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Pima County Climate Brief

University of Arizona
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This climate brief was prepared as a service to Pima County by climate experts at the University of Arizona who have been engaged in international, national and regional climate assessments and climate adaptation programs over the last several decades. It provides an overview of major climate issues and opportunities for Pima County.

Background

In 2017, the Pima County Board of Supervisors passed two significant resolutions to address climate change. Resolution 2017-39 mandated that staff undertake work to align County operations with the Paris Agreement, and Resolution 2017-51 outlined the specific areas where the County should direct climate mitigation and adaptation efforts. Furthermore, a specific recommendation outlined in 2017-39 was the Board's direction to take "a leadership role in regional collaborative efforts to develop solutions and policy recommendations to address the *Fourth National Climate Assessment's Southwest Chapter*" (due to be released in December 2018).

As a result, County staff reached out to the University of Arizona, Institute of the Environment to request a presentation on climate risks and adaptation opportunities with the intention of better informing County departments and staff about current climate research and the implications for our region. As contributors to current and previous *National Climate Assessments*, we offered to provide a presentation at a lunch "brown bag" held on April 18, 2018. This written summary is a follow up to that presentation and addresses some of the questions that were raised and discussed.

Evidence the climate is changing

It is well documented that the climate is changing. It is the overwhelming consensus of scientists from the 195 countries involved in the International Panel on Climate Change[1], as well as the scientific community in the United States[2] that human activities, especially emissions of greenhouse gases, are the dominant cause of the average global temperature increases observed since the mid-20th century. Both the changes in the atmosphere and the associated global and regional impacts are now documented through evidence from multiple observing systems on every continent, in the oceans, and in the atmosphere[1].

…and why it matters:

More important than the fact that human-caused climate change is occurring is the fact that associated changes in the climate are dramatically increasing risks to state and national economies, and to our community in Pima County. The impacts are not only financial, they can be measured in terms of quality of life for Pima County residents. Many of the things we value about living in Southern Arizona are at risk – including a reliable water supply, scenic vistas and clean air, efficient transportation systems, abundant recreational opportunities and wildlife, and a healthy economy. Increased risks associated with increased temperatures, include:

- "Chronic, long-duration hydrological drought"[3],
- Intense storms and downpours[4],
- Changes in air quality (e.g., see Anenberg et al. 2017,[5] Spracklen et al. 2009,[6] Val Martin et al. 2015[7]),
- Outbreaks of insect pests and diseases[8,9],
- Greater incidence of large wildfires[3].

These risks are all associated with climate change and affect our quality of life. Climate variability and change are closely connected to increased risks to water supplies[10,11], major wildfires[12,13], health impacts due to higher temperatures[14], and longer duration of the season for vector-borne diseases[15], in Pima County. All of these impacts have associated costs, including costs associated with rising utility bills for cooling.

Climate variability vs climate change:

There has always been variability in weather and climate, and this will continue. The difference we are seeing between current conditions and those prior to the last century is that the variability is now superimposed on long-term climate trends driven by greenhouse gas emissions. The new "normal" for climate means increased energy in the atmosphere, because more of the sun's energy is trapped within the Earth's lower atmosphere due to increasing concentrations of greenhouse gases. More energy leads to higher temperatures, altered atmospheric circulation patterns, and more extreme weather events.

Climate change and Extreme events:

Most of the risk associated with climate change is not due to gradual long-term trends in temperature and precipitation. Rather, it is related to the extreme events that are already becoming more intense as a result of having excess energy in the atmosphere. Global warming makes some extreme weather events more likely or more severe, including heat waves, intense precipitation, droughts, and wildfires[4,16,17,3]. Sea level rise due to warming of the oceans and ice melt has also significantly increased risks along the coasts of the U.S.

Climate change is a risk multiplier:

Climate change is rarely, if ever, the only source of risk for communities, businesses, or the environment. Rather, there are underlying risks such as poverty, an aging population, changes in land use, invasive species, or poor resource management decisions that can be exacerbated by climate change. For example, land development policies that increase the area of paved surfaces and rooftops, without adequately managing the increased storm-water runoff, can lead to flooding—even in the absence of changes in the climate. However, with more intense precipitation associated with increasing heat in the atmosphere[4,18], the risk of flooding is multiplied.

Many people tend to view the drivers of climate change—such as increases in temperature or more intense precipitation—as a series of unrelated factors. However, the climate system is interconnected; thus, increases in temperature have an effect on both precipitation and evaporation, and these climate "drivers" impact a range of environmental conditions. The impacts of climate changes also have impacts on linked human systems, including, for example:

- transportation,

- communication,
- electricity generation and transmission,
- health care,
- water supply and treatment.

When one component of these interconnected systems is affected by a climate impact, it can cause cascading effects. For example, if a wildfire damages the electricity delivery system for a regional power company, then all of the systems that are dependent on electricity may collapse, potentially for long periods of time, depending on how robust the power system is and how much of the grid is protected from broad-scale outages.

The good news:
The good news is that many of the increased risks of climate change can be managed in order to reduce the costs of impacts, including infrastructure costs, protection of public safety, and protection of natural resources. Moreover, as climate modeling capabilities have improved over the past several decades, climatologists are able to provide better information about future temperature and precipitation conditions. The scientific community understands the physics and the trends well, and can provide estimates of plausible changes for multi-decade periods.

Planning for Pima County's future in the context of climate change provides an opportunity to take an integrated look across programs, goals, departments and constituencies in a new light. It provides an incentive to think about investments in terms of both short- and long-term benefits and costs, and to incorporate sustainability and social objectives, while also increasing the benefits of public investments[19].

Big picture climate stressors and some opportunities for adaptation by Pima County
Given what we know from observations and from climate modelling at multiple scales, some key issues and opportunities associated with climate change for Pima County include heat, drought and flooding, as illustrated in the following table:

Stressor: Heat
On average, more people in the United States die each year from heat-related illness than any other weather-related disaster, according to the *National Climate Assessment*[20]. Climate models project substantial and statistically significant increases in temperatures in Pima County, including increases in the number of very hot days (days during which the maximum temperature exceeds 100°F) over the course of the 21st century. An increase in heat waves is also expected, consisting of longer periods of abnormally hot weather lasting days to weeks. Direct impacts include: • impacts on health, such as heatstroke; • increases in electric energy use and energy bills; • increasing costs of field operations; • and impacts on infrastructure such as roads and electric transmission lines[21]. Indirect impacts include: • more intense and larger wildfires; • increased particulates and ozone in the air; • increased cases of asthma and respiratory disease (especially in children and the elderly); • reduced productivity of outdoor workers;

- reductions in soil moisture;
- increased water requirements for agricultural crops and landscaping; and
- loss of riparian habitat and biodiversity[3,21,22,23].

Heat-related Adaptation Opportunities

- Air quality warnings and cooling centers for at-risk people with asthma or heat stress;
- changing hours of outdoor activities for field operations to avoid the middle of the day;
- increased air conditioning;
- training of staff to recognize early signs of heat stress and heatstroke and to take appropriate action;
- design of roadways to use materials that are more resistant to heat stress and reduce the urban heat island effect;
- changes in landscape choices to more heat and drought tolerant species;
- changes in wildfire suppression techniques and in building construction at the urban/wildland interface; and
- planting trees to improve air quality by absorbing pollutants, intercepting particulates, and shade surfaces to lower local air temperatures.

Stressor: Drought

The hydrological cycle is directly affected by rising temperatures. Through evaporation, precipitation and cloud formation, water and energy are redistributed across the globe. In the Southwest, higher temperatures are creating shifts in historic hydrological conditions and changing the nature of drought, floods and wildfires[3,10,11,13]. The current drought is considered exceptional in terms of the magnitude of warming and additional evapotranspiration stresses[24,25].

Direct impacts include:

- Ongoing loss of snowpack at high elevations with increasing temperatures;
- loss of soil moisture due to increased evaporation;
- stress on wildlife, natural vegetation and riparian areas; and
- increased water demand for agriculture and urban landscaping.

Indirect impacts include:

- Amplified water shortages in the Colorado River[3,10,26]. The Colorado is a major source of drinking water for Pima County through the Central Arizona Project; and
- diminishing snowpack and reduced run-off threaten local groundwater recharge and water supplies;
- increased dust and particulates in the air; and
- reduced rainfall and runoff damage aquatic ecosystems as well as the overall health of our watersheds[11].

Drought-related Adaptation Opportunities

- Investments in water conservation are almost always the least expensive option for responding to drought, though there are a range of consequences that require consideration;
- use of reclaimed municipal wastewater, water harvesting, greywater use, artificial recharge of groundwater, and careful planning of groundwater recovery systems are already components of water management within Pima County but can be expanded;

- high density residential land use reduces per capita water consumption (because the amount of landscaping per person is reduced);
- careful selection of drought tolerant landscaping plants and agricultural crop varieties can reduce water use;
- green infrastructure can provide urban cooling, recreation and habitat improvements, and improved air quality;
- public transportation can reduce vehicle miles traveled and improve air quality;
- training in management of irrigation systems can improve efficiency of outdoor irrigation;
- managing vegetation to reduce fuel near possible ignition sources such as roads and campsites can reduce wildfire risk;
- assessing appropriate herd size on ranches can limit drought-related losses;
- changes in management of riparian areas can reduce impacts on habitat; and
- long-term water supply planning for the region is critical; for example, the Lower Santa Cruz River Basin Study is underway and will assess potential water supply shortages and optional changes in management practices or infrastructure investments

Stressor: Flooding

While there is high confidence that temperatures will increase across the Southwest; scientists are less confident in projections of regional precipitation. However, basic physics tells us that rainfall intensity is likely to increase over time even if the overall average amount of precipitation on an annual basis is reduced[2,18]. Warmer air can contain more water vapor than cooler air, and rising temperatures have increased the amount of water vapor in the atmosphere, resulting in more intense precipitation nationally and globally. This is correlated with flooding—particularly flash flooding associated with summer convective thunderstorms in the Southwest and with wintertime atmospheric rivers—and can have consequences for multiple kinds of infrastructure, as well as for public safety and achieving resource management objectives[11,16].

Direct impacts include:

- Erosion that can affect roads, bridges and a range of other built infrastructure;
- potential for loss of life during flood events;
- loss of habitat along floodways that currently stabilizes stream channels;

Indirect impacts include:

- Debris flows on slopes, especially after wildfire;
- siltation of reservoirs and riverbeds;
- increased potential for disease vectors to spread; and
- reduced water quality in aquatic systems.

Flood-related Adaptation Opportunities

- Improving flood management, for example, through development of multi-purpose green infrastructure that provides more absorbent floodways and greenspace while enhancing recharge;
- reinforcement of bridge abutments and bank protection;
- improvements in the design of other infrastructure above and below ground;
- flooding also has the potential to increase groundwater recharge through scouring of riverbeds and increased transmission of water to the aquifer; and

- new engineering standards are under development by the American Society of Civil Engineers that include consideration of higher temperatures and more intense storms (for selection of building and infrastructure materials), more intense precipitation (for design of floodways and culverts) and other climate impacts.

Conclusion:

The future will look different from the past: the changes associated with human-caused global warming require that we actively manage the risks in order to protect our economy, our community and our quality of life. Pima County's efforts to build on previous sustainability efforts and address climate mitigation and adaptation at the local level are concrete steps in the right direction.

Our system of managing risk will have to prepare for a future unlike conditions that have existed in our lifetimes. Science can help with that; the University of Arizona is uniquely positioned to provide knowledge and information through conversations, partnerships and innovative projects. Moreover, there are opportunities associated with explicitly preparing for climate changes, including new ways to incorporate sustainability and quality of life objectives into Pima County programs and projects, and a multitude of ways to adjust management practices and infrastructure investments in order to reduce risks and maximize opportunities.

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