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Rocky Mountain Research Station

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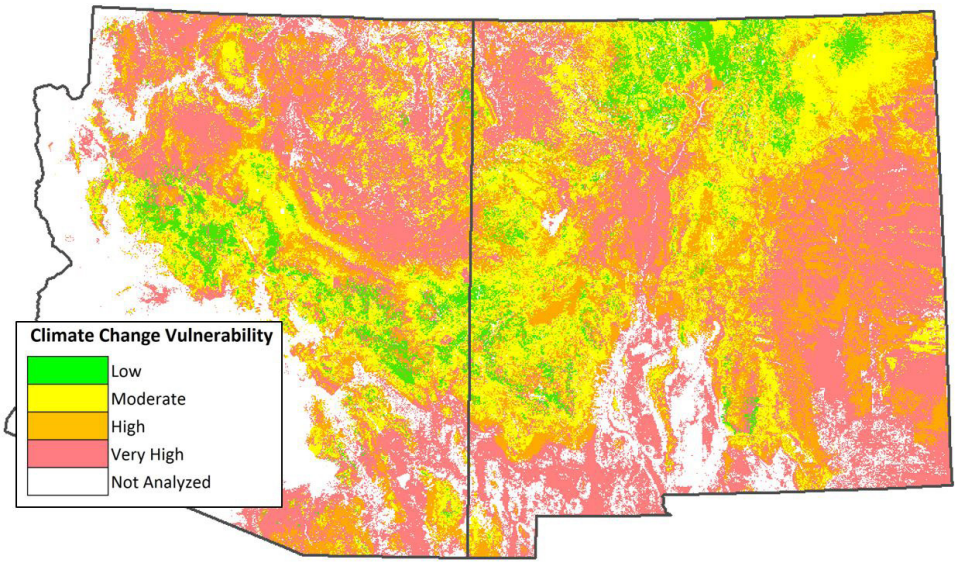
Warmer and Drier: How Vulnerable Are Southwestern U.S. Ecosystems to Climate Change?

Climate change and the Southwestern United States

The most arid region of the United States—the Southwest—is expected to become even warmer and drier in the future as the climate changes, according to several global climate models. The USDA Forest Service and its partners need information about the potential effects of a changing climate so that adaptation strategies can be developed for people and ecosystems.

The Southwest is particularly vulnerable to climate change because several temperate ecosystem types are at their southernmost limits. Further, some ecosystem types may be more at risk than others as there are differences in how much change is expected. Region 3 Forest Service ecologist Jack Triepke, and Rocky Mountain Research Station research ecologist Megan Friggens, partnered with other collaborators to create a series of publications to help resource managers assess and identify vulnerable ecosystems in this footprint. They produced a General Technical Report (GTR) that synthesized vulnerability assessment methods and results and identified knowledge gaps for the region. To help fill these gaps, Triepke and colleagues recently published the results of a modeling study in the journal *Ecosphere* that quantifies vulnerability on all lands in the Southwest at subregional scales relevant to resource managers. Vulnerability in this study is defined as how likely the predominant vegetation is to change under future climate.



Patterns of climate vulnerability within the study area of Arizona and New Mexico. Vulnerability to climate change was categorized as low, moderate, high, and very high, according to the difference between historic and future climate. One of the main takeaways from the study is the large extent of change anticipated for the region by the year 2090, with only about 6 percent of the study area expected to remain unchanged. (Figure from Triepke et al. 2019.)

Assessing climate change impacts at the local scale

Climate vulnerability was determined by comparing the pre-1990 climate with the 2090 forecasted climate for each plant community within Arizona and New Mexico. In these two states, there is a huge diversity in vegetation ranging from low desert to alpine ecosystems. The researchers used 26 “Ecological Response Units” (ERUs), a relatively fine-scaled classification and mapping system (e.g., ponderosa pine forest, sagebrush shrubland), to assess vulnerability.

One of the main takeaways from this effort is the large extent of change anticipated for the Southwest region by the year 2090, with only about 6 percent of the

area expected to remain unchanged. Says Triepke, "Our assessment suggests high vulnerability conditions for the majority of lands in the Southwest, with some evidence that climate impacts are already happening and affecting ecosystem services."

Although most of the lands in the study were considered vulnerable, the patterns were not consistent across the region or among ERUs. The vegetation of the higher elevations in this region, including the Alpine and Bristlecone Pine ERUs, was particularly at-risk, as were vegetation communities at their southernmost extent such as sagebrush shrubland. The two major montane forests—Mixed Conifer–Frequent Fire and Ponderosa Pine Forest—were projected to have lower vulnerability in the northernmost extents of each state. Grasslands make up 40 percent of the area, and more than 75 percent were in the high to very high vulnerability categories.

Opportunities for proactive management

Using this information, land managers can consider the vulnerability of each ERU and the ecosystem services they provide, and then develop adaptation strategies and approaches based on knowledge of local conditions and plant functional traits. For example, in vulnerable areas of fire-adapted forests and woodlands that have been altered by woody encroachment, thinning and prescribed burning may promote gradual realignment by reducing the risk of high-severity fire and abrupt type conversions. In high-vulnerability areas affected by fire, managers may choose to focus tree planting at the upper or lower edges of the ecotones, depending on the management objective and likely changes to vegetation patterns. "The comprehensive nature of the model outputs means that we can use this data to identify adaptation options both within and across landscapes to fit a variety of management needs," explains Friggens.

Already, results of this analysis have been used in New Mexico's State Wildlife Action Plan to help identify critical habitat needs for New Mexico's wildlife.

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KEY MANAGEMENT CONSIDERATIONS

- RMRS-GTR-309 provides a comprehensive review of findings from previously implemented vulnerability assessments and identifies key assessment methodologies, knowledge gaps, and research needs.
- To address some science gaps identified in RMRS-GTR-309, an assessment of the vulnerability of Southwestern upland ecosystems to climate change was conducted by comparing the pre-1990 climate and late 21st century climate forecast for each plant community within Arizona and New Mexico.
- A substantial amount of vegetation community change is predicted across the region by the year 2090 and some of this change is already ongoing.
- Land managers can use the information in this study to consider the vulnerability of each "Ecological Response Unit" and the ecosystem services they provide, and then work across jurisdictions to develop adaptation strategies.

SCIENTISTS / MANAGER LEADS

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FURTHER READING

Friggens, M.; Bagne, K.; Finch, D.; Falk, D.; Triepke, J.; Lynch, A. 2013. Review and recommendations for climate change vulnerability assessment approaches with examples from the Southwest. Gen. Tech. Rep. RMRS-GTR-309. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 106 p. https://www.fs.usda.gov/treesearch/pubs/44184

New Mexico State Wildlife Action Plan: Climate Change. Final Report submitted to the New Mexico Department of Game and Fish for the New Mexico State Wildlife Action Plan September 17th, 2015 in fulfillment of FS Agreement #15-CO-11221632-081. Rocky Mountain Research Station, Albuquerque, New Mexico. 98p. http://www.wildlife.state.nm.us/download/conservation/swap/New-Mexico-State-Wildlife-Action-Plan-SWAP-Final-2019.pdf

Triepke, F. Jack; Muldavin, Esteban H.; Wahlberg, Maximillian M. 2019. Using climate projections to assess ecosystem vulnerability at scales relevant to managers. Ecosphere. 10(9): e02854. https://www.fs.usda.gov/treesearch/pubs/58613

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