Impacts of Climate Change on the Natural Resource Economy

The global natural resources economy — made up of renewable and non-renewable resources — is estimated to be valued at more than $40 trillion.\(^1\) The United States is the world’s leading producer of food commodities: seafood, crops and livestock account for more than $300 billion of the U.S. economy. Oregon and the greater Pacific Northwest encompass a complex natural resource economy: coastal fisheries, vineyards, semiarid rangelands, farms (dryland and irrigated) account for more than $139 billion in revenue.\(^2\) Because the United Nations estimates that the global population will increase by 2 billion over the next thirty years, the corresponding demand on sustaining natural resources, complicated by the impacts of a warming planet, has presented immediate and ongoing challenges for all sectors of the natural resources industry while also imperiling short- and long-term food security.\(^3\) While dependent on stable climate systems for economic productivity, farming, ranching, forestry and interrelated land-use change contribute to approximately 20 -25% of global emissions annually.\(^4\)

Complications that arise from climate change and imperil the natural resource economy include extreme and more frequent\(^5\) weather events (e.g. reduced snowmelt/ increased snow pack, below/above normal seasonal temperatures, flooding, drought, heavy rainfall, wind and sandstorms); reduced air quality (ozone, fires); UV radiation; proliferation of vector-borne diseases due to increased heat, rainfall and humidity; intensifying allergen loads; water availability and quality; and rising sea levels and acidification.\(^6\)

The need for significant adaptation and technological advances is critical for the natural resources economy to meet present and increasing domestic and global demand. Technological advances like micro-hydropower, crop genetics and pest management have, for the most part, mitigated the aggregated effect of regional climate trends on U.S. agricultural production, known as Total Factor Productivity, or “TFP”.\(^7\)\(^8\) Even while taking into account present rates of innovation, climate change could cause agricultural production to drop to pre-1980 levels.


\(^8\) “5 Ways Technology Has Changed Farming.” Iowa Agriculture Literacy, 3 June 2018, iowaagliteracy.wordpress.com/2018/06/02/5-ways-technology-has-changed-farming/
levels over the next 30 years, by an average of 3% to 4% per year under medium to high emissions scenarios.\(^9\) Increasing population will demand better production but natural resource producers are not at present sufficiently situated to meet demand. However, making the shift to a resilient and efficient natural resources economy can be achieved via informed decision-making. According to a 2016 United Nations report, a smarter use of natural resources can inject $2 trillion into the global economy by 2050 while concurrently following an aggressive climate reduction strategy.\(^{10}\)

**The Natural Resources Forecast**

**Farming**

Currently, agriculture, food, and related industries contributed $1.053 trillion to U.S. (GDP) in 2017, 5.4% share, with U.S. farms contributing $133 billion.\(^{11}\) Climate change will most likely increase crop losses, according to USDA’s Economic Research Service. In 2019, farmers were unable to plant 19.4 million acres, nine times the 1.8 million acres left unplanted in 2018.\(^{12}\) Such losses will increase taxpayer-funded crop insurance payouts, which in turn will raise premiums for federal crop insurance.\(^{13}\) Additionally, frontline communities -- those whose income depends on natural resources, particularly farmers, tribes and low income populations in rural communities -- are the first to be affected by the impacts of climate change.\(^{14}\)

Agricultural yields are expected to continue to decline for most major crops due to temperature and precipitation swings as well as frequency and intensity of extreme weather events like floods and droughts.\(^{15}\) A rise in average temperature can trigger plant diseases and increase water stress, which may lead to decreasing crop productivity.\(^{16}\) Fresh water for irrigation is also likely to become more scarce.\(^{17}\) Hotter temperatures may dramatically increase ozone levels which can be poisonous to crops and people as well as endanger livestock and imperil the quality of food staples like milk and eggs.\(^{18}\) Communities dependent on agricultural production are further vulnerable to the health consequences of higher temperatures: rising populations of disease-bearing insects like ticks and mosquitoes as a result of more favorable breeding conditions have led to a greater incidence of Lyme Disease and West Nile Virus, increased risk of heat stroke, reduced air quality as a result of

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\(^{12}\) Food Production is a Major Cause of Climate Change, but Farmers Can be Part of the Solution Walljasper, Christopher, *The Midwest Center for Investigative Reporting* www.investigatemidwest.org 10/4/19

\(^{13}\) Eisch, Helena Bottemiller. ""I'm Standing Right Here in the Middle of Climate Change': How USDA Is Failing Farmers.” *POLITICO*, 15 Oct. 2019


\(^{16}\) Rojas-Downing, M., 2017


ozone and smoke from increasingly frequent and severe forest fires, pollen, and asthma-inducing particulates, all of which can trigger cardiovascular and respiratory illnesses.

Not all climate change impacts on agriculture are perceived as negative, however. Increased CO₂ levels can improve the photosynthetic activity and water uptake efficiency which may increase crop productivity. While agricultural production near the equator may experience increasingly desert-like conditions that challenge food production, agricultural producers farther north have seen an increase in growing seasons and yields: Canadian farmers have begun planting corn and soybeans, with output doubling in a decade. In western Oregon, dry farming (relying on moisture from winter rainwater that’s stored in the soil instead of irrigation) has improved crop yields for tomatoes, potatoes and zucchini while vintners are experimenting with new varietals that are more heat resistant.

An increasing number of American farmers think agriculture could be shifted from a significant source of greenhouse gas emissions to instead be a massive carbon sink, pulling carbon dioxide out of the atmosphere and storing it in millions of acres of soil while increasing crop resilience. Strategies to restore soil-organic carbon include erosion reduction, managing soil pH, crop rotation and double-cropping, and conservation tillage and mulching which blocks oxygen from triggering the decomposition cycle that releases CO₂.

However, motivating farmers to change long-standing farming practices to experiment with new practices may require a well-considered mix of economic incentives, education and resources.

**Forestry**

Revenues in the U.S. forest products industry totaled ~$280 billion, with ~$18 billion in output reported by the Oregon Forest Resources Institute. Revenues are projected to continue to decline, driven by a slowdown of housing construction from and increased foreign competition in downstream wood production markets. Exports totaled $2.3 billion in 2018-19 and were solely in logging production. In Oregon, the forest products industry has declined steadily for decades with timber harvests declining by 50% over the same period. As people rely more on digital publications and email, there has been a corresponding decline in demand for stationery and printing paper. Federal reductions in federal harvests, international competition, automation and a surfeit of workers as the result of automated timber-falling and milling have all had a role in the industry’s

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18 ibid.
falling fortunes. In 2016, the wood products industry employed fewer than 30,000 people statewide and was responsible for only about 2% of the state’s GDP, down from 4% in 2005 and 15% in 1995.29

Another blow to the industry is tree mortality rates which have dramatically increased in the Pacific Northwest over the past two decades, driven by wildfires, insects, and disease as a result of drought conditions and increased temperatures; as a result, timber managers have adjusted by changing planted species, shortening rotation rates, and reducing investment in some areas.30

In 2017, the U.S. Forest Service spent over $2 billion dollars on wildland fire suppression, going from 15% of its budget to 55%.31 Over the past 50 years, the average size of wildfires in California has increased by approximately 500 percent, affected by hotter, drier summers and increasing residential growth.32

Because of a perfect storm of compounding factors, the forest products industry is increasingly in peril. Experts project that logging and mill jobs are not likely to return, instead foreseeing forest industry’s future in carbon sequestering, forest maintenance/development, and fire control.33 The potential to sustain forests’ role in climate mitigation may be possible by assigning economic value to conservation activities, forest and watershed restoration, fuels reduction, prescribed fire, and pile burning, with the objective of mitigating the potential for extreme fires and encouraging more carbon sequestration world-wide.34 Reforestation, afforestation, lengthened harvest cycles on private lands, and restricting harvest on public lands may increase net ecosystem carbon balance by 56% by 2100. Co-benefits include increased water availability and biodiversity of forest species.35

Ranching

With an anticipated improvement in the global standard of living, demand for livestock products is expected to double along with human population by 2050. Climate change threatens the livestock industry through its impact on feed and forage quality, water availability, breeding, milk production, disease and biodiversity. Additionally, competition for land and water will compromise global cereal harvest used for livestock feed. Meanwhile, the livestock sector contributes 14.5% of global greenhouse gas (GHG) emissions, driving further climate change. The potential impacts on livestock include changes in production and quality of feed crop and forage, water availability, animal growth and milk production, diseases, reproduction, and biodiversity. These impacts are primarily due to an increase in temperature and atmospheric carbon dioxide (CO2) concentration,

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30 USGCRP, 2018
precipitation variation, and a combination of these factors. Livestock lacking genetic biodiversity are at risk, with climate change being a main driver of biodiversity loss.

Ranchers can play a key role in both reducing GHG emissions and bolstering global food security. The use of tailored assessments and supportive policy regarding ranch-specific climate change adaptation and mitigation measures may facilitate the transition to sustainable livestock production. Among peer-reviewed studies, intra-species livestock diversification, planting different crop varieties, and implementing a mixed crop-livestock system that improves efficiency through increased production that uses fewer resources all offer the greatest adaptive impact by facilitating resilience.

Decreasing deforestation rates, replanting trees, planting climate change adapted varieties, and efficiently managing resources work toward carbon mitigation via sequestration. Grazing management practices such as not reaching pasture “carrying capacity”, employing rotational grazing and avoiding degraded grazing lands also play a significant role. According to a beef industry study in Brazil, a 25% reduction in GHG emissions was accomplished by improving animal and herd efficiency through grazing land use change.

Livestock methane emissions, known as enteric fermentation, constitute 39% of livestock GHG emissions. Improved breeding and animal nutrition, such as a 1% increase in dietary fat and increased protein content, has been shown to reduce enteric emissions upwards of 4-5%. A software tool developed by India’s National Dairy Development Board, has resulted in increasing dairy milk production and reducing methane production by 15%; the software “calculates optimal feed mixes for each of the 2.4 million animals in more than 30,000 villages by evaluating type of food, weight of the animal, and fat content in its milk.” Reducing the rate of enteric methane emissions affects near-term warming rate and, with sustained emissions reductions are sustained, may also limit peak warming.

Another emerging and sustainable technology is the use of anaerobic digesters — tanks maintain manure under anaerobic conditions and essentially convert methane into CO₂ — to reduce methane emissions while producing biogas that can be used for fuel. Anaerobic digesters, however, are expensive for producers and may require policies that incentivize their use.

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37 Rojas-Downing, M., et al, 2017
39 P.J. Gerber, et al. (2013)
40 P.J. Gerber, et al. (2013)
Commercial Fishing

In the United States, commercial fisheries contribute $153 billion USD in sales to the U.S. economy; Oregon’s commercial ocean fishing industry generates roughly $570 million.\textsuperscript{45,46} Since the beginning of the Industrial Revolution in 1880, human activities have caused more than 600 billion tons of carbon to be released into the atmosphere and the oceans have absorbed roughly 25% of it, causing a corresponding increase in ocean acidity.\textsuperscript{47} Increasing ocean temperatures and acidity also impact fish survival, species abundance, and predator–prey distribution and timing.\textsuperscript{48}

As ocean temperatures rise, fish populations move toward cooler waters near the poles and plankton production decreases, diminishing the marine food web, both shrinking and depleting some fish populations entirely.\textsuperscript{49} In the Pacific Northwest, salmon populations already on the endangered species list are being affected by warming temperatures, notably Chinook salmon in the Columbia and Willamette River basins; Coho salmon in Oregon and sockeye salmon in the Snake River Basin in Idaho. In 2015, massive die offs of salmon in the John Day River were attributed to the warm water temperatures and low water levels.\textsuperscript{50} A decline in Pacific Ocean salmon stocks between 2014 and 2017 accounted for an 80% drop in the total catch caught off of the Oregon coast, a 72% drop in stock value.\textsuperscript{51}

Ocean warming has also resulted in an increased occurrence of algae blooms along coastal areas across the globe. In 2015, the US Pacific Coast witnessed the largest algal bloom ever observed; the increased levels of domoic acid resulted in a complete shutdown of shellfish harvesting. In 2016 West Coast waters cooled, but the Gulf of Alaska remained warm. In Oregon, Salem city officials are making a proactive, $75 million effort to treat water with activated carbon and chlorine after a significant toxic algae bloom in 2018.\textsuperscript{52} The bloom was widely attributed to hot, dry conditions and rapid snowmelt which create ideal conditions for algae blooms,\textsuperscript{53} and cost the city nearly $2 million in water supply remediation.\textsuperscript{54}

Cooling continued throughout 2018, but, according to the National Oceanic and Atmospheric Administration (NOAA), Arctic waters remained warm. NOAA’s climate change studies suggest that heat waves will become

\textsuperscript{49} ibid.
more common, cover larger areas, and last longer.\textsuperscript{55} Ice sheet and mountain glaciers melt have contributed significantly to sea level rise: globally sea levels rose 6 inches in the 20th century, and the oceans are now rising more than twice as fast, putting coastal communities at economic and personal risk.\textsuperscript{56} Along Oregon’s 360 mile coastline, coastal communities have been experiencing higher wave heights, increasingly powerful winter storms, and significant shoreline erosion.\textsuperscript{57}

Recently, U.S. and Canadian researchers have developed a tool that incorporates projected changes in ocean climate onto a geographic fishery management area. Now fishermen, resource managers, and policymakers can use it to plan for the future sustainability of the lobster fishery in Nova Scotia and Canadian waters of the Gulf of Maine, with the potential for application in other coastal regions.\textsuperscript{58}

Finally, according to a recent study in \textit{Frontiers in Marine Science}, investment in habitat restoration in shoreline environments, such as mangroves, sea grasses, and tidal marshes, shows great promise for mitigating climate change over any other ecosystem. The study indicates that, annually, these ecosystems could trap and store 2 to 35 times more carbon than even ocean phytoplankton. In Oregon, seagrass provides a natural habitat for crabs, salmon, and other wildlife that support coastal fishing communities. Eelgrass, also found along the Oregon coast, absorbs carbon, storing it in both its shoots and roots; it also acts as a buffer against ocean acidification by drawing CO\textsubscript{2} out of the water during photosynthesis. The sequestered carbon, known as “blue carbon”, is essentially plant matter that gets buried under wet sediment where exposure to oxygen cannot trigger decomposition that would release carbon dioxide. However, according to an ongoing Oregon State University study, eelgrass is beginning to disappear from Coos Bay along the Oregon coast.\textsuperscript{59} OSU was recently awarded $1.6 million from NOAA for climate related research, $750,000 of which is for research regarding the environmental and economic benefits provided by tidal wetlands in the Pacific Northwest and the effect of sea level rise on those benefits.\textsuperscript{60}

\textsuperscript{57} https://oregonexplorer.info/content/coastal-climate-change-effects?topic=44&ptopic=38