Climate Change in the Sierra Nevada: General Trends

**Climate Changes**

**Air Temperature**
- Air temperatures are projected to increase (+2.4 to +3.6˚C) by the end of the century, with largest increases during summer months

**Precipitation**
- Annual precipitation has increased slightly (~2%) over the last 30 years, compared with mid-20th century baselines
- Projections vary by model and geographic region, but annual precipitation is expected to increase marginally by 2100
- By 2100, a greater proportion of precipitation (~+18 to +55%) will fall during extreme storm events
- Warmer temperatures will cause shifts from snow to rain between 1500 m to 3000 m (4291 ft to 9843 ft)

**Climate-Driven Changes**

**Snowpack and Snowmelt**
- Decreased annual snowpack (-67% to -87%) by late century
  - Elevations below 2000 m (6562 ft) are projected lose 70-90% of their snowpack by late century
- Earlier spring snowmelt

**Climatic Water Deficit**
- Annual climatic water deficit (i.e., degree to which evaporative demand exceeds soil moisture) projected to increase +34%
- Longer dry season

**Wildfire**
- Increased wildfire frequency, intensity, and size
- High-intensity wildfires are projected to increase by 44%

**Hydrology**
- Inhibited groundwater storage and recharge
- Runoff center of mass will advance 1-7 weeks by 2100, though advances will be non-uniformly distributed
- Key hydrological vulnerabilities by sub-region:
  - Northern: decreased mean annual flow
  - Central: longer periods of low flow conditions
  - South-Central: changes in runoff timing

Understanding the Climate Change Modeling Process

**Downscaled Coupled Ocean-Atmospheric Global Climate Models**
- Geophysical Fluid Dynamics Laboratory (GFDL)
- Parallel Climate Model (PCM)
  - Models were downscaled to 270 m

**Emission Scenario**
- A2 “Business-as-usual”
  - Assumes most nations fail to act to lower emissions

**Projections**
- Seasonal climate change impacts at early-, mid-, and late-century intervals for each of the Sierra Nevada sub-regions (north, central, and south), as compared to historical PRISM data trends from 1961-90

- **High certainty:** The future Sierra Nevada will feature warmer temperatures, lower snowpack, and shifting distributions of plants and animals.
- **Medium certainty:** Storms will become more severe, and precipitation patterns and wildfire regimes will change.
Climate Change in the Northern Sierra Nevada Sub-Region

The Northern Sierra Nevada Sub-Region includes the Modoc, Lassen, and Plumas National Forests, as well as the Lava Beds National Monument and Lassen National Park.

<table>
<thead>
<tr>
<th></th>
<th>Historical (1961-90)</th>
<th>2010-29</th>
<th>2030-49</th>
<th>2060-79</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air Temperature</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>8.5°C</td>
<td>+1.1° to +1.4°C</td>
<td>+1.5° to +1.7°C</td>
<td>+2.7° to +3.1°C</td>
</tr>
<tr>
<td>Summer</td>
<td>17.3°C</td>
<td>+0.9° to +1.5°C</td>
<td>+1.6° to +2.2°C</td>
<td>+2.5° to +3.9°C</td>
</tr>
<tr>
<td>Winter</td>
<td>0.6°C</td>
<td>+0.8° to +1.2°C</td>
<td>+0.9° to +1.5°C</td>
<td>+2.2° to +2.9°C</td>
</tr>
<tr>
<td><strong>Precipitation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual</td>
<td>770mm</td>
<td>0 to +5%</td>
<td>-3 to +10%</td>
<td>-11 to +10%</td>
</tr>
<tr>
<td>Spring</td>
<td>65mm</td>
<td>0 to +16%</td>
<td>-10 to +19%</td>
<td>+4 to +24%</td>
</tr>
<tr>
<td>Summer</td>
<td>15mm</td>
<td>+3 to +40%</td>
<td>-21 to +2%</td>
<td>-52 to +6%</td>
</tr>
<tr>
<td>Fall</td>
<td>61mm</td>
<td>-5 to -14%</td>
<td>0 to +2%</td>
<td>-14 to -27%</td>
</tr>
<tr>
<td>Water Deficit</td>
<td>116mm</td>
<td>0 to +6%</td>
<td>0 to +12%</td>
<td>-4 to +16%</td>
</tr>
</tbody>
</table>

**Snowpack and Hydrological Changes**

Projections for this sub-region include decreased annual snowpack and runoff, and increased climatic water deficit. These changes will be greater in the northern sub-region than any other area of the Sierra Nevada.

<table>
<thead>
<tr>
<th></th>
<th>Historical (1961-90)</th>
<th>2005-34</th>
<th>2035-64</th>
<th>2070-99</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Snowpack</strong></td>
<td>751mm</td>
<td>-39 to -41%</td>
<td>-39 to -59%</td>
<td>-73 to -87%</td>
</tr>
<tr>
<td>Runoff</td>
<td>165mm</td>
<td>-5 to -14%</td>
<td>-5 to -12%</td>
<td>-31 to +10%</td>
</tr>
<tr>
<td>Water Deficit</td>
<td>500mm</td>
<td>+6 to +13%</td>
<td>+6 to +25%</td>
<td>+25 to +44%</td>
</tr>
</tbody>
</table>

Further information and citations can be found in the source reports, *Future Climate, Wildfire, Hydrology, and Vegetation Projections for the Sierra Nevada, California: A climate change synthesis report in support of the Vulnerability Assessment/Adaptation Strategy process* (Geos Institute 2013), and *A Climate Change Vulnerability Assessment for Focal Resources of the Sierra Nevada* (EcoAdapt 2014), available online on the EcoAdapt Sierra Nevada Project Page: [http://ecoadapt.org/programs/adaptation-consultations/calcc](http://ecoadapt.org/programs/adaptation-consultations/calcc).