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Climate Change Adaptation for People and Nature: A Case Study from the U.S. Southwest

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Abstract

In the U.S. Southwest, global climate change, acting in concert with extant stressors such as urbanization and over-allocation of water resources, is changing ecosystems in measureable and sometimes dramatic ways. Twenty-first century projections indicate accelerating climate change and cascading ecological consequences. Effects observed to date include large-scale forest dieback, large and severe wildfires, and changes in the flow regimes of rivers and streams with attendant changes to riparian and aquatic ecosystems. Rising temperatures and changing precipitation patterns are pushing ecosystems across physiological and ecological thresholds, causing widespread mortality and, in some cases, major changes in composition, structure and function. These changes have prompted action by the conservation community to reduce the adverse effects of climate change. The Southwest Climate Change Initiative (SWCCI), a project led by The Nature Conservancy, works with local stakeholders in affected landscapes, reduces adverse impacts on ecological and social systems using scientific knowledge and practical tools. The Initiative has learned through practical experience that: 1) managers must embrace change and manage for resilience rather than resistance; 2) strong local science-management partnerships are critical to effective adaptation planning and implementation; 3) planners and managers must broaden the scope and accelerate the pace of conservation activities if ecosystem services are to be sustained; 4) adaptation often does not require radically new or different management practices, rather, conservationists already have many of the tools they need; and 5) rapid documentation and widespread communication of methods and findings can build rapidly regional capacity for climate change adaptation. Our experience suggests that adaptation efforts can be effective if they are focused at the local scale; employ learning networks; and engage in ecosystem-based adaptation: the sustainable management, conservation and restoration of ecosystems so that they continue to provide the services that allow people to thrive in changing environments.

Keywords: climate change adaptation; ecosystem-based adaptation; ecological thresholds; learning networks
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1 Introduction

In the Four Corners states of U.S. Southwest — Arizona, Colorado, New Mexico and Utah — climate change is already changing ecosystems and affecting people in readily measureable ways [*Karl et al.*, 2009]. Rising spring and summer temperatures and other changes in climate are exacerbating long-standing sources of ecosystem stress such as urbanization, over-allocation of water, and colonization by non-native species. In fact, this arid region has been identified as a bellwether of climate change in North America due to recent ecological changes — uncharacteristically large and severe fires, widespread insect

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outbreaks, forest dieback, and other signs of ecological degradation — that have been associated with changing temperature, precipitation and stream flow regimes through quantitative scientific analysis [*Breshears et al.*, 2005; *Allen*, 2007; *Karl et al.*, 2009; *Parmesan and Yohe*, 2003; *Williams et al.*, 2010]. This suite of ecological changes threatens ecosystem services such as water supply and flood control and could also harm natural resource-based industries including farming, ranching, nature tourism and outdoor recreation, resulting in estimated annual losses of billions of US$ per year [*Hurd and Coonrod*, 2008; *PCE*, 2009; *Backus et al.*, 2010].

These climatological and ecological trends, and projections for accelerating change in ecological and economic systems in the 21st century provide motivation for natural resource managers, conservationists and the public to take action to reduce adverse local and regional effects of global climate change [*Rajagopalan et al.*, 2009; *Carter and Culp*, 2010; *Glick and Stein*, 2010; *NRC*, 2010]. In response, several scientific and conservation organizations created the Southwest Climate Change Initiative (SWCCI), whose goal is to address the threat of climate change to the region's natural areas and the benefits they provide to people. This paper will describe SWCCI's objectives and approach by explaining:

(1) How biodiversity and ecosystem services in arid regions of the Earth like the U.S. Southwest are being affected early, and sometimes severely, by climate change; why we can expect even more change; and why action is necessary now in the most vulnerable places if the natural systems that sustain us are themselves to be conserved.

(2) How the SWCCI is advancing climate adaptation by developing information and tools to understand and address climate impacts in the arid lands of the U.S.

(3) How sharing knowledge and tools in deliberately structured way, site by site and regionally, helps to build capacity for understanding and coping with a changing world.

(4) How conservationists can respond to this challenge by adopting an integrated approach called ecosystem-based adaptation (EBA), which uses the power of nature to help people adapt to climate change.

2 Rapid ecological transformation in the U.S. Southwest

The U.S. Southwest is a bellwether region of temperate North America. Because of its semi-arid climate, its ecosystems are sensitive to directional and episodic changes in temperature and precipitation [*IPCC*, 2007]. The region is undergoing three major transformations linked to climate variability and directional climate change: 1) damaging wildfires whose severity and size are outside of the historical range of variability even for the fire-adapted forest types that characterize the region [*Westerling et al.*, 2006; *Karl et al.*, 2009]; 2) widespread and rapid forest dieback resulting from insect outbreaks that occur during droughts of unexceptional depth but exceptional warmth [*Breshears et al.*, 2005; *Adams et al.*, 2008; 2012]; 3) changes in rivers and streams — earlier snowmelt and peak runoff and changing stream and river temperatures, with cascading effects on aquatic and riparian ecosystems and critical water shortages for cities and farms [*Stewart et al.*, 2005; *Seager et al.*, 2007; *Rajagopalan et al.*, 2009; *Seager and Vecchi*, 2010; *WWA*, 2010; *Overpeck and Udall*, 2010; *USBR*, 2011].

Accordingly, the U.S. Southwest is now being recognized as an epicenter of climate change effects in North America — that is, a place where climate change is changing ecosystems in ways we can see and measure, and that directly affect nature and natural resource-based livelihoods such as farming, ranching and nature-based tourism [*Diffenbaugh et al.*, 2008; *Karl et al.*, 2009; *Overpeck and Udall*, 2010; *Robles and Enquist*, 2010; *deBuys*, 2011]. In an arid region that is subject to rapid population growth, water shortages, proliferation of non-native species, grassland degradation, and uncharacteristically large and severe wildfires, climate change interacts with these stresses such that ecological thresholds are transcended, exacerbating ecosystem degradation and societal stress