Climate Change Trends and Vulnerabilities, Carlsbad Caverns National Park, New Mexico

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Climate Trends for the Area within Park Boundaries

• Temperature shows no statistically significant trend from 1950 to 2010, with some areas showing slight increases and others showing slight decreases (Figures 1, 3).
• Precipitation is increasing at a statistically significant rate of 51% per century for the park as a whole (Figures 2, 4).
• Analyses of atmospheric measurements and other data show that emissions from cars, power plants, and other human activities are causing climate change (IPCC 2013).
• If we do not reduce our emissions, models project substantial future warming, but show no agreement on whether precipitation may increase or decrease (Figures 5-7).

Past Impact

• Across the western U.S., climate controlled the extent of burned area from 1916 to 2003 (Littell et al. 2009).

Future Vulnerabilities

• Under high emissions, fire frequencies could increase up to 25% by 2100 (Moritz et al. 2012).
• Past warming has reduced snowfall and rainfall across northern New Mexico, which may continue to reduce summer streamflow and water supplies further south (Garfin et al. 2014).
• Germination of Agave and Yucca species showed reduced germination under hotter temperatures in the southern Chihuahua Desert (Pérez-Sánchez et al. 2011).
• Continued increases in precipitation may contribute to continued shrub encroachment in the Chihuahuan Desert, but decreased precipitation would tend to reduce shrub and grass productivity (Morton et al. 2013).
**Table.** Historical rates of change per century and projected future changes in annual average temperature and annual total precipitation (data Daly et al. 2008, IPCC 2013; analysis Wang et al. in preparation). The table gives the historical rate of change per century calculated from data for the period 1950-2010. We use the 1950-2010 rate of change because the weather station network was more stable for that period than for 1895-2010. Because a rate of change per century is given, the absolute change for the 1950-2010 period will be approximately 60% of that rate. The table gives central values for the park as a whole. Figures 1, 2, 5, and 6 show the spatial variation. Figures 3, 4, and 7 show the uncertainties.

<table>
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<th>1950-2010</th>
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<tr>
<td>Temperature</td>
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<tr>
<td>Precipitation</td>
<td>+51%/century</td>
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<td><strong>Projected (compared to 1971-2000)</strong></td>
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<tr>
<td>Low emissions (IPCC RCP 4.5)</td>
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<tr>
<td>Temperature</td>
<td>+2.1ºC (3.8ºF.)</td>
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</tr>
<tr>
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<td>-1%</td>
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<tr>
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<td>-3%</td>
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Figure 1.

Historical Trend in Annual Average Temperature, 1950-2010

Map: P. Gonzalez.
Figure 2.

Historical Trend in Total Annual Precipitation, 1895-2010

Map: P. Gonzalez.
**Figure 3. Temperature.**
Historical and projected average annual average temperature for the area within park boundaries. For projections, each bar shows one standard deviation above and below the average of up to 33 climate models. (Data: Daly et al. 2008, IPCC 2013. Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service.)
Figure 4. Precipitation.
Historical and projected annual total precipitation for the area within park boundaries. For projections, each bar shows one standard deviation above and below the average of up to 33 climate models. (Data: Daly et al. 2008, IPCC 2013. Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).
Figure 5.

Projected Change in Annual Average Temperature, 2000-2010

High Emissions Scenario RCP6.0

Map: P. Gonzalez.
Projected Change in Total Average Precipitation, 2000-2010

High Emissions Scenario RCP6.0

Carlsbad Caverns National Park

Guadalupe Mountains National Park

Map: P. Gonzalez.
Figure 7. Projections of future climate for the area within park boundaries. The large black dot is the current combination of temperature and precipitation. Each small dot is the output of a single climate model. The large color dots are the average values for the four IPCC emissions scenarios. The lines are the standard deviations of each average value. (Data: IPCC 2013, Daly et al. 2008; Analysis: Wang et al. in preparation, University of Wisconsin and U.S. National Park Service).

![Projected Climate Change](image-url)

References


