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Research Brief

Simultaneous Climate Stressors Multiply Risks

Issue Overview

Some of the more damaging consequences of climate change have occurred when communities have experienced two or more stressors at once, such as extreme heat and extreme low precipitation, or high storm surge and heavy rainfall. Planning for and effectively adapting to these types of co-occurrences is challenging since most past studies have analyzed climate stressors as independent events, resulting in a lack of evidence to support anecdotal observations that these co-occurrences of extremes are happening more often. A new study by Stanford researchers and their collaborators develops a new methodology to fill in these gaps. The study finds that the probability of a region experiencing both warm temperature and low precipitation in the same year has increased substantially due to climate change.

Points for Policymakers

- **Climate change has doubled the probability that a region will experience a year that is both warm and dry.** The increased risk of co-occurrence has implications for such concerns as agricultural markets, food security, and disaster preparedness.
- **The probability that warm and dry conditions will affect key crop and pasture regions simultaneously has also risen, potentially limiting the ability of international trade to buffer the impacts of yield shocks within a region.** Of particular concern is the yield volatility, which can increase the risk of commodity price volatility, poverty vulnerability, and supply chain disruption.
- **Ambitious reduction of emissions like the goals laid out in the UN Paris Agreement substantially curbs increases in the probability that extremely hot years co-occur with low precipitation simultaneously in multiple regions.** Without significant emissions reductions, the co-occurrence of climate stresses is likely to continue to increase. These projections are critical for managing future risks, and for evaluating the benefits of achieving mitigation targets.

Background

Human-caused global warming has already led to measurable changes in climate trends and weather patterns, with an increase in stressors that negatively affect many localities and regions. For instance, the researchers' framework revealed that global warming has already substantially increased the probability that warm and dry conditions will co-occur in crop and pasture regions. The probability that key region pairs such as China and India experience these conditions has risen from less than 5% in 1980 to 15% today, and is projected to substantially increase in the future. The projections are considerably less dire in scenarios of rapid decarbonization, which highlights the benefits of ambitious mitigation (i.e., emissions reductions) in the next few decades.

Without serious intervention, the increased probability of hot and dry conditions co-occurring, particularly in multiple regions simultaneously, poses risks to food security in several ways. First, agricultural markets will be more exposed to the shock of low yields in multiple regions, which can cause commodity price volatility and supply chain disruption. Staple crops including wheat, rice, corn, and soybeans, are particularly affected by hot and dry conditions, which cause low yields. Vulnerable populations, such as those in poverty, can thus be expected to at risk of food insecurity with more frequency and intensity.

In addition to food security, hot-dry combinations can also exacerbate fire risk by drying out vegetation in the summer and fall, fueling intense, fast-spreading wildfires like those that have devastated the West in recent years.

The risks associated with the co-occurrence of climate extremes beyond hot-dry combinations will only become more dire without significant mitigation of greenhouse gases. Building resilience and preparing for future climate change will determine the extent to which these impacts are felt in climate-sensitive sectors like disaster preparedness and recovery, weather-related insurance and reinsurance, and supply chains.

About the Authors

The research was produced by the Climate and Earth System Dynamics Group at Stanford University, which is led by **Noah Diffenbaugh**, the Kimmelman Family Senior Fellow of the Stanford Woods Institute for the Environment and the Kara J Foundation Professor of Earth System Science in the School of Earth, Energy & Environmental Sciences at Stanford University. The first author was postdoctoral scholar **Ali Sarhadi**. **Danielle Touma**, who received her Ph.D. in Earth System Science from Stanford in 2018 and is currently a postdoctoral scholar at UC Santa Barbara, was a co-author on the study.

This research brief is based on the study, "Multidimensional risk in a nonstationary climate: Joint probability of increasingly severe warm and dry conditions," published November 28, 2018, in the journal *Science Advances*.