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Research Brief

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UN Paris Accord Targets: Extreme Events and Economic Effects

Background

The United Nations (UN) Paris Accord, the first worldwide agreement to limit GHG emissions, seeks to hold the global average temperature to well below 2°C and limit the temperature increase to 1.5°C above pre-industrial levels. However, despite the international agreement to pursue pathways that hold global temperature rise below 2°C, the individual voluntary commitments made by countries to scale back their emissions (called nationally determined contributions, or "NDCs") suggest likely global warming that is closer to 3°C.

Two recent studies by Stanford researchers attempt to quantify the consequences of the different global warming goals and commitments articulated in the UN Paris Agreement.

The first study, led by Noah Diffenbaugh, quantifies the probability of unprecedented climate extremes for a future in which the 2°C goal is met and for a future in which only the NDC commitments are met. Extreme events pose critical risks to humans and ecosystems. Diffenbaugh and his colleagues find that the 1°C of global warming that has already occurred has increased the odds of record-breaking extreme events. They also find that constraining global warming to less than 2°C is very likely to limit the risk relative to the 3°C world implied by the NDCs, but that the odds of unprecedented extremes will still increase in a 2°C world relative to present.

About the Researchers

Noah Diffenbaugh is the Kimmelman Family Senior Fellow of the Stanford Woods Institute for the Environment and the Kara J Foundation Professor of Earth System Science at Stanford University. **Marshall Burke** is an Assistant Professor of Earth System Science and a fellow of the Freeman Spogli Institute for International Studies, the Stanford Woods Institute for the Environment and the Center on Food Security and the Environment at Stanford University.

Photo: DasWortgewand

Limiting warming to the 1.5°C target is likely to generate tens of trillions of dollars in avoided damages.

The second study, led by Marshall Burke, quantifies the economic damages that are likely to occur at the different levels of global warming outlined in the Paris Agreement. A major deterrent to achieving the Paris goals is the perceived cost associated with the transition away from fossil fuels and other GHG emitting activities. However, in order to accurately reflect the value of reducing emissions, such assessments must also consider the economic benefits that arise from avoiding climate damages. Burke and his colleagues (including Diffenbaugh) find that achieving the 1.5°C global warming target is likely to save trillions of dollars in avoided damages relative to the 2°C target, with most countries and people in the world likely to benefit. They also find that achieving the 2°C target is likely to provide substantial economic benefits relative to the NDCs. Critically, the magnitude of the economic benefits that they calculate are substantially greater than the most recent published estimates of the cost of achieving the lower global warming targets.

Research Findings – Risk of Extreme Events

The researchers found that human activities have already increased the probability of both the hottest day and the warmest night over most of the world, including over the majority of the geographic area of East Asia, North America, Europe and Australia. They also found that limiting global warming to 2°C is likely to substantially limit exposure to large increases in record-setting hot events. For example, more than half of Europe exhibits three-fold increases in record-setting hot days for 2-3°C of global warming, but those increases are held to less than 10% of Europe if global warming is held to less than 2°C.

As with temperature extremes, large fractions of the observed area already exhibit increased probability of record-level wet events, including more than two thirds of the geographic area in North America, Europe, East Asia, and Australia. Likewise, exceeding 2°C of global warming is likely to lead to three-fold increases in record-setting wet events for up to one half of the geographic area in those regions. At the same time, large fractions of Earth's temperate zones are likely to experience increased probability of record-setting dry conditions should global warming surpass 2°C, especially in many heavily populated and highly vulnerable areas like the Mediterranean, southern Africa, Southeast Asia, and southern South America.

Photo: Staff Sgt. Daniel J. Martinez, USANG

Higher global temperatures increase the odds of record-breaking extreme events.

Research Findings – Economic Benefits

The research team used measurements of gross domestic product (GDP) to estimate the global and country-specific economic impacts of the 1.5°C, 2°C and NDC warming targets. The results indicate significant economic savings associated with limiting warming to 1.5°C instead of 2C. By mid-century, holding global temperatures to 1.5°C instead of 2°C would lead to an increase in global GDP (gGDP) of 1.5%-2.0% and $7.7-11.1 trillion in avoided damages. By end-of-century, meeting those would lead to median gains in gGDP per capita of 3.4% and $36.4 trillion in avoided damages. For example, the researchers found that by end of this century, there is more than a 75% chance that limiting warming to 1.5°C will reduce economic damages relative to 2°C, and more than a 60% chance that the accumulated global benefits will exceed $20 trillion (under a 3% discount rate). Further, they found that the 2.5-3°C of global warming implied by the NDC national commitments can be expected to reduce per capita economic output by 15-25% by end of this century, relative to a world that didn't warm.

At the country level, most countries – containing more than 90% of the global population – are likely to experience benefits at 1.5°C compared to 2°C, including the world's three largest economies (United States, China, and Japan) and a large fraction of the world's poorest countries. Countries in the tropics and sub-tropics—where temperatures are already warmer than the economic optimum—are particularly vulnerable to economic damages from global warming. Many of these countries have the highest chance of gaining economic benefits at 1.5°C compared to 2°C, and even a small reduction in future warming would have a significant positive effect on GDP.

Points for Policymakers

- Emissions consistent with the commitments countries have made are likely to fall short of averting substantial increases in record-setting extreme events, as well as reductions in global GDP of 15-25% at the end of this century.
- The UN aspirational emissions targets (1-2°C scenario) are likely to yield substantial reductions in climate risk – and associated reductions in economic damages – relative to the warming implied by the nationally determined contributions (2-3°C scenario) under the UN Paris Accord.
- The overall global benefit of reaching the UN Paris Accord's aspirational goal (1.5°C) is likely in the tens of trillions of dollars—more than 30 times greater than recent estimates of the cost of abatement necessary to achieve that goal.
- Achieving more stringent mitigation targets than those set forth by the NDCs will likely benefit most countries, with particularly large benefits for the poorest populations.
- The researchers have been intentionally conservative in their analyses, meaning that future climate risk could be higher than predicted - an important consideration as policymakers consider planning and investment for climate mitigation, infrastructure investment, and land use development.

Conclusion

The new Stanford research shows that the UN Paris Agreement's goals of limiting global warming to 2°C and pursuing 1.5°C is likely to generate substantial benefits, both in terms of avoided economic and environmental damages due to reductions in the risk of unprecedented extreme events. In particular, the research finds that achieving the 1.5°C target is likely to generate tens of trillions of dollars in avoided damages, making the benefits of achieving the 1.5°C target at least 10 times larger than recent published estimates of the cost of reducing emissions. Further, the researchers find that, at the national level, most countries are likely to benefit, including the United States and China, as well as most of the world's poorest countries. Taken together, the new studies show that aspirational goals articulated in the UN Paris Agreement are likely to both reduce economic damages and curb the increasing risk of record-setting extreme climate events.