Tree deaths have doubled across the western US

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Increasing tree die-offs in the West are illustrated by these gray, needleless limber pine, the likely victims of drought, interspersed with orange, dead limber and ponderosa pine killed by Rocky Mountain pine beetles in Colorado's Rocky Mountain National Park in recent years. Image courtesy Jeremy Smith, University of Colorado

(PhysOrg.com) -- A new study led by the U.S. Geological Survey and involving the University of Colorado at Boulder indicates tree deaths in the West's old-growth forests have more than doubled in recent decades, likely from regional warming and related drought conditions.

The study, published in the Jan. 23 issue of Science, documented tree deaths in all tree sizes in the West located at varying elevations, including tree types such as pine, fir and hemlock. Significant die-offs

also were documented in the interior West -- including Colorado and Arizona -- as well as Northwest regions like northern California, Oregon, Washington and southern British Columbia.

The researchers speculated higher tree deaths could lead to substantial ecological changes in the West, including cascading effects affecting wildlife populations. The tree deaths also could lead to possible increases in atmospheric carbon dioxide levels contributing to warming, which could stem from lower CO2 uptake and storage by smaller trees and increased CO2 emissions from more dead trees on the forest floors.

The study shows the establishment of new, replacement trees is not keeping pace with climbing tree mortality in the study plots, said CU-Boulder geography Professor Thomas Veblen, study co-author. The new study is the largest research project based on long-term forest plots ever published on North American forests, said Veblen.

USGS researchers Phil van Mantgem and Nathan Stephenson led the study. Co-authors included Veblen and Jeremy Smith of CU-Boulder, John Byrne of the U.S. Forest Service Rocky Mountain Research Station, Lori Daniels of the University of British Columbia, Jerry Franklin and Andrew Larson of the University of Washington, Peter Fule of Northern Arizona University and Mark Harmon of Oregon State University.

"This regional warming has contributed to widespread hydrologic changes, such as a declining fraction of precipitation falling as snow, declining water snowpack content, earlier spring snowmelt and runoff, and a consequent lengthening of the summer drought," wrote the researchers in Science.

"The increase in tree mortality rates documented in the study is further compelling evidence of ecosystem responses to recent climate warming,"

said Veblen. "The findings are consistent with other well documented, climate-induced ecological changes, including increased wildfire activity since the mid-1980s and bark beetle outbreaks that are occurring at unprecedented levels in western North America forests, including Alaska."

Climate records from Colorado's subalpine forests, which are roughly 8,500 to 10,000 feet in elevation, show a marked increase in temperatures over the past 50 years during all seasons of the year, Veblen said. Colorado has experienced drought since the mid-1990s, peaking in 2002 and which became the most severe drought of the past century, he said.

In the Science study, the tree deaths measured in Colorado are all from stands re-measured prior to any stands being attacked in the current bark beetle outbreak, said Veblen. "The previous elevated rates of tree mortality in these forests may have been harbingers of the abrupt increase in tree mortality due to the current bark beetle outbreaks in Colorado."

During the past decade, mountain pine bark beetles have killed roughly 3.5 million acres of lodgepole pine forests in northwestern Colorado, and the outbreak has spread to the study's forest plots on the state's Front Range only within the last year, Veblen said. During the same time period, spruce bark beetles also killed large areas of spruce forest in northern and southwestern Colorado, he said.

"Forest entomologists and ecologists agree that warming temperatures are highly favorable to the population growth and survival of these beetles," said Veblen. "Moisture-stress induced by both warming and reduced snowpack increases tree susceptibility to bark beetle attack."

Veblen said the study suggests increased tree mortality rates may be

indicators of climate-induced stress that could increase tree susceptibility to more abrupt causes of tree deaths like bark beetle outbreaks. "Recent events in subalpine forests in Colorado fit that pattern quite well," he said.

Given the evidence that recent climate-induced ecosystem changes are now so abundant, society needs to discuss policies that will help humans adapt to the changes under way, said Veblen. In the context of wildfire management, land managers need to reconsider the effectiveness of both fire suppression and fire mitigation efforts, including fuel reduction projects like timber thinning, he said.

"Instead, we need to consider developing land-use policies that reduce the vulnerability of people and resources to wildfires," Veblen said. "Activities include reducing residential development in or near wildland areas that are naturally fire-prone and where we expect fire risk to increase with continued warming."

The 76 western forest study plots harbored nearly 59,000 living trees. The research team studied the plots during two periods -- from 1955 to 1994 and again from 1998 to 2007, said Veblen. The permanent study plots on Colorado's Front Range were part of a study funded by the Colorado Commission on Higher Education in 1982-83 during a short-lived program when CCHE had a research grant program, Veblen said.

Provided by University of Colorado at Boulder