HOW CAN TOURISM RESEARCH BENEFIT FROM MULTI-DISCIPLINARY ASSESSMENTS OF CLIMATE CHANGE? LESSONS FROM THE U.S. SOUTHWEST

Barbara Morehouse[1], George Frisvold[2], Rosalind Bark-Hodgins[2]

[1]Department of Geography & Regional Development, University of Arizona, Tucson, AZ, USA

[2]Department of Agricultural & Resource Economics, University of Arizona, Tucson, AZ, USA

morehoub@email.arizona.edu

ABSTRACT This study reports on Climate Assessment Project for the Southwest (CLIMAS) research on climate and nature-based tourism and recreation. Three case studies – of the ski industry, national park recreation, and wildfire management – illustrate different ways of using climate data for tourism research.

KEYWORDS*:* U.S. *Southwest, skiing, national parks, water-based recreation, fire management*

INTRODUCTION

The U.S. Southwest has spectacular landscapes, warm sunny weather, and diverse recreation and tourism opportunities. But the region also faces high seasonal, inter-annual, and decadal climate variability and high forest fire risk. Droughts, heat waves, severe frost, and floods are among other serious, climate-related threats. Recent projections suggest that substantial climate change is likely to occur, posing additional risks. Hoerling and Eischeid (2007) project that, for the Southwest, "a near perpetual state of drought will materialize in the coming decades as a consequence of increasing temperature (p. 19)." Other climate change models predict declining snowpack, shorter and more variable snow seasons, warmer winter temperatures leading to less snowpack and more sublimation, earlier spring snowmelt, and a rise in the elevation at which snowpack can be maintained (Mote et al., 2005, Diffenbaugh et al., 2005, Knowles et al., 2006).

CLIMAS was established in 1998 with funding from the National Oceanic and Atmospheric Administration to assess impacts of climate variability and longer-term climate change on human and natural systems in the US Southwest and Mexican border area, and to improve the region's capacity to respond to climatic events and longer-term change. Research on the outdoor recreation and tourism sectors across the US and especially in the Southwest indicate a marked vulnerability to climate variability and change (Arizona Governor's Drought Task

Force, 2004, New Mexico Drought Task Force, 2004). The implications are large, for the U.S Department of Agriculture categorizes many non-metro Southwest counties as "recreation counties" – counties economically dependent on recreation, tourism and seasonal housing (Fig. 1) (Johnson and Beale, 2002, Reeder and Brown, 2005).

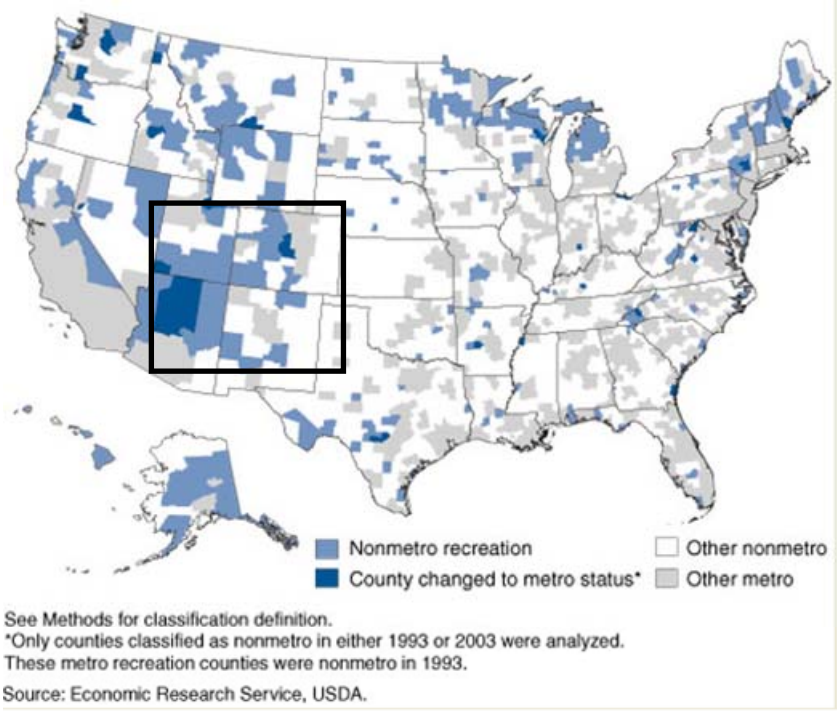

Figure 1: Non-metro recreation counties are clustered in the Southwest

At the national level, seasonal housing - recreation rentals and second homes - has expanded rapidly. From 1965 to 1990 U.S. housing units doubled, while second homes rose from 4 % to 5.5 % of the total. By 2000, 6.5 % of Arizona housing units were second homes (Smith, 2007). Typically second homes provide access to environmental amenities unavailable at the place of primary residence and tend to stimulate greater local demand for goods and services than generated by other visiting recreationists and tourists. Many seasonal home owners plan to retire to their second home (Stewart and Stynes, 1993, Stynes et al., 1997).

Arizona is not typically considered a ski destination, but two medium-sized, high elevation ski resorts operate in the state. These resorts cater mostly to local skiers. The resorts generate local jobs, spending, and tax revenues. These economic benefits are important to the tribal-run Sunrise Park Resort and surrounding communities in the rural White Mountains region (Gibson and Evans, 2002) The other resort, the Arizona Snowbowl, is located near a ready market, Flagstaff, the state's third largest metropolitan area. The snow reliability at both resorts is variable and is influenced by the phase of the El Niño-Southern Oscillation (ENSO): La Niña winter seasons are typically dry in Arizona while El Niño winter seasons typically

portend a good ski season. In response to this variability Sunrise has invested in snowmaking capacity that covers ten percent of its runs and Snowbowl's management have attempted to pass a plan (against tribal and environmental objections) to provide the resort with effluent-based snowmaking capacity for all runs. This extensive plan and Sunrise's own plans to increase snowmaking capacity are signs that Arizona's resort managers are not only investing in snowmaking as an adaptation to inter-annual variability but also to longer-term climate change. Without such adaptation skiing is likely to become marginal in Arizona, resulting in economic hardship for winter-recreation dependent communities and tribes.

In concert with expansion of residential and recreational facilities, forest fire incidence has increased in the region. Research confirms a strong link between climatic patterns and interannual variability in forest fire activity. Added to climate-fire interactions are risks posed by heavy build-up of fuel loads from decades of proactive fire exclusion and recent drought, and by growth in second homes and other facilities (Allen et al., 2002, Westerling et al., 2006). A federal assessment of communities bordering federal lands and at risk from wildland fire listed 182 communities in Arizona and New Mexico alone (U.S. Federal Agencies, 2001). From 2000–2004 alone, there were 46 fires of >100,000 acres, three of which caused considerable damage in Arizona and New Mexico (National Interagency Fire Center, 2007).

METHODS

An econometric model of annual Southwest national park visitation was estimated with data for 42 parks from 1979-2003 to examine how climate-related variables affect visits. A fixed-effects model was estimated accounting for autocorrelation and using panel corrected standard errors (Gibson and Evans, 2002). Control variables included state population, gasoline prices, an exchange rate index, park age, extended road closures, and changes in visitation measurement protocols. Climate-related variables included levels of Lakes Mead and Powell, a park's July heat index (Beck, 1995), and a variable indicating if a park was in a climate division with a January–December 12-month Standardized Precipitation Index (SPI) $\leq$ -2. An SPI of -2 indicates a year with precipitation two standard deviations below average and is generally categorized as "extreme drought." A dummy variable also accounted for the Cerro Grande fire. Reductions in visits were then entered into the Money Generator Model II, an input-output model developed for the U.S. National Park Service to estimate impacts of visitor spending on local economies (Steadman, 1979). Water-based recreation at Lake Mead National Recreation Area (NRA) and Glen Canyon NRA accounts for a large share of

regional park visitor spending. Combined visitor spending at the two NRAs was $385 million in 2005 compared to $391 million in spending at Grand Canyon National Park (Stynes et al., 2002).

For the ski study, an econometric model of season visits at both resorts was estimated with data from 25 ski seasons (1981/82-2005/06) to examine how ENSO phase affects visits. A statistical test determined that data from the two resorts should not be pooled indicating that the resorts are different, perhaps in part because only Sunrise has snowmaking adaptation. The results of two separate regressions suggest that the El Niño phase is a positive and significant determinant of visits at Snowbowl but not at Sunrise. Snowbowl is more reliant on good natural snow conditions than Sunrise and might therefore benefit from snowmaking adaptation (Bark-Hodgins and Colby, 2007). However, snowmaking is not without its challenges: (1) it is expensive; (2) above -5°C snowmaking is technically difficult (Scott et al., 2003); and (3) it requires large volumes of water. Climate change is likely to shorten the ski season in Arizona because as temperatures rise more precipitation will fall as rain, the number of days in which it is technically feasible to make snow will decline, and more frequent heat waves (Diffenbaugh et al., 2005) could collapse snowpack. For the water-strapped Snowbowl it might be impossible to rebuild snowpack, which would reduce the season's skiable days and the resort's economic viability. In fact forecast temperature data for Arizona's Climate Division 2, where the resorts are located, indicates significant warming over the next century. By adding this warming to historic resort temperature data it seems likely that by 2030 April skiing will be marginal and by 2099 ski seasons will be restricted to December-February (Bark-Hodgins and Colby, 2007).

Research on the use of climate information for managing fire risk in southwestern forests centered on a series of annual fire-climate workshops, beginning in 2000. Participants invited to the annual conferences included fire climatologists and meteorologists, fuels managers, fire managers, and fire ecologists. To generate a broad understanding of fire issues, some of the workshops included members of the Joint Fire Science Board, fire social scientists, representatives of the Mexican fire fighting establishment and other experts. Each workshop featured presentations by climatologists, fire managers, and other experts, followed by development of a fire-climate forecast for the upcoming fire season. Over the past seven years, the workshops have evolved into annual meetings held under the auspices of the Predictive Services Office of the National Interagency Fire Center (PSO, NIFC), in collaboration with CLIMAS and the Desert Research Institute's Center for Ecological and Fire Applications. At these meetings, fuels managers and fire managers representing each region of the U.S., in consultation with climatologists, develop climate-fire outlooks for their specific

area. A national climate-fire forecast is also developed (Fig. 2). A proceedings document is published for each workshop and made available on the Web (Morehouse, 2000, Garfin and Morehouse, 2001, 2002, Garfin et al., 2003, Crawford et al., 2006). Given that recreation is the primary use of many of the nation's forests, these forecasts provide information useful for assessing levels of risk associated with recreational use, and potentially for anticipating fire outbreaks from human causes, such as untended campfires and improper disposal of cigarettes.

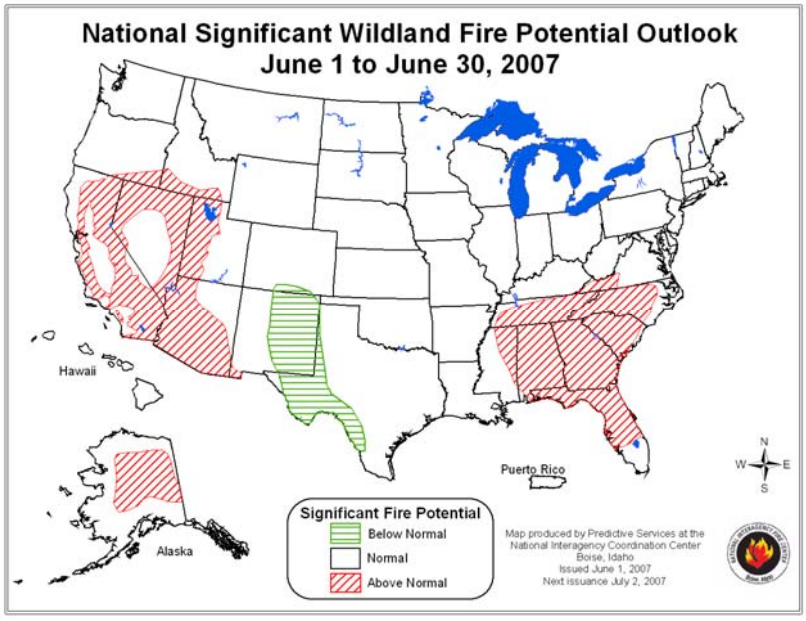

Figure 2: June 2007 Wildfire Outlook
Source: PSO, NIFC.

RESULTS

For the National Parks model variables capturing effects of fire and drought were statistically significant. A year of extreme drought (SPI $\leq$ -2) reduced visits by 7 % while the Cerro Grande fire in New Mexico reduced visits to Bandelier National Monument by 21 %. From 1999-2003 lake levels at Lake Mead fell 2.1 %, while Lake Powell levels fell 5.4 %. Based on regression results, the drop in lake levels from 1993 to 2003 contributed to a fall of more than 0.5 million visits to Glen Canyon NRA in 2003, with a loss of 758 jobs, $ 32.1 million in visitor spending $ 13.4 million in personal income. For Lake Mead NRA, lower lake levels contributed to 0.9 million fewer visits, 680 lost jobs, with a $ 28.1 million loss in visitor spending and a $ 9.6 million loss in personal income.

Climate change will likely reduce ski season length in Arizona. This is a concern because the ski industry is capital intensive and therefore each skiable day lost changes the financial

viability of the resort. It is also not clear that Arizona's skiers will continue to ski in large numbers at local resorts if only man-made snow is available. More snow reliable substitute resorts in Colorado and Utah may benefit whilst local economic impacts in Arizona could be severe unless local communities can adapt by making the most of every good natural snow season and developing non-winter recreation activities.

Loss of forest resources, and the economic and social benefits they provide, poses serious threats to rural economies. This is nowhere more evident than in Arizona, a state that receives substantial economic revenue from recreational and tourism activities. Fire-climate forecasts are proving to be a valuable tool to assess seasonal risk for managing recreational uses of U.S. forests and for managing the forest resources themselves.

DISCUSSION

The results highlight some challenges and opportunities for researchers studying climate-tourism-recreation relationships. Economics has important contributions to make, but measuring impacts of climate variability requires reliable time series data and reconciliation of data collected by different agencies, for different purposes, and at different temporal and spatial scales. Availability of good climate information and forecasts, as well as about the interactions among climate, environment, and society is also essential. Further, economists need help from other disciplines to specify explanatory variables in multivariate statistical models and to interpret results. There are well-developed econometric methods to deal with data problems and complex error structures in multivariate models. Panel data analysis, following observations across time and comparing them across space, provides greater power to determine causation from climate change to changes in tourism and recreation. Economics also has tools to estimate how physical and environmental changes translate into micro-level economic responses. These responses can be measured as monetary impacts that can be aggregated up to local, state or national impacts to inform public policy.

Assessing climate-fire-society relationships requires close collaboration among climatologists, meteorologists, fire ecologists, and social scientists. It also requires development of good working relationships with fire managers, fuels experts, decision makers, and policy experts. The workshop process for producing annual climate-fire forecasts at regional and national scales, is an example of how such collaboration can be fostered and sustained over time. These workshops led to a noticeable increase in awareness about climate impacts on wildland fire regimes, and by extension, on risks associated with recreational and other uses of forested areas. Climate change is likely to lead to increased fire hazard,

particularly in southwestern forests. Further, some burned over-areas are not likely to regenerate as the same kinds of forests; instead, species adapted to hotter and drier conditions such as those predominant at lower elevations are likely to emerge. As climate change unfolds, reasonably skillful fire-climate forecasts and ancillary fire ecology knowledge will become increasingly essential not only managing forest fire and its social impacts, but also for anticipating the likely economic and social impacts on valuable economic sectors such as recreation and tourism. .

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