Climate Change Vulnerability for South Central Colorado

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Outline

• The Climate of the Rio Grande National Forest
  • Historical Data
  • Projected Data
• Forest Implications
Climate is what you expect, and weather is what you get.
The Climate of the Rio Grande National Forest
Historical Data
Rio Grande National Forest Overview

- Elevation: 7,600-14,335 ft
- Area: 2,906 square miles
Mean Annual Temperature
28 °F - 40 °F

Annual average temperature for south-central Colorado on a latitude-longitude plane. Data are provided at a 4km resolution by the PRISM climate group at Oregon State for the 1981-2010 period of record.

“Rio Grande National Forest Historic Climate Assessment” (2019)
Average Maximum Temperature
40°F - 58 °F

The contour plot above depicts annual average maximum daily temperature for south-central Colorado on a latitude-longitude plane. Data are provided at 4km resolution by the PRISM climate group at Oregon State for the 1981-2010 period of record.

“Rio Grande National Forest Historic Climate Assessment” (2019)
Average Minimum Temperature
16°F - 30°F

The contour plot above depicts annual average daily minimum temperature for south-central Colorado on a latitude-longitude plane. Data are provided at 4km resolution by the PRISM climate group at Oregon State for the 1981-2010 period of record.

“Rio Grande National Forest Historic Climate Assessment” (2019)
Average Annual Precipitation
12” - 55”

Amount of precipitation (in) expected annually for south-central Colorado. Data are provided at a 4km resolution by the PRISM climate group at Oregon State for the 1981-2010 period of record.

“Rio Grande National Forest Historic Climate Assessment” (2019)
The Climate of the Rio Grande National Forest

Future Projections
Future Projections
Future Emission Scenarios

Global Temperature Projections for various RCP Scenarios

- **RCP8.5**: Business-as-usual, 2.1 trillion tons carbon
- **RCP6.0**: Emissions peak 2080, 1.4 trillion tons carbon
- **RCP4.5**: Emissions peak 2040-50, 1.2 trillion tons carbon

Source: Adapted from IPCC Fifth Assessment Report, 2013

The graph shows the increase in average global temperature from 1950 to 2100, with projections for three different RCP scenarios. The 2°C target is indicated, showing the potential impact of different emission pathways on global temperature.
We can use the RCPs to plan for the future

Scientists use the RCPs to model climate change and build scenarios about the impacts. You can use these scenarios to plan for the future.

If we follow the RCP 8.5 pathway, **more adaptation** will be needed.

RCP 8.5 leads to much greater temperature increases, and this means greater impacts and greater costs. To adapt to these changes will also cost more. A balance must be struck between the cost of impacts and the cost of adaptation.

If we follow the RCP 2.6 pathway, **less adaptation** is needed.
Please enter an ecoregion name to begin

This interactive graph shows modeled RCP 8.5 and RCP 4.5 data for forest ecoregions. Downscaled modeled data: LOCA. Historical observed data: Livneh.

Click to view a user guide and map of the ecoregions.

www.climate-by-forest.nemac.org
Rio Grande National Forest Ecoregions

https://climate-by-forest.nemac.org/
San Juan Mountains – Weminuche Wilderness

https://climate-by-forest.nemac.org/
San Juan Mountains – South San Juan Wilderness

https://climate-by-forest.nemac.org/
Brazos Uplift

https://climate-by-forest.nemac.org/
Sangre de Cristo

https://climate-by-forest.nemac.org/
Projected Average Daily Maximum Temperature

Observed mean (1950-2013) = 51.4°F

RCP 4.5:
Mean = 55.8°F
+4.4°F

RCP 8.5:
Mean = 57.1°F
+5.7°F

Mid-century (2050)

https://climate-by-forest.nemac.org/
# Projected Average Daily Maximum Temperature

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td></td>
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<td>RCP4.5 Mean Temp (°F)</td>
<td>RCP8.5 Mean Temp (°F)</td>
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<tr>
<td>Brazos Uplift</td>
<td>56.3</td>
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<td>50.7</td>
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<td>51.4</td>
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<td>Sangre de Cristo</td>
<td>58.8</td>
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<td>64.1</td>
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</tbody>
</table>

[https://climate-by-forest.nemac.org/](https://climate-by-forest.nemac.org/)
Projected Average Daily Minimum Temperature

Observed mean (1950-2013) = 18.4°F

RCP 8.5:
Mean = 24.2°F
+5.8°F

RCP 4.5:
Mean = 22.7°F
+4.3°F

Projected Average Daily Min Temp (°F) in the San Juan Mountains – Weminuche Wilderness Ecoregion

Mid-century (2050)

https://climate-by-forest.nemac.org/
# Projected Average Daily Minimum Temperature

<table>
<thead>
<tr>
<th>Rio Grande National Forest Ecoregion</th>
<th>Observed (1950-2013) Mean Temp (°F)</th>
<th>Mid-century (2050) Mean Temp (°F)</th>
<th>End-of-century (2098) Mean Temp (°F)</th>
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<tr>
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<td>RCP8.5</td>
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<td>22.7</td>
<td>24.2</td>
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<td>Sangre de Cristo</td>
<td>26.8</td>
<td>30.4</td>
<td>31.9</td>
</tr>
</tbody>
</table>
Projected Days per Year with Maximum Temperature Above 90°F (Heat Days)

- Observed mean (1950-2013) = 0.6 days/yr
- RCP 8.5: 2.6 days/yr + 2 days/yr
- RCP 4.5: 1.7 days/yr + 1.1 days/yr

Projected Days Per Year with Max Above 90°F in the San Juan Mountains – Weminuche Wilderness Ecoregion

https://climate-by-forest.nemac.org/
## Projected Days per Year with Maximum Temperature Above 90° F (Heat Days)

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Observed (1950-2013) Days/Year</th>
<th>Mid-Century (2050) RCP4.5 Days/Year</th>
<th>Mid-Century (2050) RCP8.5 Days/Year</th>
<th>End-of-century (2098) RCP4.5 Days/Year</th>
<th>End-of-century (2098) RCP8.5 Days/Year</th>
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<tr>
<td>Brazos Uplift</td>
<td>2.1</td>
<td>12.6</td>
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<td>1.7</td>
<td>2.6</td>
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<td>San Juan Mountains – Weminuche Wilderness</td>
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<td>5.9</td>
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<tr>
<td>Sangre de Cristo</td>
<td>3.5</td>
<td>16.0</td>
<td>21.1</td>
<td>23.4</td>
<td>62.6</td>
</tr>
</tbody>
</table>

[https://climate-by-forest.nemac.org/]
Projected Days per Year with Maximum Temperature Below 32°F (Icing Days)

Observed mean (1950-2013) = 66.3 days/yr

- RCP 4.5: 48.3 days/yr (22 days/yr decrease)
- RCP 8.5: 44.3 days/yr (18 days/yr decrease)

https://climate-by-forest.nemac.org/
<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Observed (1950-2013)</th>
<th>Mid-Century (2050)</th>
<th>End-of-century (2098)</th>
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<tbody>
<tr>
<td></td>
<td>Days/Year</td>
<td>RCP4.5 Days/Year</td>
<td>RCP8.5 Days/Year</td>
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<tr>
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<td>37.2</td>
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<td>66.3</td>
<td>48.3</td>
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<td>Sangre de Cristo</td>
<td>26.2</td>
<td>18.6</td>
<td>16.4</td>
</tr>
</tbody>
</table>
Projected Days per Year with Minimum Temperature Below 32°F (Frost Days)

Observed mean (1950-2013) = 273.3 days/yr

RCP 4.5
239.3 days
-34 days/yr
RCP 8.5
225.0 days
-48.3 days/yr

Mid-century (2050)

Projected Days Per Year with Min Below 32°F (Frost Days) in the San Juan Mountains – Weminuche Wilderness Ecoregion

https://climate-by-forest.nemac.org/
## Projected Days per Year with Maximum Temperature Below 32° F (Frost Days)

<table>
<thead>
<tr>
<th>Ecoregion</th>
<th>Observed (2050-2013)</th>
<th>Mid-century (2050)</th>
<th>End-of-century (2098)</th>
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<tbody>
<tr>
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<td>Days/Year</td>
<td>RCP4.5 Days/Year</td>
<td>RCP8.5 Days/Year</td>
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<tr>
<td>Brazos Uplift</td>
<td>235.6</td>
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<td>273.3</td>
<td>239.3</td>
<td>225.0</td>
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<td>Sangre de Cristo</td>
<td>214.1</td>
<td>188.8</td>
<td>175.7</td>
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</table>
Projected Growing Degree Days (GDD)

Observed mean (1950-2013) = 584.4 °F-days

RCP 4.5:
1089.5 °F-days
+505.1 °F-days

RCP 8.5:
1275.4 °F-days
+691 °F-days

Mid-century (2050)

Projected Growing Degree Days in the San Juan Mountains – Weminuche Wilderness Ecoregion

https://climate-by-forest.nemac.org/
# Projected Growing Degree Days (GDD)

<table>
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<th>Ecoregion</th>
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<tr>
<td></td>
<td>Observed Days</td>
<td>RCP4.5°F-days</td>
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<td>Brazos Uplift</td>
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<td>584.4</td>
<td>1089.5</td>
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<td>1374.8</td>
<td>2067.9</td>
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Source: [https://climate-by-forest.nemac.org/](https://climate-by-forest.nemac.org/)
Projected Precipitation

Projected Total Precipitation in the San Juan Mountains – Weminuche Wilderness Ecoregion

Mid-century (2050)

https://climate-by-forest.nemac.org/
## Projected Precipitation

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<td>Total Annual Precip (in.)</td>
<td>RCP4.5 Total Annual Precip (in.)</td>
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<td>18.0</td>
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Overview: Projected changes for the San Juan Mountains – Weminuche Wilderness Ecoregion

By the mid-21st century...

- Daily Max Temp: +4.4°F to +5.7°F
- Daily Min Temp: +4.3°F to +5.8°F
- Heat Days (max > 90°F): 1.1 days/yr to 2 days/yr
- Icing Days (max < 32°F): 18 days/yr to 22 days/yr
- Frost Days (min < 32°F): 34 days/yr to 48.3 days/yr
- Growing Degree Days: +505.1°F-days to +691°F-days
- Precipitation projections are highly variable with the likelihood of more extreme events occurring

By the end of the 21st century...

- Daily Max Temp: +6.1°F to +6.9°F
- Daily Min Temp: +3.5°F to +4.5°F
- Heat Days (max > 90°F): 13.3 days/yr to 19.3 days/yr
- Icing Days (max < 32°F): 24.8 days/yr to 44 days/yr
- Frost Days (min < 32°F): 42.6 days/yr to 80.6 days/yr
- Growing Degree Days: +513.1 °F-days to +675.7 °F-days
- Precipitation projections are highly variable with the likelihood of more extreme events occurring
Forest Implications
Projected Increase in Risk of Very Large Fires by Mid-Century

Increase in Weeks with Risk of Very Large Fires (%)

0 50 100 200 300 400 500 600
Snowpack

Snowpack change 1955-2014

More water
- 100% increase
- 50%
- 25%
- 10%

Less water
- 50%
- 25%
- 10%
- 100% decrease

USDA
United States Department of Agriculture
Southwest Climate Hub

VIRGINIA W. MASON AND KELSEY NOWAKOWSKI, NGM STAFF. SOURCES: NATURAL RESOURCES CONSERVATION SERVICE; CALIFORNIA DEPARTMENT OF WATER RESOURCES; DARRIN SHARP AND PHILIPMOTE, OREGON STATE UNIVERSITY
Declining snowpack, heavy rainfall, and summer droughts are increasing the risk of winter flooding, low summer streamflow, and reduced water quality.
Wildlife

- Species movement
- Adaptive capacity of wildlife and vegetation
- Change in tree species and impacts on wildlife species requiring special habitat types (spruce-fir specialists)
- Change in habitat structure
- Vulnerability of riparian species
- Potential increase of invasive riparian species
Insects

- Mountain pine beetle
  - Host trees: lodgepole pine, ponderosa pine, and limber pine

- Spruce beetle
  - Host tree: Engelmann spruce
  - Among the most relevant disturbance agents causing tree mortality in the RGNF

- Western Spruce budworm (defoliator)
  - Host trees: Douglas-fir, subalpine fir, white fir, and Engelmann spruce (least favorable)

- Western tent caterpillar (defoliator)
  - Host trees: alder, cottonwood, and aspen (main host)

"Climate Change and Selected Forest Insect and Pathogens in the Rio Grande National Forest" (Negrón 2019)
Pathogens

- Dwarf mistletoes
- Armillaria root disease
- White Pine Blister Rust
- Sudden Aspen Decline

“Climate Change and Selected Forest Insect and Pathogens in the Rio Grande National Forest” (Negrón 2019)
Climate-Driven Shifts in Vegetation Cover

Shifts in modeled vegetation class under RCP 8.5, with fire suppression

https://climatetoolbox.org/tool/Future-Vegetation
Vegetation Class Niche Shifts

- Blue shaded box represents RGNF elevational gradient (2316 – 4358 m or 7,600-14,335 ft)
- Potential loss of Limber pine, Bristlecone pine, and Lodgepole pine
- Threatened: Engelmann Spruce, Blue Spruce, White fir
- Secure: Ponderosa Pine, Douglas-fir, Aspen, and subalpine fir
Thank you!

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Lauren.Kramer@usda.gov

https://www.climatehubs.usda.gov/hubs/southwest
References

• The Climate Toolbox https://climatetoolbox.org/
• Climate by Forest https://climate-by-forest.nemac.org/
• Box folder “climate_change_workshop”