SOLUTIONS

Moving Forward with Imperfect Information

"Scientists cannot eliminate uncertainties about climate and related risks. Even concepts as seemingly simple as gravity are subject to uncertainties in a scientific context."

This study finds much more evidence and agreement within the scientific community, compared to the 2009 National Climate Assessment, for increased flood risk in the Southwest—due to a combination of decreased snow cover on the lower slopes of high mountains and an increased fraction of winter precipitation falling as rain, which will run off more rapidly.

Key Messages

1

With few exceptions, there is now more evidence and more agreement among climate scientists about the physical climate and related impacts in the Southwest than there was in the 2009 National Climate Assessment.

2

Climate models, downscaling, and resulting projections of the physical climate are imperfect. Representing the influence of the diverse topography of the Southwest on regional climate is a particular challenge.

3

The adaptive capacity of decision-making entities and legal systems to handle climate impacts is unclear. This creates a challenge for identifying vulnerabilities to climate in the Southwest.

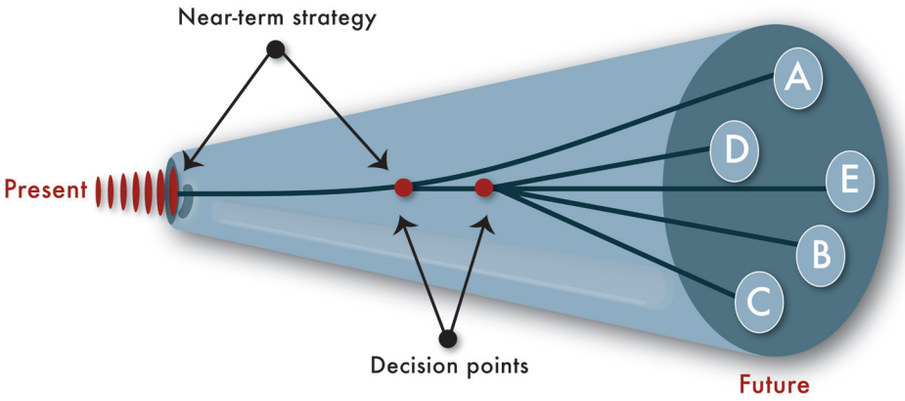
The nineteenth chapter of the *Assessment of Climate Change in the Southwest United States* builds on information from previous chapters, focusing on uncertainties, monitoring, and data challenges. "Moving Forward with Imperfect Information" summarizes the scope of what we do and do not know about climate in the southwestern United States. The chapter outlines uncertainties that hamper scientific understanding of the climate system and draws attention to efforts being made to address uncertainties in order to spur successful adaptation to the impacts of climate change. The chapter emphasizes issues related to climate and impact models, and scenarios of the future.

Estimating uncertainty is about describing the limits to knowledge and involves expert judgment about the state of that knowledge. There are uncertainties about understanding the climate system, the complexities within climate models, the related impacts to the environment, and the use of climate information in decision making. Uncertainty is introduced in each step of the climate planning-and-response process—in the scenarios used to drive the climate models, the information used to construct models, and the interpretation of model output for decision making.

For more information about *Assessment of Climate Change in the Southwest United States*, see: www.swcarr.arizona.edu, www.cakex.org, www.islandpress.org/NCAreports.
This fact sheet developed by Institute of the Environment, University of Arizona.

Confidence

For each key message in this assessment, the scientific team evaluated the body of scientific information, the type of information used, the amount, quality, and consistency of evidence, and the uncertainty associated with any results. The authors gave a subjective rating of the degree of confidence in the outcome (high, medium-high, medium, medium-low, or low), by considering the quality of the evidence and the level of agreement among experts with relevant knowledge and experience.



Cone of Uncertainty used in Denver Water Scenario Planning Initiative. The increase in uncertainties related to scientific understanding of the distant future (around 100 years hence) has prompted many resource managers and planners to consider multiple scenarios of the future, which can be evaluated at key decision points in the near or medium term (roughly 10–50 years into the future). Among federal agencies, the National Park Service has championed this approach. As a first step in climate change adaptation planning, Denver Water is testing the implications of a simple 5°F temperature increase. Initial results show major supply losses and demand increases. Additional climate change conditions will be evaluated in an effort to develop a robust adaptation plan.

Scenario & Model Uncertainties

Knowing future greenhouse gas emissions is key to determining the future climate of the Earth. Beyond fifty years into the future, accurately capturing population trends, economic trends, and technological advances, upon which emission rates depend, becomes more difficult. Currently, there is no broadly accepted method for quantifying the uncertainties associated with future emissions. In the meantime, *plausible* scenarios of future emissions illustrate a suite of possibilities to aid in planning.

Climate models have a proven ability to simulate the influence of increased greenhouse gas emissions on global and continental temperature trends, demonstrating that models can capture the dynamics of the climate system, despite uncertainties. Climate models are less successful in simulating climate dynamics at smaller geographic scales. Downscaling—merging large-scale climate information from global models with local factors, such as fine-scale topography—can address these issues. But…downscaling can require trade-offs between including many climate models, which increases certainty, with improving modeling of local-scale processes, which needs more computer

Communication Uncertainties

Societal and individual perspectives are molded by experiences, which affect the use of scientific information in making decisions. Decision makers often have other challenges—such as economic vitality, public health, and safety—which may have a higher perceived value than concerns about climate change. Taken together, these factors can slow the incorporation of climate information into decision making.

Moving Forward

Despite the fact that model projections are imperfect, entities in the Southwest are used to addressing uncertainty and risk. They are moving forward and incorporating climate information in planning and management, using innovative strategies that run the gamut from approaches that optimize for a desired set of conditions, to resilience strategies and iterative risk management frameworks that enhance the capacity to recover from disasters and increase the capacity to adapt to changing circumstances.

Sample of evolution of knowledge about climate in the Southwest.

To construct this table (small sample shown here), the authors of this chapter took statements quoted from the Southwest section of the 2009 National Climate Assessment and identified the relative change in level of agreement among scientists about the statement, and changes in the pertinent level of evidence, compared to this current assessment of climate in the Southwest.

2009 National Assessment, Southwest Chapter	This Assessment							
	Agreement					Evidence		
	Much Less	*Less*	*Same*	*More*	*Much More*	*Same*	*More*	*Much More*
Human-induced climate change appears to be well underway in the Southwest. Recent warming is among the most rapid in the nation, significantly more than the global average in some areas.				X			X	
Projected declines in spring snowpack and Colorado River flow.					X			X
Increasing temperatures and shifting precipitation patterns will drive declines in high elevation ecosystems such as alpine forests and tundra.			X			X		
Some species will move uphill, others northward, breaking up present-day ecosystems; those species moving southward to higher elevations might cut off future migration options as temperatures continue to increase.		X				X		

Information from: Averyt, K., L. D. Brekke, D. E. Busch, L. Kaatz, L. Welling, and E. H. Hartge. 2013. "Moving Forward with Imperfect Information." In *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*, edited by G. Garfin, A. Jardine, R. Merideth, M. Black, and S. LeRoy, 436–461. A report by the Southwest Climate Alliance. Washington, DC: Island Press.