parklands are in Alaska, and tourism brings about ?? to the state each year.

The superficial assertion that warming of cold regions like Alaska is desirable ignores the fact that such regions face 100-200 years of severe ecological upheaval during the transition to a fundamentally different environment. Significant climate change has already occurred in Alaska.

- Average temperatures have increased statewide, with summers in the interior becoming much warmer and drier (Fairbanks summer temperatures are increasing at a rate of 3°C/100 years, while summer precipitation has decreased by 17% over the last 100 years).
- Over the last ten years, the growing season has become longer at high latitudes (45°-70° North).
- Continuous permafrost has warmed 2 to 4°C over the last century, and all permafrost measurement sites in Alaska warmed between the mid-1980's and 1996.

### Likely impacts:

- Continuation of Alaskan warming will lead to the disappearance of most discontinuous permafrost over the next 100 years. In the many cases the ground level can collapse by up to 5 yards or more, leading to significant damages to ecosystems and human infrastructure.
- Houses, roads, airports, military installations, pipelines, and any other facility built on ice-rich permafrost are at risk. Over \$5 million has been spent over the last several years in a failed effort to reconstruct and maintain less than a mile of road near the University of Alaska Fairbanks.
- Ecosystem effects include destruction of trees and caribou habitat; clogging of salmon spawning streams; reduction in forested areas; expansion of lakes and wetlands; and increased rates of coastal and riverbank erosion, slope instability, landslides and erosion.
- The melting of permafrost and the warming of tundra will lead to the release of carbon and methane deposits from the formerly frozen lands, which could make them an additional source of atmospheric greenhouse gases.
- Forest impacts associated with warming and drying include increased damage from blow-downs, pest outbreaks in coastal forests, and drought-induced mortality, insect-caused mortality, and severe forest fires in the boreal forests.
- Numerous low-lying coastal delta areas are threatened by erosion from increased runoff and inundation from a combination of rising sea-level and storm surges made more severe by decreased sea-ice. Such disruption of coastal ecosystems could have severe consequences for animal habitats, and native settlements and subsistence activities.

## **Pacific Northwest: Climate Change Vulnerabilities and Impacts**

The dependence of the NW on a reliable supply of water creates a significant regional vulnerability to climate change. The availability of adequate water supplies is directly tied to the amount, timing, and type of regional precipitation (snow or rain). Model projections indicate that NW regional consequences of warming are likely to include changing patterns of precipitation and drought, changes in timing of runoff, and increased inundation of coastal areas (that are already subsiding in some cases) from sea-level rise. Such changes, and in particular the expected disruption of the regional water cycle, pose significant threats to NW ecosystems and economic activities; forests, freshwater ecosystems, agriculture, industrial processes, hydroelectric energy production, and urban centers all depend on adequate supplies of water.

- Agriculture is critical to the regional economy. The NW leads the nation in potato and apple production, and over 50 additional crops are grown in significant quantities.
- Commercial timberlands cover 36% of the region's land area, producing half of the nation's softwood lumber and plywood.
- Hydroelectricity constitutes 14% of the energy consumed and about 60% of the energy generated in the region.

Impacts in one sector may trigger subsequent changes across other sectors, impacting the quality and quantity of water available to other components of this highly integrated watershed.

### **Likely Impacts**

- Peak runoff comes earlier in the spring because of more rain and less snow in the winter, and late winter to early spring flow is enhanced, increasing the chance of spring flooding.
- There is reduced summer and early fall flow, particularly in west-side rivers (i.e., west of the Cascades Mountain range), due to the warmer and drier summer climate. Lower flows are detrimental to fisheries and threaten irrigation water supplies needed for agriculture.
- In the Columbia River basin, there will likely be an overall decrease in annual run-off, with increased competition among hydropower production, fisheries protection, and irrigation needs.
- Forests and rangelands face increased drought stress, pest outbreaks, and fires, along with shifts in forest zones and composition, and possible increases in blow-downs from wind storms. In addition to their economic and recreational importance, NW forests sequester more carbon per acre than any other ecosystem in the world. Loss of forest = loss of carbon sink.
- Freshwater fisheries will be affected, with west-side salmon migration and spawning hurt by decreased summer and fall run-off and fish habitat and egg-smolt survival hurt by increased wintertime river flows.
- The rate of coastal inundation and saltwater intrusion to freshwater ecosystems could be increased by sea-level rise. Olympia is already having drainage system problems and has incurred substantial mitigation costs from sea-wall construction to prevent flooding.
- Coastal erosion, landslides and bluff failures are also major risks to ecosystems and urban centers, and coastal development. Eleven major delta's in the region have decreased by 78% in the recent past. Existing wetlands will disappear faster than new ones appear, leading to loss of coastal habitat for outmigrating salmon, spawning oceanic species, and mammals and seabirds.

## Great Plains: Climate Change Vulnerabilities and Impacts

The Great Plains states produce much of our nation's wheat and beef supplies, and are highly vulnerable in the face of the region's frequently dry climate. The further drying expected from climate changes poses a significant risk to the area. The region is bounded on the west by the Rocky Mountains, on the north by Canada's southern border, on the south by the edge of the desert/scrub ecosystem, and on the east by the edge of the bluestem grassland area. The Great Plains include parts of 10 states (MT, ND, WY, SD, NE, CO, AR, NM, OK, and TX), occupy about one third of the landmass of the conterminous United States, and are home to 6.2 million inhabitants. Agriculture is the base of the economy, despite the constraints of the dry and variable environment. Most of the farmers are wheat producers, but livestock operations are increasing.

- Over 90% of the land in the Great Plains is in farms and ranches, and 75% is cultivated.
- The Great Plains states account for 51% of the nation's wheat, 40% of its sorghum, 36% of its barley, 22% of its cotton, 14% of its oats, and 13% of its corn.
- The region produces 40% of the nation's cattle.

All sectors of life in the Great Plains are dependent on the very limited water supply in the region. Water shortages there are already a problem. Water sources in the area include rain; surface waters such as rivers, streams, and lakes primarily from snowmelt; and deep aquifers such as the Ogallala aquifer. Agricultural water needs often exceed rainfall, so irrigation water supplied from the deep aquifers is already common; however, overdraft of the Ogallala aquifer has already caused the water table to drop, a problem which could become even more severe in the future.

### Likely Impacts

- *Water shortages.* As climate change leads to warmer conditions and an intensified hydrological system, the soils of the area are anticipated to further dry. The simultaneous drop in aquifer levels, greater run-off from extreme downpours, and shorter duration of snow cover will exacerbate the water problem in the region. The need for irrigation may rise while water supplies are simultaneously diminishing.
- *Water quality.* There are already problems of salinization of water in the region, and climate change is anticipated to aggravate the problem.
- *Soil degradation and erosion.* Soil fertility in many regions is declining, and increased intensity of farming may lead to even lower soil quality. Better soil tillage practices would simultaneously improve soil fertility, soil carbon storage capacity, and soil moisture holding capacity.
- *Disease and pest impacts on agriculture and cattle.* Climate-stressed crops or cattle will be more vulnerable to pests; new pests and diseases may emerge.
- *Recreation, Wildlife and Fisheries.* Riparian areas (wetlands and prairie potholes) are extremely vulnerable to warmer and drier climate, and are intensively used by hunters, anglers, and birdwatchers.
- *Native species.* Climate change will disrupt and stress ecosystems, providing opportunity for more pest weed invasions. Native species will face increasing levels of competition from introduced species, such as cheat grass, Japanese brome, Russian thistle, and leafy spurge. Economic losses from these invasives can be great: for example, in North Dakota alone, economic losses from the leafy spurge exceed \$14.4 million per year.

## **Southeast: Climate Change Vulnerabilities and Impacts**

The Southeast is a complex region including wetlands, coastal zones, agricultural and forestry areas, and urban regions, and rapid population growth is already providing significant stresses on fragile regional ecosystems, making the Southeast vulnerable to climate change. For example, in 1870, the population of south Florida was about 100; currently, the same region, which includes Dade, Broward, and Palm Beach counties, has a population exceeding 5.2 million people. The Southeast has more than 50% of the country's barrier islands and 85% of the nation's coastal wetlands, as well as more than 80% of the direct hits from hurricanes. The region provides our country with a variety of crops, fisheries, and wood products:

- Fisheries, including shrimp and other shellfish, comprise a \$1 billion annual business
- Loblolly pine plantations and other forestry activities constitute a \$XX industry
- Oranges and other fruit trees constitute a \$XX industry

Much of the region's growth is in coastal areas, increasing the risk from frequently occurring extreme weather events. Hurricane Andrew in 1992 killed 58 people, and cost \$30 billion, and Hurricane Fran in 1996 killed 36 people, and cost at least \$5 billion. Louisiana's Barrier Islands are vanishing. These islands shelter important coastal wetlands that serve as nurseries for many fish and shellfish. The Florida Everglades have already been significantly altered by human activities. Approximately half of the ecosystem has already been lost or severely altered in the past century due to drainage for agriculture and urban development, and nitrogen inputs from agricultural run-off.

### **Likely Impacts**

- *Extreme climate events.* The Southeast is becoming increasingly vulnerable to extreme events including hurricanes, floods, drought, ice storms, heat waves, and tornadoes because of rapid population growth and development in vulnerable coastal locations.
- *Coastal areas.* Sea level rise will intensify the coastal areas' vulnerability to storm surges and extreme events. 100 to 1000 feet of Florida beach could be eroded from a 1 foot rise in sea-level.
- *Water resources.* The demand for water is beginning to exceed the available water supply, and competition for water uses is beginning to intensify. Climate variability and change exacerbate this competition for water.
- *Forestry.* Forest production will be impacted by both shifts in temperature regimes, as well as precipitation, increasing the difficulty of forest management. There may be marked shifts in forest species composition.
- *Agriculture.* Irrigation is not currently prevalent in southeastern agriculture, meaning that the area's agriculture systems are ill prepared for the more intense droughts expected from climate change.
- *Urban areas and human health.* Climate variability and change, especially warmer temperatures, will exacerbate air quality problems.
- *Parks and public lands.* Non-native and invasive species are problematic. Areas like the Everglades are already stressed by invasive species, and will further be hit with rising sea level. Up to a third of the park is vulnerable to sea-level rise of one foot. Much of the mangroves of the area are severely at risk from sea-level rise.