Restoring Connections

SKY ISLAND ALLIANCE
Protecting our Mountain Islands and Desert Seas

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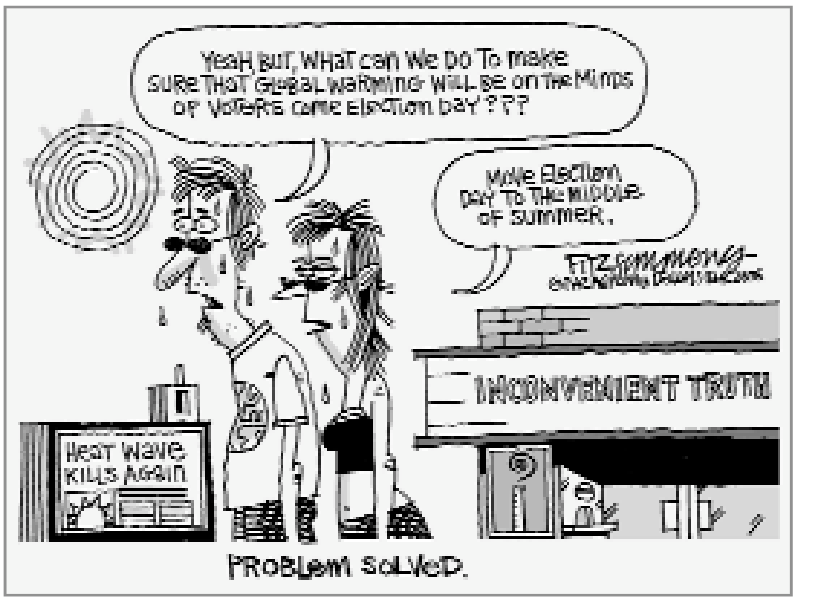
The Big Picture

We can't get enough of this Big Picture. Ever been to the Tumacs? Check 'em out on one of our public hikes this Fall. Visit www.skyislandalliance.org for details.

Islands in a sea of change

By Melanie Lenart, Postdoctoral Research Associate with the University of Arizona's Climate Assessment for the Southwest (CLIMAS)



By David Fitzsimmons, reprinted with permission of The Arizona Daily Star.

Weather changes with the winds, while climate changes over decades. At these time scales, mountains don't move. Like sitting ducks, their ecosystems rest among the most vulnerable to the ongoing climate shift of global warming.

In the Sky Islands, global warming can come on the wings of bugs. It comes with a temperature rise that can play musical chairs with species habitat. Through it all, wildfire will likely play a major role in how rising temperatures manifest in the Southwest.

Over the past century, global temperature has increased by about 1 degree Fahrenheit on average, according to analyses by the Intergovernmental Panel on Climate Change (IPCC). Much of this warming has taken hold since the mid-1970s, the start of what some scientists call a climate shift—one largely due to increasing greenhouse gas levels from the burning of coal, oil, gas and forests. They are projected to rise at least 2 degrees and perhaps 10 degrees or more in coming decades.

Temperatures have risen faster in the Southwest than in the rest of the country or the world as a whole. Western Regional Climate Center data show temperatures increased by about 1 degree Fahrenheit a decade in Arizona and by about 0.6 degrees Fahrenheit a decade in New Mexico since the mid-1970s climate shift. Note that Arizona's average temperature increased during each recent decade by the amount the globe warmed overall in a century. Although population growth has impacted some climate stations, the upward trend occurred throughout the state, at rural as well as urban sites.

What's more, the pace of the warming seems unlikely to slow anytime soon. Several recent modeling efforts suggest the Southwest's annual temperature could continue to climb by 0.5 degree to 1.5 degrees Fahrenheit a decade throughout this century.

The rise in temperature from the ongoing warming will have some annual ups and downs, as any climatic factor fluctuates with natural variability. For instance, a major volcanic eruption could temporarily cool things down for a year or so, while a strong El Niño event could heat things up. But IPCC scientists have high confidence in projections that global temperatures will continue warming for at least decades to come, based on existing greenhouse gas levels and the changes they launch.

Even small changes in temperature can make big differences for some high-elevation ecosystems, especially when they occur in winter. On many mountainsides across the West, wintertime temperatures often hover within a few degrees of freezing, as revealed in an analysis by Roger Bales of the University of California-Merced (*Water Resources Research*, 2006). So we can expect a continuation in the West-wide trend toward earlier snowmelt found by Iris Stewart of Scripps Institution of Oceanography and colleagues (*Journal of Climate*, 2005).

Higher-elevation sites are likely to warm faster than their lower-elevation counterparts, according to a global-scale analysis of model projections led by Raymond Bradley of the University of Massachusetts and colleagues (*Geophysical Research Letters*, August 2004). But the researchers caution that a general lack of high-elevation climate stations makes it difficult to detect this difference so far.

At Arizona's highest-elevation climate station—the McNary station above 7,000 feet in elevation—the number of frost days has been dropping by an average of half a day a year since about 1940, according to an analysis by Ann Lynch, a research entomologist with the U.S. Forest Service. At a 2004 conference focusing on the sky islands, Lynch connected the warming to devastating insect attacks. Bark beetles ravaged about 1.9 million acres of Arizona forests in 2003. Later research by David Breshears of the University of Arizona and colleagues supported the case that high temperatures shared the blame with drought for the scale of the damage.

Freezing temperatures tend to keep insects at bay, while longer warm periods can allow them to go through more than one reproduction cycle. So short winters or warm winters of the future could again turn forests into insect fodder.

The variety of insects feasting on Mount Graham's forests in 2003 included an exotic maritime species adapted to a warmer climate. The bug-killed trees added fuel to a fire in 2004 fire that swept through about half of the spruce-fir forest—the only existing habitat for the endangered Mount Graham red squirrel.

Biologists might want to start brainstorming about ways to keep the red squirrel from joining the list of extinct animals, perhaps by dispersing some members of the species further north. If it's not fire, another impact related to rising temperatures is likely to push the spruce-fir beyond its tolerance level and off the mountaintop. It currently occupies only about 1,500 acres at the peak, the mountain's coolest area.

Mountain species are adapted to cooler, wetter climates that come with the high-elevation territory. The cutthroat trout, for instance, needs cool streams to survive. Temperatures in the mountains run cooler than those in the valleys below, a fact that helps explain our attraction to these island oases in a sea of desert. Globally, temperatures drop by about 3.5 degrees Fahrenheit on average for every 1,000-foot increase in elevation.

Lower evaporation rates come with the lower temperatures, allowing moisture to accumulate and support forests, especially in areas where wintertime temperatures allow snow to build up. Mountains also help generate rain and snow by funneling winds and clouds up into the higher atmosphere where they can cool down and precipitate. The combination of lower temperatures and more precipitation allows mountains to support species that can't survive in the warmer, drier desert climate.

Precipitation—or the lack of it—often wields even more influence than temperature in how particular species fare and how large wildfires get. Unfortunately, projecting changes in precipitation remains an elusive venture, especially at the regional scale. While temperature models generally agree on an upward trend, models of precipitation run the gamut from more to less precipitation for the Southwest.

Higher evaporation rates and earlier snowmelt make it likely the landscape will face more severe drying if precipitation decreases, or even if it increases only slightly or inconsistently. Because of this and concerns related to long-term patterns in sea surface temperatures, many researchers worry about a potential increase in long-term western drought as the globe heats up.

At the same time, there's reason to believe the Southwest will receive more precipitation overall as the climate warms, when considering the processes involved. Warm air holds more moisture, and tends to release it in more often in heavy rainfall events. Seasonal rainfall patterns in the Southwest depend upon the jet stream's path, the power of tropical storms and the monsoon's arrival and strength. All of these have the potential to favor us with more precipitation as the climate warms. (This line of thinking is summarized below, but more details and some of the caveats can be found in the *Southwest Climate Outlook* articles available at the website given at the end.) In short, we should prepare for more floods as well as more drought.

From year to year, the jet stream's high-level winds control how much moisture arrives, especially during winter and spring. And El Niño wields a crucial influence on the jet stream's path. El Niño events may become more frequent and long-lasting in a warmer climate, as they arguably have in recent decades. In the Southwest, the odds of enjoying a wet winter and spring go up when El Niño warms tropical Pacific Ocean temperatures near the coast of South America.

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Rising ocean temperatures in the Pacific and Gulf of California could also increase the Southwest's share of tropical storms, swept into the area with the remnants of hurricanes in the fall and with the monsoon in summer.

The Southwest does not fall in a hurricane zone, but tropical cyclone remnants detectably boost regional rainfall tallies, especially in September, as an analysis by University of Arizona researcher Elizabeth Ritchie has shown. Many climatologists expect warming sea surface temperatures to boost hurricane strength, including in the Pacific region that affects the Southwest. But it remains unclear whether this will translate to more rainfall for our region.

Meanwhile, the summer monsoon draws its moisture in part from the Gulf of California. Once the gulf's sea surface temperatures reach about 84 degrees Fahrenheit, daily rainfall amounts in the Southwest increase, especially in Arizona, as researcher David Mitchell documented based on intense monitoring over several seasons (*Geophysical Research Letters*, 2001). A temperature rise on land also spurs the shift in winds that defines the monsoon. Basically, baking mountainsides pull in monsoonal winds and rains with their heat, whether metaphorically blazing in the midday sun or literally burning during fire season.

Oddly, wildfires can rage just as ferociously during seasons following high rainfall, as in 2005, as they can during really dry years, such as 2002. The 2005 fire season broke the record for area burned in Arizona set in 2002, when one of the driest years on record burned nearly half a million acres of mostly forest in the White Mountains. The difference involves whether fires burn in lower-elevation grasslands or higher-elevation forests.

Wet winters followed by dry springs stoke grassland fires. The grasses that flourish within a matter of days of a wet spell soon shrivel up into what firefighters call fine fuel. These grasses can even carry fire into the Sonoran Desert where our classic saguaros live. The 2005 fires spread through more than 700,000 acres, including about 50,000 acres of Arizona desert. Although grasses carry the fire, woody species near saguaros generally deal the fatal blow, something to remember when considering management practices to protect this southwestern cactus species.

Variability in rainfall can boost wildfire hazard in forests as well as grasslands. Several analyses have revealed that a wet winter or spring a year or two before a dry year can boost the amount of area burned in some Sky Island forests. It only takes about 40 dry days to transform the branches and logs firefighters call "thousand-hour fuels" into tinder.

An eventual season of dryness is virtually inevitable in the Southwest, as natural variability in rainfall helps define our semi-arid system. And May and June, peak fire season here, are typically dry. The difference between a wet spring and a dry spring rarely exceeds a few inches of rainfall for both Arizona and New Mexico.

Variability between seasons could actually increase with global warming, as moisture from the previous season can influence conditions in the coming season. A moist El Niño winter is often followed by a weak summer monsoon, in part because the jet stream so favorable in winter and spring can serve as a barrier in summer. Conversely, a dry La Niña winter/spring can help pull in the tropical winds that transport the monsoon to the southwestern United States from its birthplace in Mexico's Sierra Madres.

Global warming is likely to widen the swings between relatively abundant rainfall and times of drought on the landscape, regardless of whether the Southwest gets more or less rainfall overall. Unless spring rainfall rates increase remarkably and consistently, a scenario that is not on the table of climate projections, we should expect more fires during warm, dry springs.

The earlier start of spring snowmelt that comes with warming temperatures is also likely to lengthen future fire seasons, with dry, flammable conditions arriving sooner in the year. The southwestern fire season's end typically depends on the monsoon's arrival, but a sputtering monsoon can boost area-burned tallies in the short-term because of its abundant mountaintop lightning strikes.

For these reasons and others, anything that can be done to make ecosystems more resilient to fire can help as global warming continues to ramp up for decades to come. ❖

More details and some of the caveats involved with the climate concepts summarized here are available in the feature article archive of CLIMAS' Southwest Climate Outlook, *found at* www.ispe.arizona.edu/climas/forecasts/ swarticles.html.

Of Life and Rain

by Sergio Avila, SIA Wildlife Biologist

This summer, at least in Tucson, the rainy season was good. Those of us who have lived in the desert for a long time realize that every time it rains the sadness expressed by old, yellow-colored leaves, dry washes and thirsty animals, changes into expressions of happiness and survival, and the result is a continuation of Nature's power: LIFE. Rain has started a chain reaction in the desert, and the effects are visible if we pay attention to the big signs: the pools, arroyos and rivers flowing; small and large cacti with yellow, orange, red, pink or white flowers; insects flying around these flowers, trying to get some nectar; birds, bats and toads try to get these insects and store some energy to breed; ants and horned lizards, the occasional desert tortoise, deer and javelina babies, and the big cats' quiet trips, are all signs of good times. Everything is connected through the presence of water, and rain is water at its best!

July was a rather pleasant month; with some cool mornings, stormy nights and all sorts of plants growing up here and there. Washes, arroyos and rivers are flowing, at least temporarily; underground aquifers are re-charging; and almost everywhere I look within and outside the city, is green with different tones and shapes, but always green. But when I look at it through somebody else's perspective, I find a sad (and sometimes selfish) approach: destruction and tragedy can be a result of rain too. Continually, people complain about the amount of water everywhere, the closed roads and flooding washes, the trash that it carries, the risks of driving in it; and TV Newscasts make it seem a "big tragedy of deadly consequences". Houses flood and are destroyed mainly because of poor development planning; cars are taken away, possibly because people make the wrong decision of driving in the washes, and there is trash because somewhere up the stream, somebody didn't take care of their garbage can and doesn't care about what happens down the stream. I think most of the outcry is the human side of a weather phenomenon, seen through the eyes of some yellow-tinted newscasts.

Except in the case of huge climate events like hurricanes or snowstorms, the presence of water is a very positive event for the continuation of life. The results are evident: our Sky Islands and surrounding deserts are a big block of happy ecosystems! But remember: golf-course "lakes," swimming pools, fountains at new developments, misters at restaurants and movie theaters, and human-made dams are not part of the water cycle, do not play a role in Nature, and do not contribute to the natural conditions in our region. In my opinion, those are part of the selfish and ignorant way that humans manipulate water for our own enjoyment.

In this web of life that connects us all, I belong to a tree. The tree I belong to has a wide trunk, strong branches and every year many new little leaves grow from neighbor branches: the branches I grew up with, when we were all small leaves. My family tree has profound roots in Mexico, and even though we don't know where those deep roots and thick branches come from, we know that they are part of the history of indigenous groups like the Chichimeca and the Nahuatl. It makes me happy to think that rain watered those roots and we got to this point, where I'm a little part of that tree and even with some inter-crossing with seeds from Chile, Spain and France, I still look like those Aztec ancestors.

This rainy season I will see the closest branch in my tree, the one I grew up next to and shared space, food, water, sunlight and other needs, have its fruits. The miracle of life, the great power that Nature gives most of us, worked its way one more time, and my family tree is growing a new little flower. This beautiful flower is expected with interminable happiness and hope; the hope for water to help it grow, get strong and sway through the dry times. The hope that rain will connect us all, and that we all connect through water; the hope that this flower has enough rain to grow up, be a juicy fruit and continue enjoying life as the most precious gift that we are awarded.

I just can't get enough with Nature. She surprises me over and over and over again, and I thank rain for connecting each little part of Nature to me. I look forward to the upcoming Spring. ❖

"This flood damaged some of the things we attach value to. But it's Nature. It's natural. The natural purpose of (Sabino Canyon) is to drain water from the Santa Catalina Mountains — and that's exactly what it's doing."
— Heidi Schewel, US Forest Service