

Stanford researchers predict heat waves and crop losses in California

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(PhysOrg.com) -- Global warming will likely put enormous strain on California's water supply and energy systems and have a devastating impact on certain crops.

Stanford researchers predict this outcome based on projections from two different emission scenarios. One assumes a continuing moderate increase in greenhouse gas emissions until 2100; the other assumes emissions would increase until mid-century and then start dropping off. Both of the scenarios indicate there will be more frequent heat waves and generally rising temperatures, the only difference being just how dramatic the increases will be.

"We will very likely see our current high temperatures much more often and also temperatures hotter than anything we've seen before under both projected levels of carbon dioxide emissions," said Michael Mastrandrea, a lecturer in the Interdisciplinary Graduate Program in Environment and Resources and a research associate at the Woods Institute for the Environment. "This is something that's going to be a huge challenge for California to deal with in the future."

Mastrandrea developed temperature projections using output from a set of global climate models scaled to reflect potential climate changes in California under both higher and lower emissions scenarios. In the next 50-100 years, average temperatures are expected to increase approximately 4-9 degrees Fahrenheit. Both the climate scenarios were developed by the Intergovernmental Panel on Climate Change (IPCC), which shared the 2007 Nobel Peace Prize with Al Gore.

Though this may not seem like a significant change, it is enough to increase the intensity and frequency of extreme weather events, such as the devastating heat wave that struck California in July

2006, lasting 12 days and causing 138 deaths, and triggering rolling blackouts for more than 1.5 million consumers due to spiking energy demands. Water consumption also peaked sharply, particularly to prevent crops from overheating.

Depending on the projected carbon-dioxide-emission scenario used for modeling, heat wave occurrences could increase by a factor of 10 or more, Mastrandrea said. In addition, extreme high temperatures currently expected to be seen once every 100 years (analogous to a 100-year flood) are projected to appear more frequently than once every 10 years, or even annually, by the second half of the 21st century.

Warming temperatures, especially in winter, can put an additional strain on water resources. Mastrandrea said other researchers have projected that snow pack in the Sierra Nevada, which provides approximately one-third to one-half of California's water supply when it melts during the summer months, will decrease from current levels by 12-42 percent by 2050.

Key crops like cherries, peaches and grapes are particularly vulnerable to the projected changes in climate, said David Lobell, senior research scholar at the Program on Food Security and the Environment at Stanford University.

Lobell analyzed the top 20 high-value perennial crops grown in California, which include grapes, almonds, pistachios, walnuts, cherries, peaches, oranges and lemons, and estimated how these crops would be affected by the expected rise in temperature.

Cherry yields are expected to decrease 20 percent by the year 2050, having a dramatic impact on sales, which amount to about \$100 million annually. Production of table grapes, such as the green, red and blue-black varieties stocked and sold in grocery stores that account for \$400 million in

annual sales, face a 5 percent decrease.

However, the effects of warming on some of California's other crops are unclear.

In the case of almonds—California produces 80 percent of the world's supply and receives a majority of the growing \$2 billion annual sales—winter temperatures above 45 degrees Fahrenheit disrupt the natural growth cycle resulting in lower yields. However hotter spring and summer temperatures, which are ideal for almond growth, may counterbalance this effect, Lobell said. A final verdict also remains to be reached regarding wine and raisin grape yields, which account for roughly \$1.8 billion and \$500 million in annual sales, respectively.

"The implication of these findings is that we now have some ability to focus on making adaptations to growing those crops we think will be hit the hardest," Lobell said. "Adaptations might include growing new varieties or switching to new crops, or simply deciding where to site new orchards that haven't been established yet."

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Provided by Stanford University

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