

Adaptation in the climate response portfolio

2016 was the Earth's warmest year on instrumental record. Globally, it was the third record-setting year in a row. Since the late 19th century, the world has warmed by about 1.1°C or 2°F. Continued emissions of heat-trapping gases will cause additional warming, even as decarbonization slows emissions rates.

Adaptation needs to be a part of the climate-response portfolio for three core reasons. First, we are not prepared for current conditions. The world can save money, lives, and disruption through smart investments in increasing preparedness. Second, additional climate change is baked into the system as a consequence of economic and technological inertia. This further climate change will amplify risks from extreme events and more gradual climatic trends. Adaptation can manage risks of those impacts and lead to additional savings. Third, effective climate adaptation can lead to a wide range of co-benefits. Adaptation can improve public health, economic activity, sustainable development, and resilience of the natural world.

Understanding climate-related risk

Risk of climate change impacts emerges from the overlap of three factors. Hazards and physical changes play a role, but climate alone does not cause impacts for people and ecosystems. Instead, it is how those hazards interact with assets in harm's way (exposure) and lack of preparedness (vulnerability) (Figure 1). Decreasing greenhouse-gas emissions, and eventually driving them to zero, provides a path for limiting hazards. Adaptation addresses exposure and vulnerability.

Vulnerability to climate impacts is widespread. We tend to think about vulnerability as an issue for the least fortunate. Without question, poverty, illness, and infirmity increase risks of devastating outcomes from even modest

About the Author

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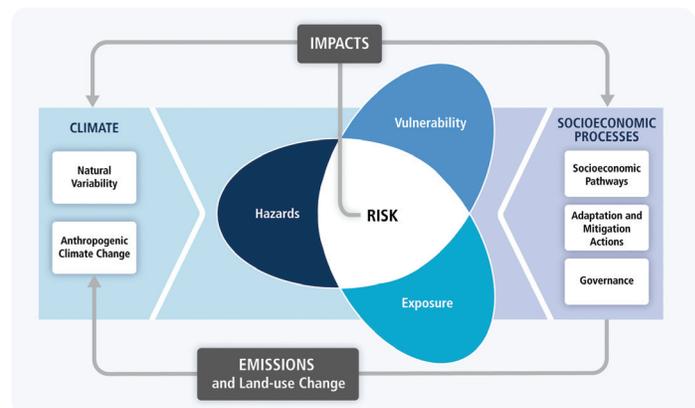


Figure 1: Hazards, vulnerability, and exposure interact to determine risks of climate change impacts. Mitigation can decrease hazards, while adaptation can decrease vulnerability and exposure. Figure from (IPCC 2014b).

climate shocks. Risks are further increased by weak social fabric or institutions, which shape, for example, community cohesion and support, emergency-response infrastructure, public-health systems, or transportation networks. But wealth does not assure protection. Historically, the overwhelming majority of lives lost from climate-related shocks have been concentrated in the world's developing countries, but most of the economic losses have occurred in the developed world. The massive economic losses from Hurricane Katrina in 2005 (more

than \$100 billion) or Hurricane Sandy in 2012 (more than \$30 billion) make it clear that we are not prepared, even in the United States.

Adaptation because we're behind the eight ball now

Much of the motivation for improving adaptation comes from the opportunity to increase preparation for risks we already face. Around the world, there are many examples of modest investments in adaptation that have already provided clear protection. There are many other examples of adaptation deficits where thoughtful investments could protect lives or property. For example:

- In Bangladesh, investments in protective structures, improved prediction, and neighborhood organizations for early warning led to a dramatic decrease in loss of life from strong tropical cyclones. Comparable storms in Bangladesh and Myanmar in 2007 and 2008 led to 4,200 fatalities in Bangladesh but 138,000 in Myanmar.
- In India, effective early warning and evacuation of nearly 300,000 people effectively limited loss of life from 2014 cyclone Hudhud.
- In France, investments in early warning and community cooling centers slashed excess mortality from the 2006 heat wave (2065 excess deaths), compared to the 2003 event (14,800 excess deaths) of comparable intensity.
- In Australia's Murray-Darling Basin, a market-based approach to water rights allocation has enhanced ability to reallocate water during shortages.
- In Israel, high-efficiency irrigation allows sustained high productivity agriculture with decreased water demands.
- In California, desalination protects some communities from water shortages during drought.

But...

- Across much of the western United States, communities in the wildland–urban interface still do not have effective defensible spaces, resulting in needless property losses.
- In Florida, increased sunny-day flooding has not been addressed.

- In Alaska, several villages suffering from increased coastal erosion have not been able to organize resources for relocation, despite concerted community efforts.
- Around the world, species and ecosystems are increasingly at risk, without meaningful investments in migration corridors or facilitated relocation.
- In 2016, the United States experienced 15 weather-related “billion-dollar” disasters, resulting in total economic losses of \$53 billion.

Adaptation because further warming is in the pipeline

Additional motivation for adaptation comes from the knowledge that some future warming is unavoidable, even with ambitious mitigation starting now. The total warming that occurs is linked to our cumulative emissions of heat-trapping gases. However, starkly contrasting emissions trajectories diverge in their cumulative emissions only over decades. As a consequence, the next few decades are an era of climate responsibility, where continued climatic changes are largely committed. For the next few decades, the priorities and targets for adaptation are largely independent of mitigation ambition. It is only around the middle of the 21st century that contrasting high and low trajectories of global emissions lead to clearly diverging temperatures. This marks the beginning of the era of climate options (Figure 2).

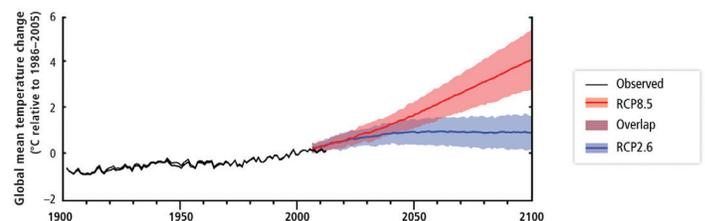


Figure 2: Observed global average temperature from 1900 to 2012 and projected trajectories of global average temperature (mean and likely range) for 2005 to 2100 in a world of continued high emissions (RCP8.5) and a world of ambitious mitigation (RCP2.6). The next few decades, where temperatures for the two trajectories are similar, is the era of climate responsibility. The second half of the 21st century is an era of climate options. Figure from (IPCC 2014b).

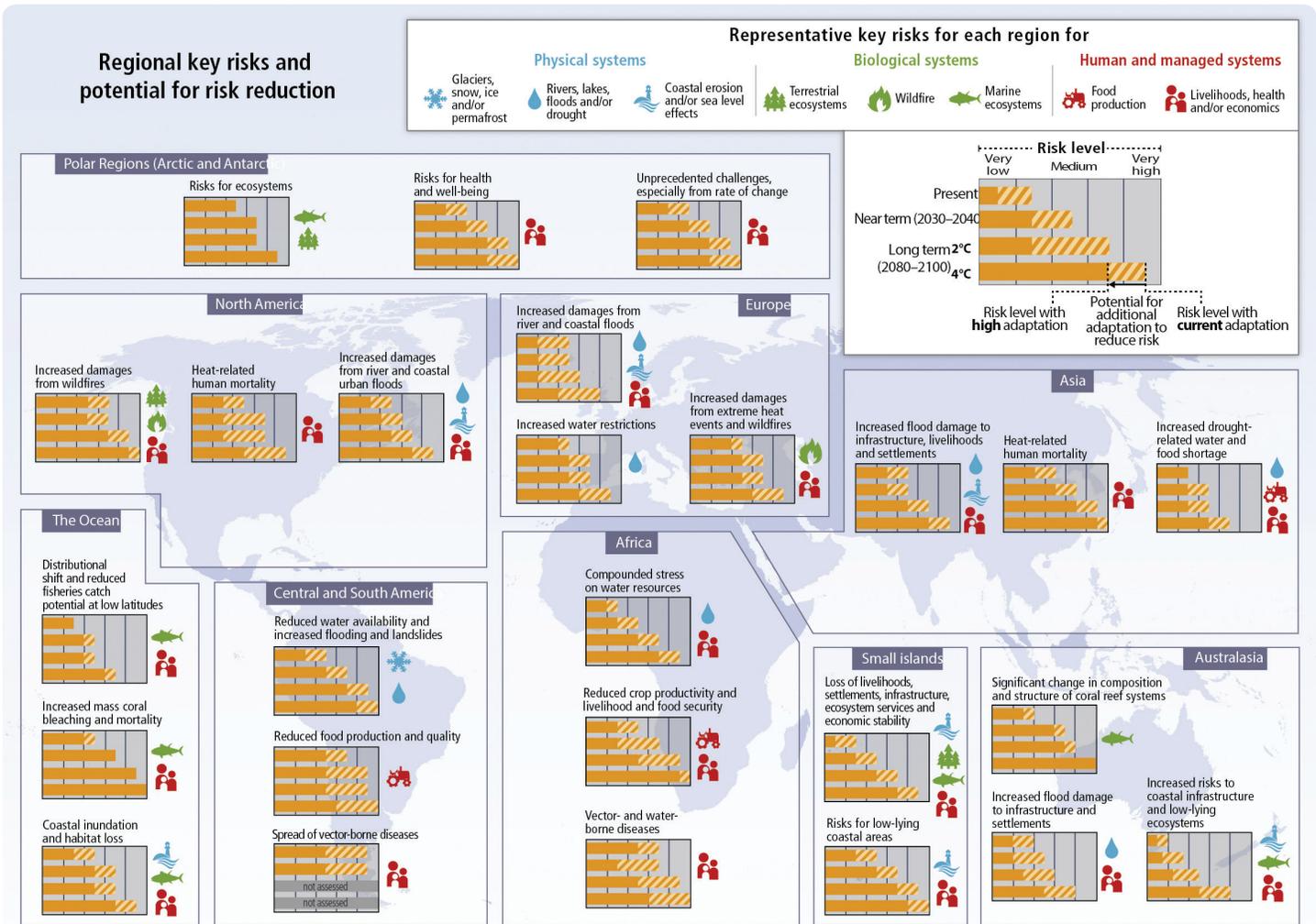


Figure 3: Representative key risks from around the world, showing risk levels at present, in mid-century, and at the end of the 21st century, for worlds of continued high emissions and ambitious mitigation. Each full bar (solid plus slashed) represents risk level with current adaptation. Each solid bar represents risk level with high adaptation. The bar area with diagonal slashes represents an expert estimate of the extent of possible risk reduction through increased adaptation. Figure from (IPCC 2014a).

With additional warming over the next few decades, risk levels increase across a wide range of sectors. But for the most important risks in each region (Figure 3), there are compelling opportunities for adaptation.

Adaptation to build a better world

Perhaps most importantly, adaptation does not need to pull resources away from other social and economic priorities. In fact, smart adaptation can lead to win-win outcomes where investments in long-term risk reduction also yield near-term benefits in economic output,

preparedness for non-climate shocks, or social cohesion. Many of the clearest examples come from improvements in the infrastructure for transportation, communications, or public health. Such investments can facilitate early warming, evacuation, and caring for injured people, but they can also make it easier to develop manufacturing, stay informed of market conditions for agricultural products, or manage chronic illness. Some of the most efficient investments in adaptation operate on a more human scale. Attention to networks of friends and family can help assure attention to the needs of the elderly and infirm, who are typically most at risk in heat events and other weather-related disasters. But adaptation investments also lead to economic opportunity and improved equality across societies. Strengthened institutions, across governments, companies, and NGOs, can improve disaster preparation, response, and recovery, but they can also enhance economic activity, educational opportunities, and environmental protection.

Points for Policymakers

- Investing in adaptation is not just about preparation for future climate scenarios, but increasing preparation for risks we already face.
- Increased warming is baked in over the coming decades, amplifying risks across a range of sectors, but practical opportunities exist for adaptation.
- Climate impacts are felt in both poor and wealthy nations. While the majority of lives lost from climate-related shocks have been concentrated in the world's developing countries, most of the economic losses have occurred in the developed world.
- Smart adaptation measures can yield near-term benefits in economic output, preparedness for other non-climate shocks, and social cohesion.

For more information, read the 2016 white paper *Climate Change 2016 Eight Ways the World Has Changed Since the Last IPCC Report*, by Christopher B. Field and Katharine Mach. Download the PDF: <https://woods.stanford.edu/sites/default/files/Field-Mach-Paper.pdf>

References

- IPCC. 2014a. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.
- IPCC. 2014b. Summary for Policymakers. Pages 1-32 in C. B. Field, V. R. Barros, D. J. Dokken, K. J. Mach, M. D. Mastrandrea, T. E. Bilir, M. Chatterjee, K. L. Ebi, Y. O. Estrada, R. C. Genova, B. Girma, E. S. Kissel, A. N. Levy, S. MacCracken, P. R. Mastrandrea, and L. L. White, editors. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA.

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