What do wildfires have to do with climate change?

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As the western U.S. faces its third year of severe drought, firefighters are still battling two large fires in California. The state, which is experiencing its worst drought since record keeping began in 1895, has already exhausted the year's $209 million budget for fighting wildfires and its fall fire season has just begun. With 1,200 more wildfires than average, state officials have called this wildfire season "unprecedented." In Oregon and Washington, more acres burned this year than in any

other region of the country. So far in 2014, 3,070,737 acres across the U.S. have been ravaged by fires—that's an area almost the size of Connecticut.

"While no single wildfire can be said to have been caused by climate change, climate change has been making the fire season in the United States longer and on average more intense," said John Holdren, President Obama's science advisor. "In the western U.S., the average annual area burned by large wildfires has increased several fold in recent decades."

There is strong evidence that climate change is resulting in longer, hotter and drier summers that will increase the frequency of large wildfires and the length of fire seasons. Trees stressed and killed by higher summer temperatures and drier soils become flammable vegetation that serves as kindling. Pests and pathogens that thrive in warmer weather kill more trees. In the western U.S., warmer winters have enabled pine beetles to survive longer, reproduce more and extend their range into higher-elevation areas. Between 2000 and 2013, beetles destroyed 47.6 million acres of forests, an area larger than North Dakota.

Average annual temperatures in the western U.S. have risen 1.9˚F since 1970 and are expected to climb 2.5˚F to 6.5˚F by 2050. According to a 2011 study by the National Academies, even 1.8˚F of warming will dramatically increase the average area burned every year in the western U.S.

"As it gets warmer, the area burned increases exponentially as a function of temperature," explained Park Williams, an assistant research professor at Lamont-Doherty Earth Observatory who studies the effect temperature has on drought. His research has shown that small changes in temperature result in large changes in the atmosphere's "sponginess."

"As the temperature rises, the ability of the atmosphere to pull water out

of the ecosystem goes up exponentially," said Williams. For the past 15 years, the atmosphere's ability to pull water out of the ecosystem has been 12 percent higher than its 120-year average.

Climate models project that by 2050, burned areas will increase 60 percent and the fire season will last 23 days longer. "Based on what we've seen in the last 30 years, we will see increased wildfire activity as long as fuels are available," said Williams. "But at some point, forests will become so fragmented because of wildfires, that we will no longer see increases in the size of wildfires."

Wildfires are also intensifying because many forests have become overgrown—there is more fuel in forests to burn. This has occurred because over grazing has removed the grass cover that once fueled natural, smaller, low-intensity wildfires, and has allowed more trees to grow. The past practice of logging large pines allowed less fire-tolerant conifer species to grow unchecked in the understory. And perhaps most importantly, policies emphasizing fire suppression over forest management and fire prevention have predominated, eliminating the smaller, less intense fires that used to clear out dead vegetation. A huge wildfire season in 1910 in Idaho and Montana that burned many towns and millions of acres of timber scared people and led the Forest Service to adopt the policy of attempting to eliminate fires altogether.

While the U.S. spends approximately $2 billion to $2.5 billion on fire suppression each year, studies indicate that the overall cost of wildfires is 10 to 50 times more. Fires destroy timber, homes, roads, bridges, gas and electricity infrastructure, and often cause power outages. These impacts take a toll on local jobs and tourism. Smoke carries soot particles that can affect human health, causing respiratory and cardiovascular problems.

Fires leave burned areas susceptible to erosion, flooding, mudslides and

landslides, and destroy the habitat of plants and animals. Floods as well as debris and sediment resulting from fires can contaminate water supplies Additional outlays include pre-suppression measures, disaster relief and the rehabilitation of burned areas after fires. A new study estimates that the global cost of climate change-induced wildfires could exceed $100 billion by 2050.

Pine beetle devastation. Credit: ex_magician

Wildfires, which are intensified by global warming, also exacerbate global warming. While forests and healthy soil normally absorb carbon dioxide, fires cause the release of carbon dioxide from vegetation and soil into the atmosphere, trapping ever more heat. Black carbon, a component of soot, absorbs heat in the atmosphere and hastens snowmelt when it lands on snow. Fires can thus turn forests from sinks that absorb carbon dioxide into sources of carbon emissions.

Some evidence indicates that Canadian forests now emit more carbon than they store. A 2010 study estimated that wildfires in the U.S. release about 290 million metric tons of CO2 each year, an amount equivalent to

4 to 6 percent of our carbon emissions from burning fossil fuels.

Globally, wildfires burn 865 million acres a year, an area over five times the size of Texas. As climate change brings warmer temperatures, more drought and changing precipitation patterns, the wildfire risk in many parts of the world will likely increase, with North America, Europe, Australia and Russia expected to be hardest hit. Currently, wildfires burn approximately 1,280,000 acres of land in Europe each year. By 2090, the area burned in the European Union could increase 200 percent. This year, southeast Australia experienced an abnormally early bushfire season; long-term trends driven by climate change will likely make bushfires more intense and lengthen the fire season. Russia has experienced three times more fires in 2014 than last year, and models suggest there will be a sharp increase in fires by the end of the 21st century, with a dramatic loss of forests.

In the Amazon, fires are becoming larger and more frequent due to dry conditions, more people living in the forest and using fire to clear land, and increased changes in vegetation due to deforestation. Victor Gutierrez-Velez, a postdoctoral research scientist at the Earth Institute studying fires in the Peruvian Amazon, explained that people affect fires both directly and indirectly.

"Humans change the climate patterns globally which can affect the weather in the Amazon," he said. "Deforestation and reforestation change the amount of fuel that's available to burn. And in the Amazon, humans are the main source of ignition, not lightning."

It's expected that these combined effects will increase fires in the Amazon, not linearly, but in more frequent pulses of atypically intense fires. "We are seeing extreme fire events without precedents," said Gutierrez-Velez. And unfortunately, once a forest burns, that forest is more likely to burn again: Fires let more sunlight into the forest, which

leads to more drought; then more flammable invasive species such as grasses can move into the area because there is more sunlight.

Since wildfires are exacerbated by a number of factors, solutions need to address a variety of issues.

Worsening wildfires and the expectations of homeowners that their property will be protected have forced federal agencies to shift money away from long-term fire management into short-term fire suppression.

San Diego County fire. Credit: slworking2

"Right now, fire management is largely crisis management," said Williams. "But money would be better spent, and we'd have a better chance to not have wildfires happen, if we treated forests first with

prescribed burns and forest thinning… set a fire on purpose where you want it, with people around to manage it."

For the last 50 years in the U.S., more and more new homes have been built near wild lands, which have a higher risk of wildfires. Over 1.2 million homes in 13 western states are located in areas at high or very high risk of fire. Zoning decisions and planning need to take these risks into consideration, and insurance premiums should be adjusted to reflect them. Homeowners in wild areas need to fireproof their houses and clear a buffer zone around their homes. More resources should go towards improving wildfire mapping and predicting.

In the western Amazon, Associate Research Scientist Kátia Fernandes at The Earth Institute's International Research Institute for Climate and Society is creating models to forecast seasonal fires in real time. The dry season in this region goes from July to September; Fernandes looks at conditions in April and May that can affect drought during the dry season.

"The main driver of fires is drought, and droughts in the west Amazon are driven by sea surface temperatures in the north tropical Atlantic Ocean," Fernandes explained. "When the ocean there is warmer than normal, the band of rainfall migrates north away from the Amazon, reducing precipitation there. The models look for these anomalies over a large area."

This three-month advance alert about coming drought is time enough for local policy makers to coordinate and implement preventive measures. It enables them to help locals using fire to clear their fields to adapt to more flammable conditions by building fire breaks and being on the lookout for out-of-control fires.

Gutierrez-Velez is studying how different types of vegetation with

different levels of flammability can help reduce the risk of wildfires in the Amazon. He is evaluating whether reforestation of marginal or deforested lands can serve to reduce the flammability of the land while reducing heat-trapping CO2 from the atmosphere.

Because of the amount of carbon we humans have released into the atmosphere, we cannot escape the effects of climate change we have already unleashed. The most important long-term solution to the wildfire problem is to curb our carbon emissions going forward to help slow global warming and perhaps limit the enormity of its risks, including intensifying wildfires.

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