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Atlas for “Climate change increases risks of wildfire and biome shifts in United States national parks in California”

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Atlas for “Climate change increases risks of wildfire and biome shifts in United States national parks in California”

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Patrick Gonzalez

Joshua Verkerke

University of California, Berkeley

patrickgonzalez@berkeley.edu

July 26, 2026

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Maps and graphs, by geographic area, from north to south

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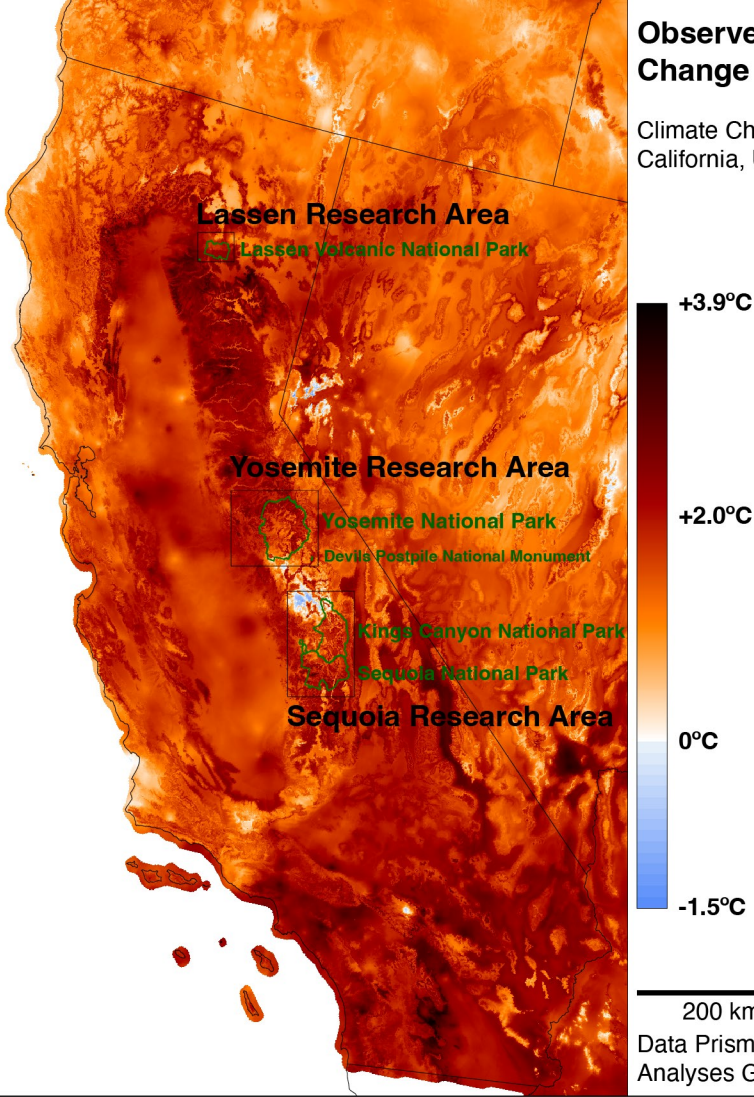
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57. Yosemite average annual precipitation change 1895–1904 to 1950–2023
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104. Sequoia summer significant precipitation change 1895–1904 to 2014–2023
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130. Sequoia National Park, observed and projected climate change
131. Sequoia biome climate niches

Observed Temperature Change 1895-1904–2014-2023

Climate Change Research Areas
California, USA



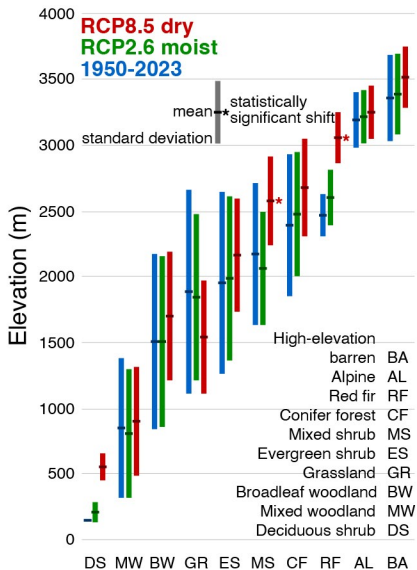
Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Biome Elevation Shifts

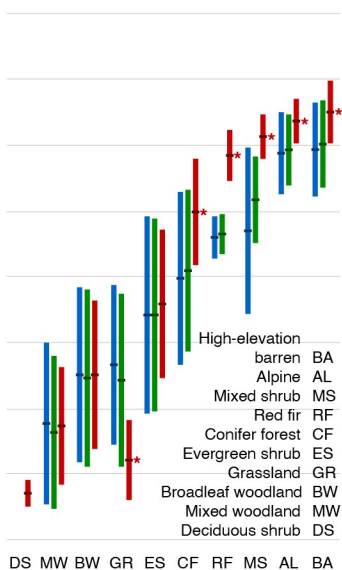
California, USA

Gonzalez and Verkerke 2026 Environmental Research Letters

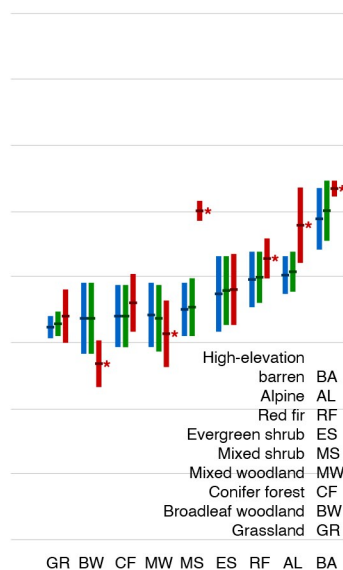
Sequoia



Yosemite



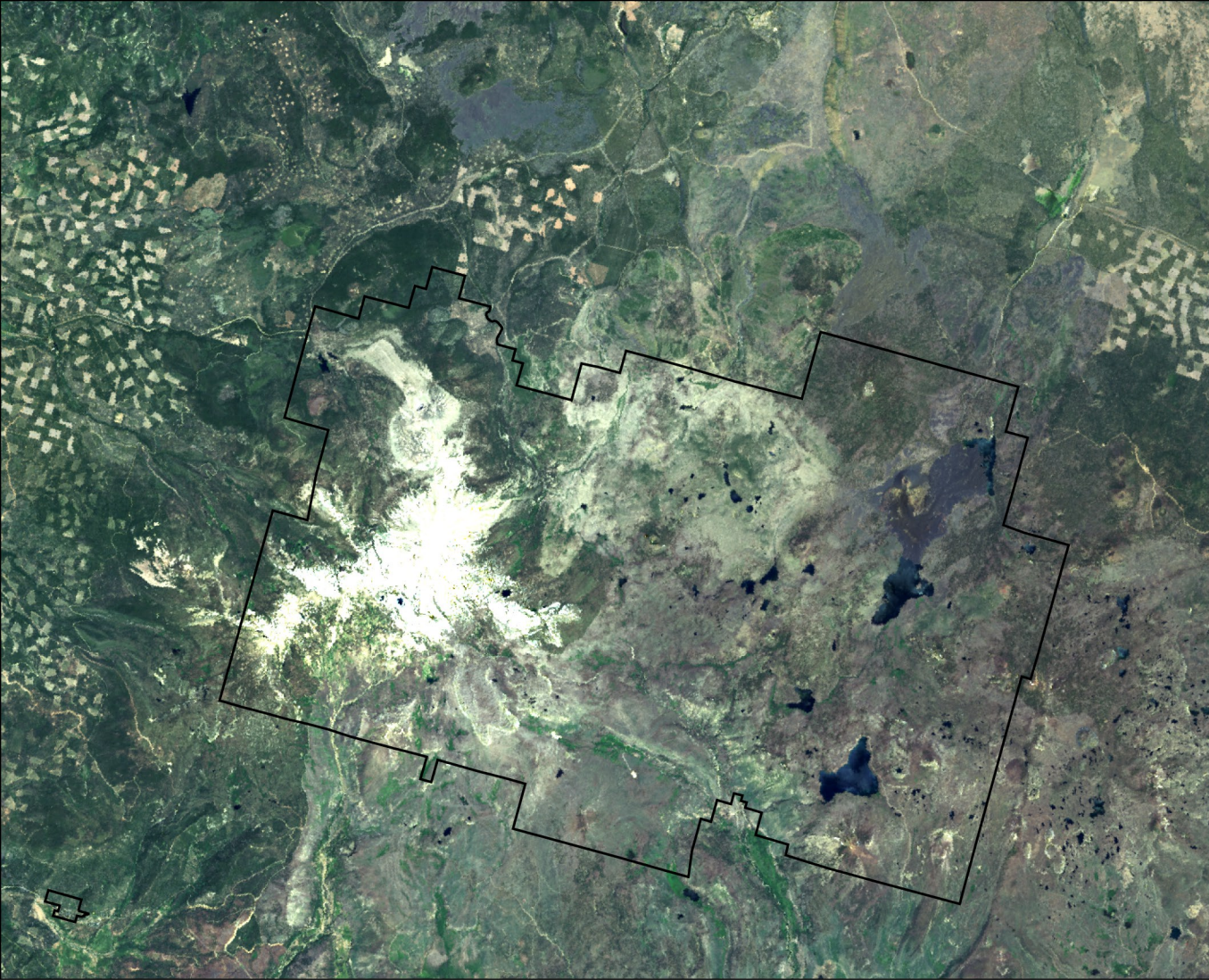
Lassen



Biome

Lassen Volcanic National Park
California, USA

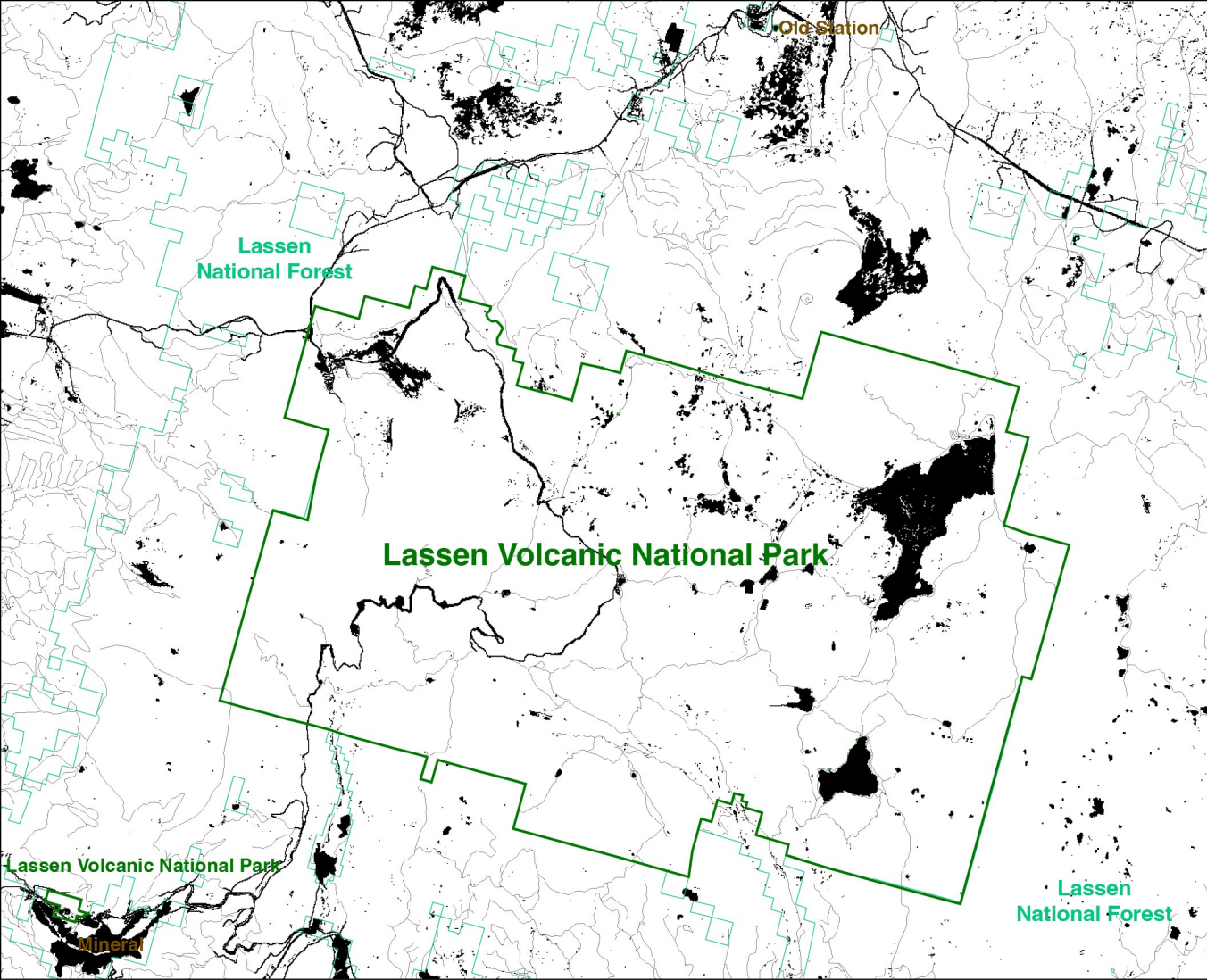
July 6, 2025
Landsat Real Color Mosaic



10 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

Lassen Research Area California, USA



natural vegetation

water, roads, urban, agriculture,
low-elevation barren



10 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

Elevation

Lassen Volcanic National Park
California, USA

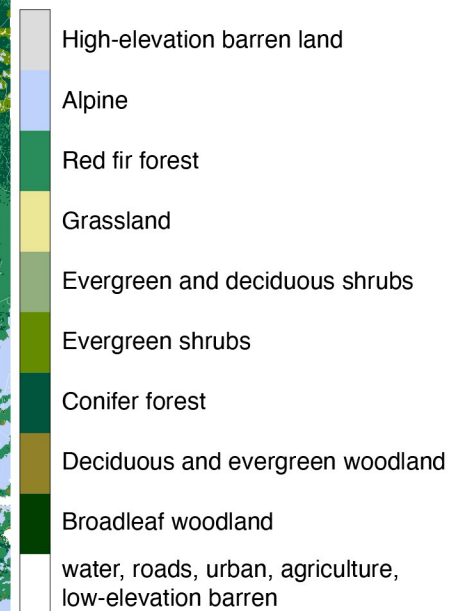


10 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

Vegetation Biomes 2023

Lassen Volcanic National Park
California, USA



10 km

Data U.S. Geological Survey Landfire
Analyses Gonzalez and Verkerke 2026

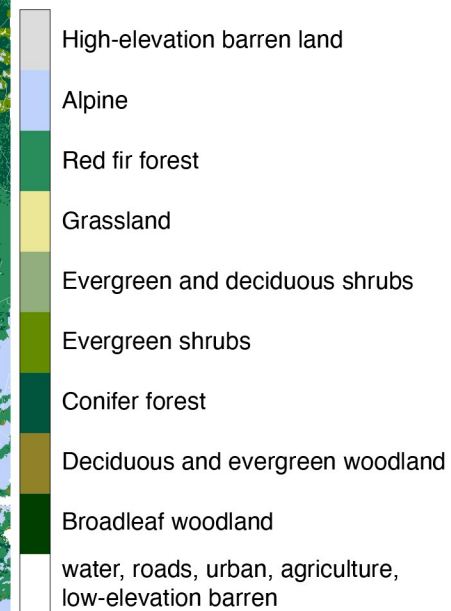
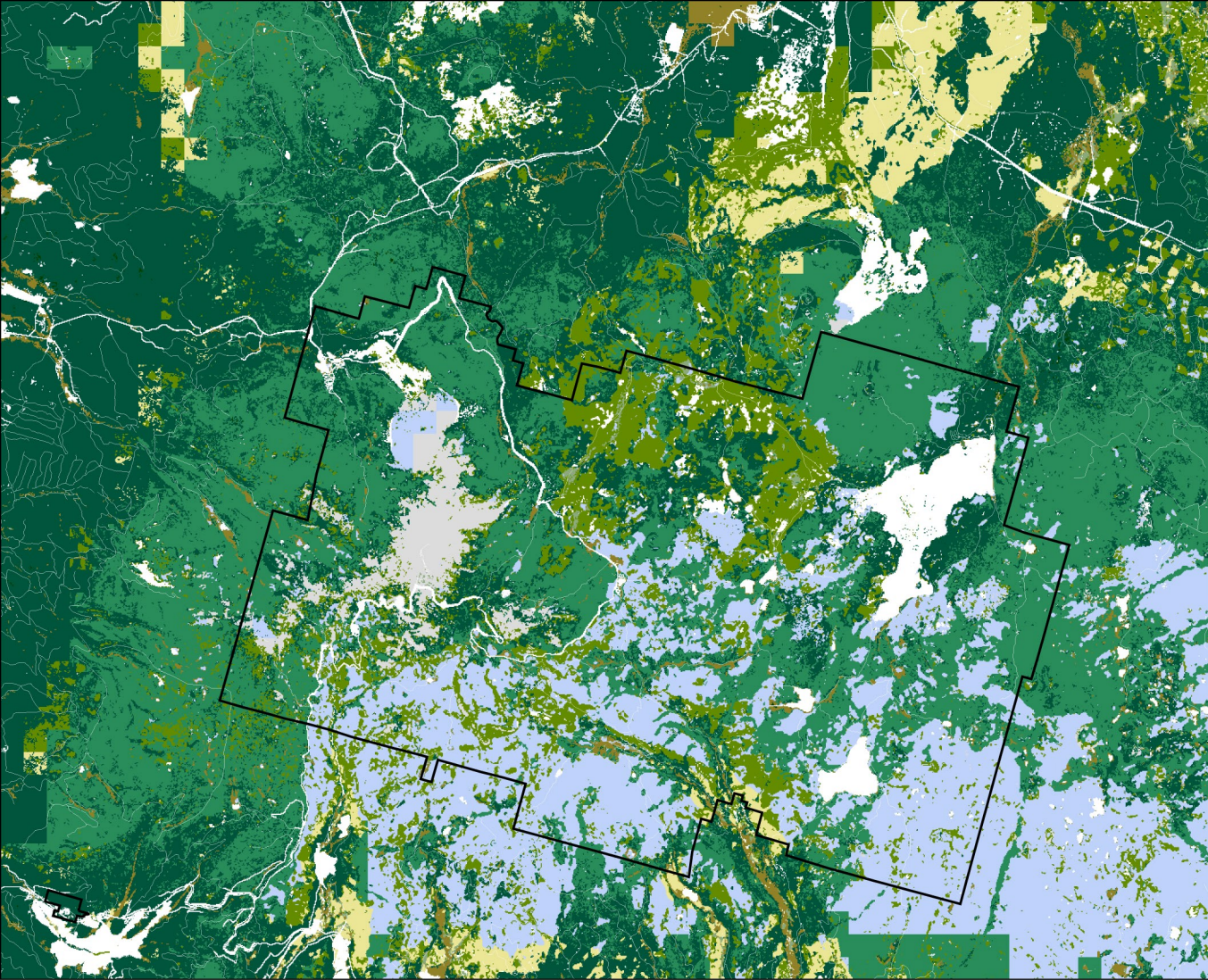
Vegetation Biomes 2100

Reduced Emissions Scenario RCP2.6

High Rainfall Projection

Lassen Volcanic National Park

California, USA



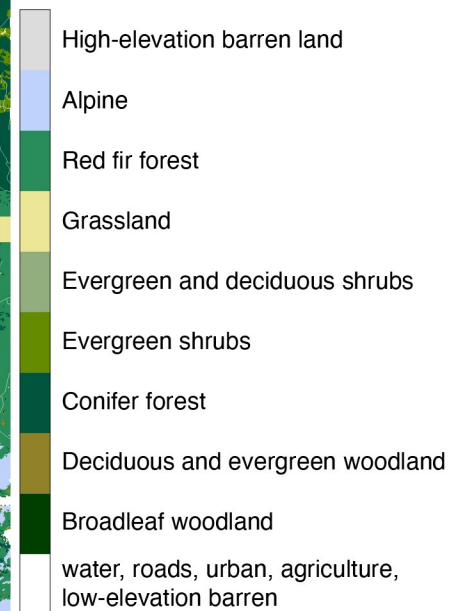
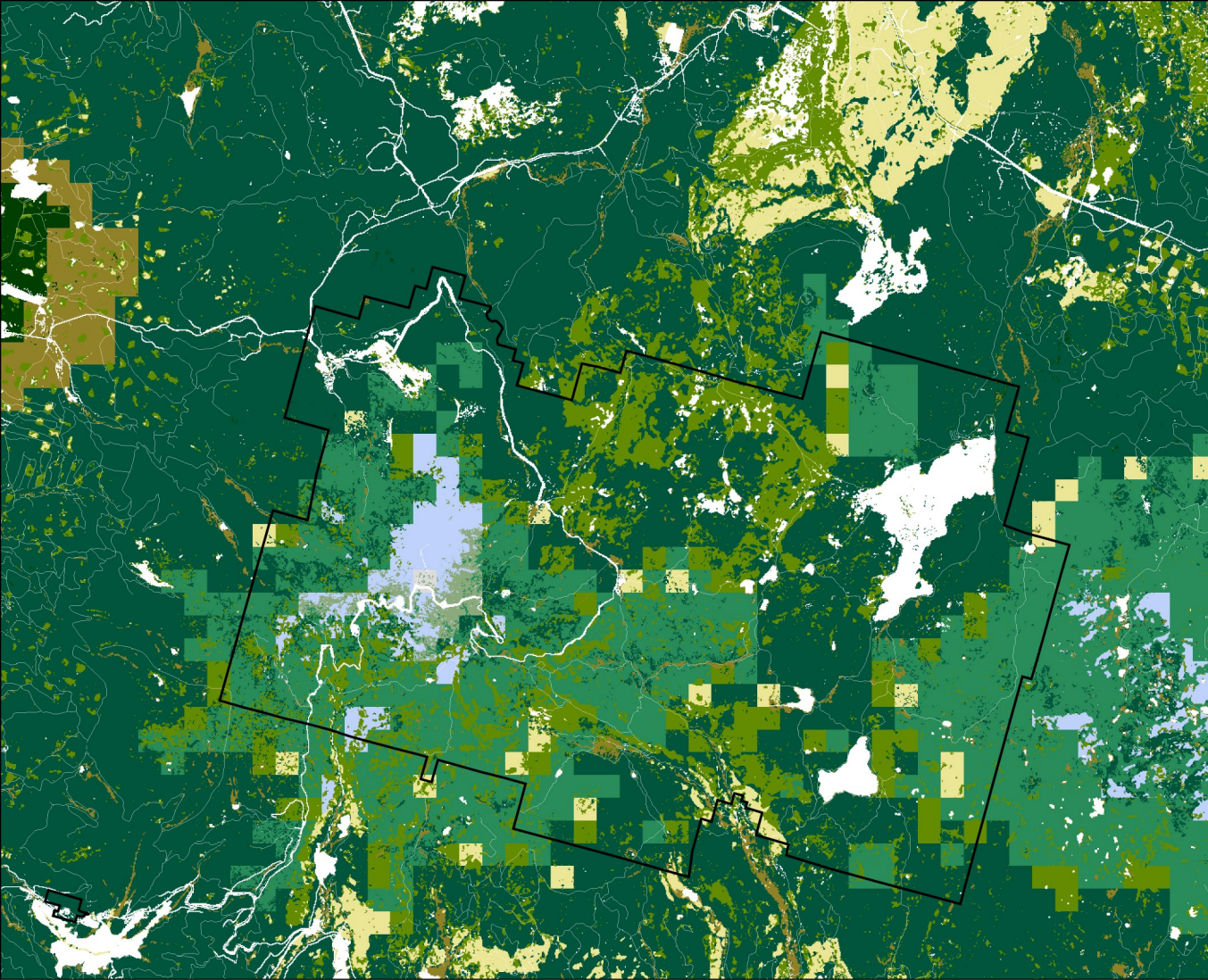
10 km

Analyses Gonzalez and Verkerke 2026

Vegetation Biomes 2100

Reduced Emissions Scenario RCP8.5
Low Rainfall Projection

Lassen Volcanic National Park
California, USA

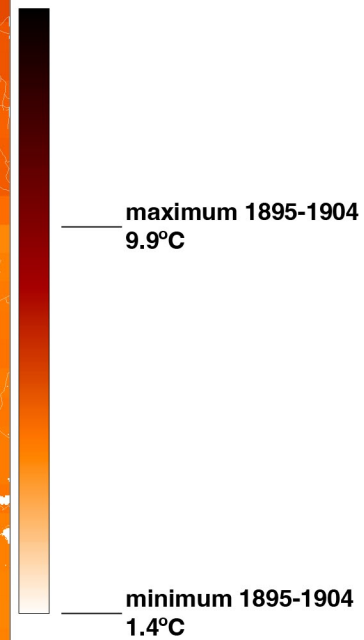
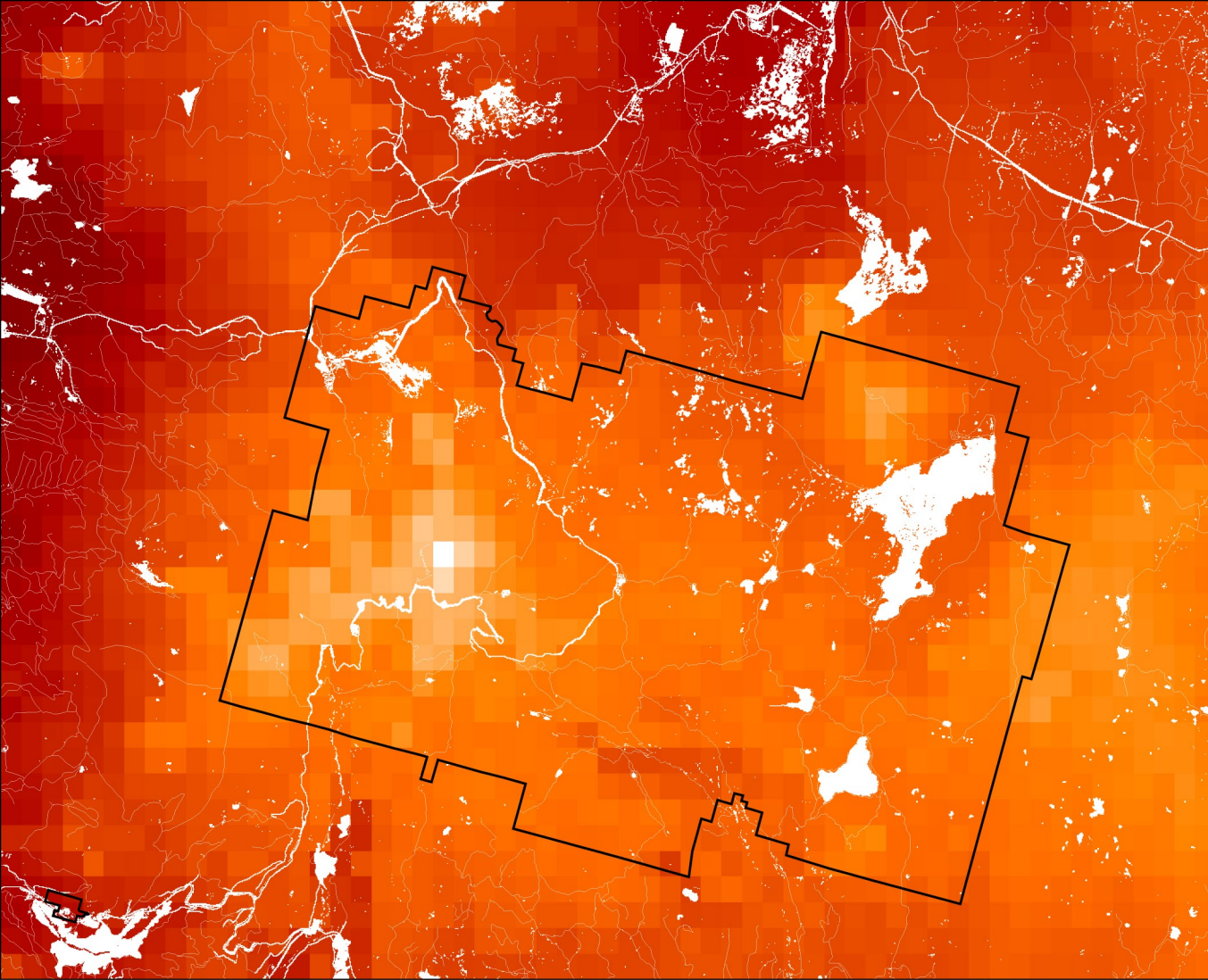


10 km

Analyses Gonzalez and Verkerke 2026

Average Annual Temperature 1895-1904

Lassen Volcanic National Park
California, USA

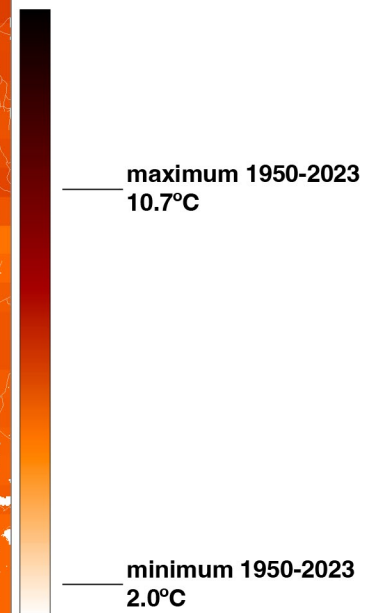


10 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Average Annual Temperature 1950-2023

Lassen Volcanic National Park
California, USA

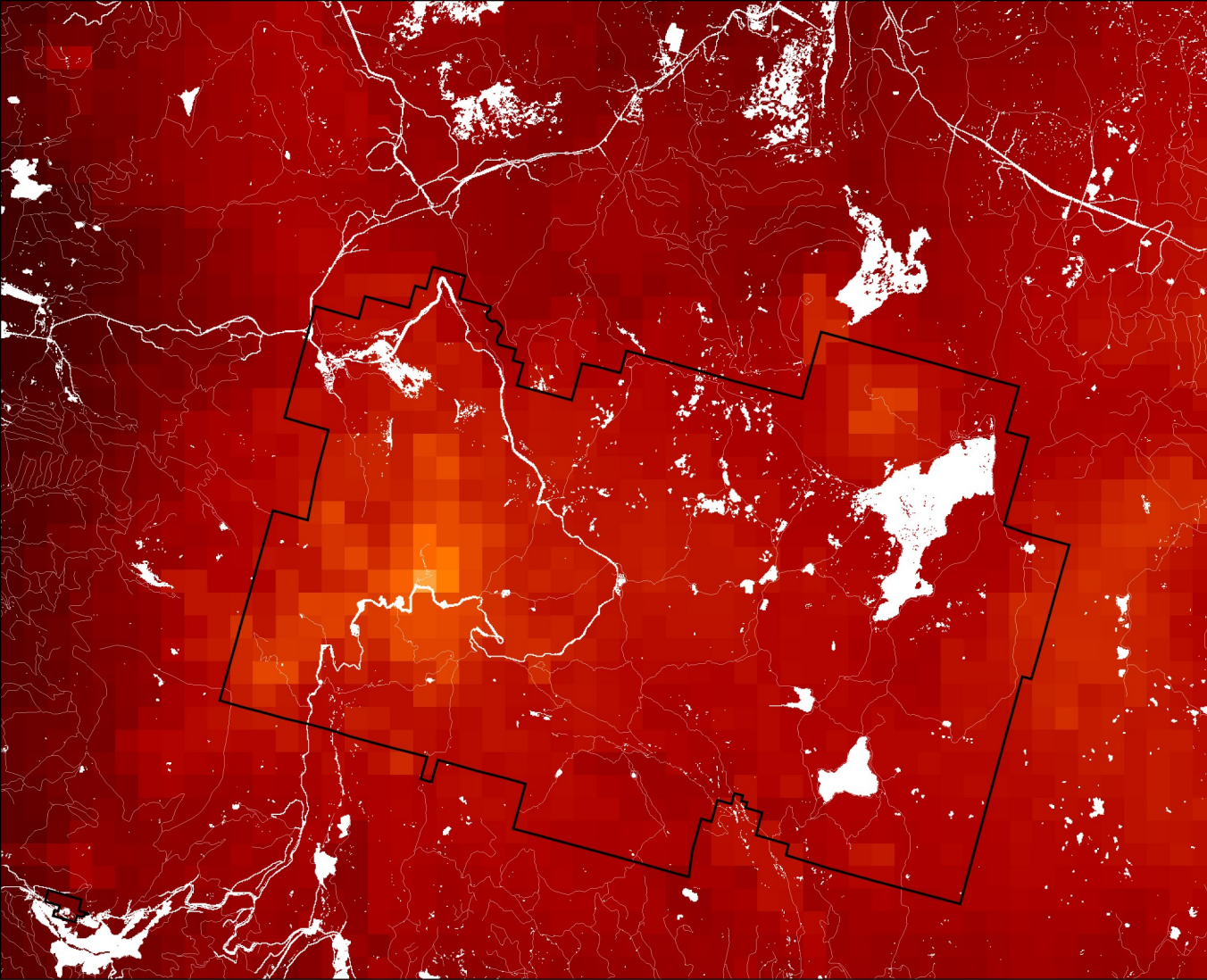


10 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Average Annual Temperature 2014-2023

Lassen Volcanic National Park
California, USA



10 km
Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

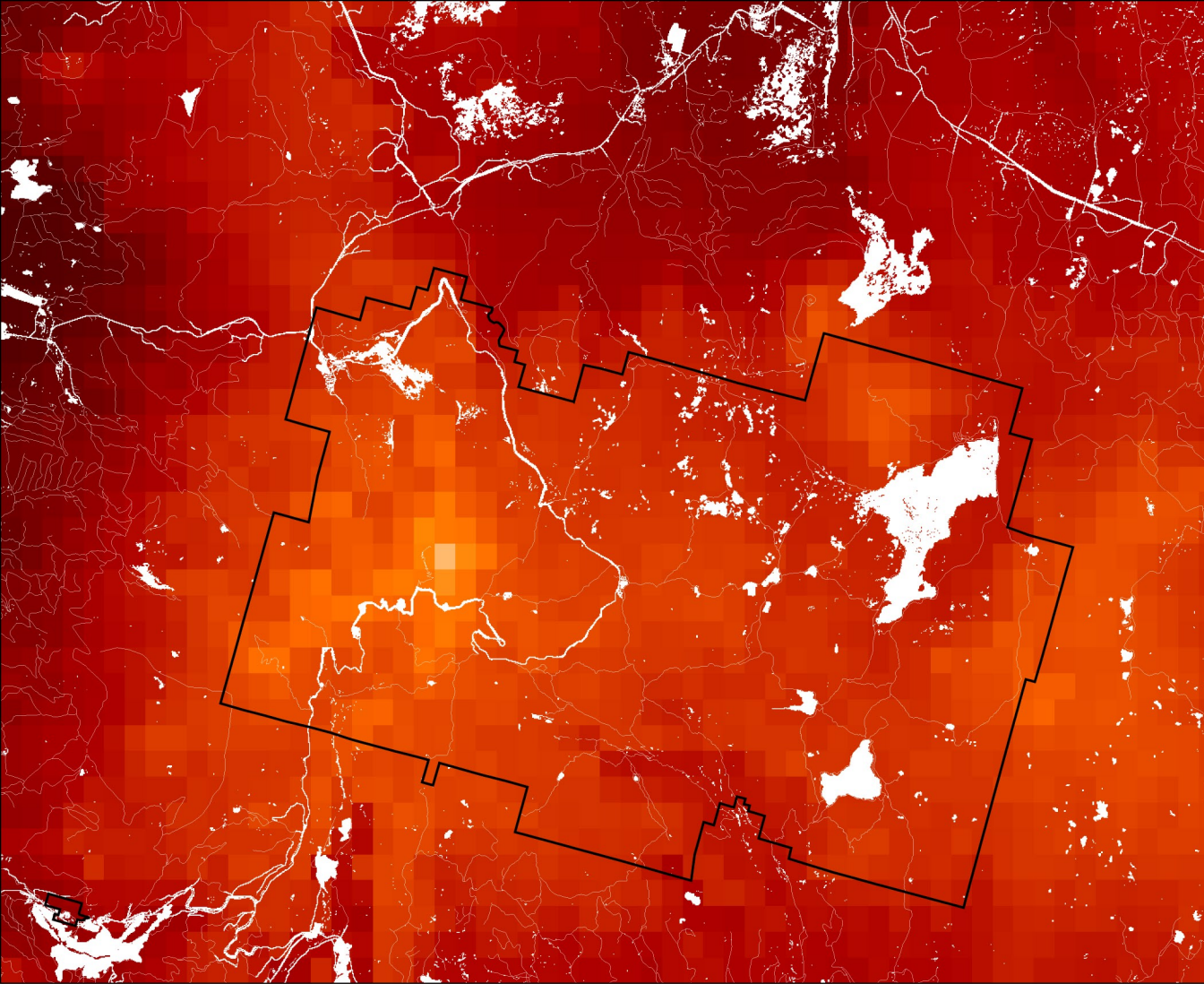
Observed Temperature Change 1895-1904–2014-2023

Lassen Volcanic National Park
California, USA



10 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

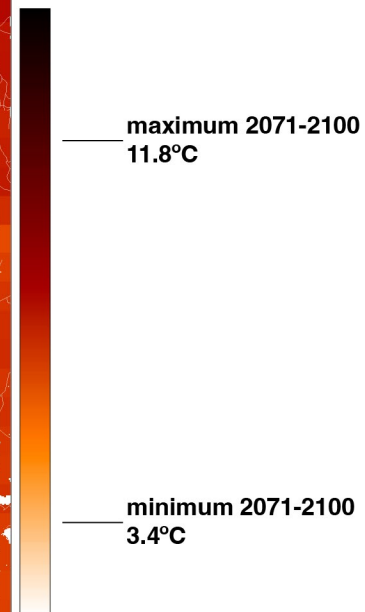


Average Annual Temperature

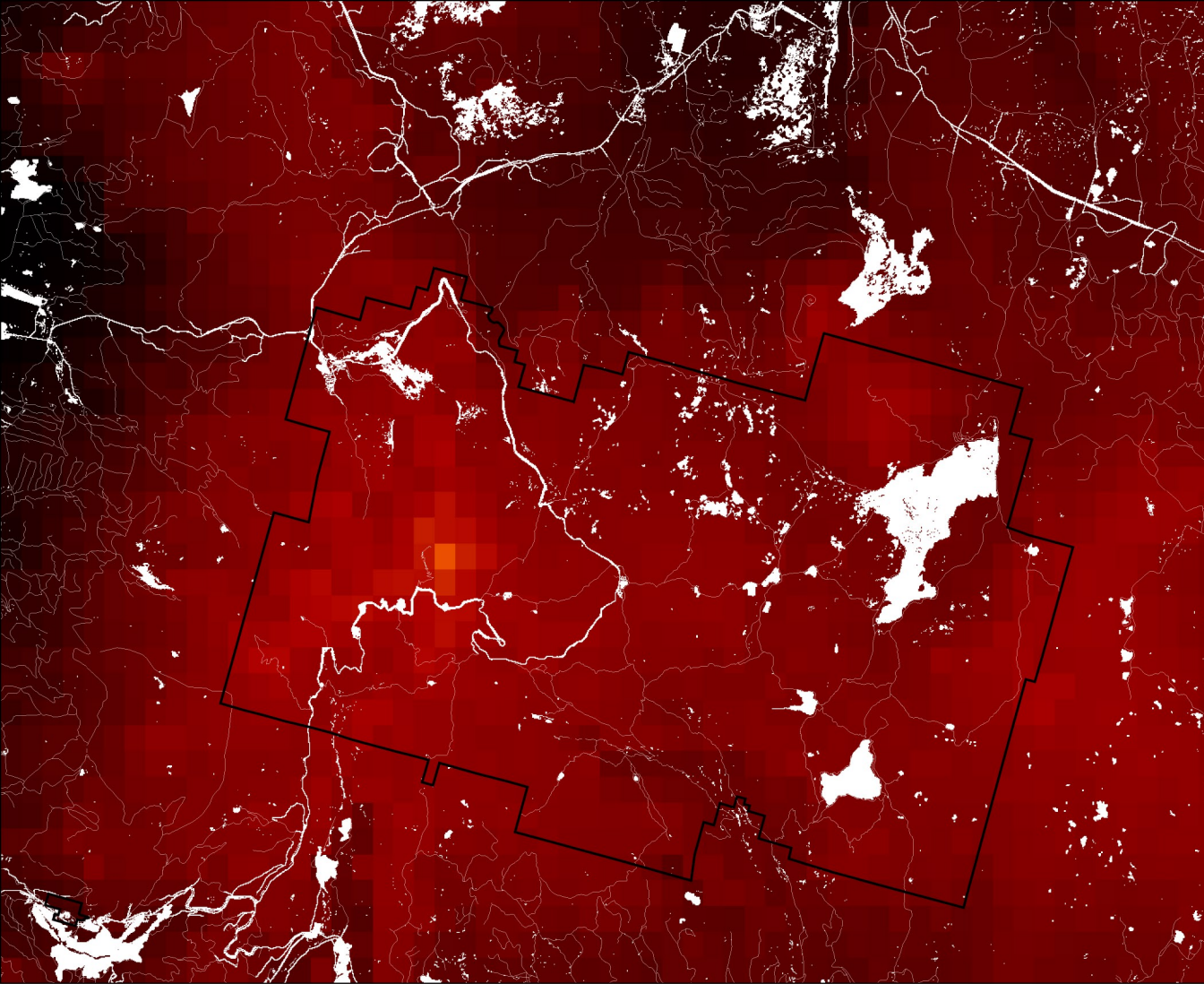
2071-2100

Reduced Emissions Scenario RCP2.6

Lassen Volcanic National Park
California, USA



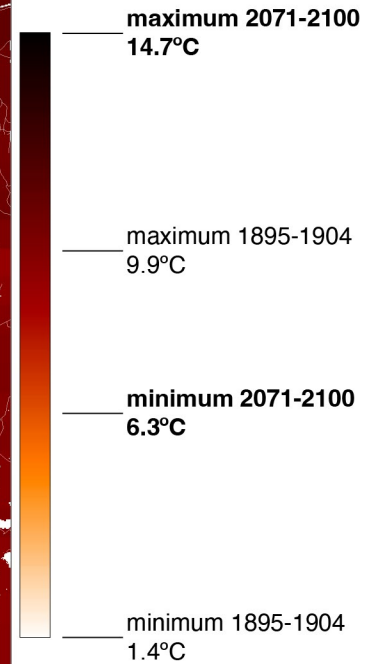
10 km
Data Gonzalez et al. 2018
Analyses Gonzalez and Verkerke 2026



Average Annual Temperature 2071-2100

Highest Emissions Scenario RCP8.5

Lassen Volcanic National Park
California, USA



10 km

Data Gonzalez et al. 2018
Analyses Gonzalez and Verkerke 2026

Average Annual Precipitation 1950-2023

Lassen Volcanic National Park
California, USA

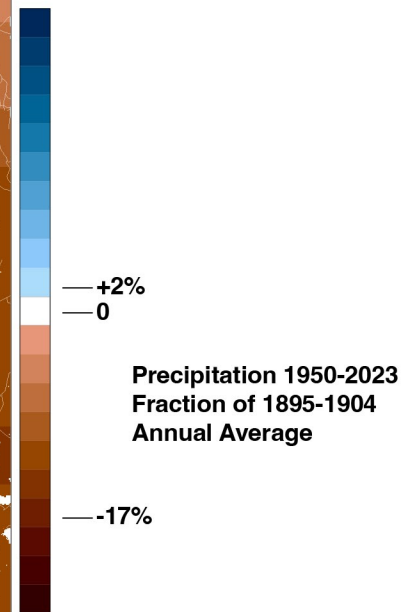


10 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Observed Precipitation Change 1895-1904–1950-2023

Lassen Volcanic National Park
California, USA

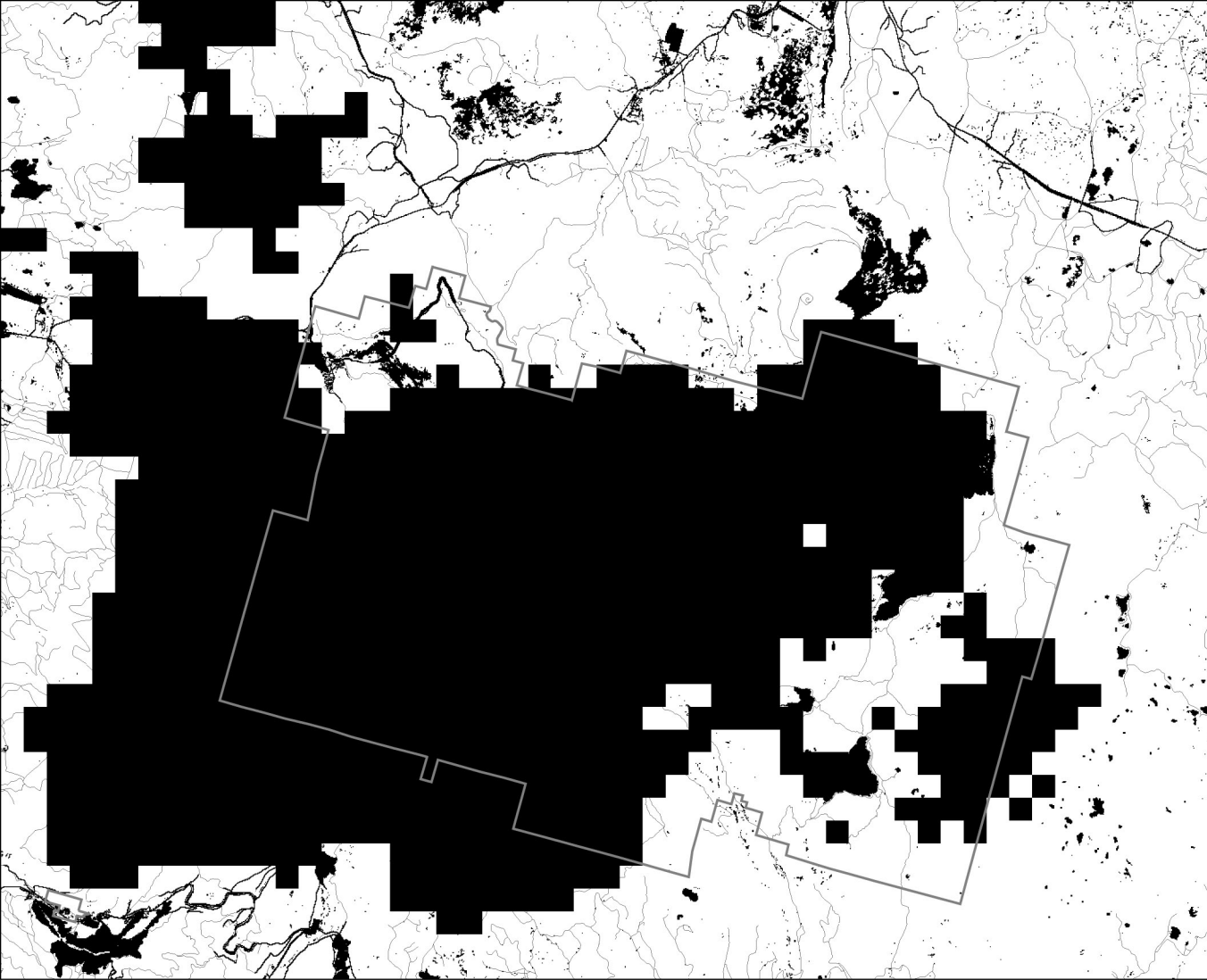


10 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Significant Precipitation
Change 1895-1904–1950-2023
July

Lassen Volcanic National Park
California, USA



change statistically significant



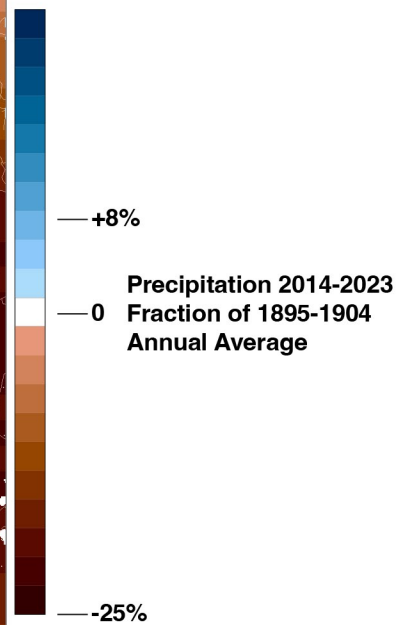
change not statistically significant

10 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Observed Precipitation Change 1895-1904–2014-2023

Lassen Volcanic National Park
California, USA



10 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Significant Precipitation
Change 1895-1904–2014-2023
July

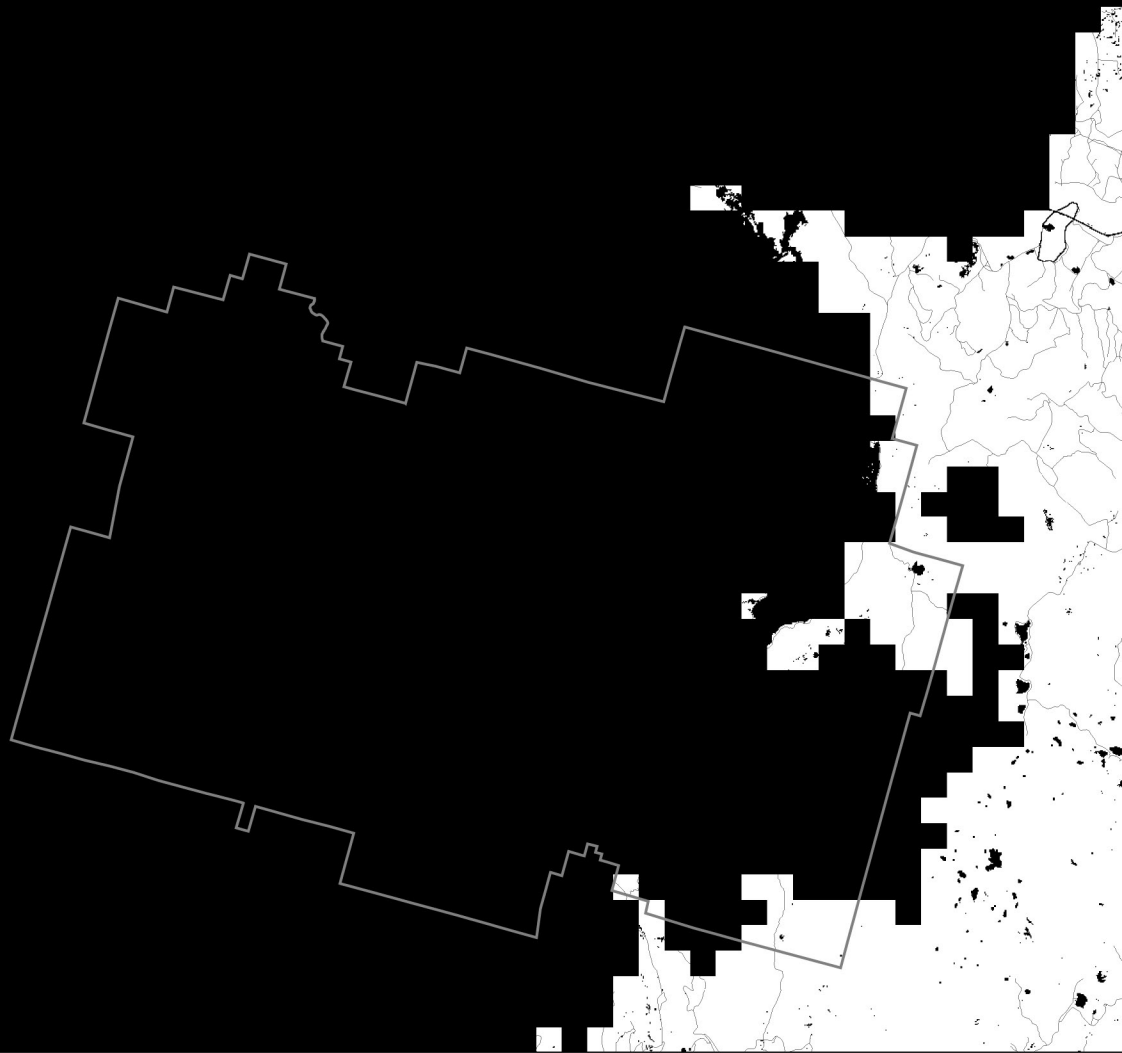
Lassen Volcanic National Park
California, USA

change statistically significant

change not statistically significant

10 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026



Projected Precipitation

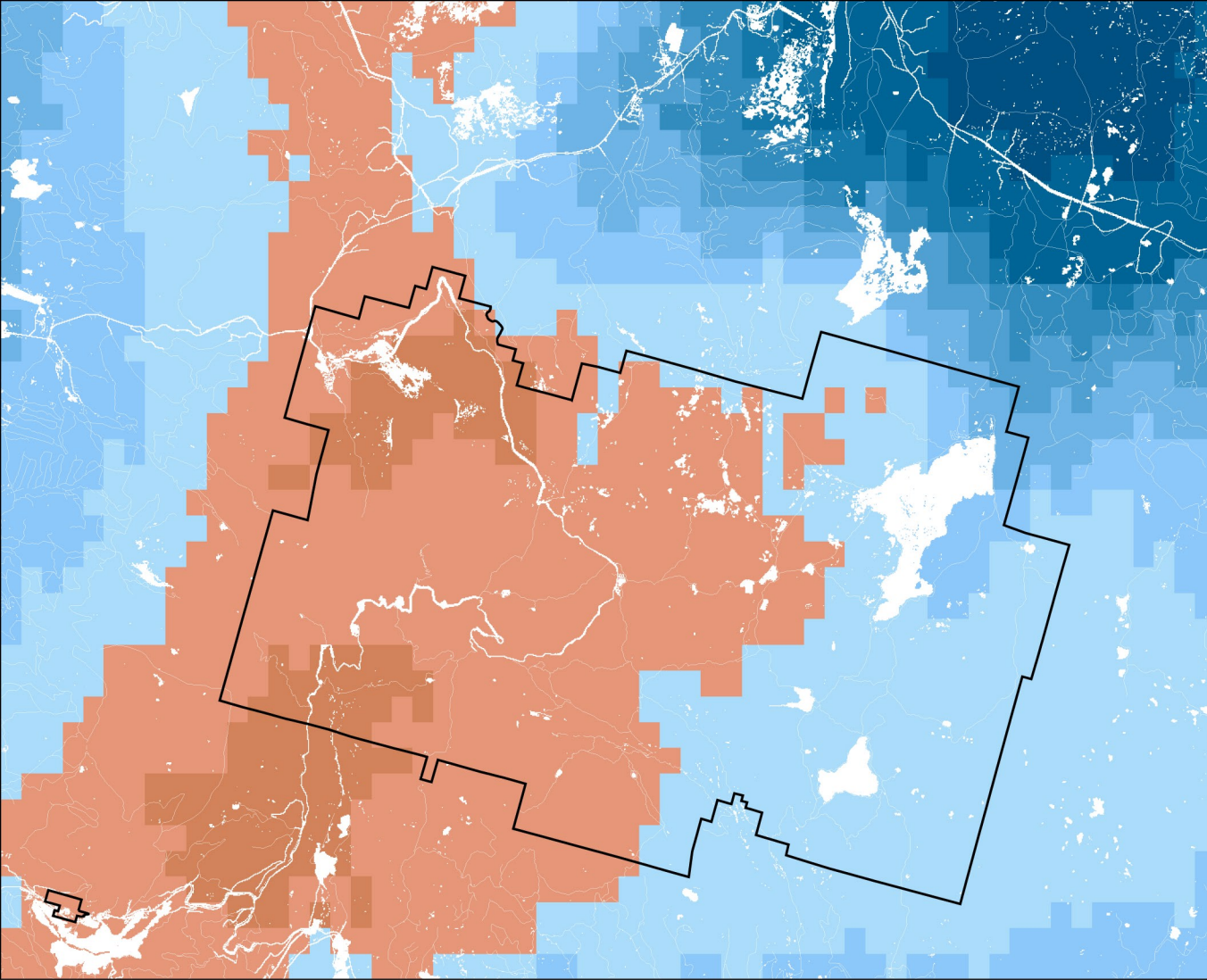
Change 1895-2100

Reduced Emissions Scenario RCP2.6

High Rainfall Projection

Lassen Volcanic National Park

California, USA



— +19%

Precipitation 2071-2100

— 0 Fraction of 1895-1904

— -4% Annual Average

10 km

Data Gonzalez et al. 2018

Analyses Gonzalez and Verkerke 2026

Projected Precipitation

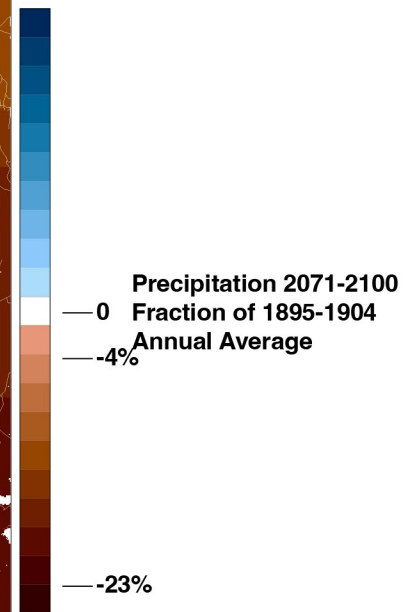
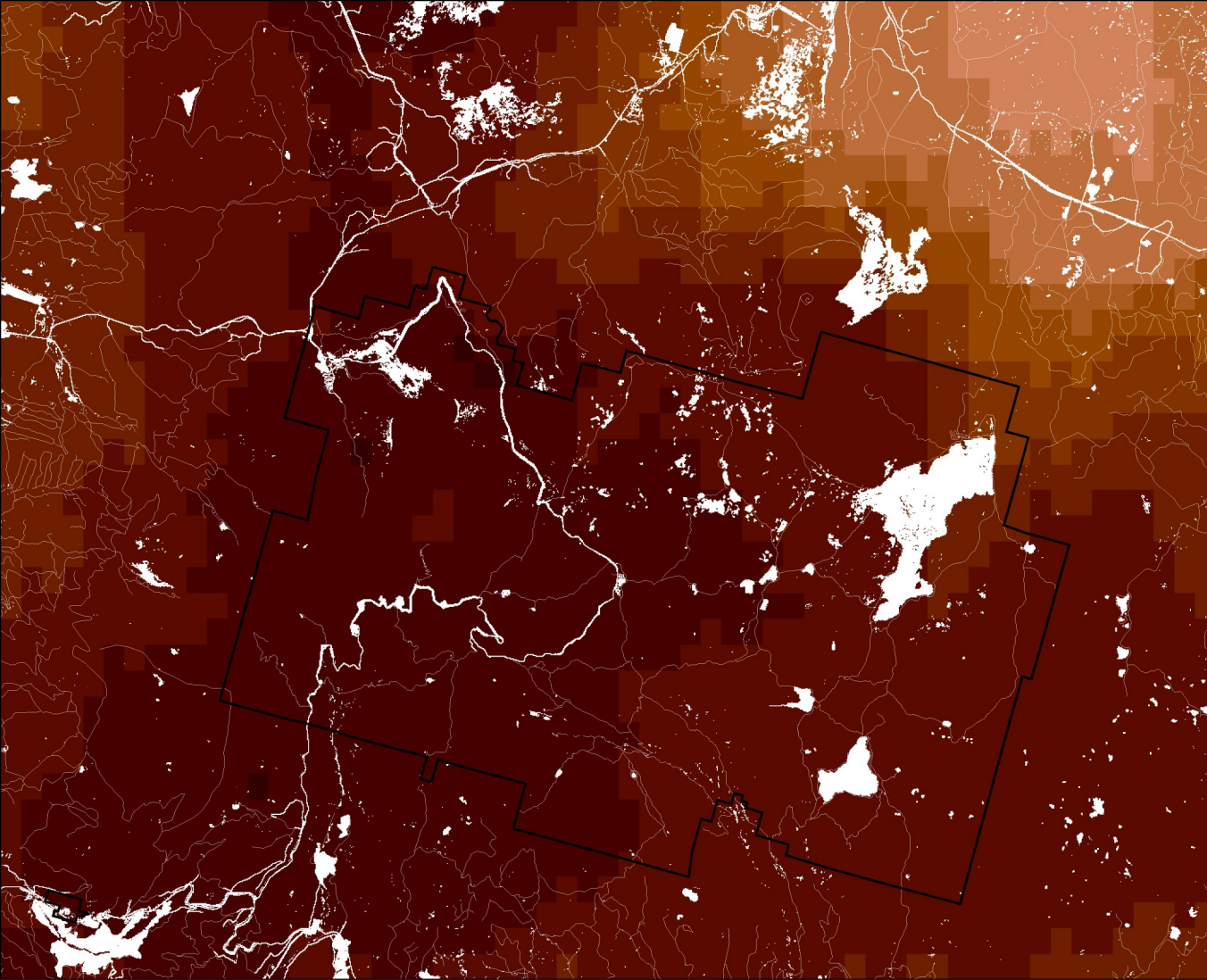
Change 1895-2100

Highest Emissions Scenario RCP8.5

Low Rainfall Projection

Lassen Volcanic National Park

California, USA

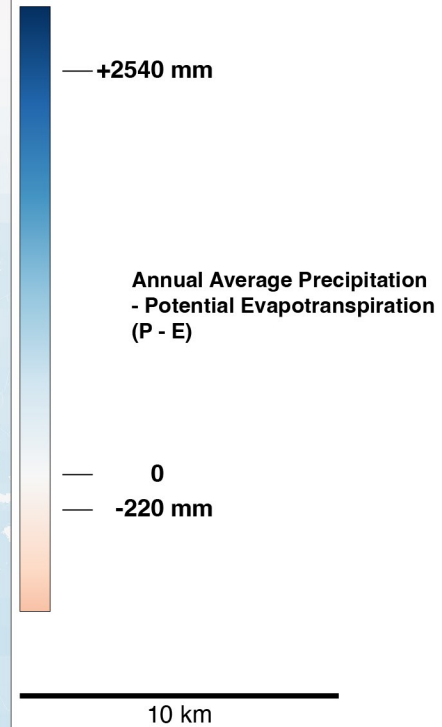


10 km

Data Gonzalez et al. 2018
Analyses Gonzalez and Verkerke 2026

Annual Moisture Balance 1950-2023

Lassen Volcanic National Park
California, USA



Analyses Gonzalez and Verkerke 2026

Annual Moisture Balance

2071-2100

Reduced Emissions Scenario RCP2.6

High Rainfall Projection

Lassen Volcanic National Park

California, USA

+2940 mm

Annual Average Precipitation
- Potential Evapotranspiration
(P - E)

0

-260 mm

10 km

Analyses Gonzalez and Verkerke 2026

Annual Moisture Balance

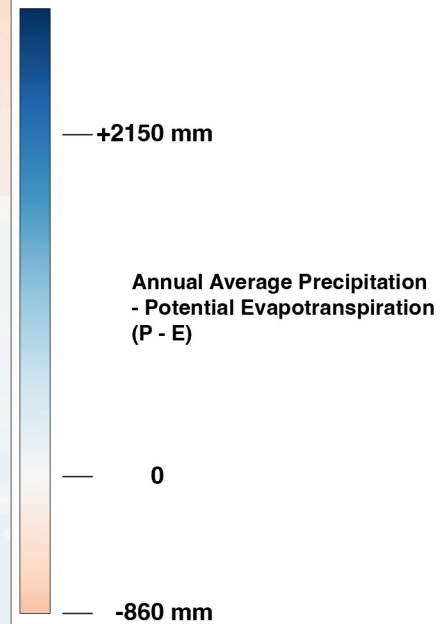
2071-2100

Highest Emissions Scenario RCP8.5

Low Rainfall Projection

Lassen Volcanic National Park

California, USA



10 km

Analyses Gonzalez and Verkerke 2026

Projected Moisture Balance Change 1895-2100

Reduced Emissions Scenario RCP2.6
High Rainfall Projection

Lassen Volcanic National Park
California, USA

≥ +500%

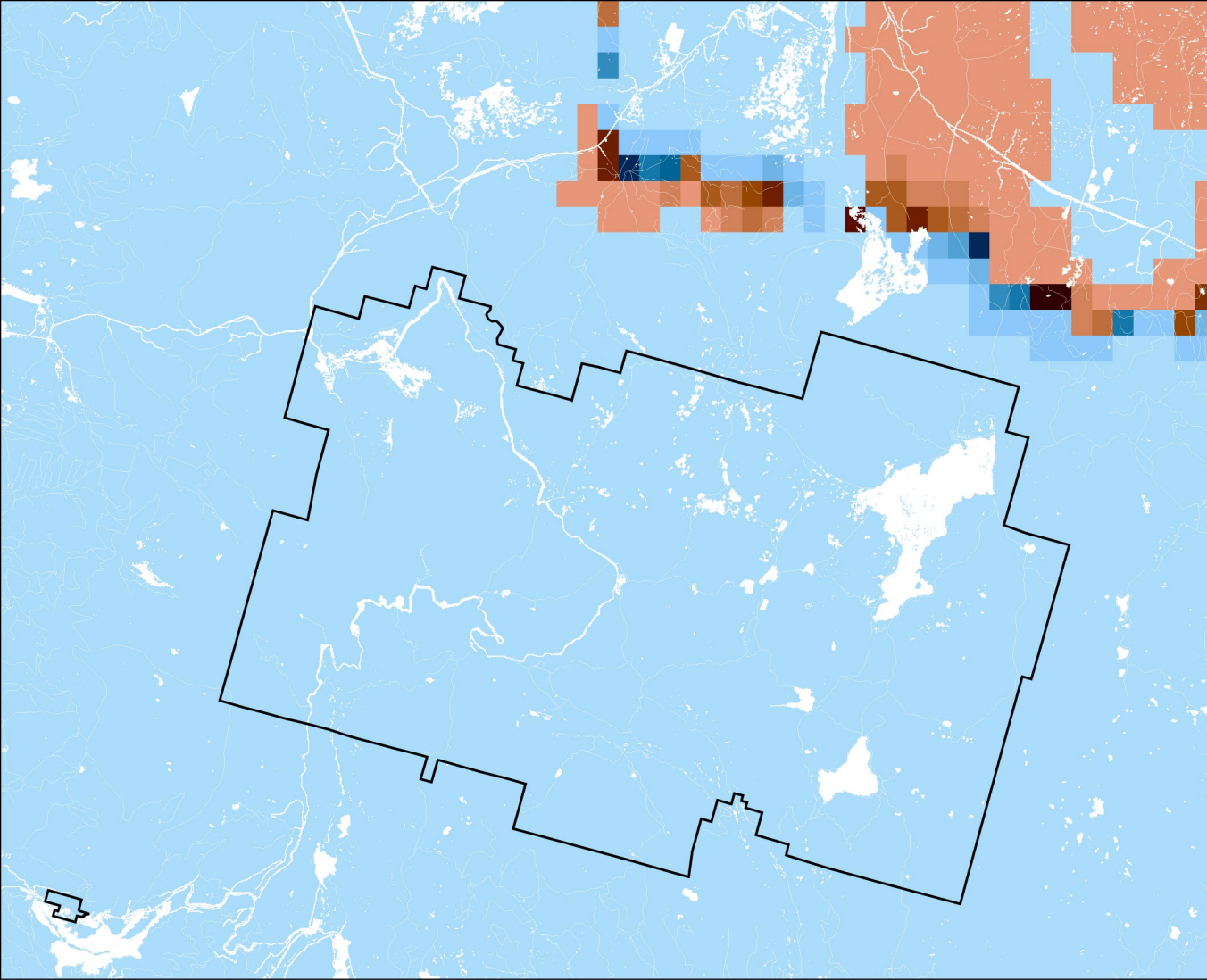
Moisture Balance 2071-2100
Fraction of 1895-1904
Annual Average Precipitation
- Potential Evapotranspiration

0%

≤ -500%

10 km

Analyses Gonzalez and Verkerke 2026



Projected Moisture Balance Change 1895-2100

Highest Emissions Scenario RCP8.5
Low Rainfall Projection

Lassen Volcanic National Park
California, USA

$\geq +500\%$

Moisture Balance 2071-2100
Fraction of 1895-1904
Annual Average Precipitation
- Potential Evapotranspiration

0%

$\leq -500\%$

10 km

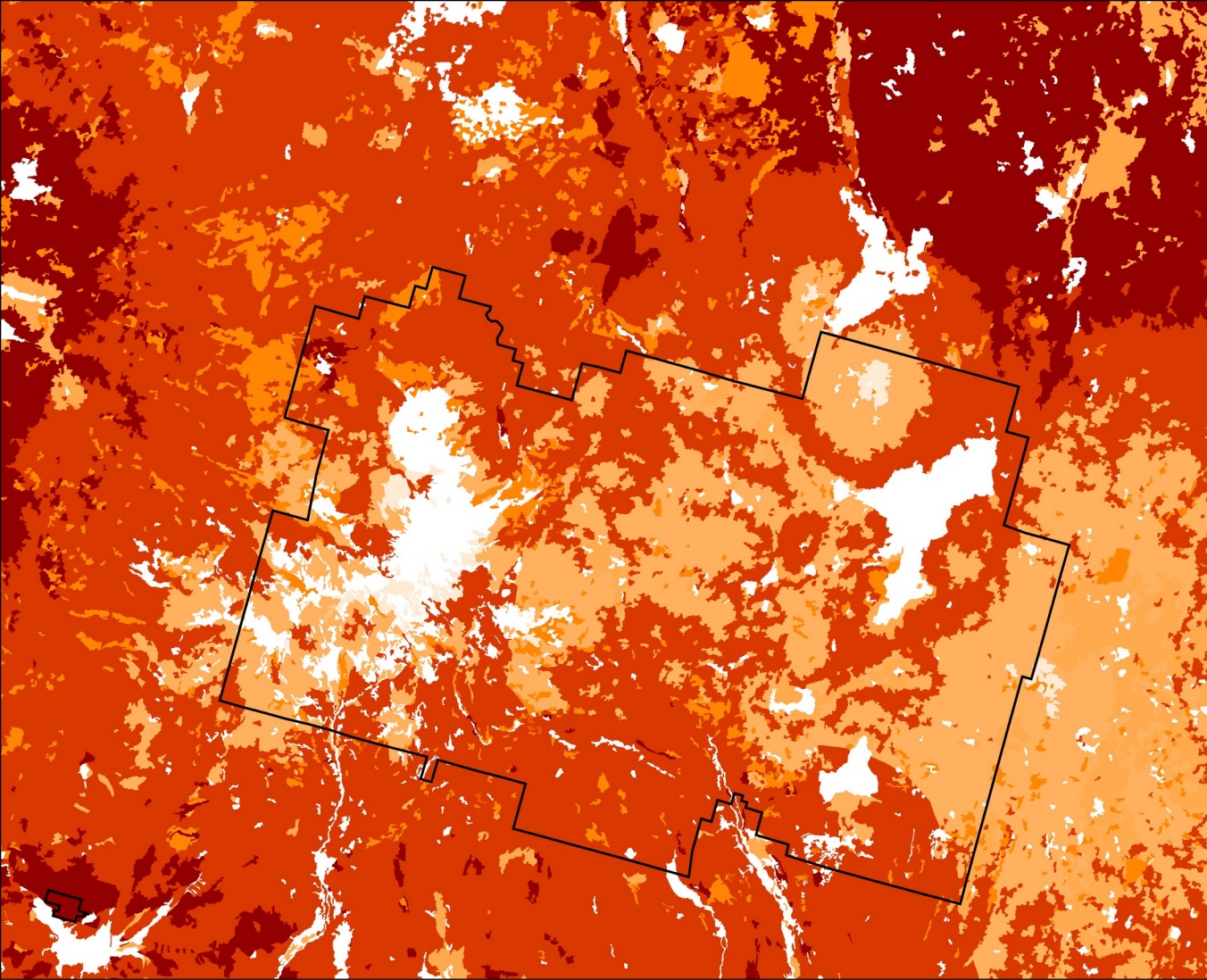
Analyses Gonzalez and Verkerke 2026

Fire Frequency 1849

Potential

Based on Estimated Vegetation

Lassen Volcanic National Park
California, USA



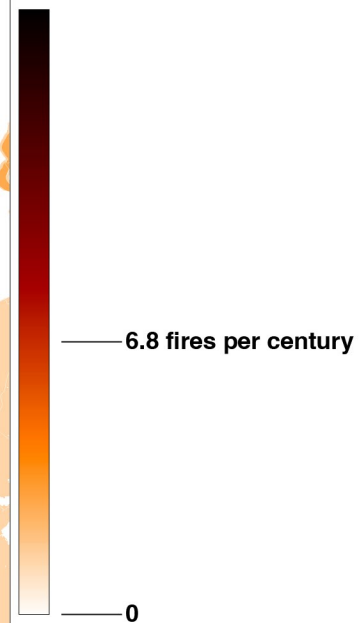
10 km

Data USDA Forest Service
Analyses Gonzalez and Verkerke 2026

Fire Frequency 1950-2023

Observed Burned Areas
Based on Field Surveys
and Remote Sensing

Lassen Volcanic National Park
California, USA



10 km

Data State of California CalFire
Analyses Gonzalez and Verkerke 2026

Fire Frequency 2023

Potential

Based on Observed Vegetation

Lassen Volcanic National Park
California, USA



10 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

Fire Frequency 2100

Potential

Reduced Emissions Scenario RCP2.6

High Rainfall Projection

Lassen Volcanic National Park

California, USA

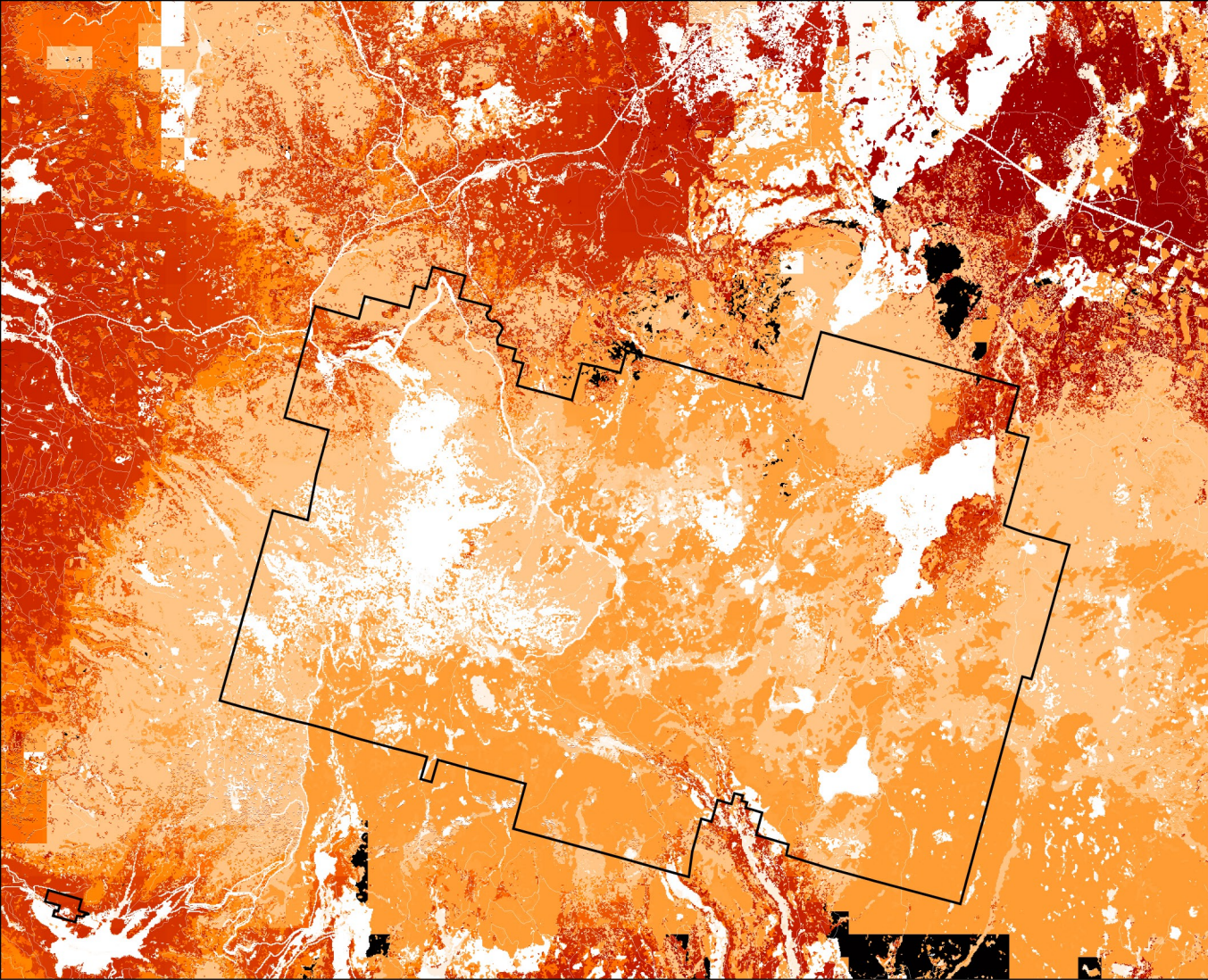
100 fires per century maximum

15

0

10 km

Analyses Gonzalez and Verkerke 2026



Fire Frequency 2100

Potential

Reduced Emissions Scenario RCP8.5

Low Rainfall Projection

Lassen Volcanic National Park

California, USA

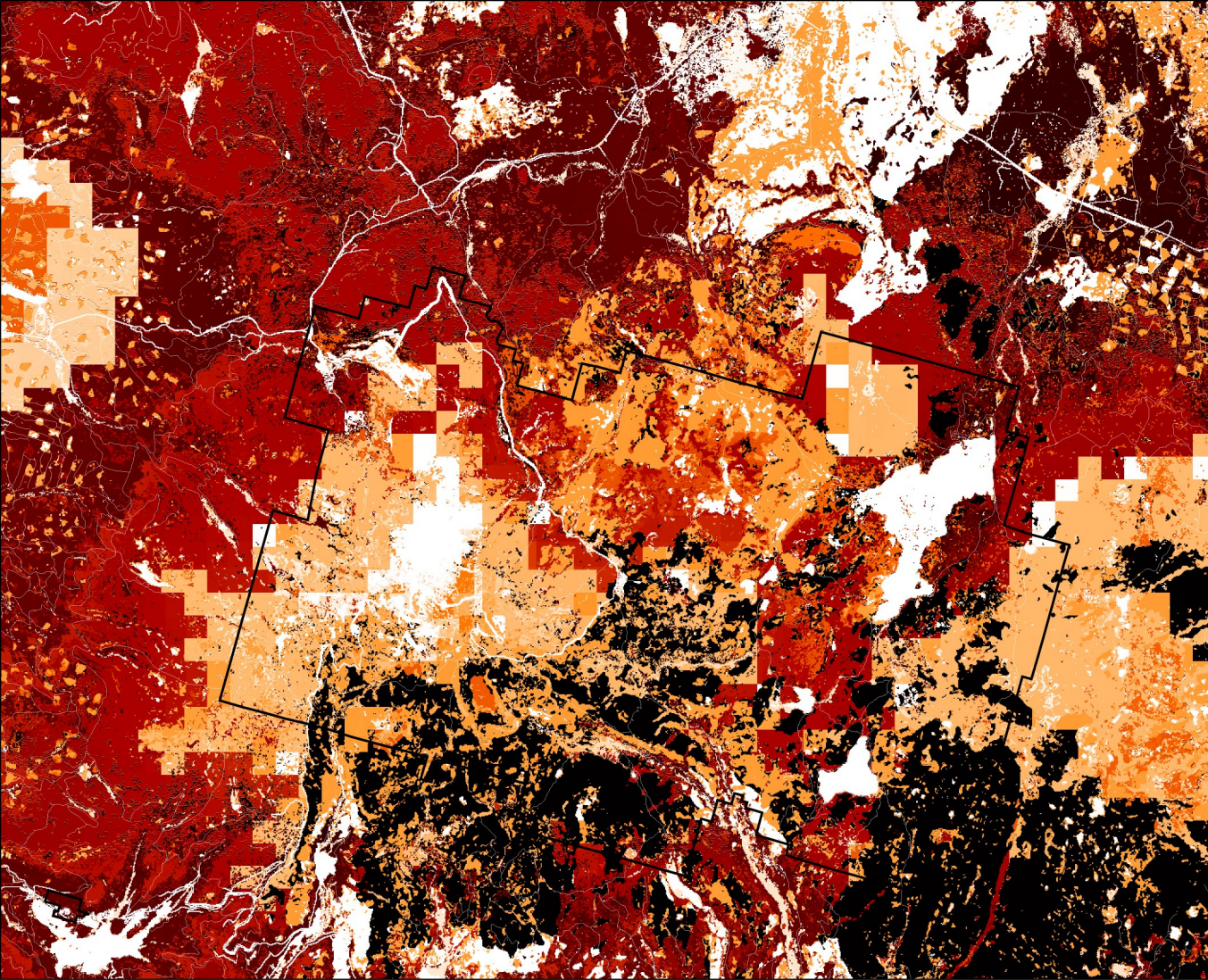
100 fires per century maximum

15

0

10 km

Analyses Gonzalez and Verkerke 2026



Projected Fire Frequency

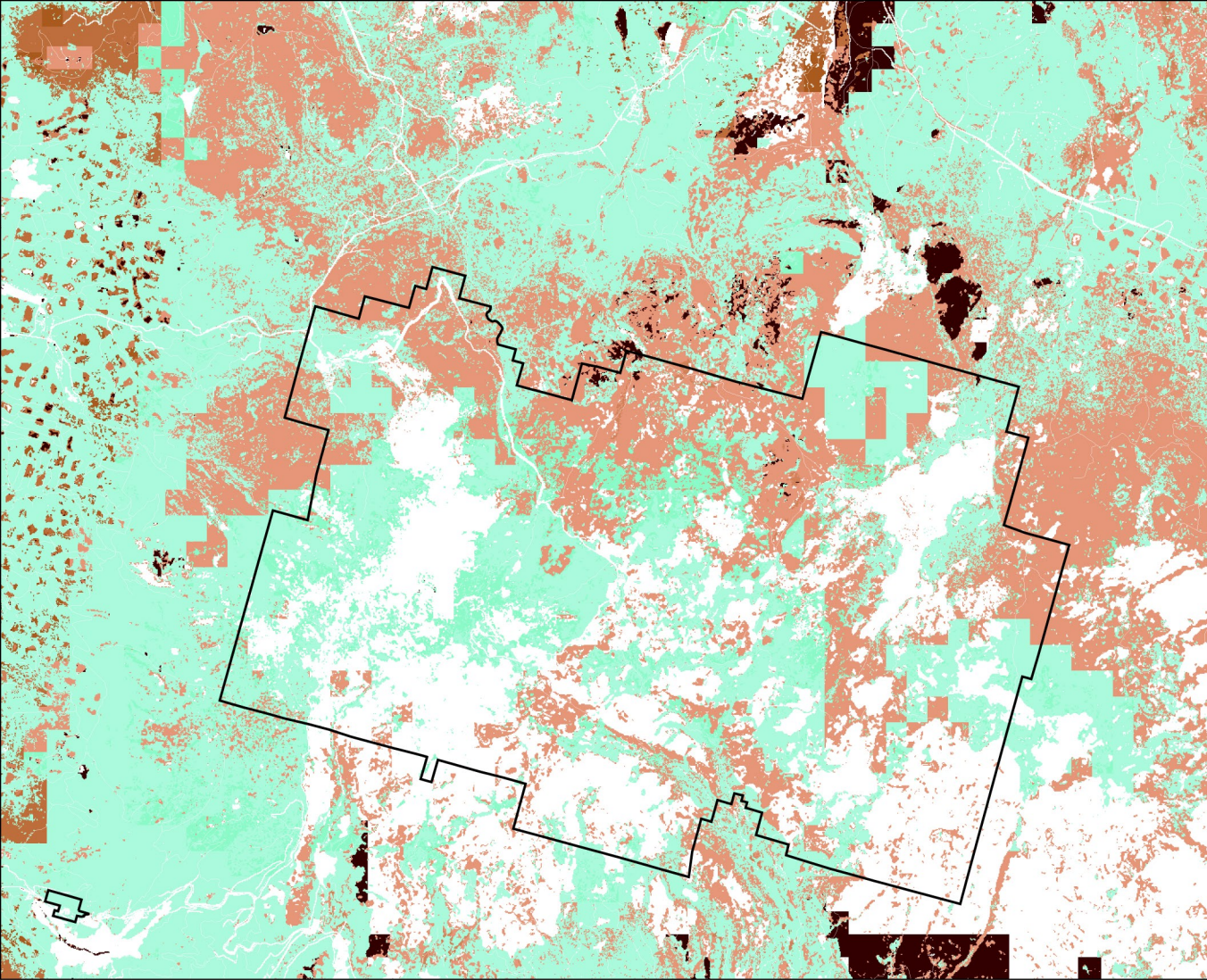
Change 1895-2100

Reduced Emissions Scenario RCP2.6

High Rainfall Projection

Lassen Volcanic National Park

California, USA



≥500%

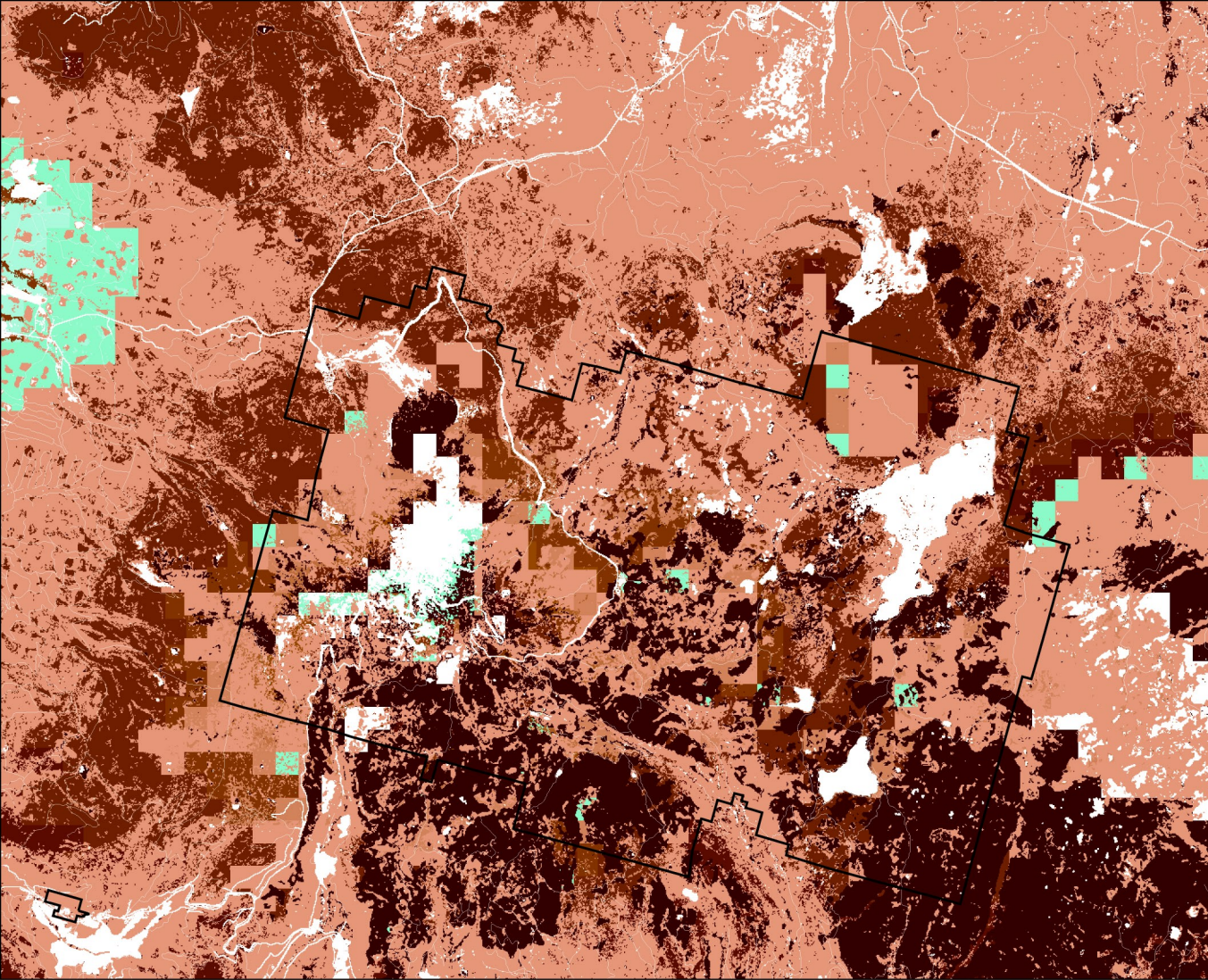
Fraction of 2023
Potential Fire Frequency

0%

-100%

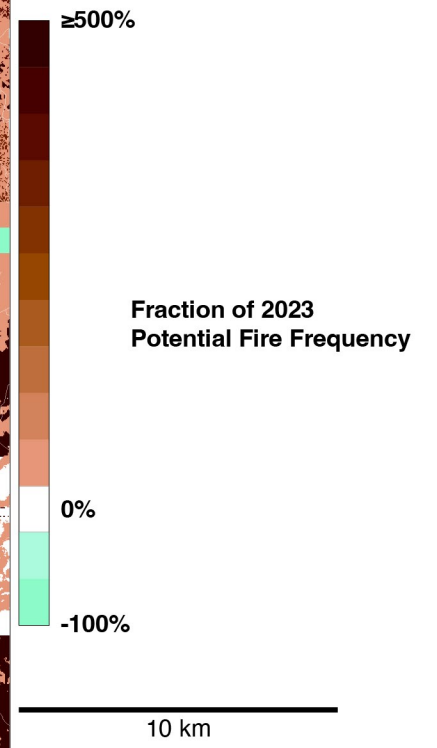
10 km

Analyses Gonzalez and Verkerke 2026



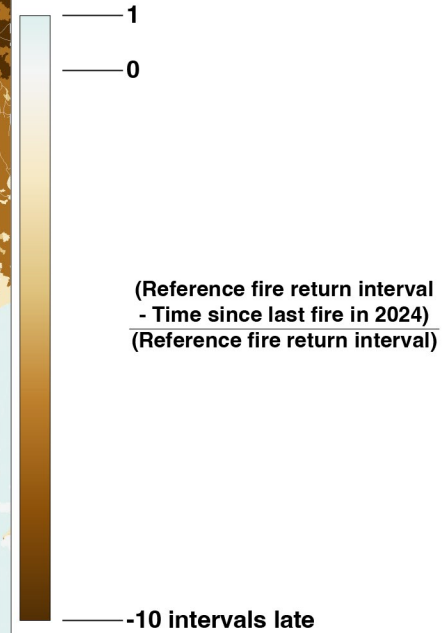
**Projected Fire Frequency
Change 1895-2100**
Highest Emissions Scenario RCP8.5
Low Rainfall Projection

Lassen Volcanic National Park
California, USA



Fire Return Interval Departure 2024 compared to 1849

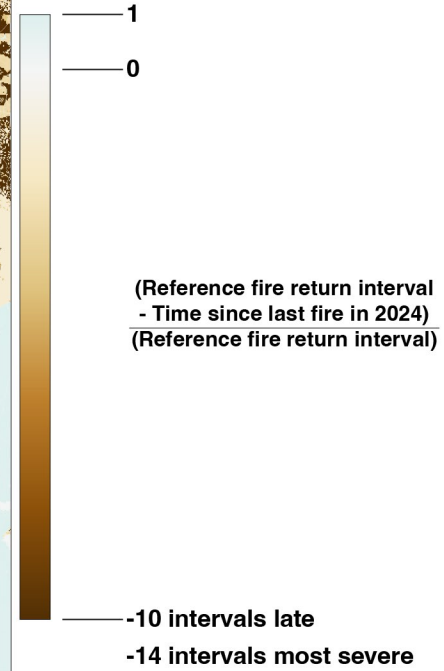
Lassen Volcanic National Park
California, USA



10 km

Fire Return Interval Departure 2024 actual vs. potential

Lassen Volcanic National Park
California, USA

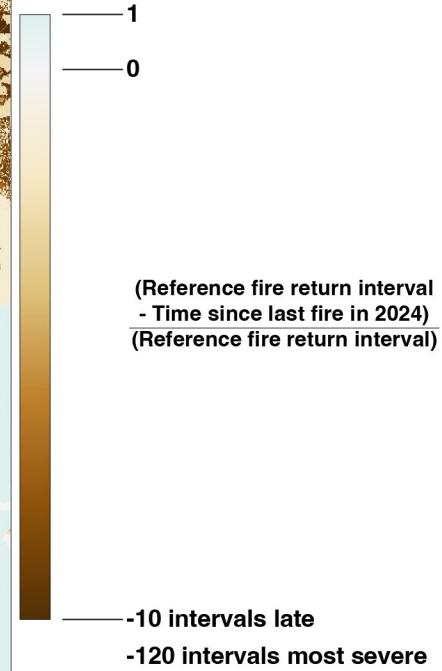


10 km

Fire Return Interval Departure 2024 compared to 2100

Reduced Emissions Scenario RCP2.6
High Rainfall Projection

Lassen Volcanic National Park
California, USA

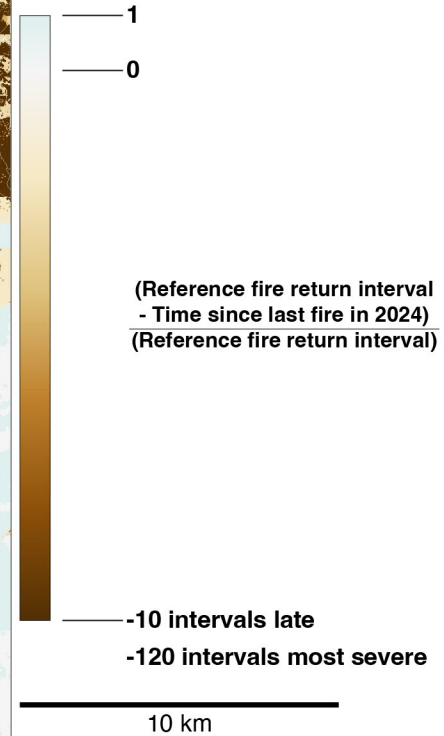
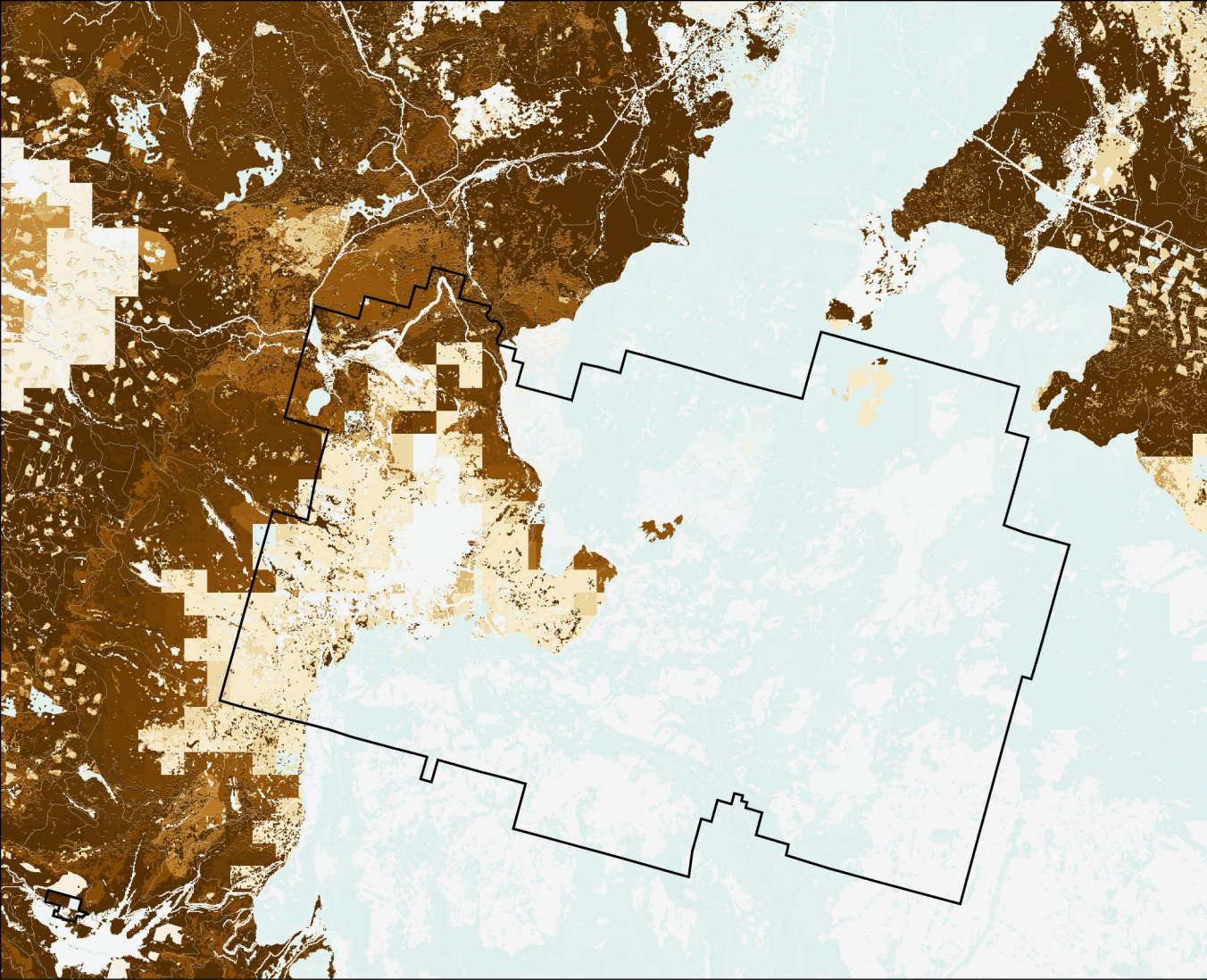


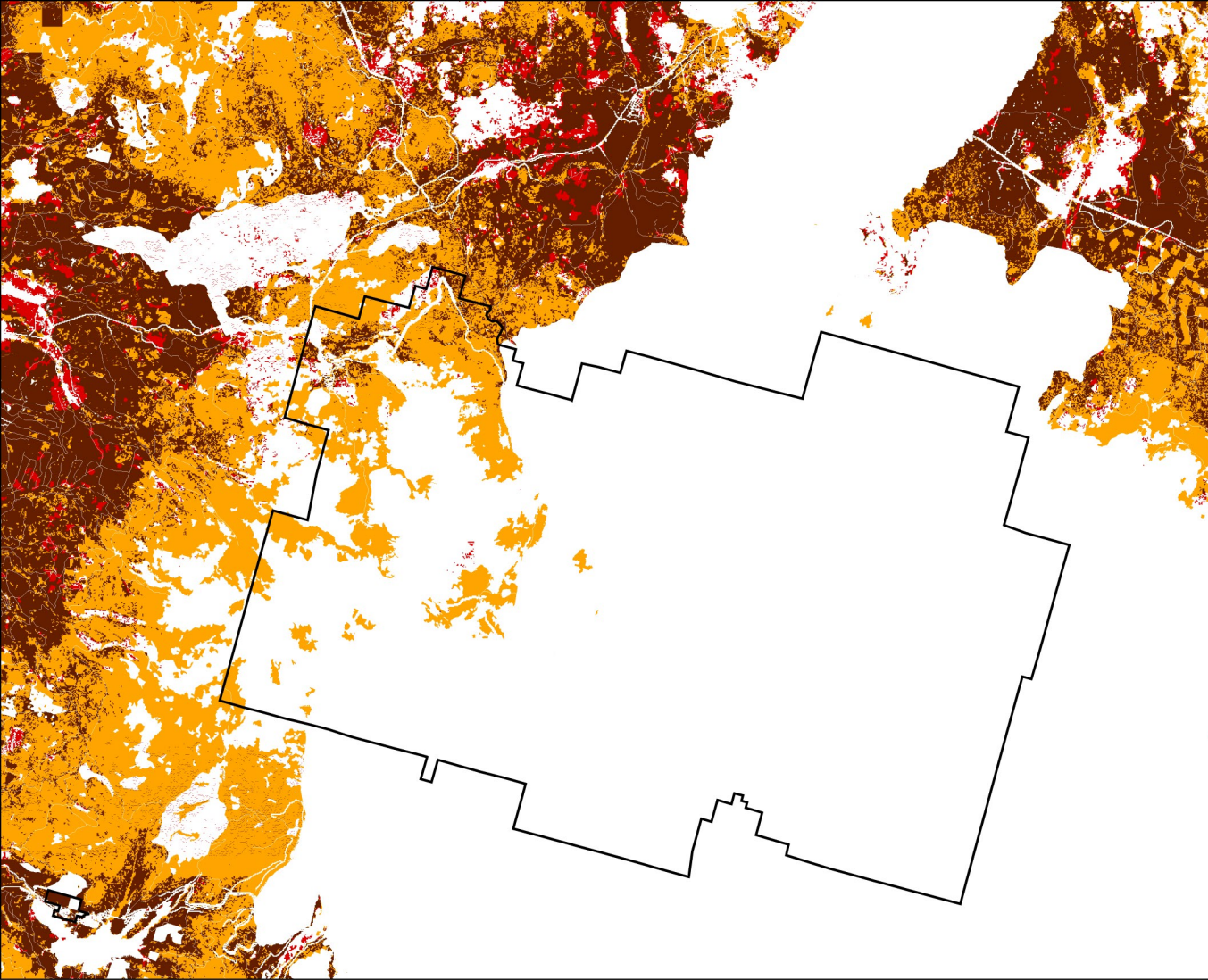
10 km

Fire Return Interval Departure 2024 compared to 2100

Highest Emissions Scenario RCP8.5
Low Rainfall Projection

Lassen Volcanic National Park
California, USA





Severe Fire Risk Areas

2024-2100

Reduced Emissions Scenario RCP2.6

High Rainfall Projection

Lassen Volcanic National Park

California, USA



Overlap
1849 and 2100



2100 only



Fire Return Interval Departure
(FRID) in 2024 $\leq$ -5 Intervals
Compared to Reference Year

1849 only



FRID > -5 Intervals
1849 and 2100



10 km

Severe Fire Risk Areas

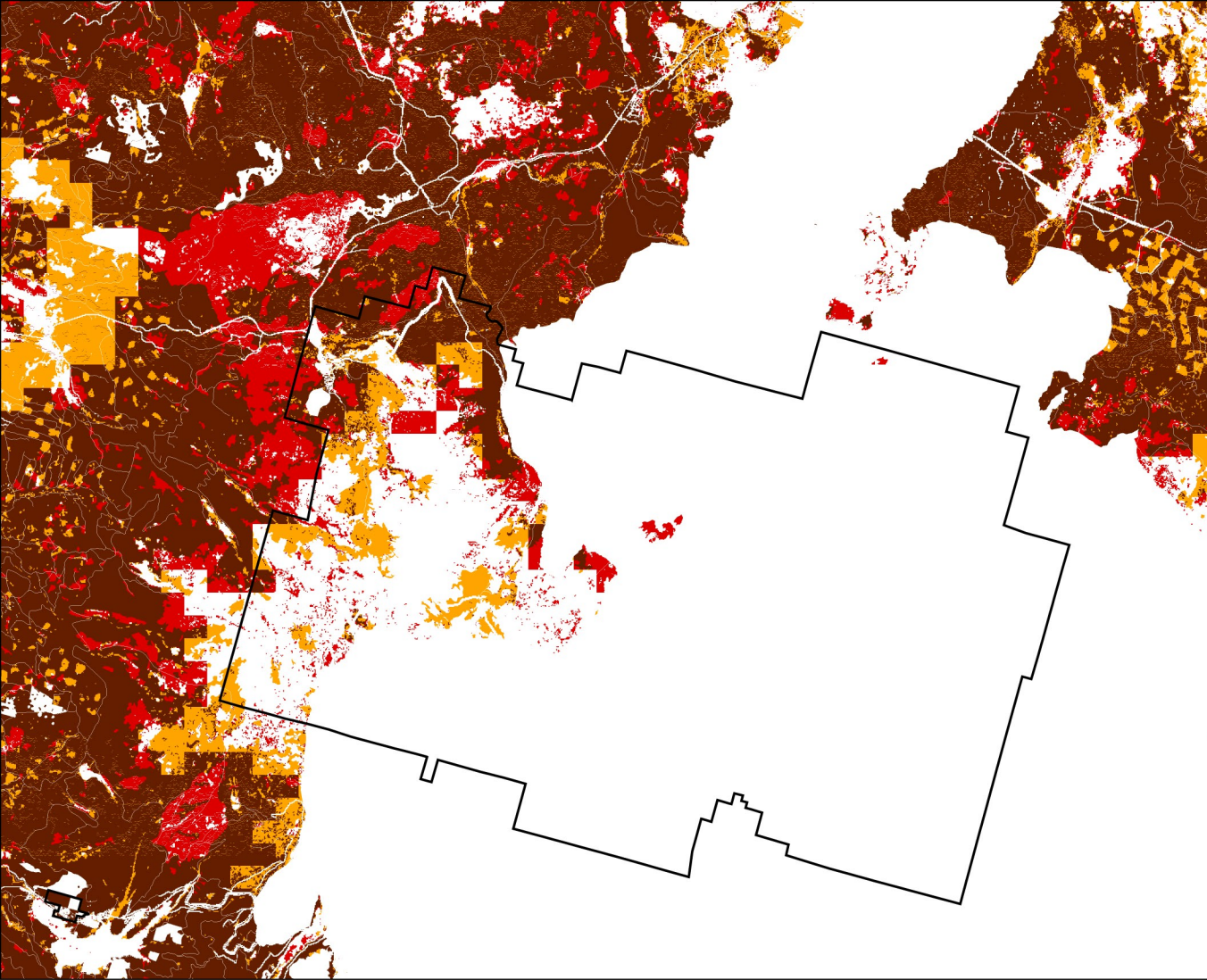
2024-2100

Highest Emissions Scenario RCP8.5

Low Rainfall Projection

Lassen Volcanic National Park

California, USA



Overlap
1849 and 2100

2100 only

Fire Return Interval Departure
(FRID) in 2024 $\leq$ -5 Intervals
Compared to Reference Year

1849 only

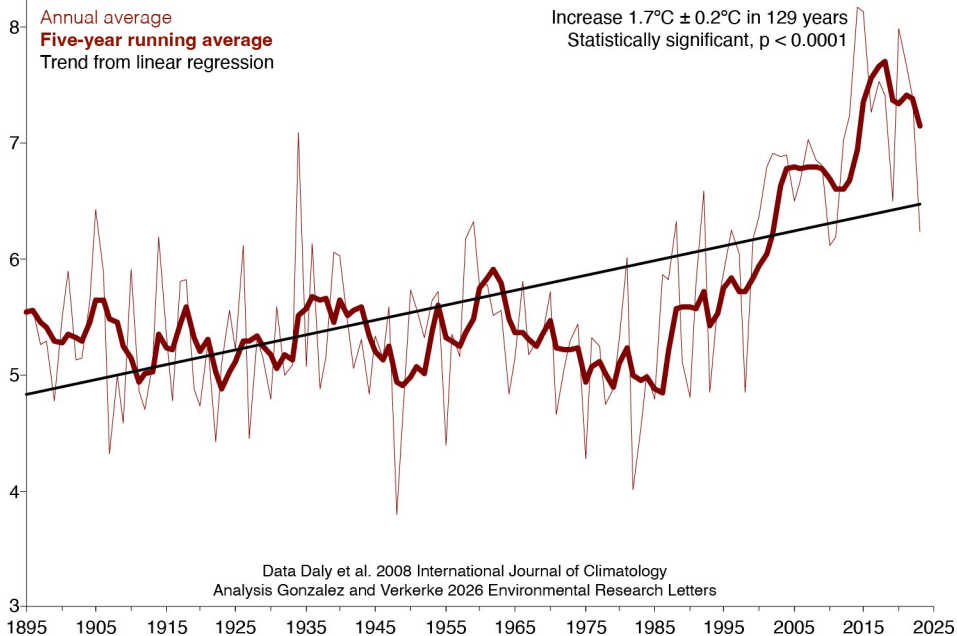
FRID $>$ -5 Intervals
1849 and 2100

10 km

Average Annual Temperature 1895-2023

Lassen Volcanic National Park, California, USA

Area within park boundaries



Total Annual Precipitation 1895-2023

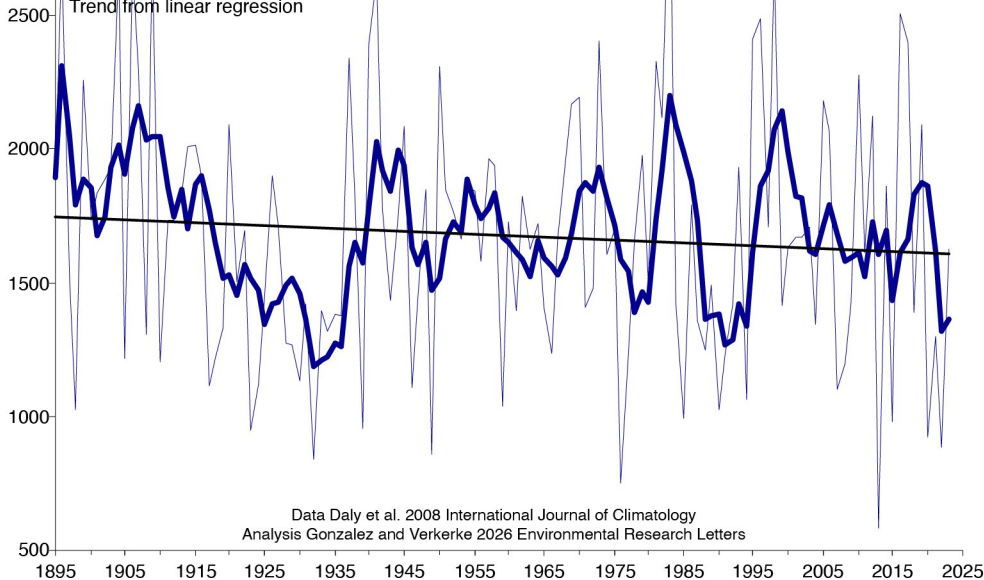
Lassen Volcanic National Park, California, USA

Area within park boundaries

3000 mm y⁻¹

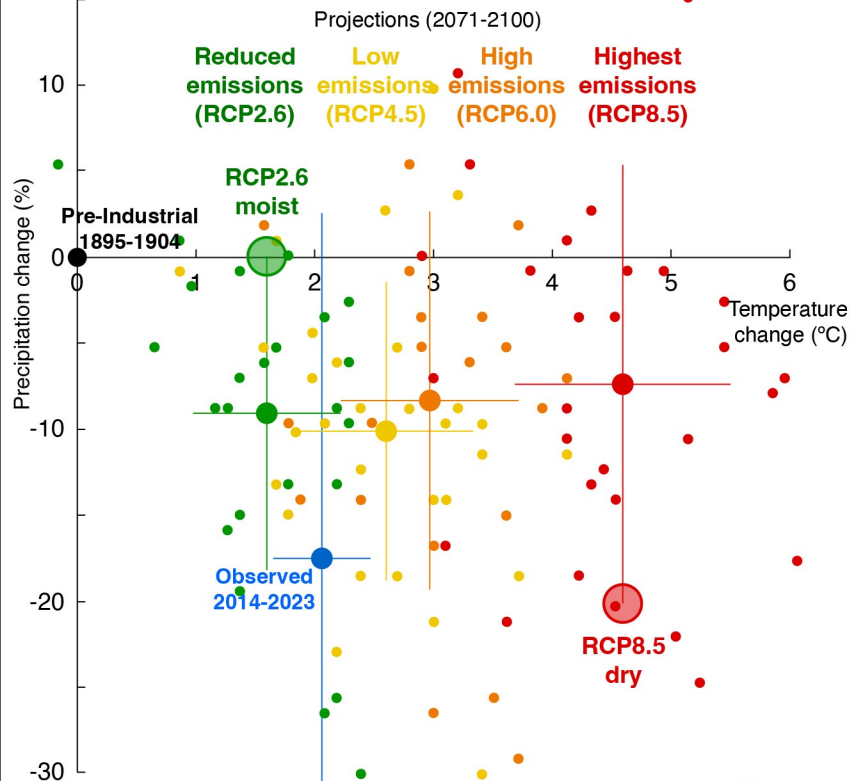
Annual average
Five-year running average
Trend from linear regression

Decrease $8 \pm 9\%$ in 129 years
Not statistically significant, $p = 0.3538$



Climate Change

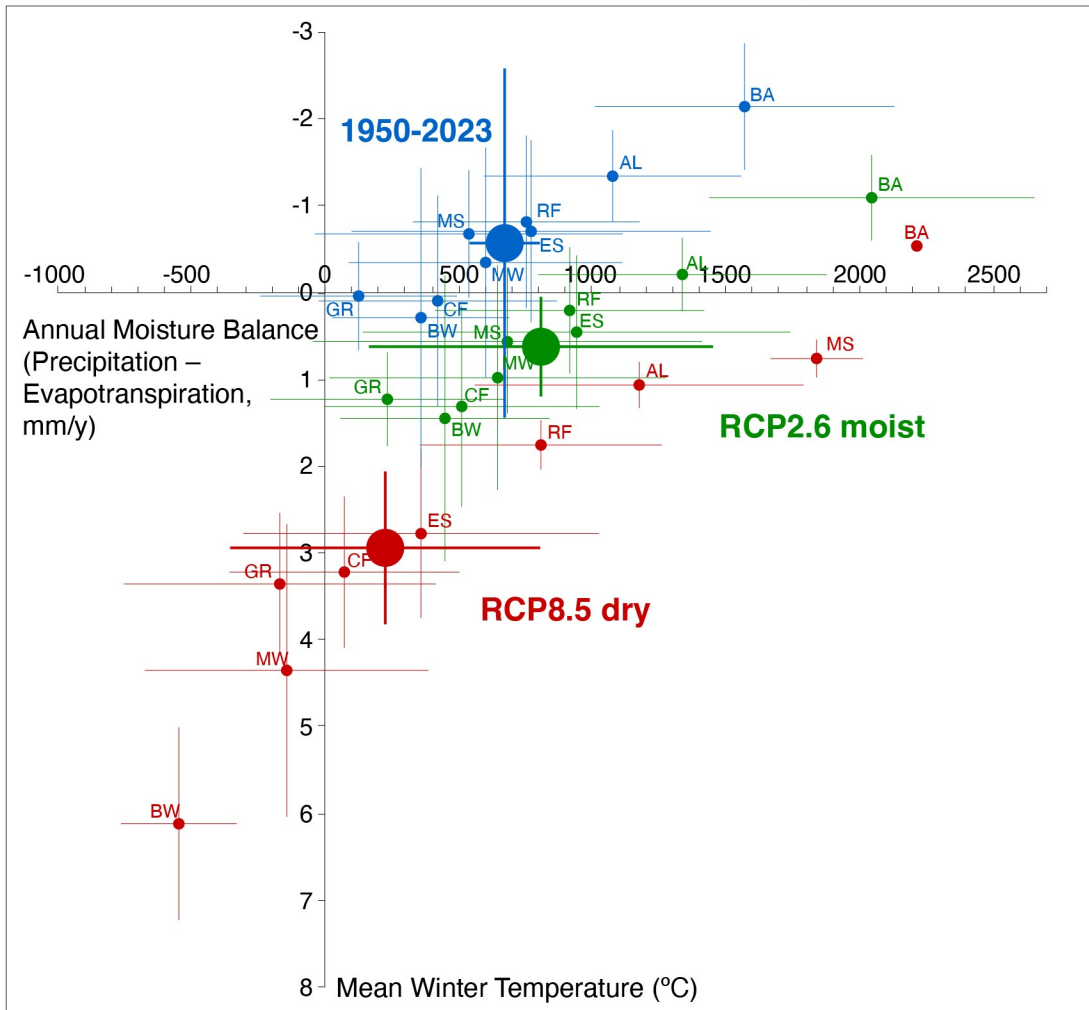
Lassen Volcanic National Park, California, USA
Change from Pre-Industrial (1895-1904)



Biome Climate Shifts

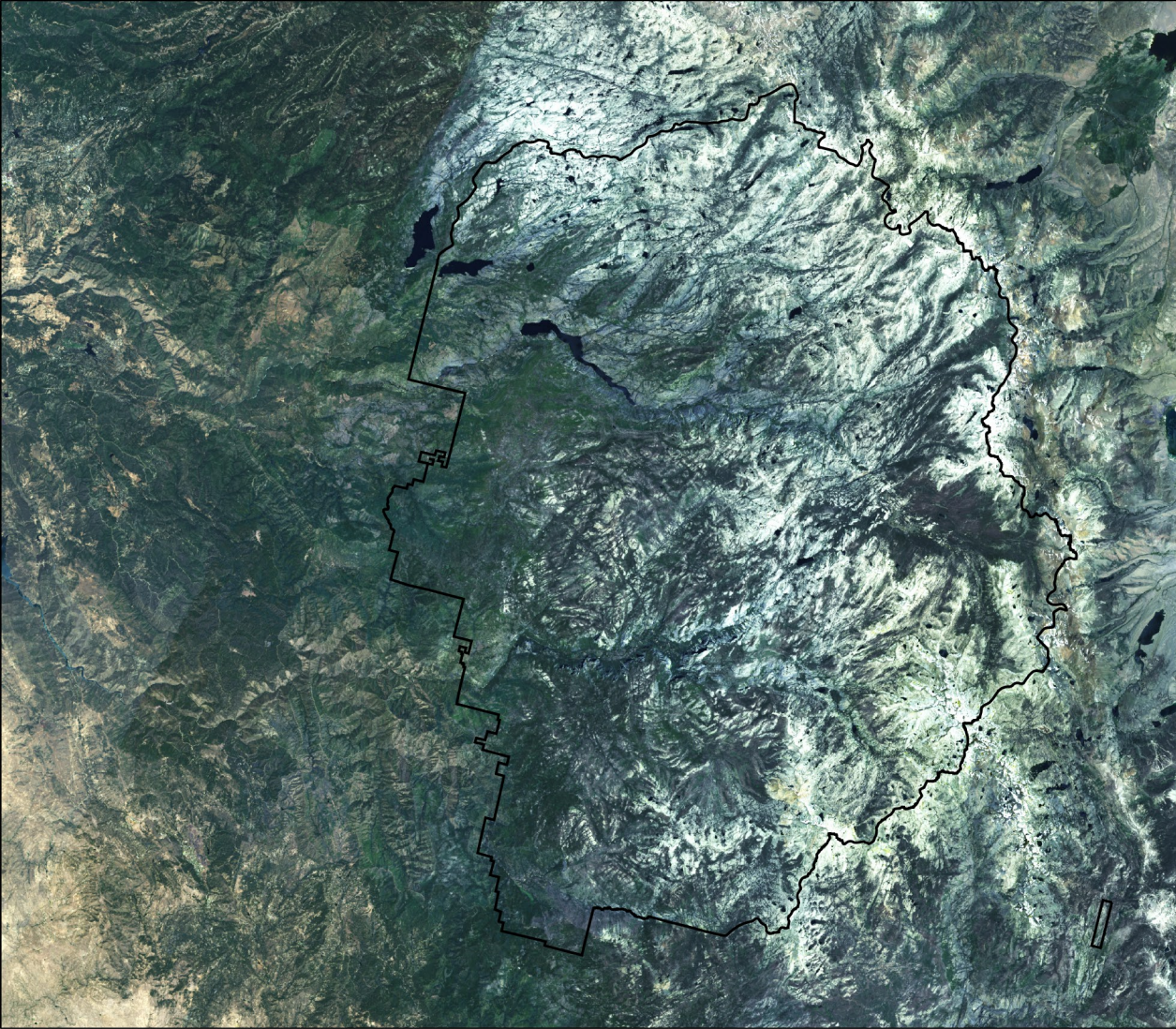
Lassen research area, California, USA

Gonzalez and Verkerke 2026 Environmental Research Letters



Yosemite National Park
California, USA

July 7-8, 2025
Landsat Real Color Mosaic

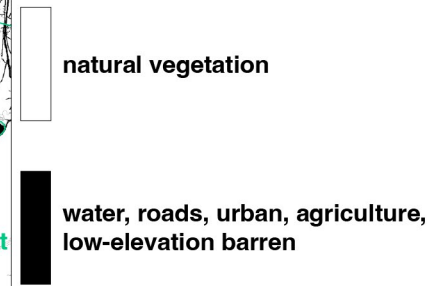
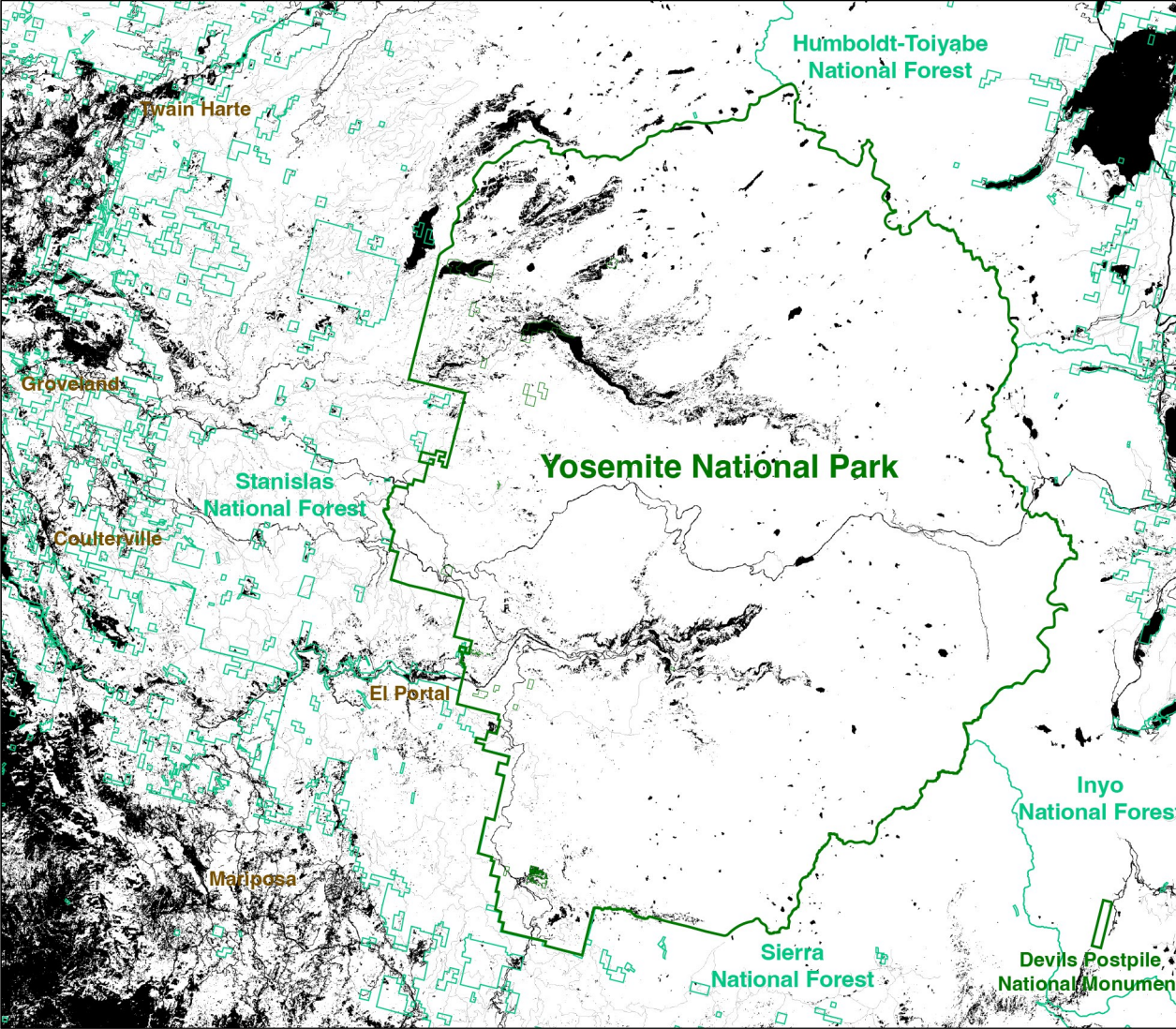


25 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

Yosemite Research Area

California, USA

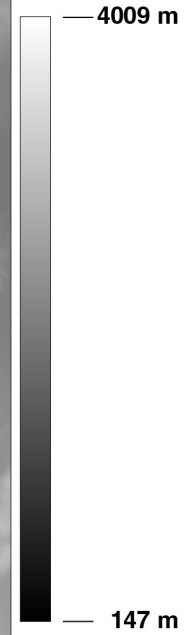


25 km
Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026



Elevation

Yosemite National Park
California, USA



25 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

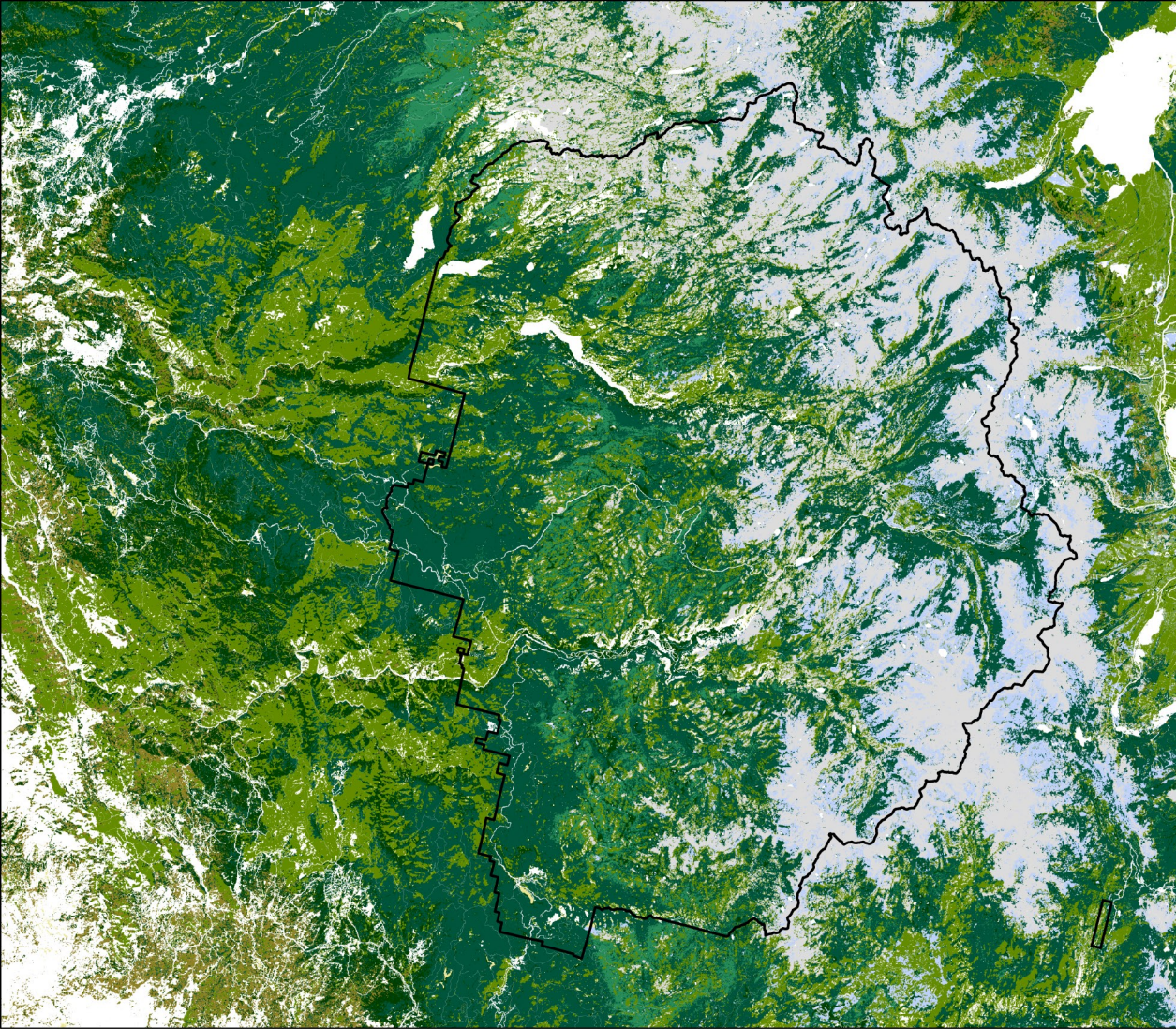
Vegetation Biomes 2023

Yosemite National Park
California, USA

- High-elevation barren land
- Alpine
- Evergreen and deciduous shrubs
- Red fir forest
- Conifer forest
- Evergreen shrubs
- Broadleaf woodland
- Deciduous and evergreen woodland
- Grassland
- water, roads, urban, agriculture, low-elevation barren

25 km

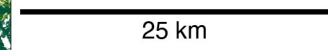
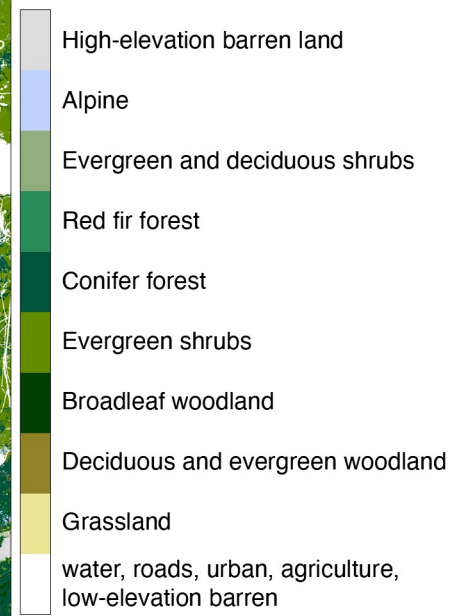
Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026



Vegetation Biomes 2100

Reduced Emissions Scenario RCP2.6
High Rainfall Projection

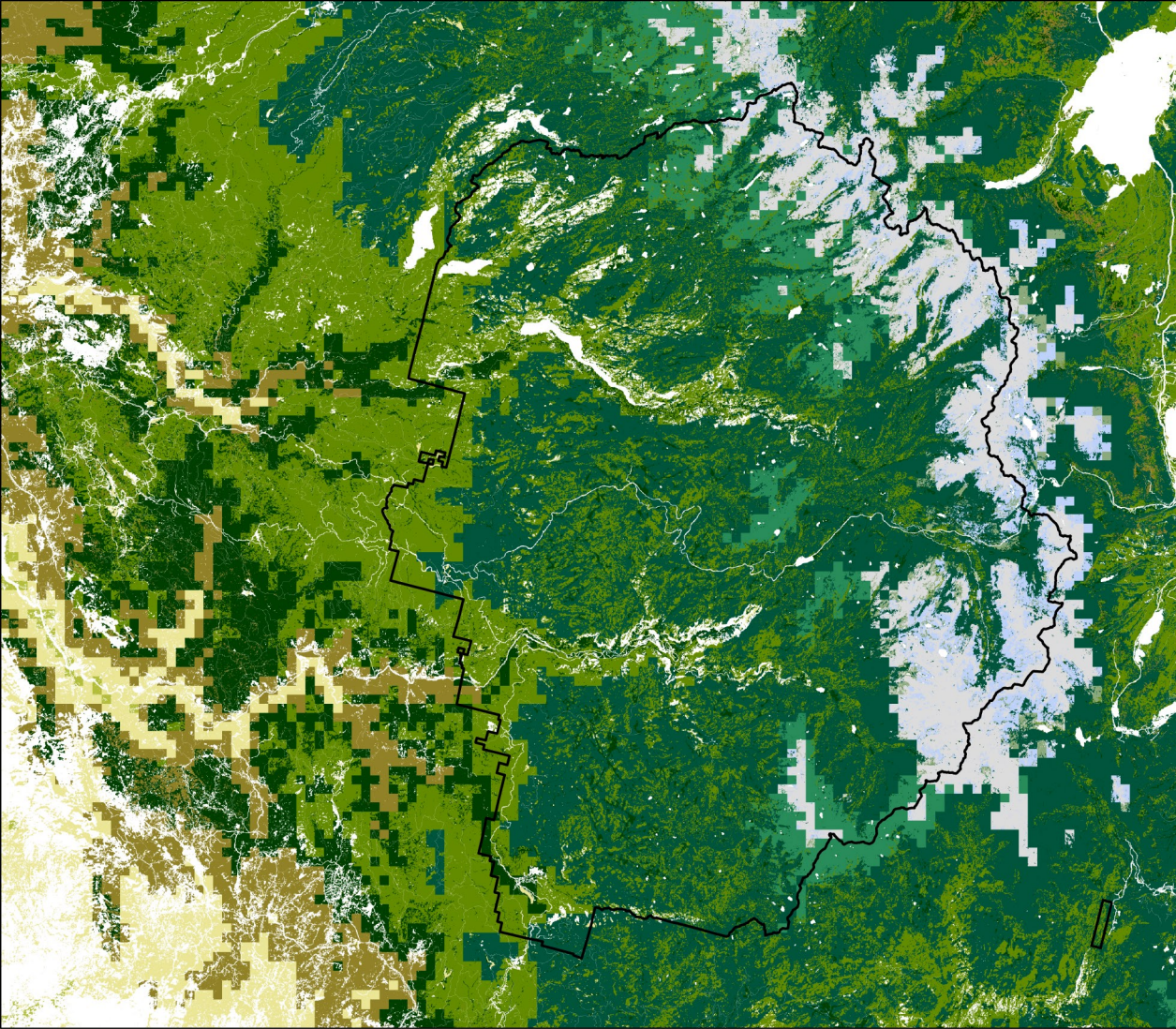
Yosemite National Park
California, USA



Vegetation Biomes 2100

Highest Emissions Scenario RCP8.5
Low Rainfall Projection

Yosemite National Park
California, USA

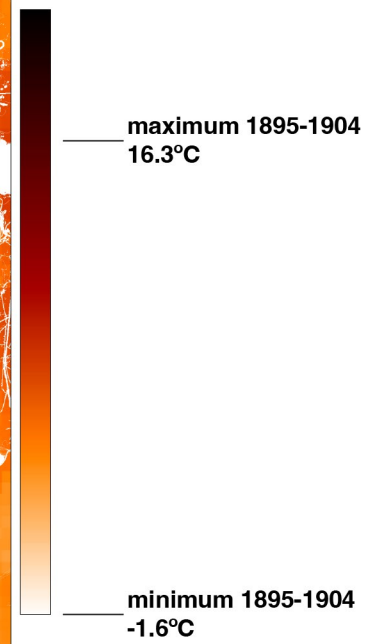


- High-elevation barren land
- Alpine
- Evergreen and deciduous shrubs
- Red fir forest
- Conifer forest
- Evergreen shrubs
- Broadleaf woodland
- Deciduous and evergreen woodland
- Grassland
- Deciduous shrubs
- water, roads, urban, agriculture, low-elevation barren

25 km

Average Annual Temperature 1895-1904

Yosemite National Park
California, USA

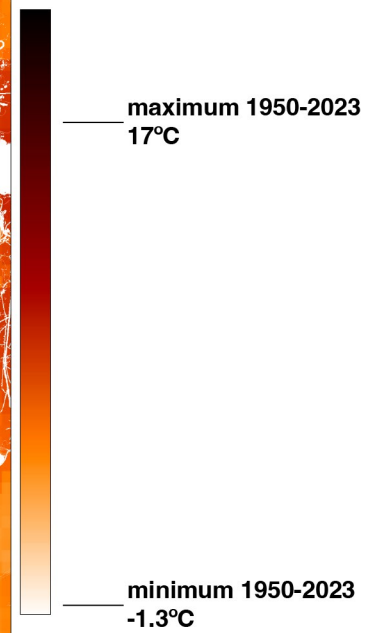


25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Average Annual Temperature 1950-2023

Yosemite National Park
California, USA



25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Average Annual Temperature 2014-2023

Yosemite National Park
California, USA

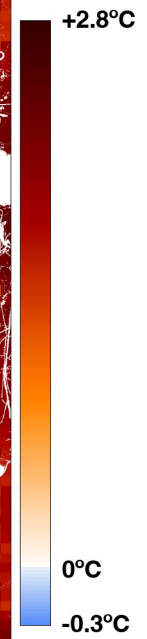


25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

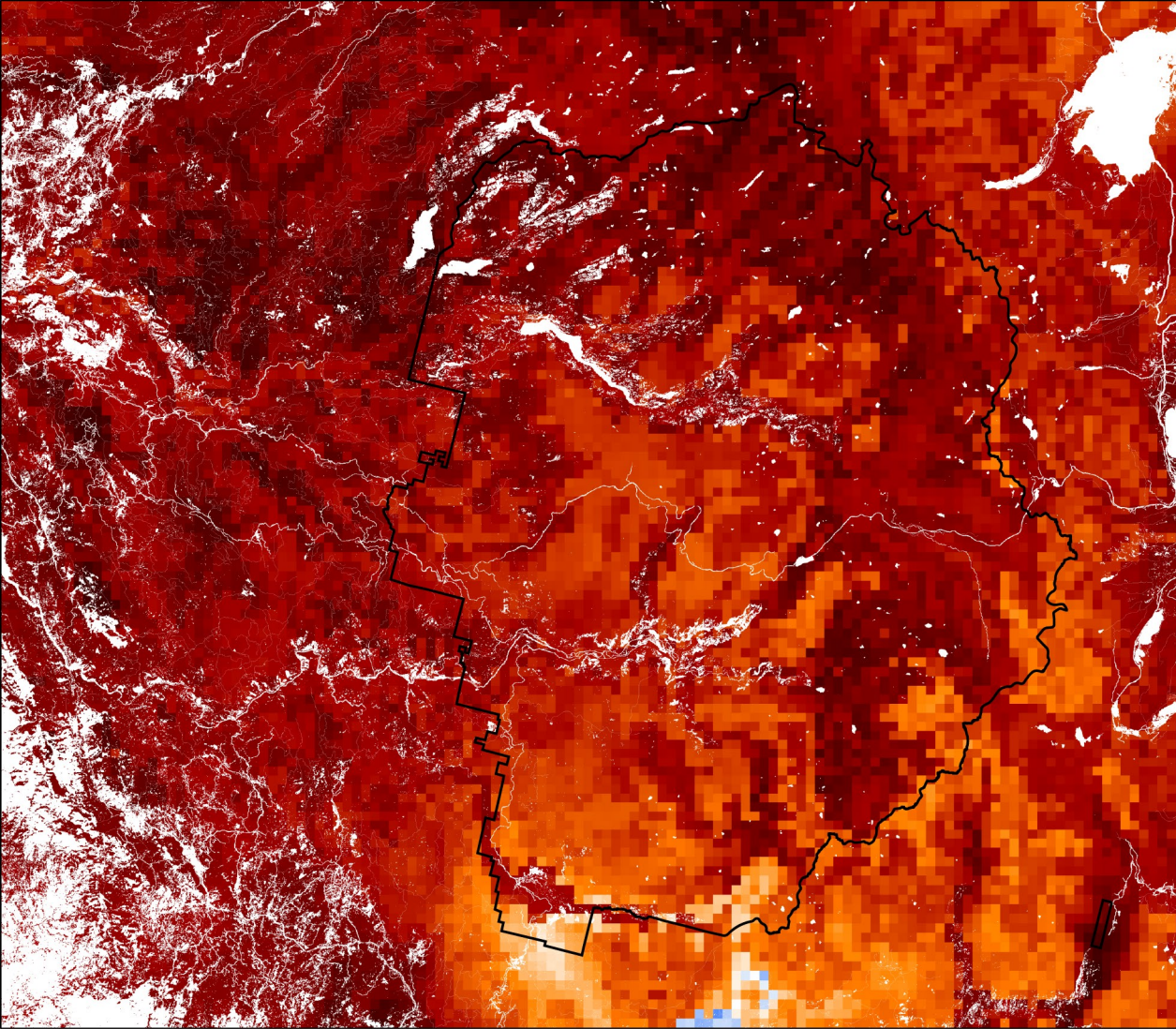
Observed Temperature Change 1895-1904–2014-2023

Yosemite National Park
California, USA



25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026



Average Annual Temperature 2071-2100

Reduced Emissions Scenario RCP2.6

Yosemite National Park
California, USA



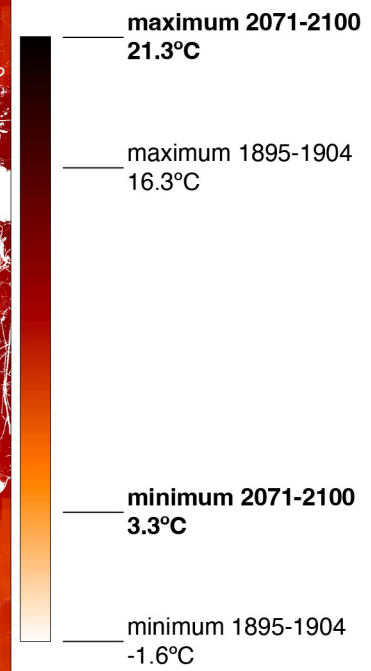
25 km

Data Gonzalez et al. 2018
Analyses Gonzalez and Verkerke 2026

Average Annual Temperature 2071-2100

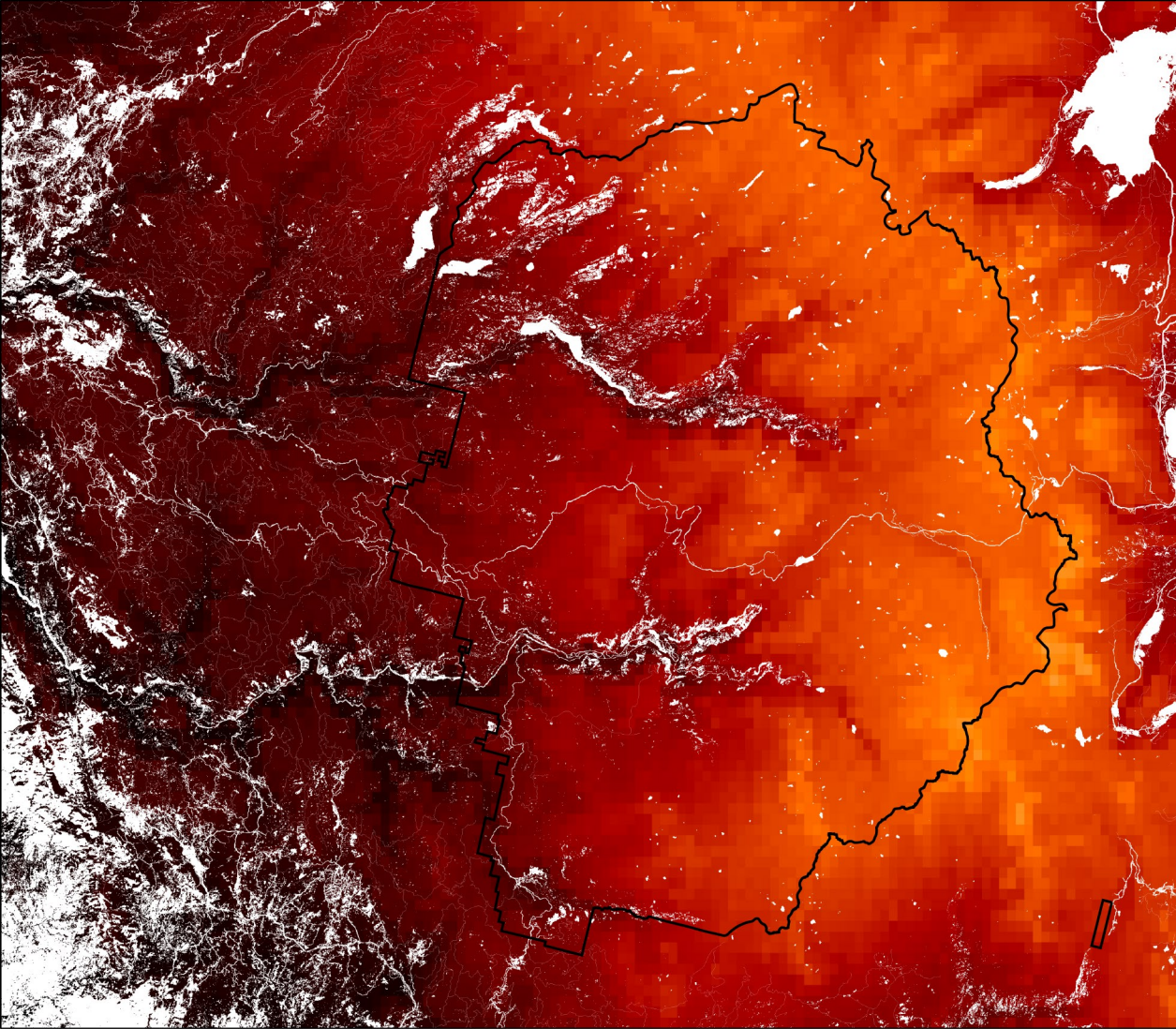
Highest Emissions Scenario RCP8.5

Yosemite National Park
California, USA



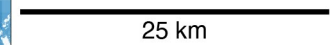
25 km

Data Gonzalez et al. 2018
Analyses Gonzalez and Verkerke 2026



Average Annual Precipitation 1950-2023

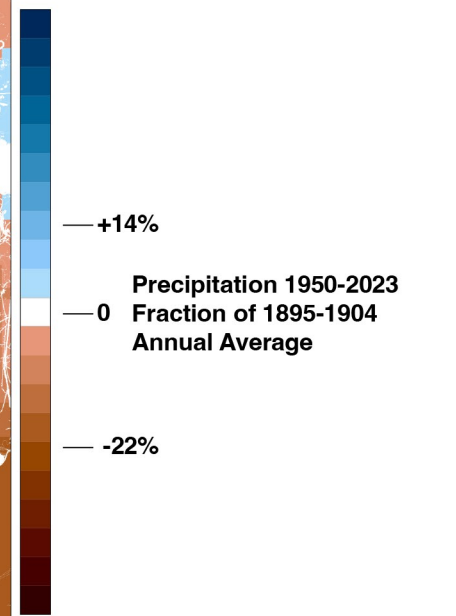
Yosemite National Park
California, USA



Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Observed Precipitation Change 1895-1904–1950-2023

Yosemite National Park
California, USA



Precipitation 1950-2023
Fraction of 1895-1904
Annual Average

25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

**Significant Precipitation
Change 1895-1904-1950-2023**
Summer

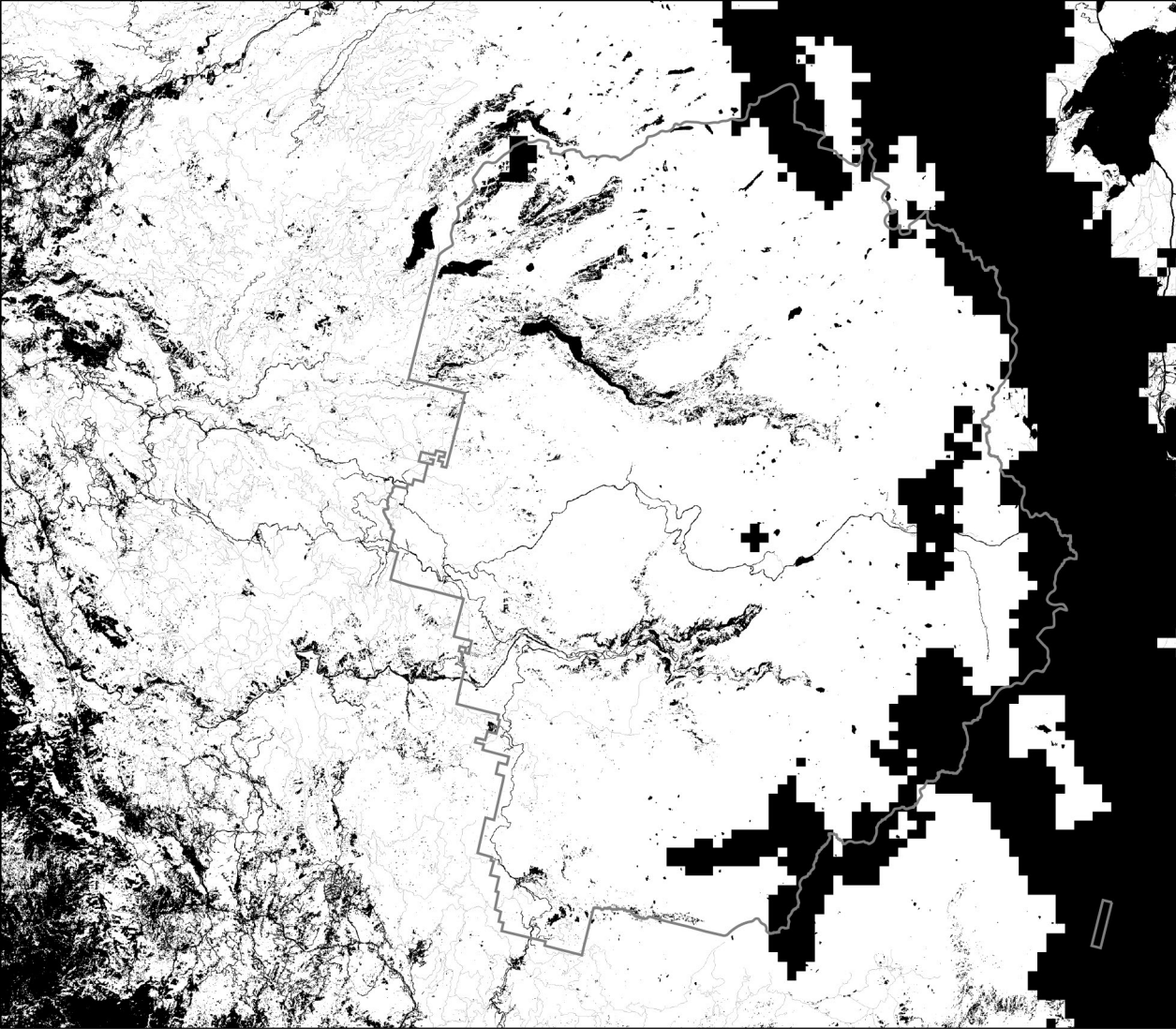
Yosemite National Park
California, USA

change statistically significant

change not statistically significant

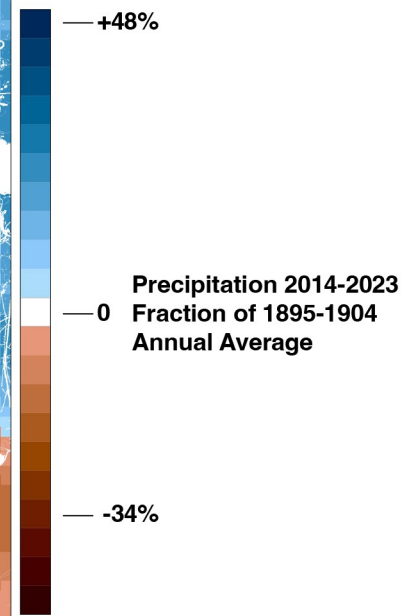
25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026



Observed Precipitation Change 1895-1904–2014-2023

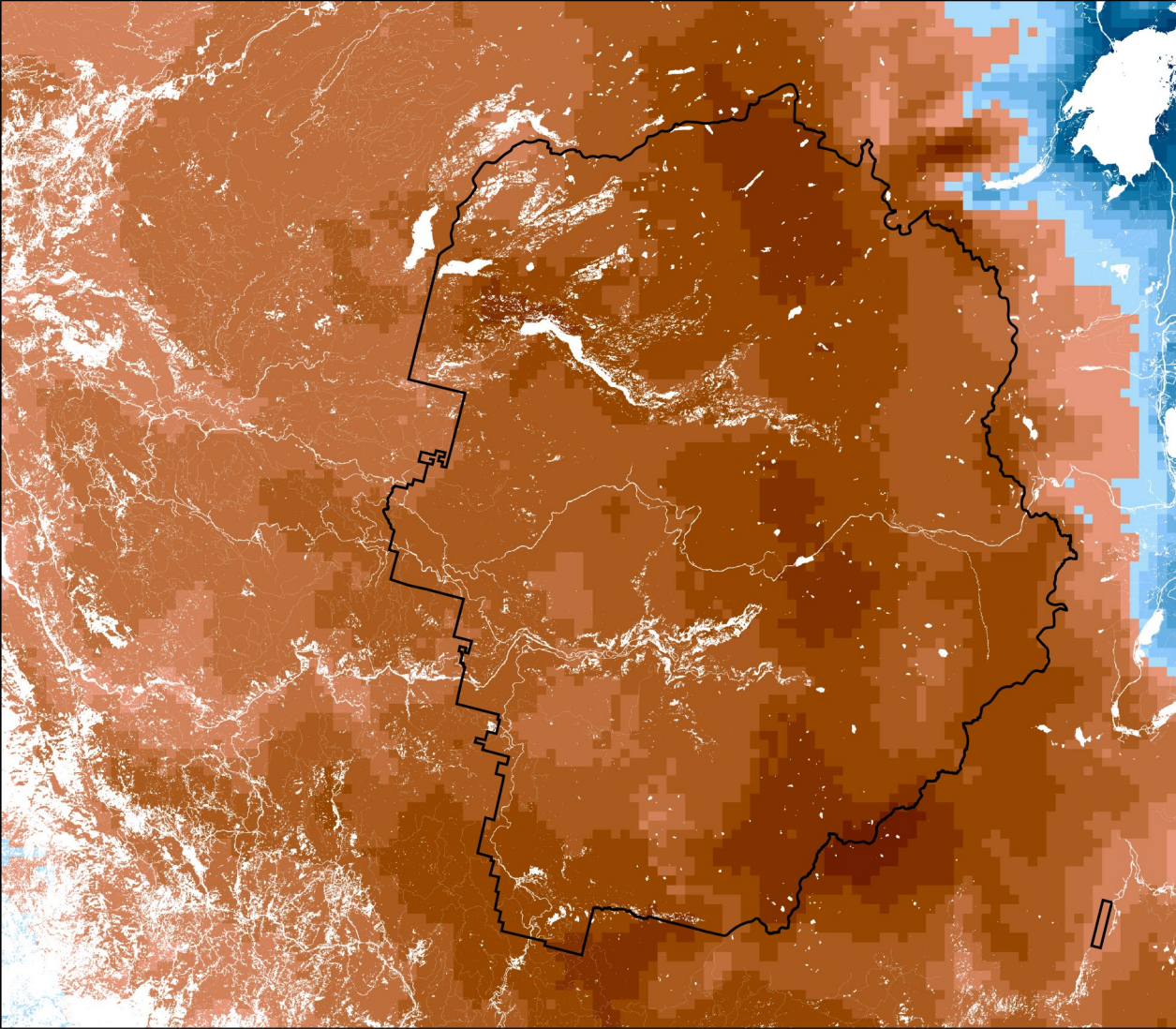
Yosemite National Park
California, USA



25 km

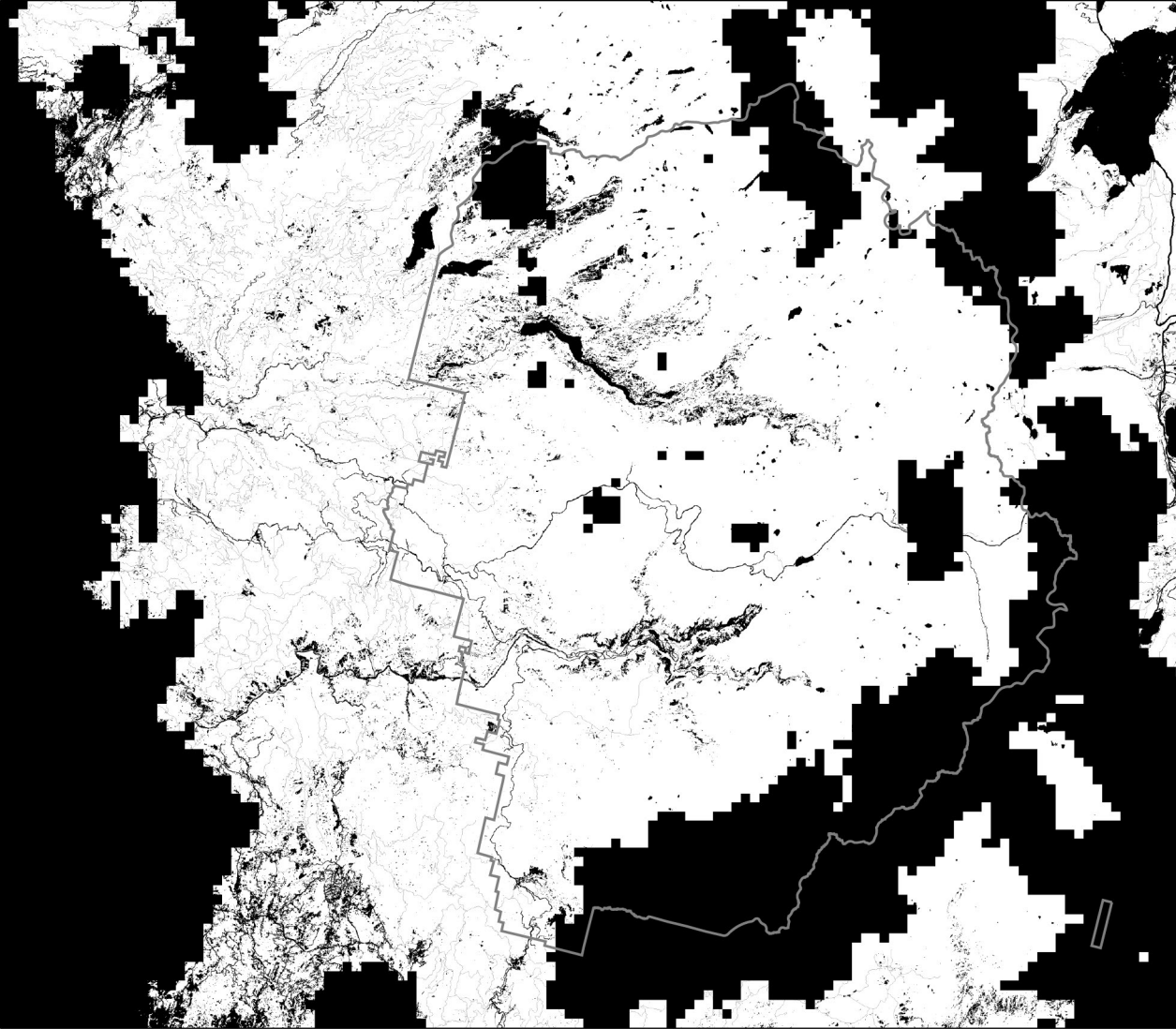
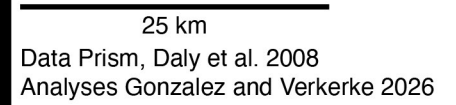
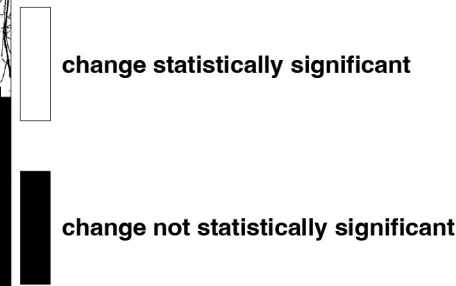
Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

This block contains a scale bar and source information. The scale bar is a horizontal line labeled '25 km'. Below it, the text reads 'Data Prism, Daly et al. 2008' and 'Analyses Gonzalez and Verkerke 2026'.



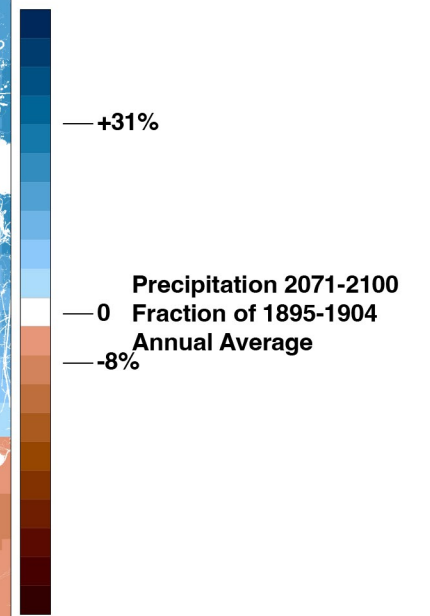
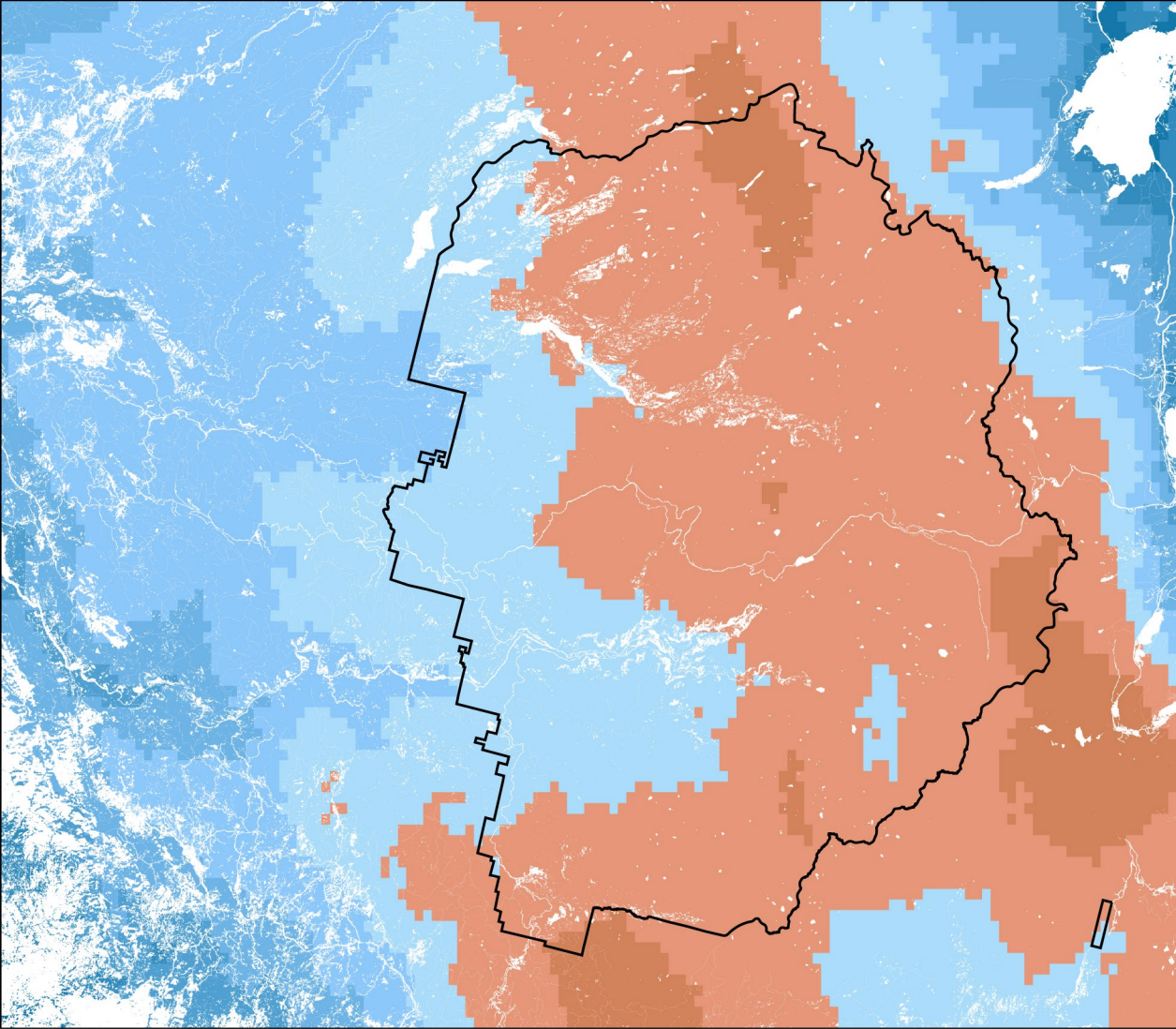
**Significant Precipitation
Change 1895-1904–2014-2023**
Summer

Yosemite National Park
California, USA



**Projected Precipitation
Change 1895-2100**
Reduced Emissions Scenario RCP2.6
High Rainfall Projection

Yosemite National Park
California, USA



25 km

Data Gonzalez et al. 2018
Analyses Gonzalez and Verkerke 2026

Projected Precipitation

Change 1895-2100

Highest Emissions Scenario RCP8.5

Low Rainfall Projection

Yosemite National Park

California, USA



Precipitation 2071-2100

— 0 Fraction of 1895-1904
Annual Average

— -29%

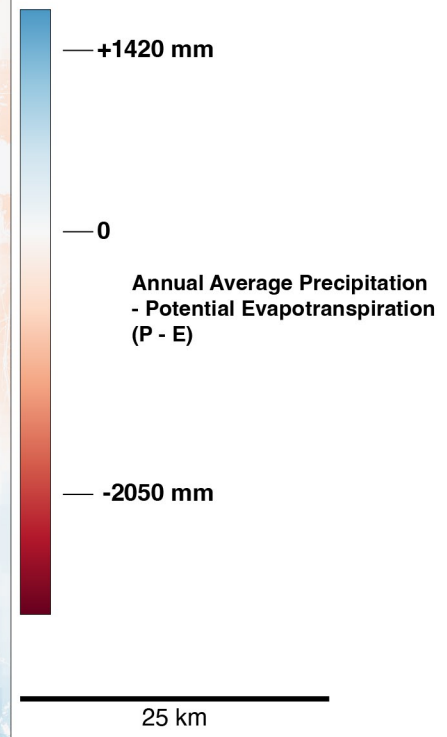
25 km

Data Gonzalez et al. 2018

Analyses Gonzalez and Verkerke 2026

Annual Moisture Balance 1950-2023

Yosemite National Park
California, USA



Annual Moisture Balance

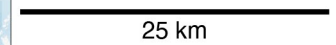
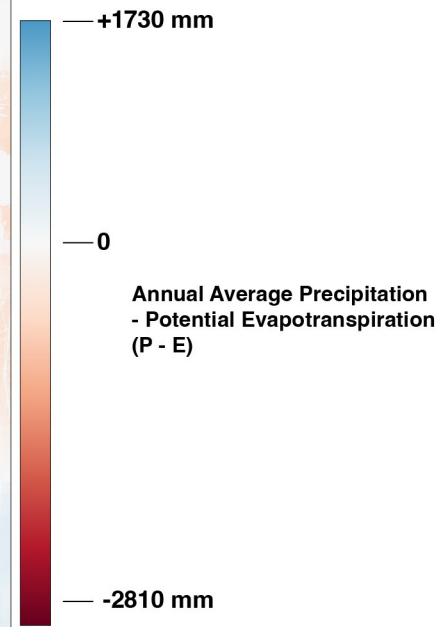
2071-2100

Reduced Emissions Scenario RCP2.6

High Rainfall Projection

Yosemite National Park

California, USA



Annual Moisture Balance

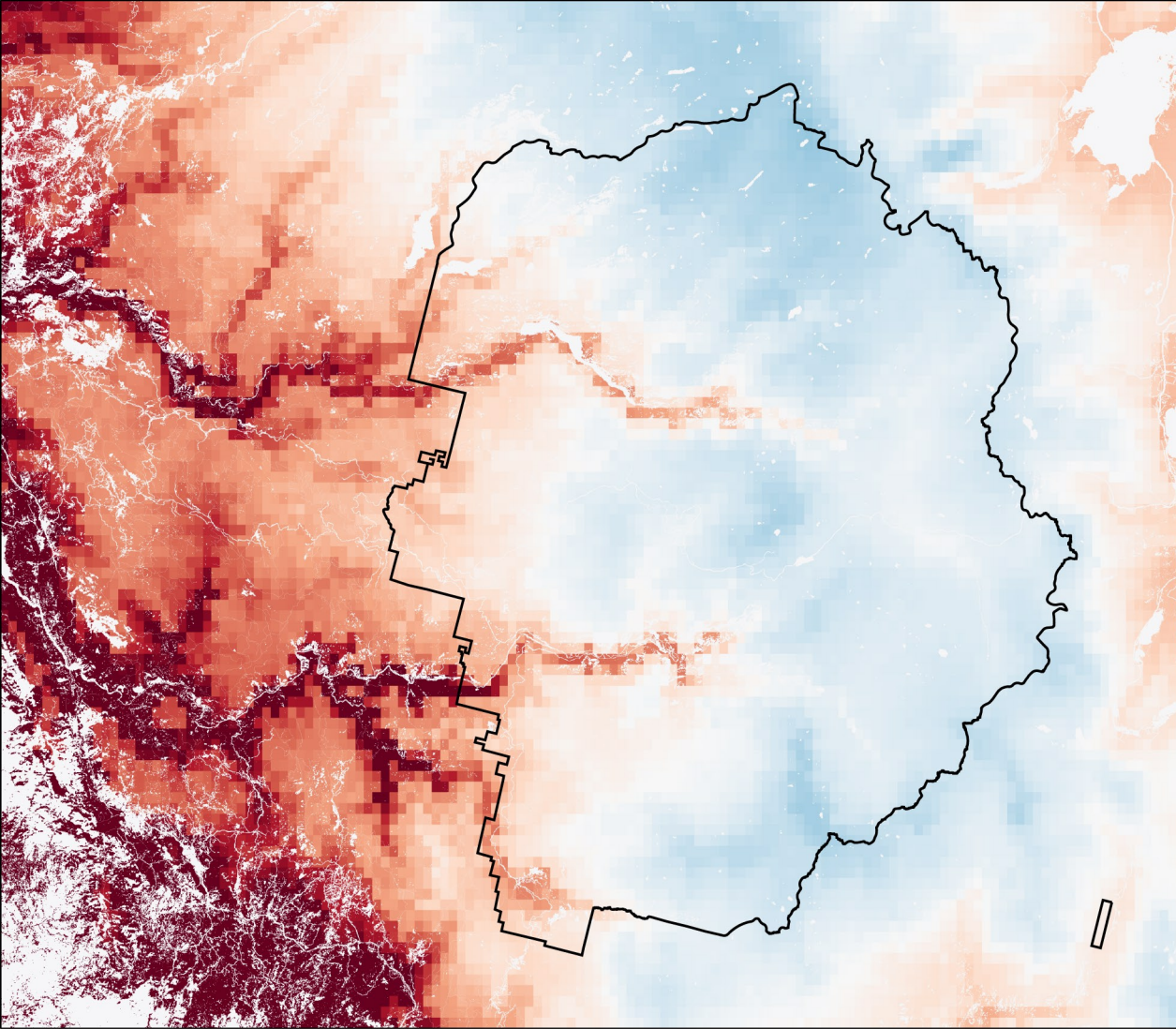
2071-2100

Highest Emissions Scenario RCP8.5

Low Rainfall Projection

Yosemite National Park

California, USA



— +1140 mm maximum

— 0

Annual Average Precipitation
- Potential Evapotranspiration
(P - E)

— -3000 mm

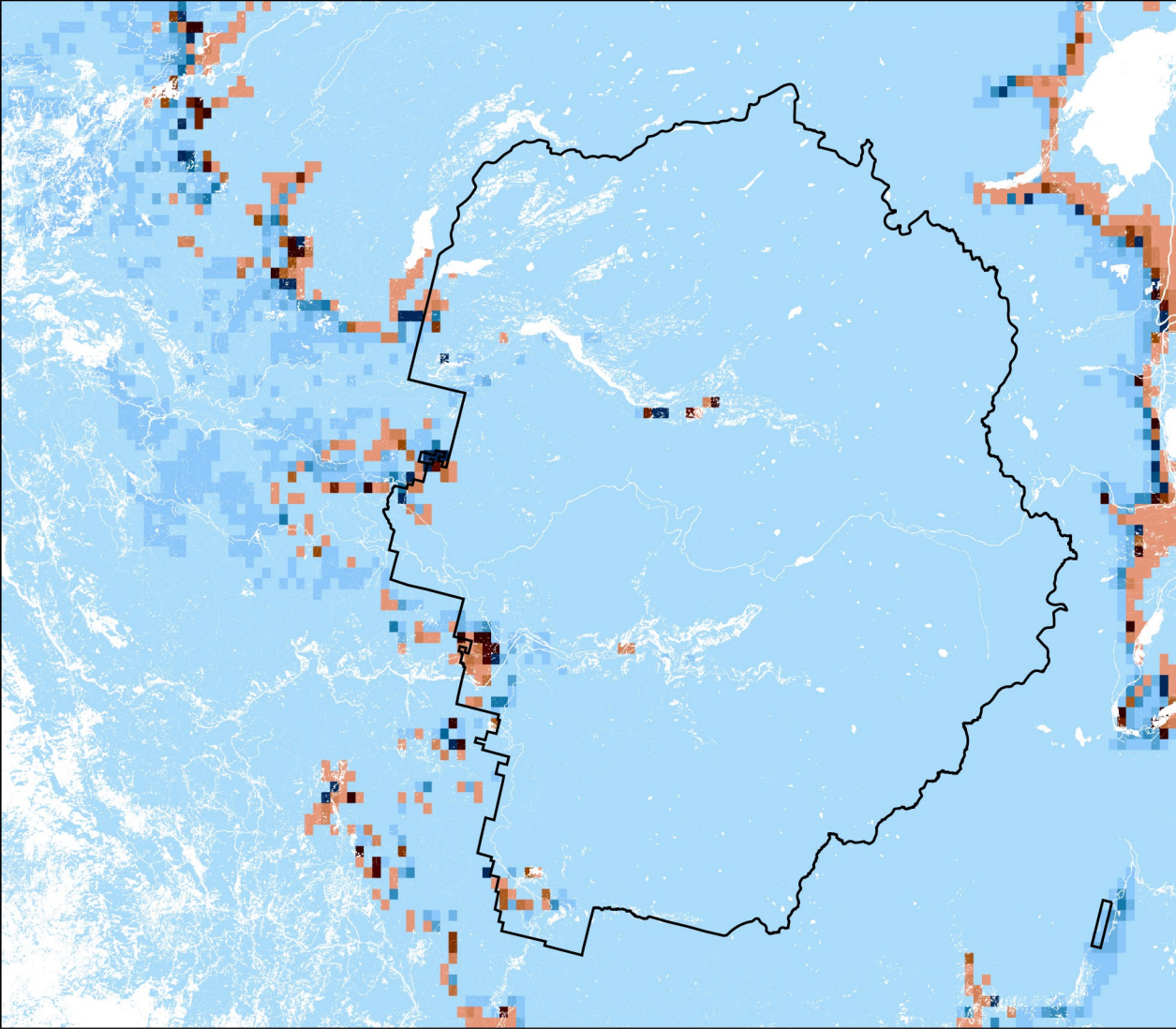
-6840 mm minimum

25 km

Projected Moisture Balance Change 1895-2100

Reduced Emissions Scenario RCP2.6
High Rainfall Projection

Yosemite National Park
California, USA



≥ +500%

Moisture Balance 2071-2100
Fraction of 1895-1904
Annual Average Precipitation
- Potential Evapotranspiration

0%

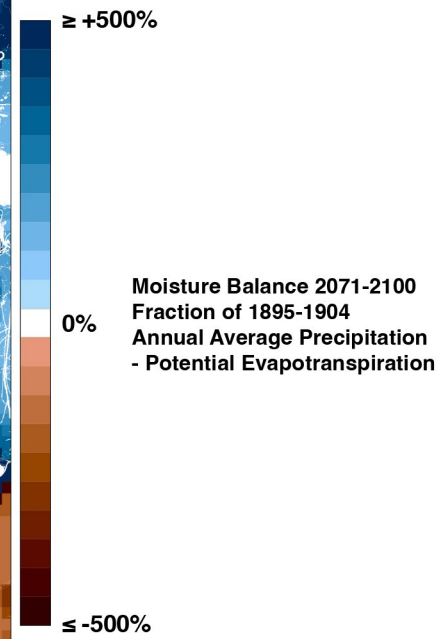
≤ -500%

25 km

Projected Moisture Balance Change 1895-2100

Highest Emissions Scenario RCP8.5
Low Rainfall Projection

Yosemite National Park
California, USA



25 km

Fire Frequency 1849

Potential
Based on Estimated Vegetation

Yosemite National Park
California, USA



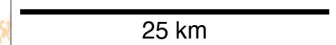
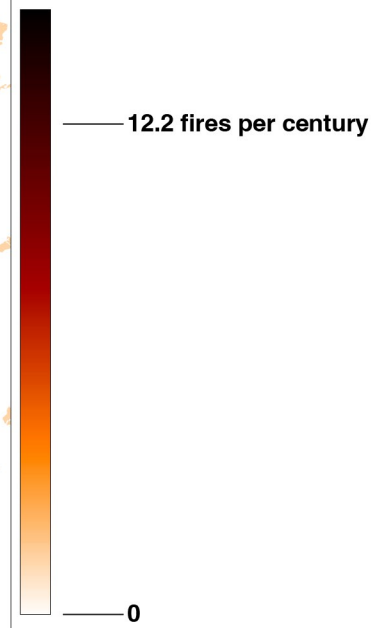
25 km

Data USDA Forest Service
Analyses Gonzalez and Verkerke 2026

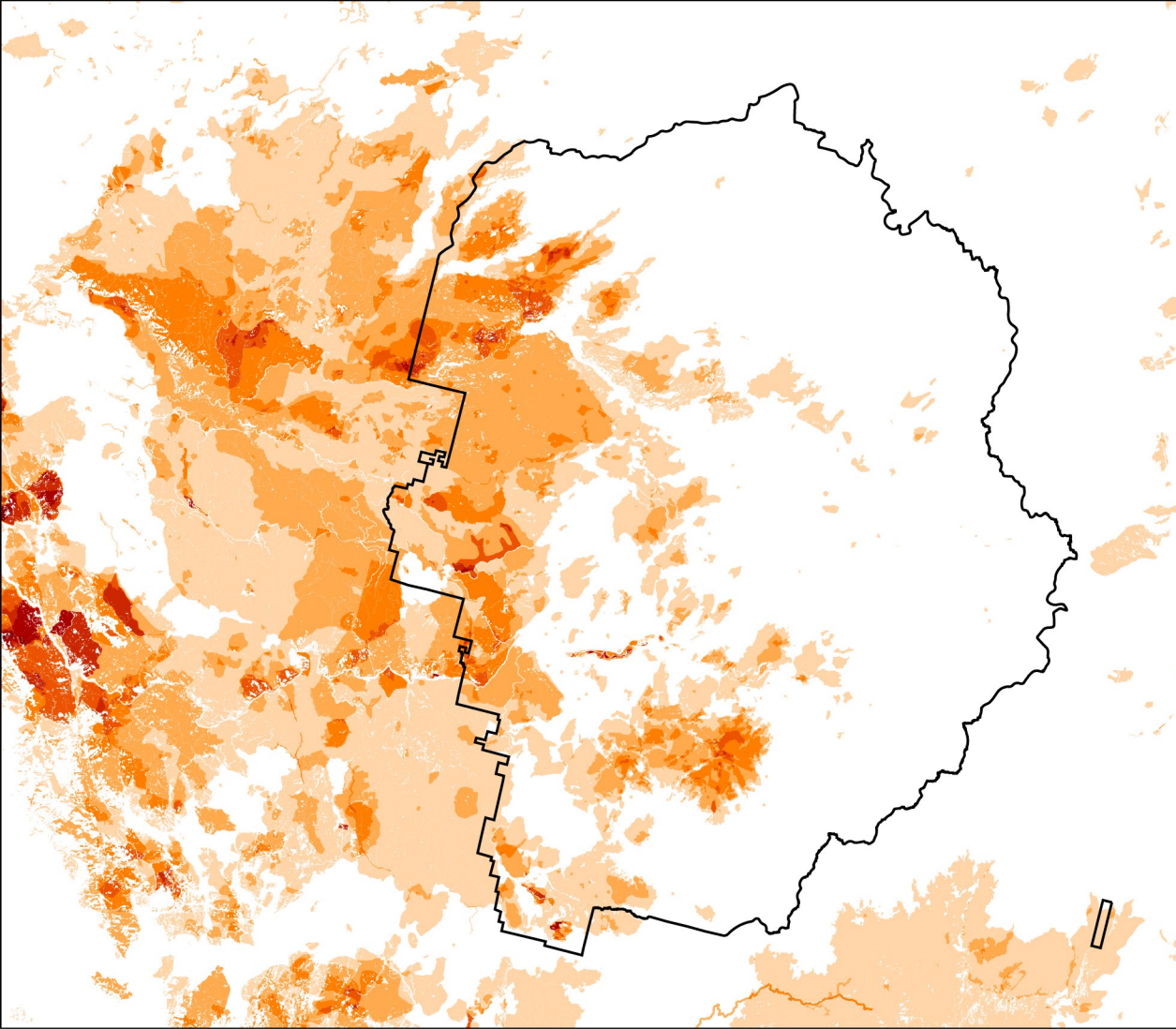
Fire Frequency 1950-2023

Observed Burned Areas
Based on Field Surveys
and Remote Sensing

Yosemite National Park
California, USA



Data State of California CalFire
Analyses Gonzalez and Verkerke 2026

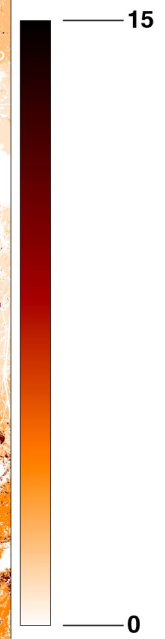


Fire Frequency 2023

Potential
Based on Observed Vegetation

Yosemite National Park
California, USA

25 fires per century maximum



25 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

Fire Frequency 2100

Potential
Reduced Emissions Scenario RCP2.6
High Rainfall Projection

Yosemite National Park
California, USA

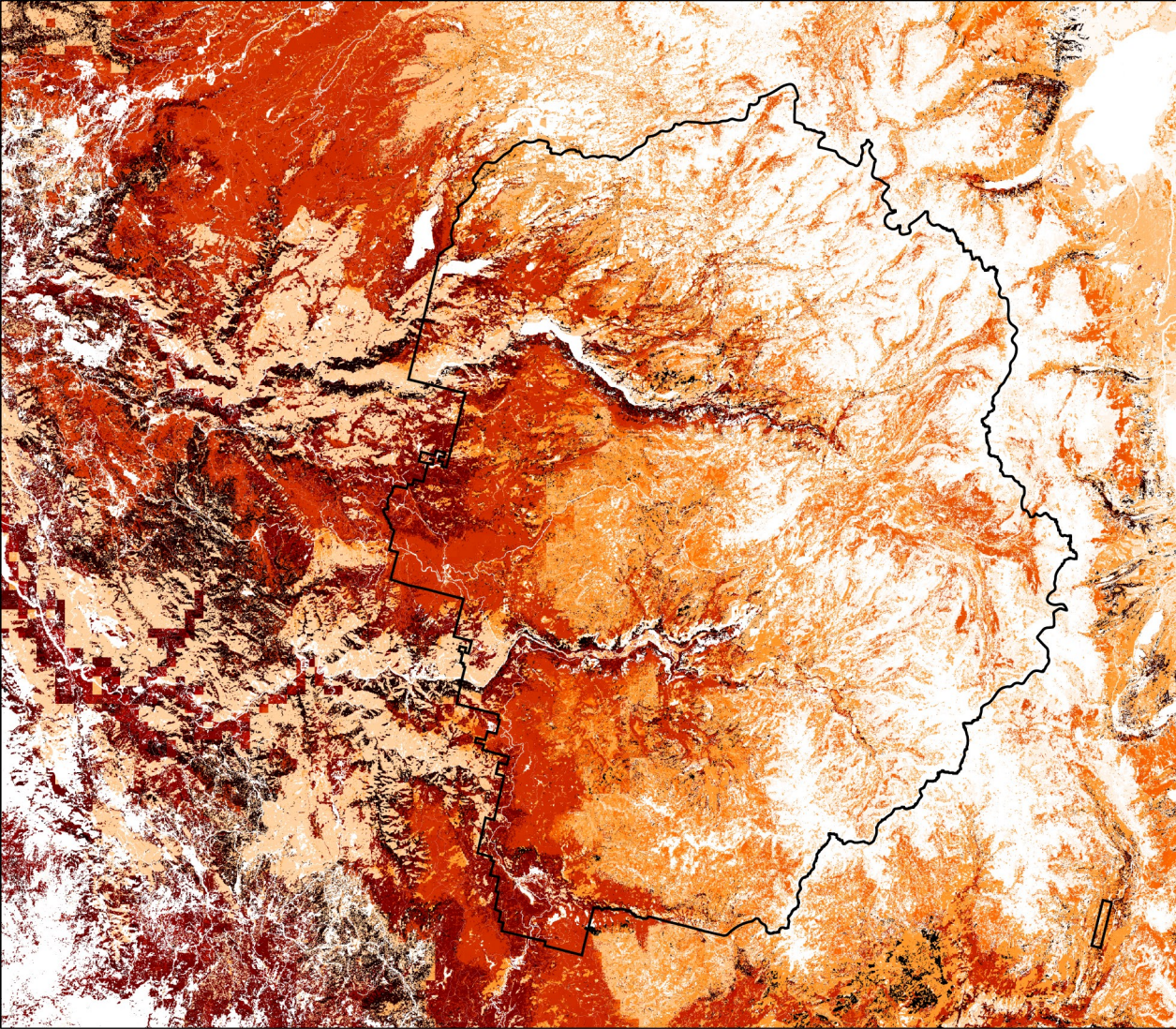
100 fires per century maximum

15

0

25 km

Analyses Gonzalez and Verkerke 2026



Fire Frequency 2100

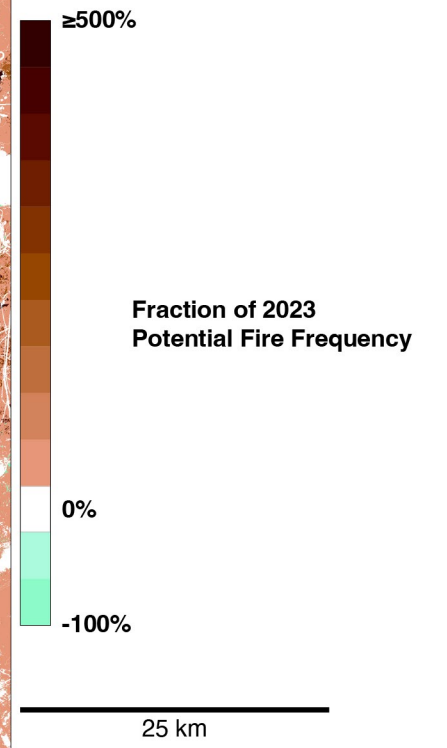
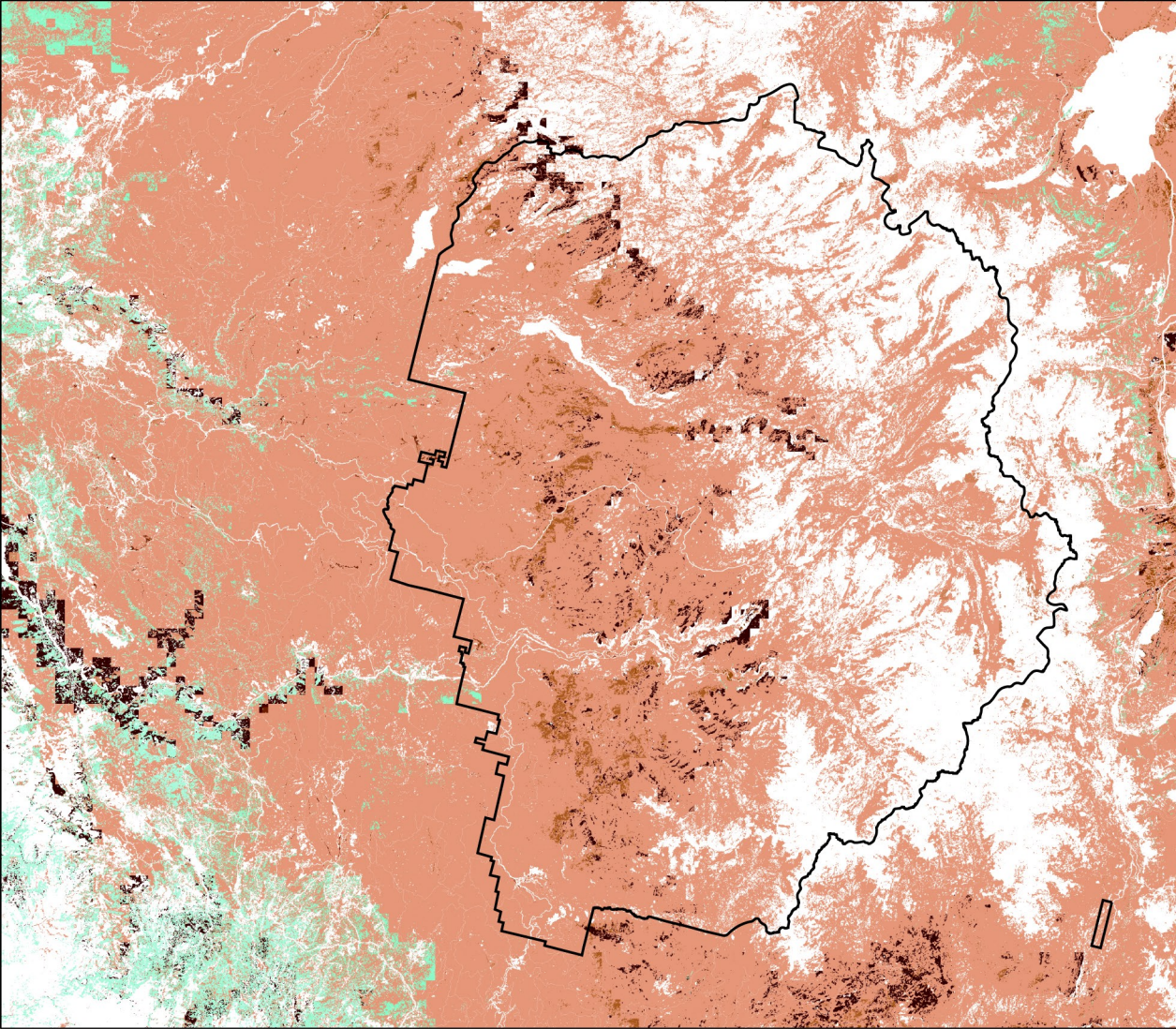
Potential
Reduced Emissions Scenario RCP8.5
Low Rainfall Projection

Yosemite National Park
California, USA



**Projected Fire Frequency
Change 1895-2100**
Reduced Emissions Scenario RCP2.6
High Rainfall Projection

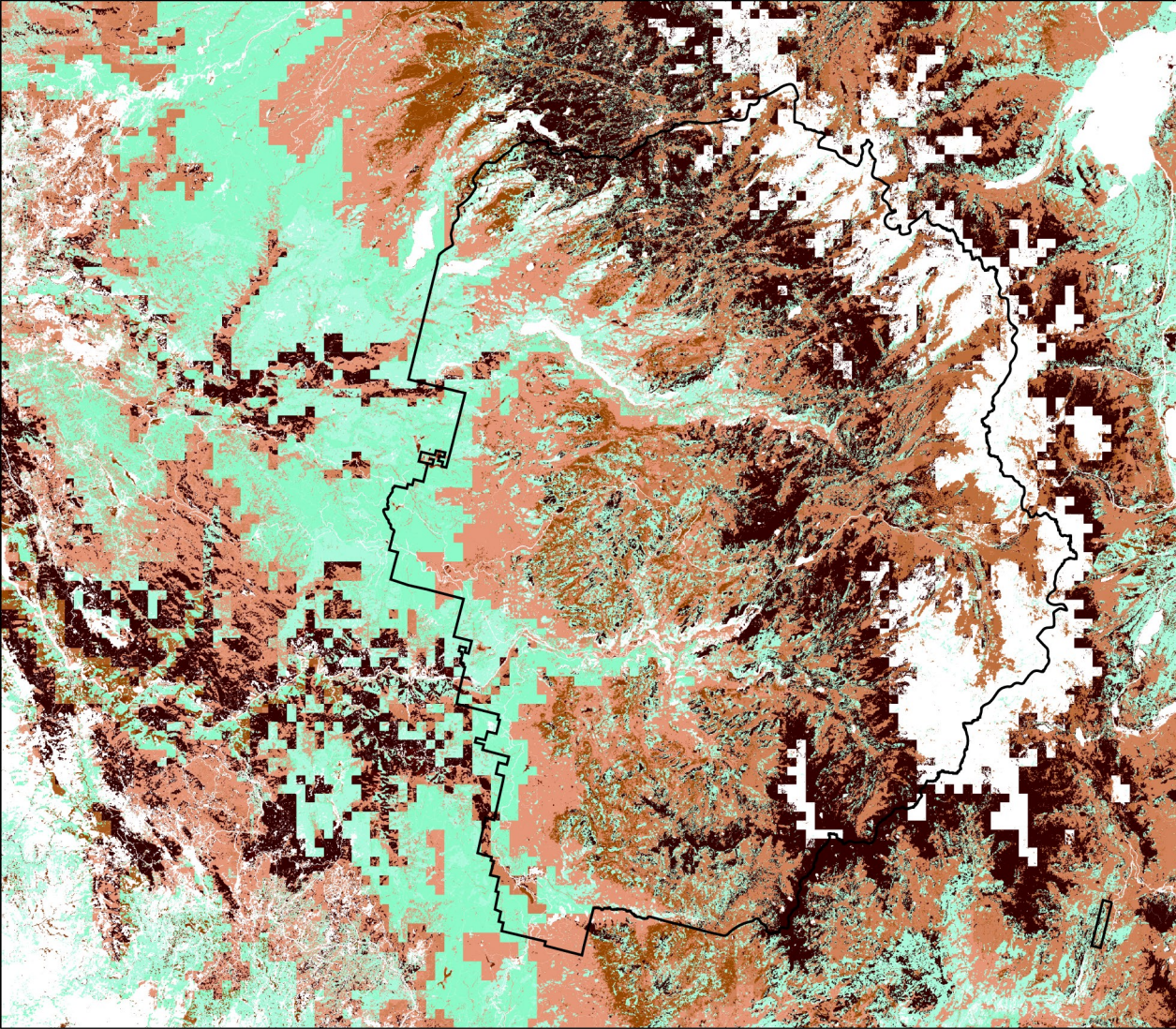
Yosemite National Park
California, USA



Projected Fire Frequency Change 1895-2100

Highest Emissions Scenario RCP8.5
Low Rainfall Projection

Yosemite National Park
California, USA



≥500%

Fraction of 2023
Potential Fire Frequency

0%

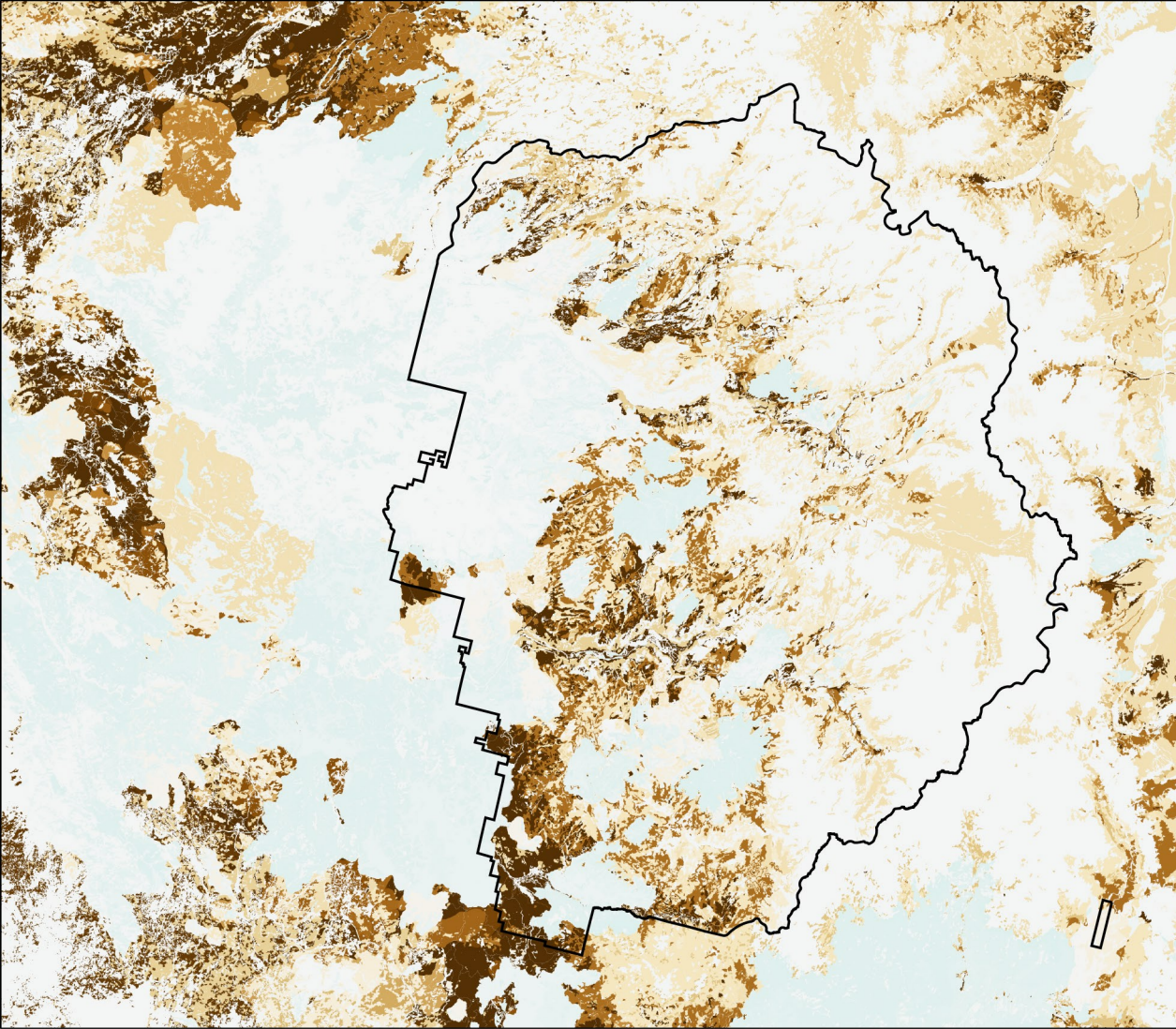
-100%

25 km

Analyses Gonzalez and Verkerke 2026

Fire Return Interval Departure 2024 compared to 1849

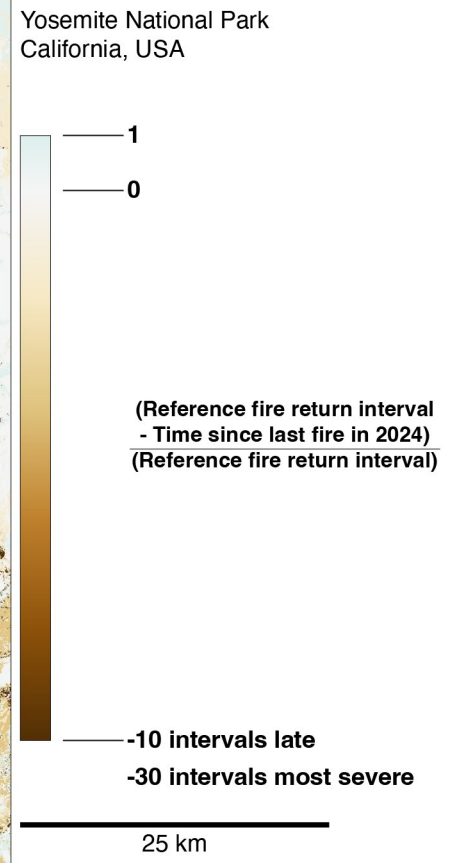
Yosemite National Park
California, USA



$$\frac{(\text{Reference fire return interval} - \text{Time since last fire in 2024})}{(\text{Reference fire return interval})}$$

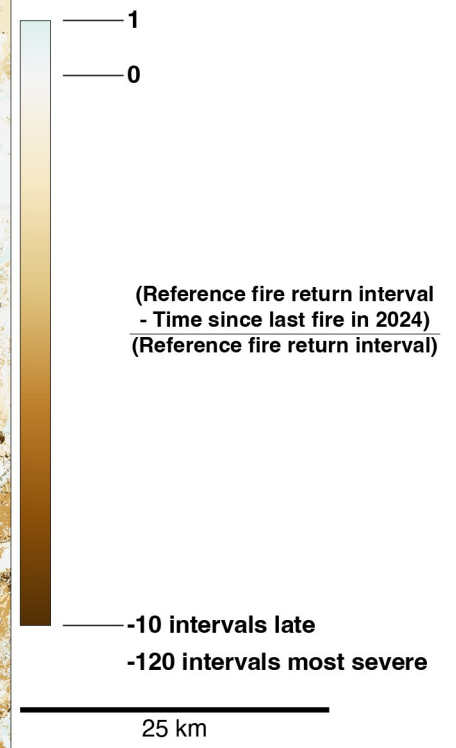
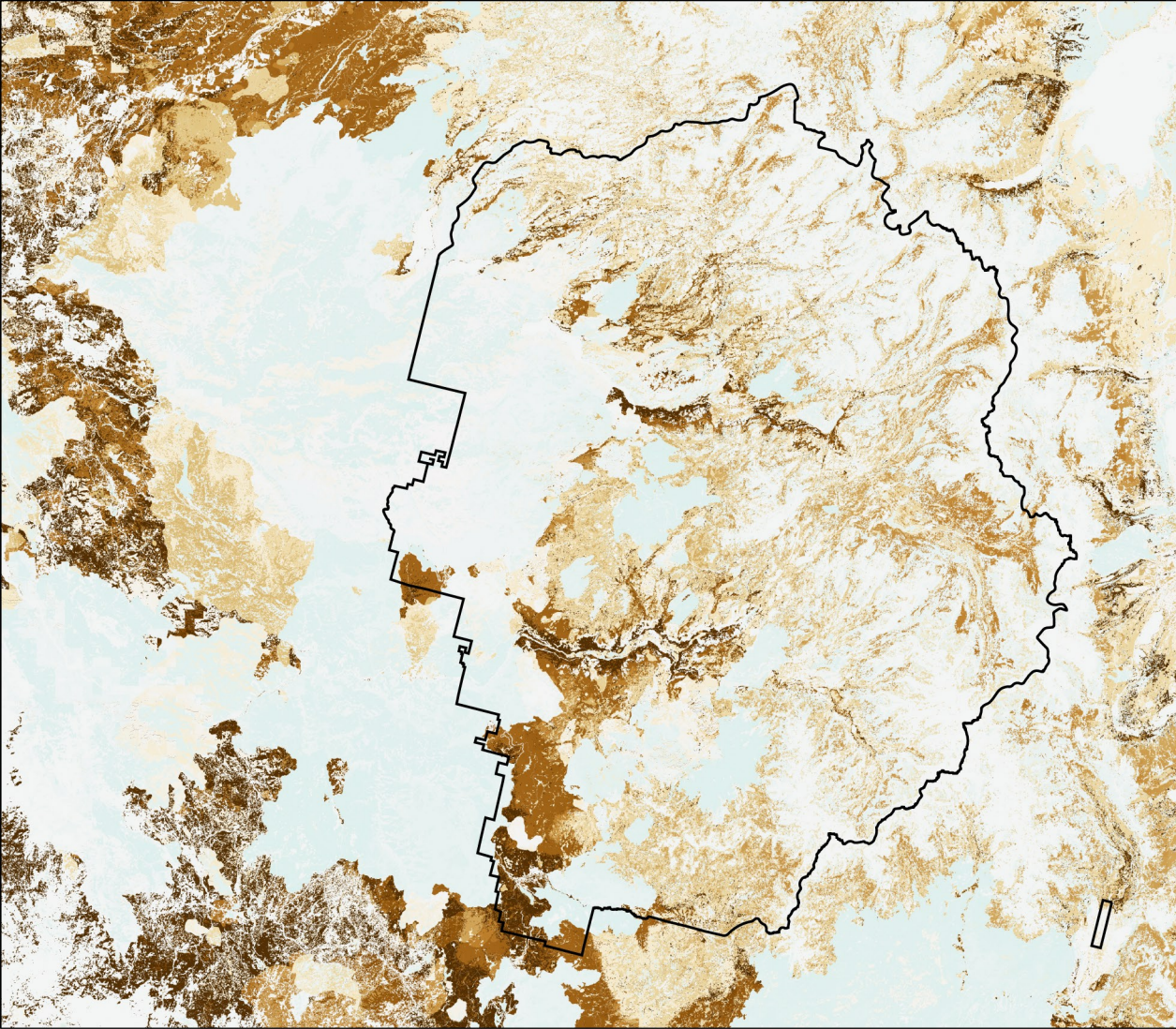
25 km

Fire Return Interval Departure 2024 actual vs. potential



**Fire Return Interval Departure
2024 compared to 2100**
Reduced Emissions Scenario RCP2.6
High Rainfall Projection

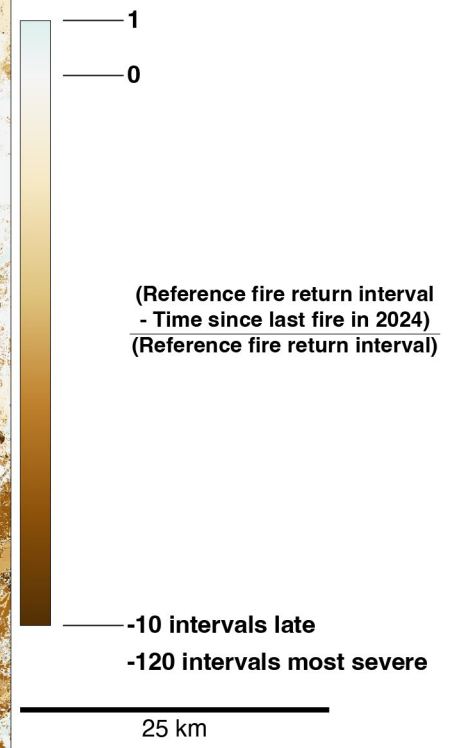
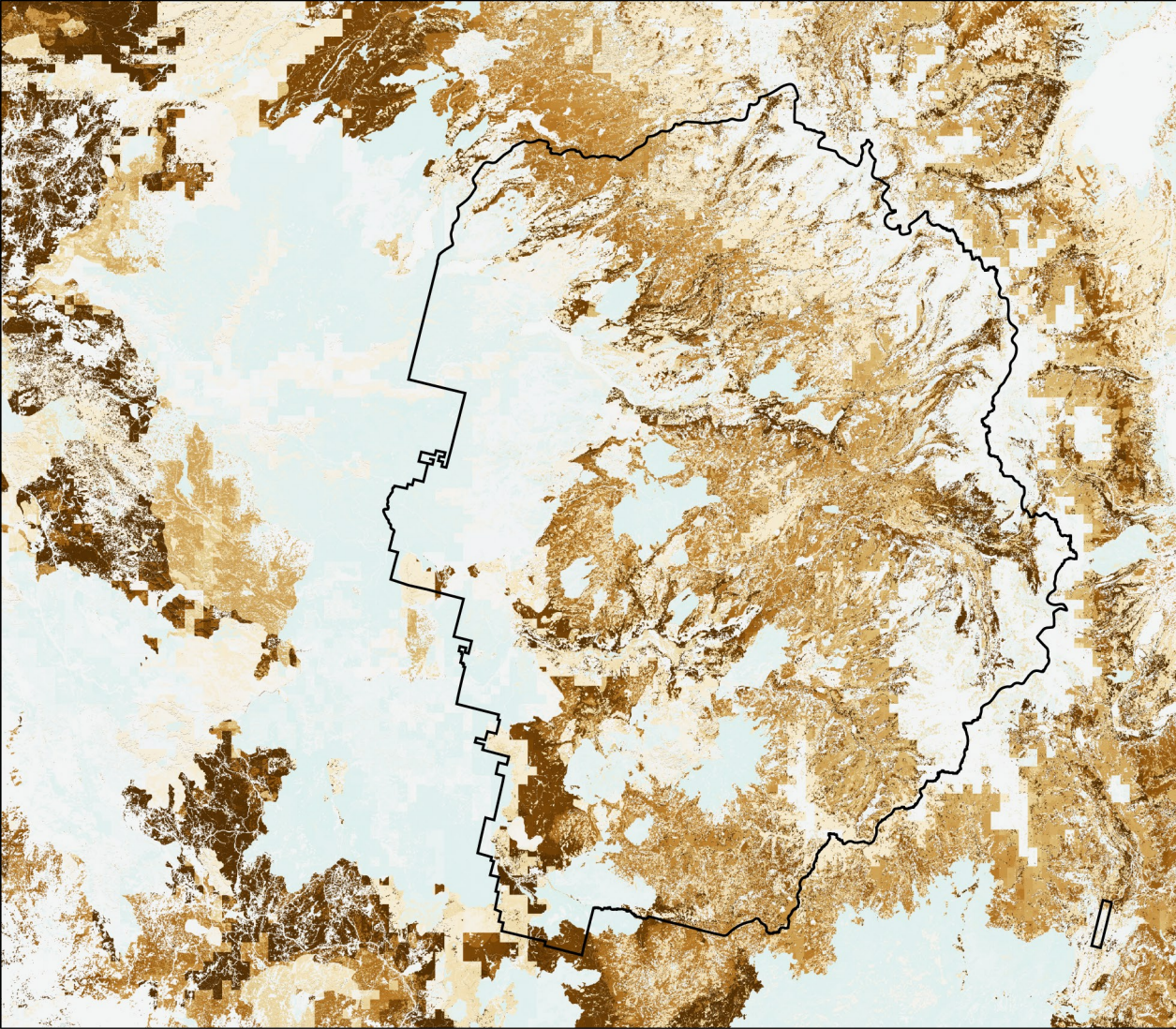
Yosemite National Park
California, USA



Fire Return Interval Departure 2024 compared to 2100

Highest Emissions Scenario RCP8.5
Low Rainfall Projection

Yosemite National Park
California, USA



Severe Fire Risk Areas

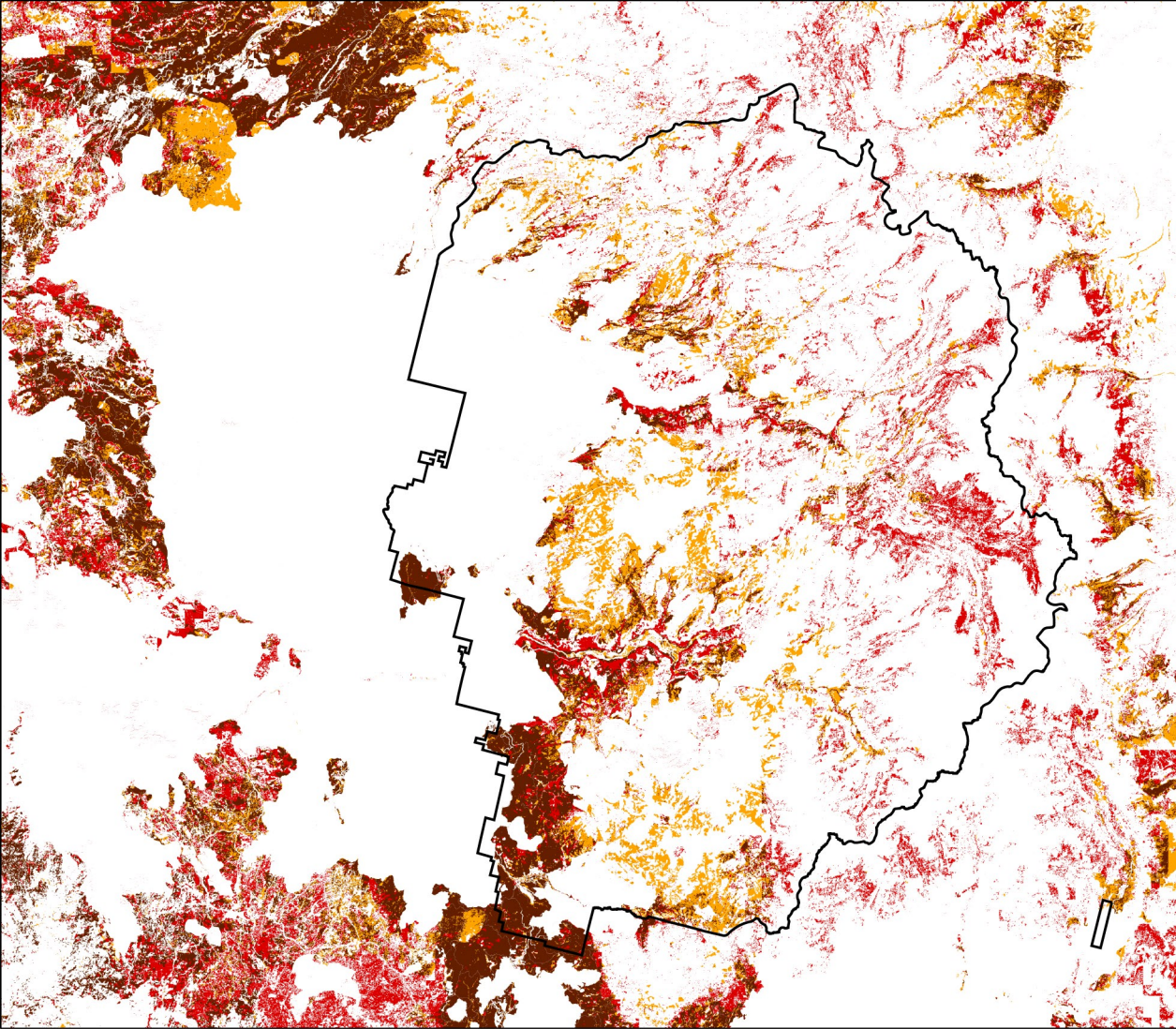
2024-2100

Reduced Emissions Scenario RCP2.6

High Rainfall Projection

Yosemite National Park

California, USA



Overlap
1849 and 2100



2100 only



**Fire Return Interval Departure
(FRID) in 2024 $\leq$ -5 Intervals
Compared to Reference Year**

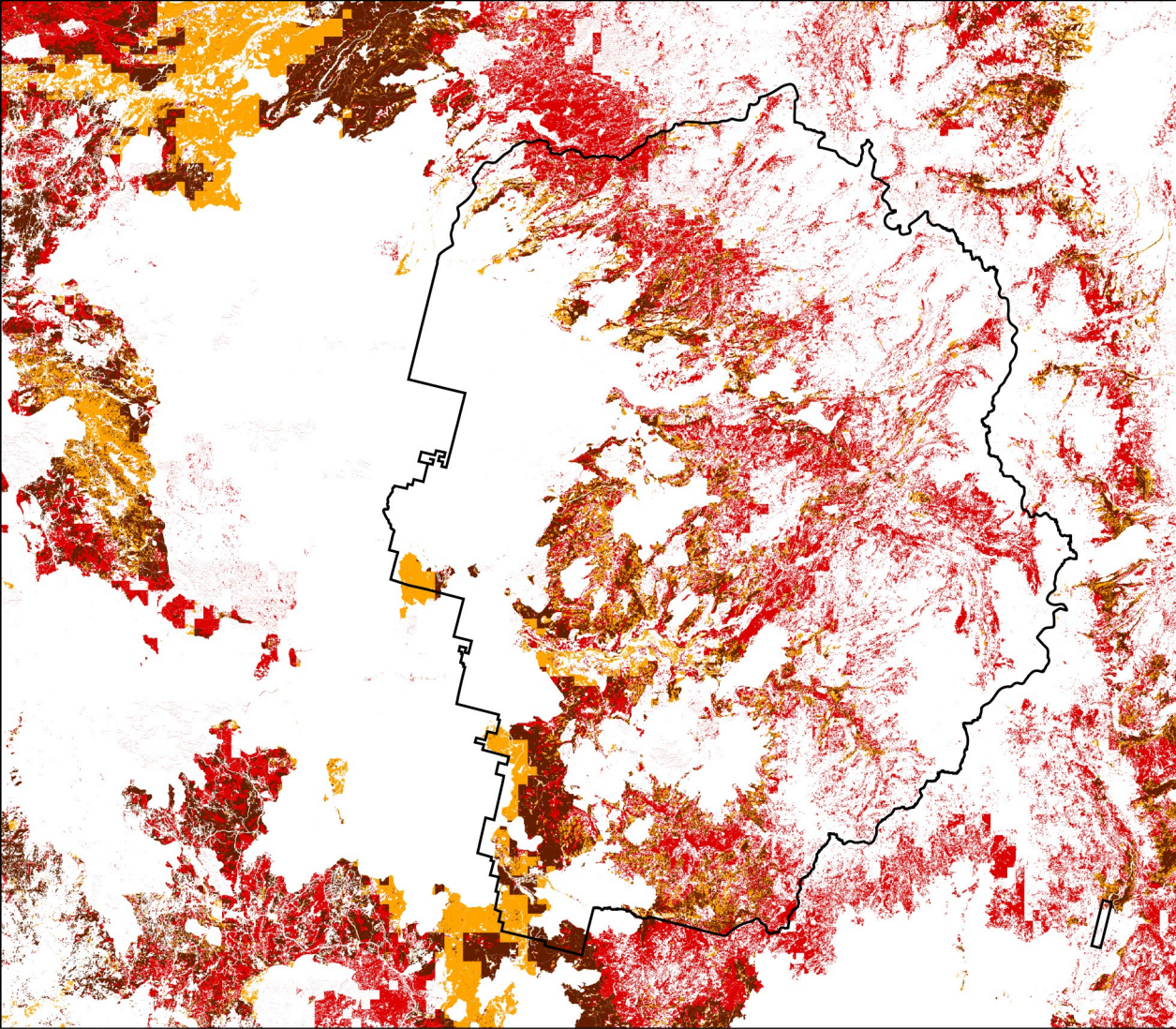
1849 only



**FRID > -5 Intervals
1849 and 2100**



25 km



Severe Fire Risk Areas

2024-2100

Highest Emissions Scenario RCP8.5

Low Rainfall Projection

Yosemite National Park

California, USA



Overlap
1849 and 2100



2100 only



Fire Return Interval Departure
(FRID) in 2024 $\leq$ -5 Intervals
Compared to Reference Year

1849 only



FRID > -5 Intervals
1849 and 2100

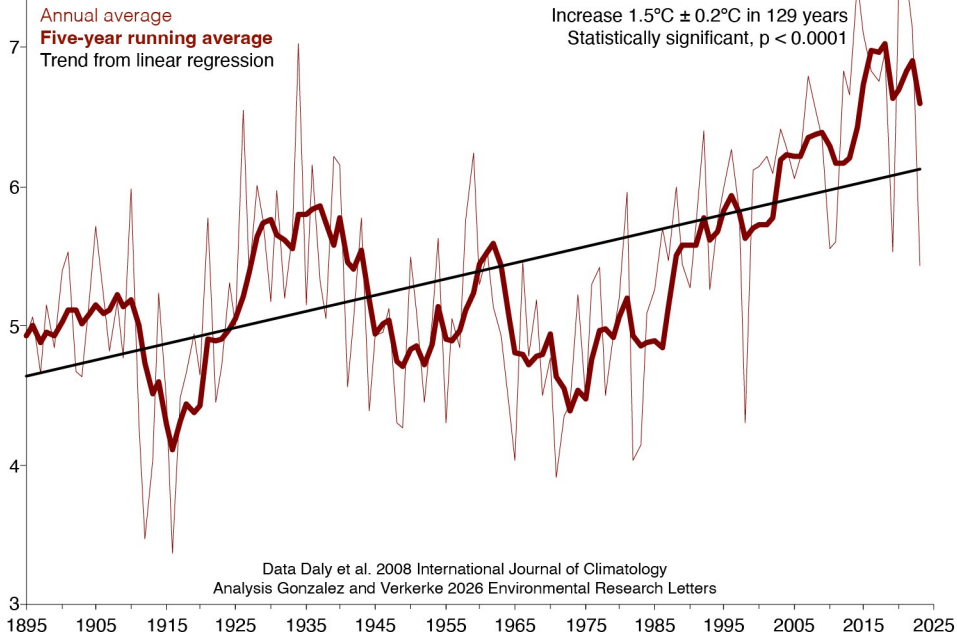
25 km

Analyses Gonzalez and Verkerke 2026

Average Annual Temperature 1895-2023

Yosemite National Park, California, USA

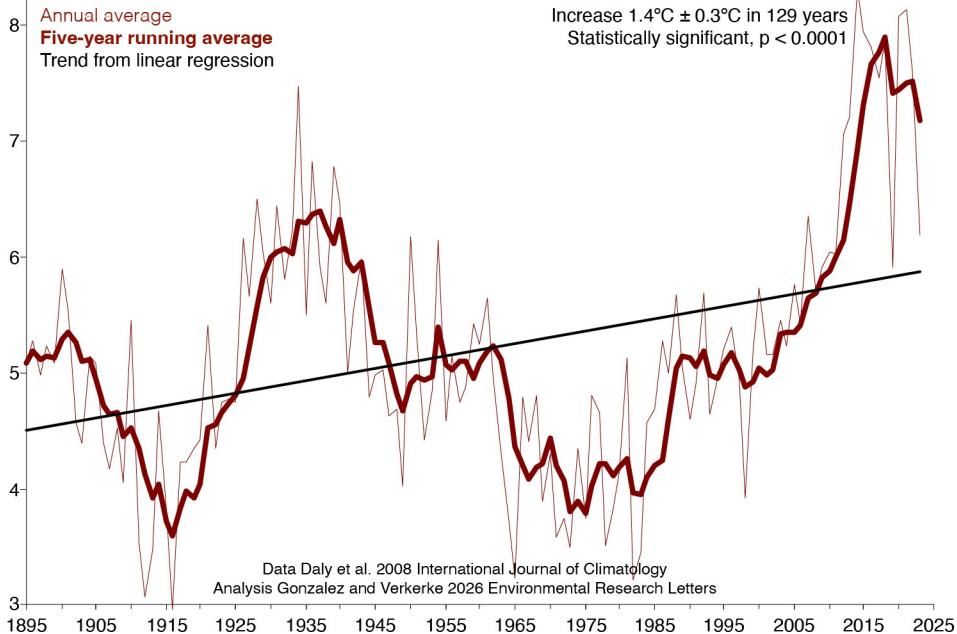
Area within park boundaries



Average Annual Temperature 1895-2023

Devils Postpile National Monument, California, USA

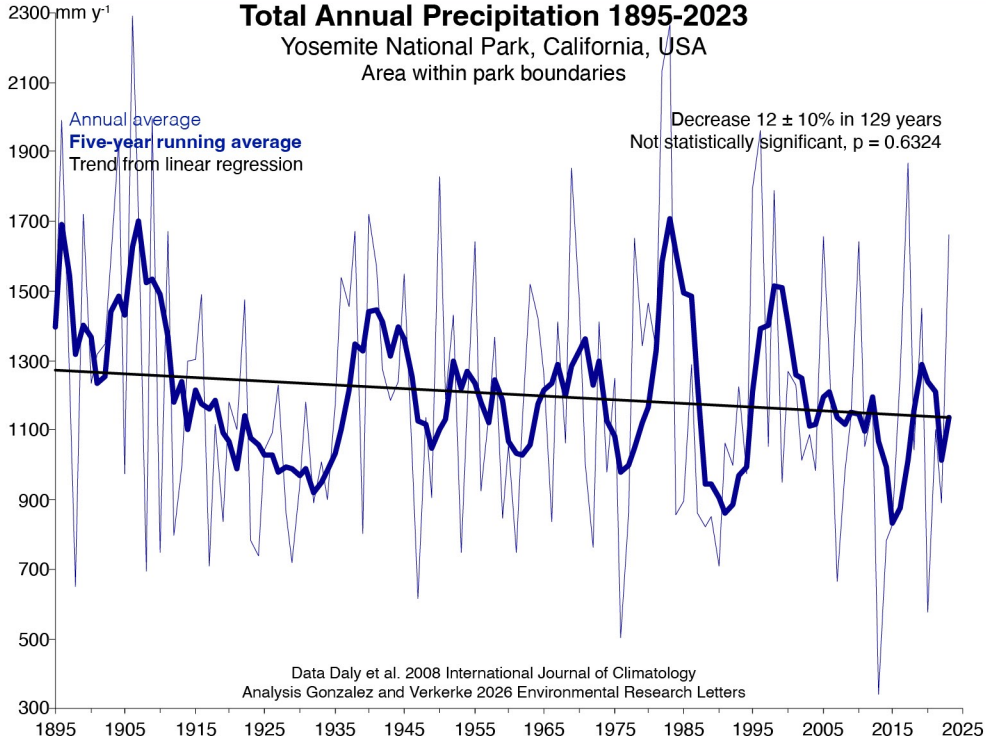
Area within park boundaries



Total Annual Precipitation 1895-2023

Yosemite National Park, California, USA

Area within park boundaries



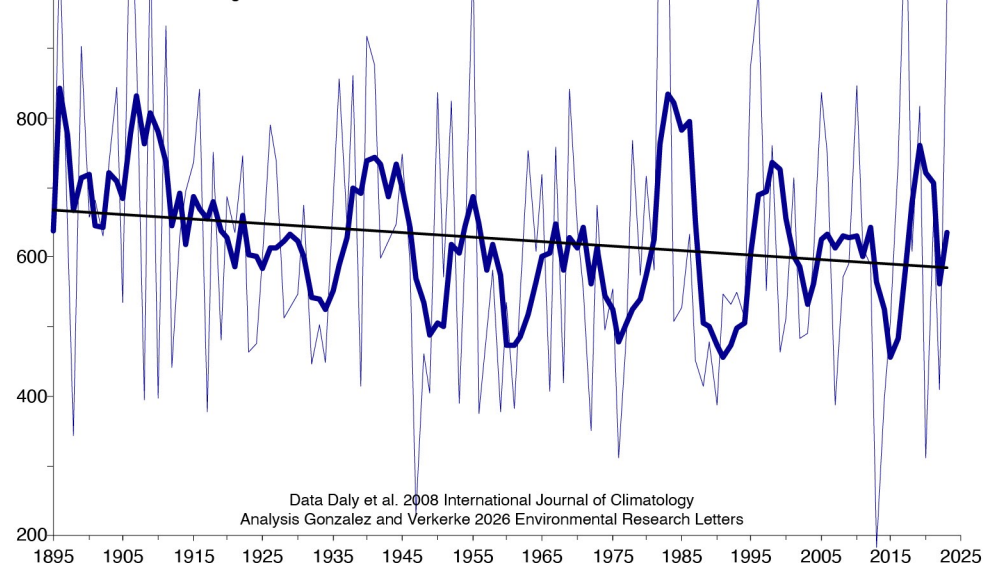
1200 mm y⁻¹

Total Annual Precipitation 1895-2023

Devils Postpile National Monument, California, USA
Area within park boundaries

Annual average
Five-year running average
Trend from linear regression

Decrease $13 \pm 10\%$ in 129 years
Not statistically significant, $p = 0.5214$

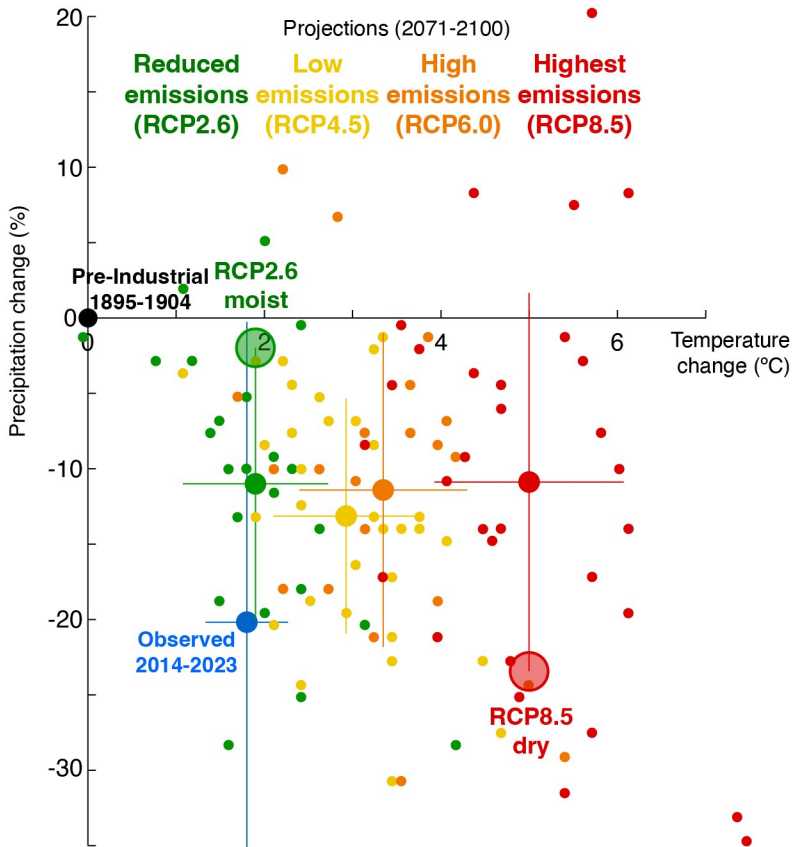


Data Daly et al. 2008 International Journal of Climatology
Analysis Gonzalez and Verkerke 2026 Environmental Research Letters

Climate Change

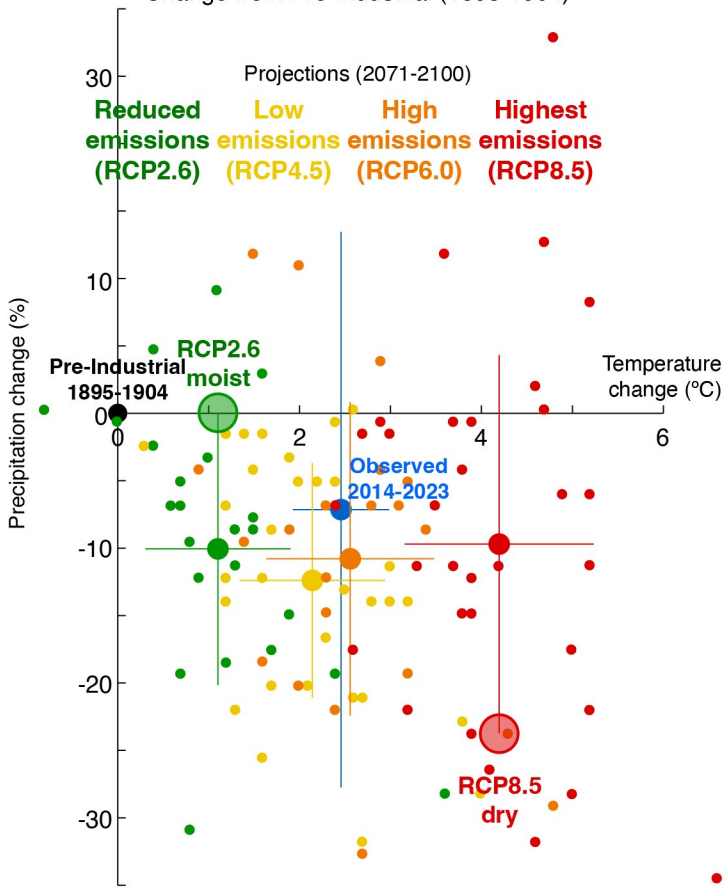
Yosemite National Park, California, USA

Change from Pre-Industrial (1895-1904)



Climate Change

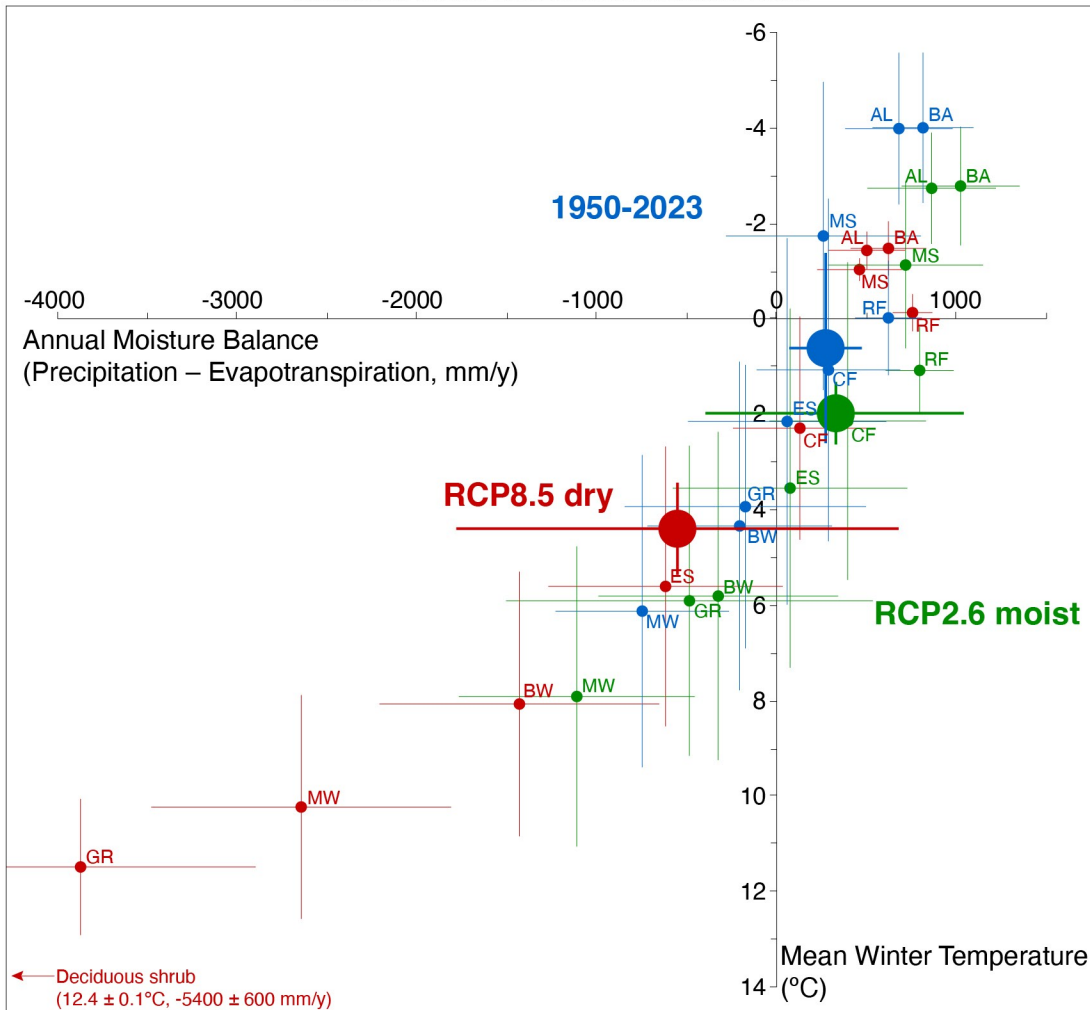
Devils Postpile National Monument, California, USA
Change from Pre-Industrial (1895-1904)

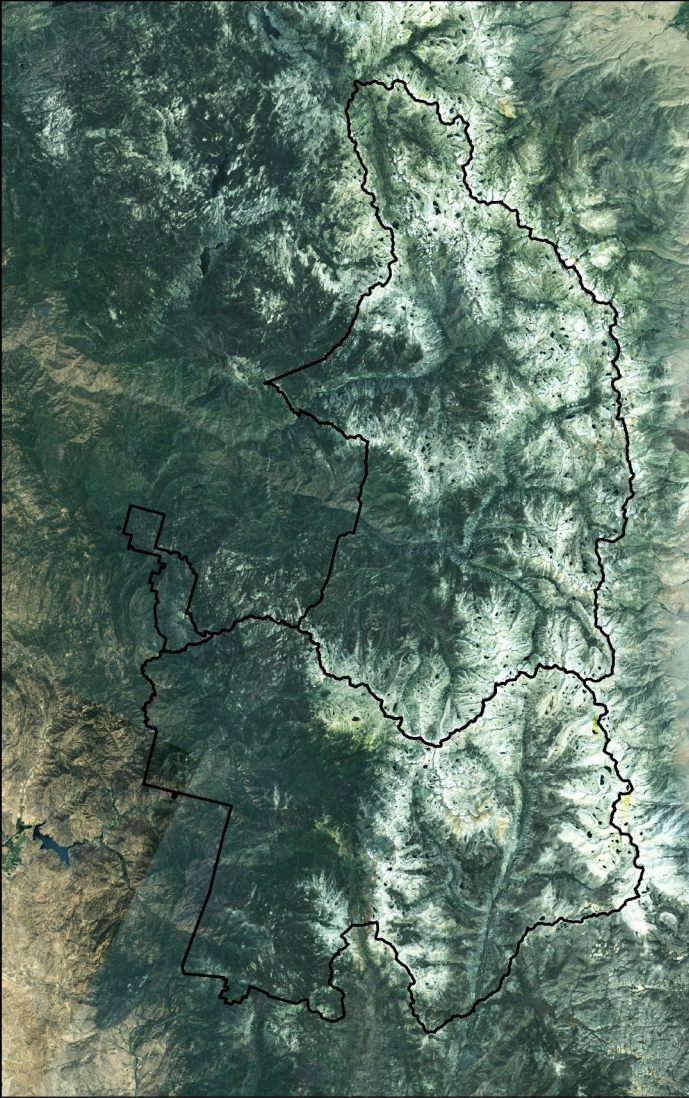


Biome Climate Shifts

Yosemite research area, California, USA

Gonzalez and Verkerke 2026 Environmental Research Letters



A satellite image showing a mountainous region with a black outline indicating the boundaries of Sequoia and Kings Canyon National Parks. The terrain is rugged with varying shades of green and brown, indicating different vegetation and geological features. A small blue lake is visible in the lower-left corner.

Sequoia and Kings Canyon National Parks, California, USA

July 8-9, 2025

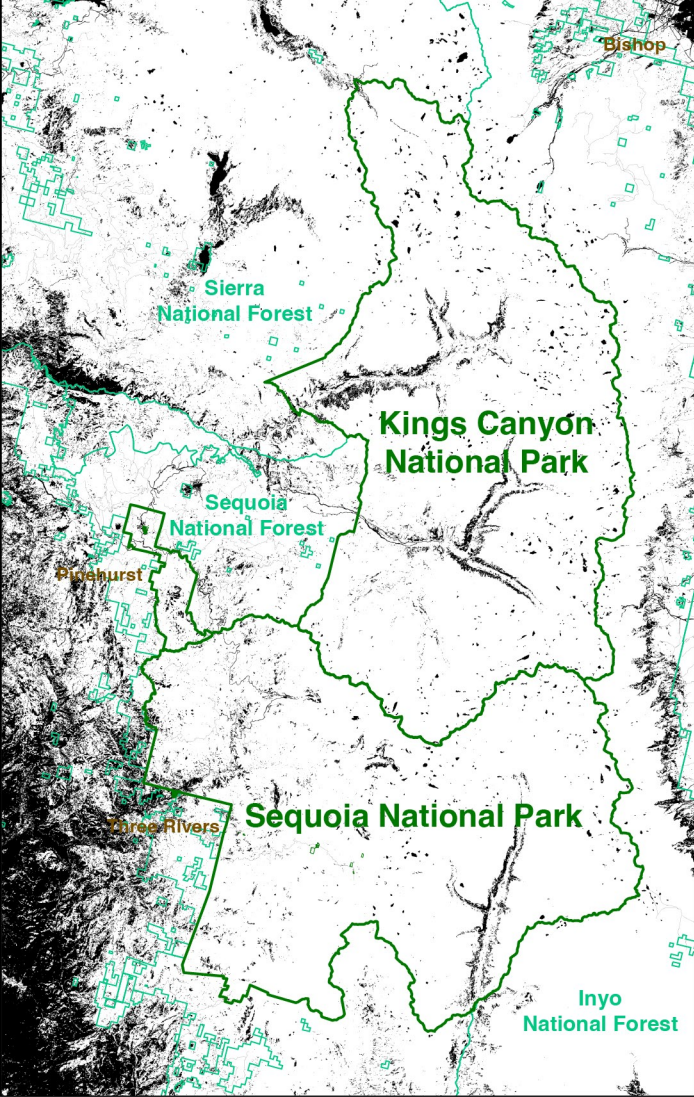
Landsat Real Color Mosaic

25 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

Sequoia Research Area

California, USA



natural vegetation

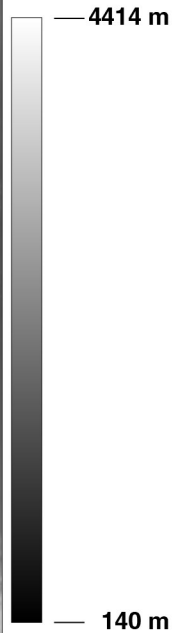
water, roads, urban, agriculture,
low-elevation barren

25 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

Elevation

Sequoia and Kings Canyon
National Parks, California, USA

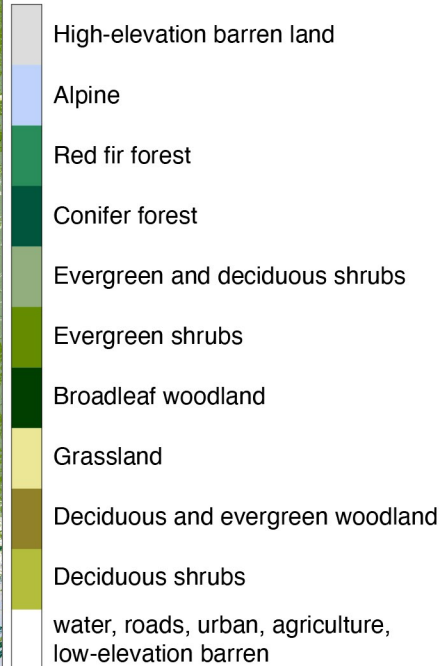


25 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

Vegetation Biomes 2023

Sequoia and Kings Canyon
National Parks, California, USA



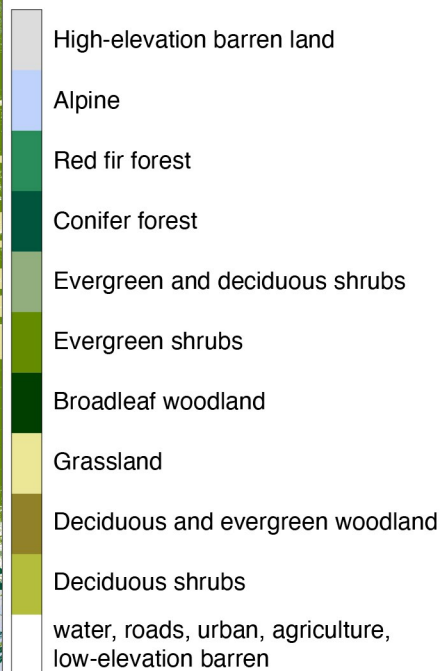
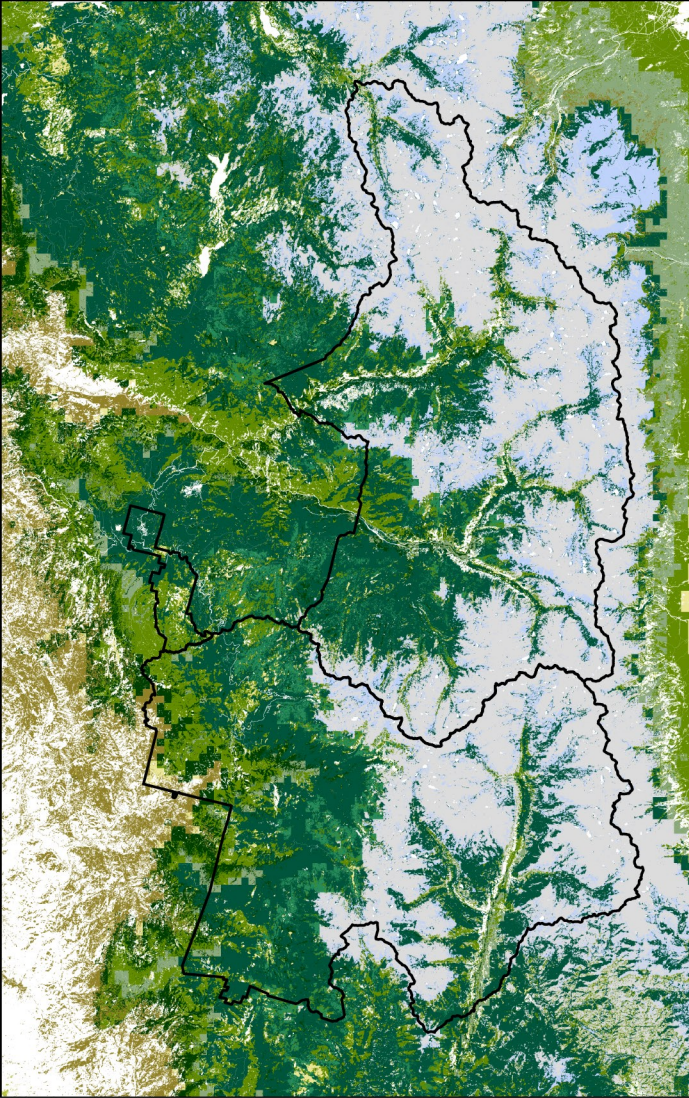
25 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

Vegetation Biomes 2100

Reduced Emissions Scenario RCP2.6
High Rainfall Projection

Sequoia and Kings Canyon
National Parks, California, USA



25 km

Analyses Gonzalez and Verkerke 2026

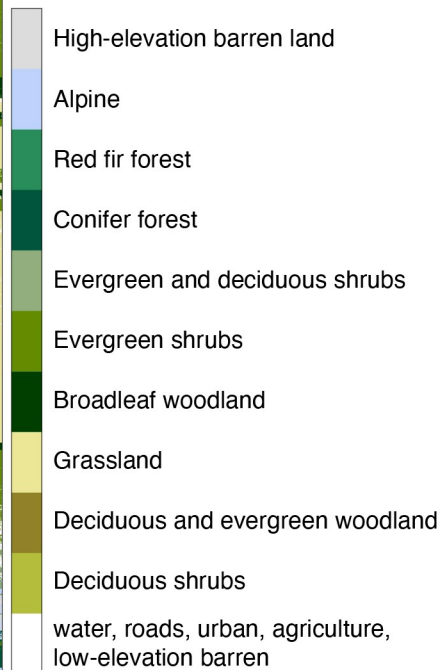
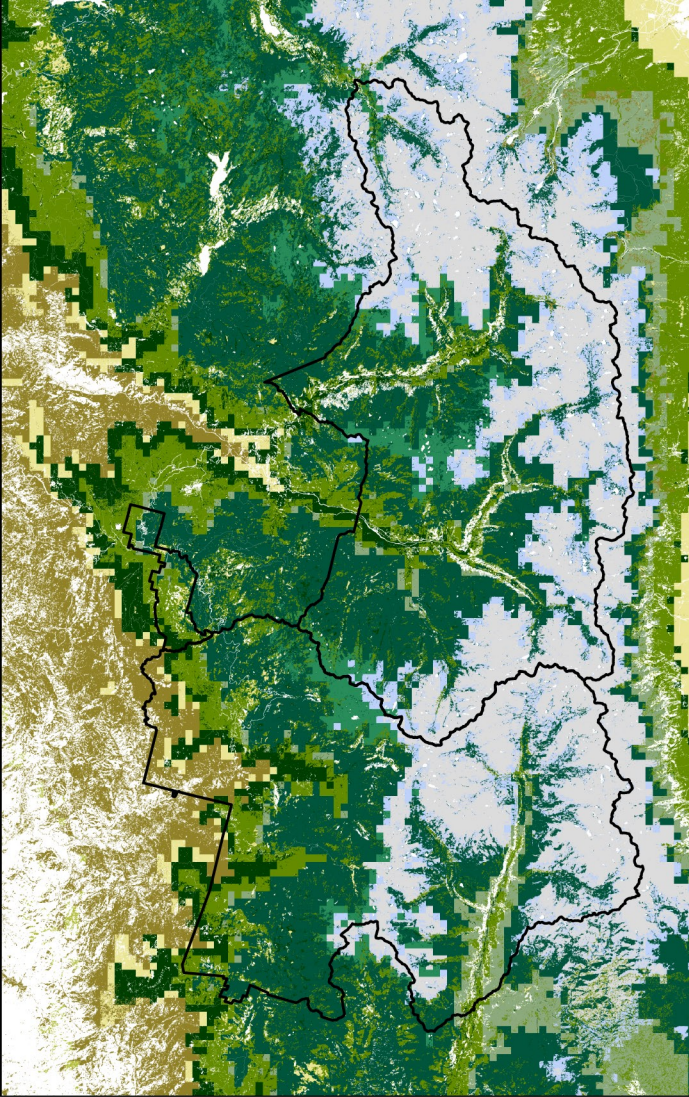
Vegetation Biomes 2100

Highest Emissions Scenario RCP8.5

Low Rainfall Projection

Sequoia and Kings Canyon

National Parks, California, USA

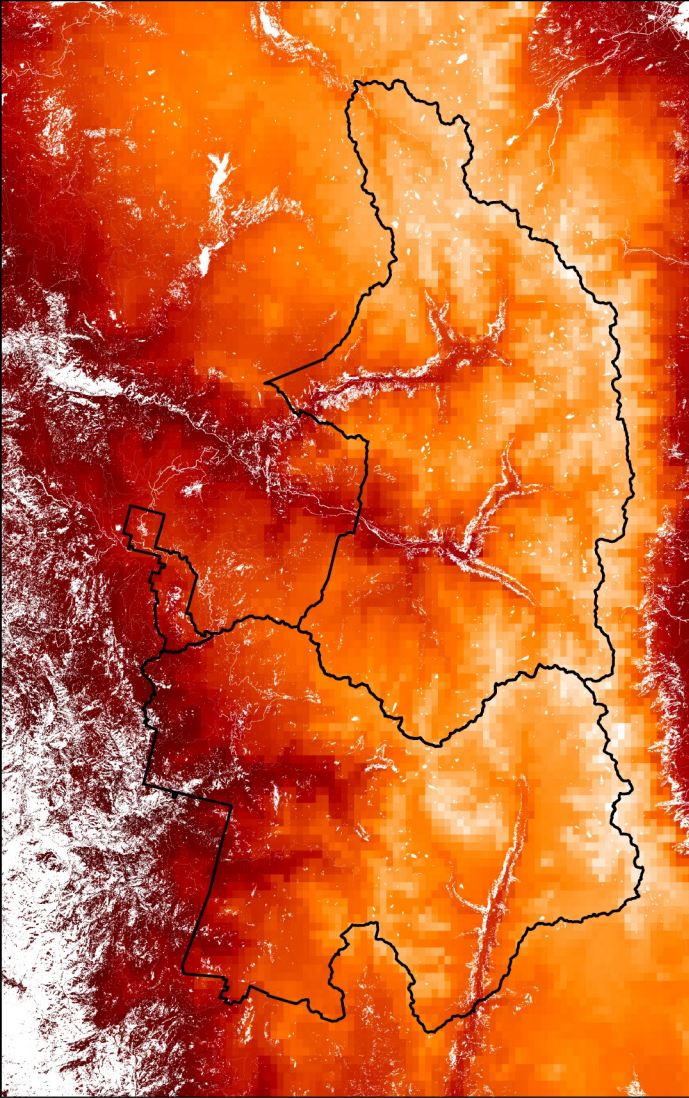


25 km

Analyses Gonzalez and Verkerke 2026

Average Annual Temperature 1895-1904

Sequoia and Kings Canyon
National Parks, California, USA



maximum 1895-2023
17.4°C

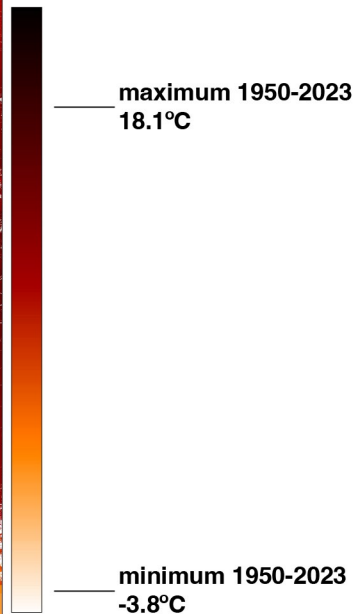
minimum 1895-1904
-4.8°C

25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Average Annual Temperature 1950-2023

Sequoia and Kings Canyon
National Parks, California, USA

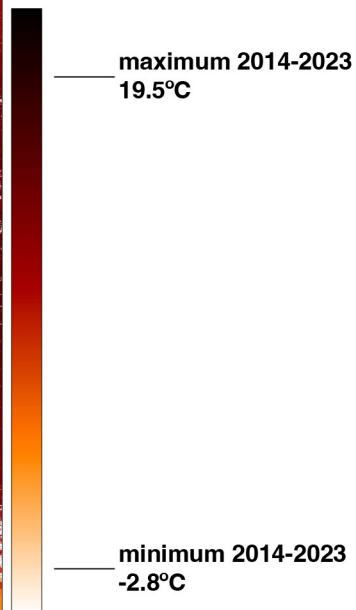


25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Average Annual Temperature 2014-2023

Sequoia and Kings Canyon
National Parks, California, USA

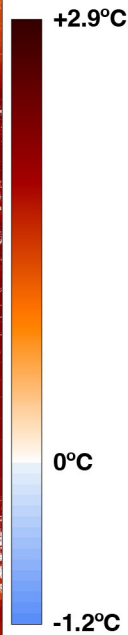
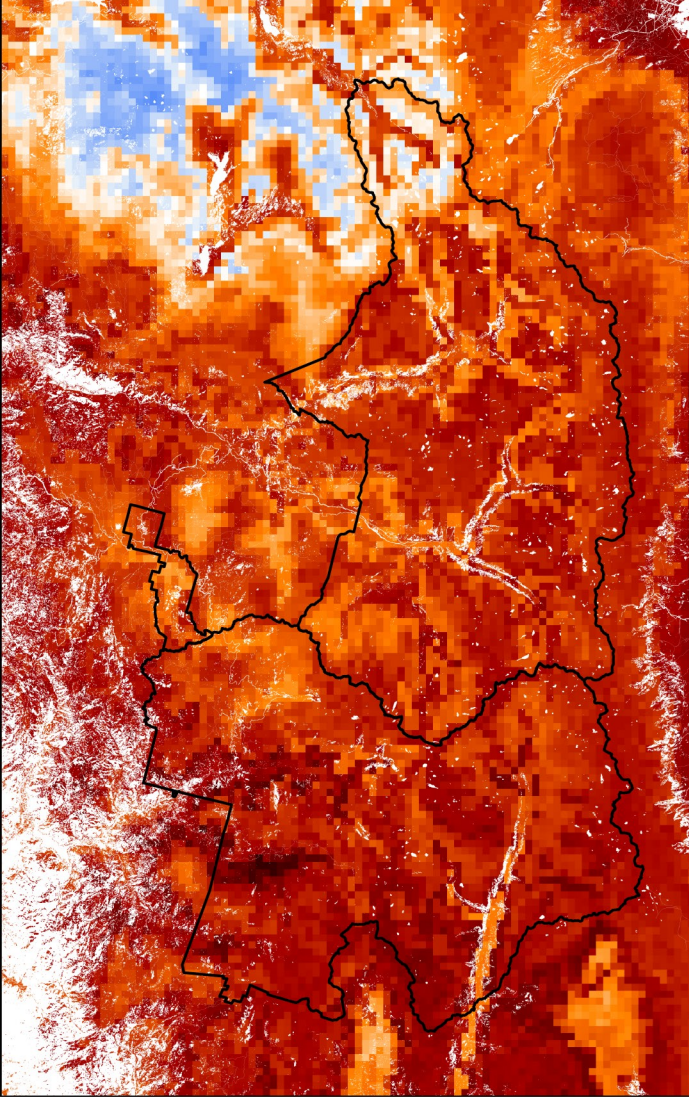


25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Observed Temperature Change 1895-1904–2014-2023

Sequoia and Kings Canyon
National Parks, California, USA



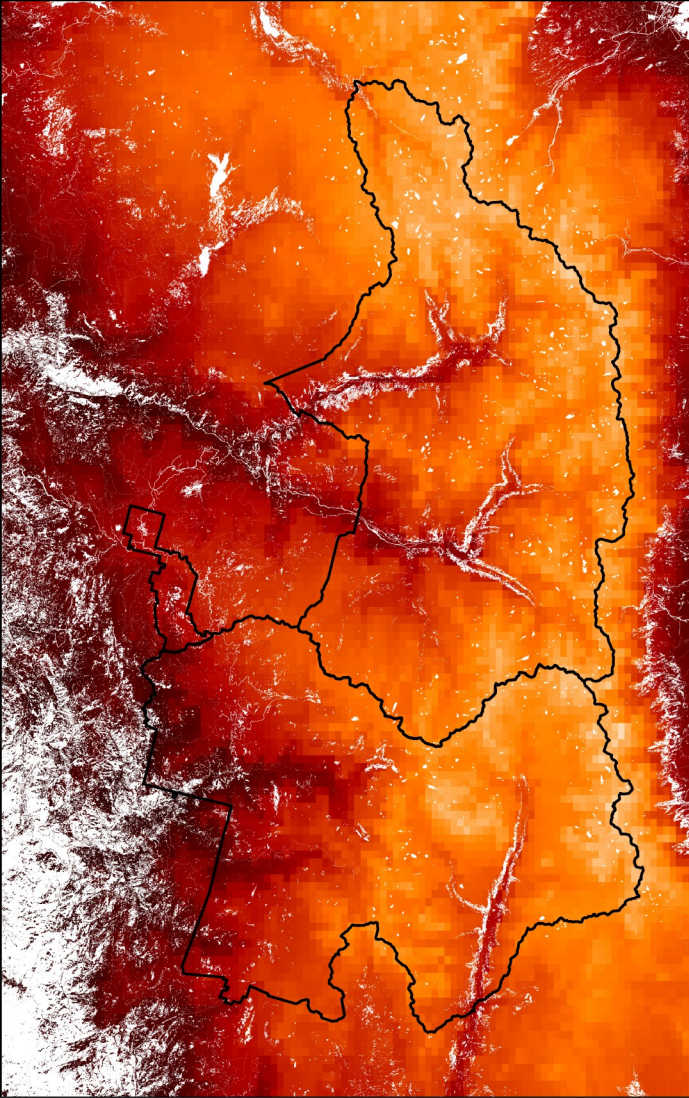
25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez et al. 2018

Average Annual Temperature 2071-2100

Reduced Emissions Scenario RCP2.6

Sequoia and Kings Canyon
National Parks, California, USA



maximum 2071-2100
19.6°C

minimum 2071-2100
-2.5°C

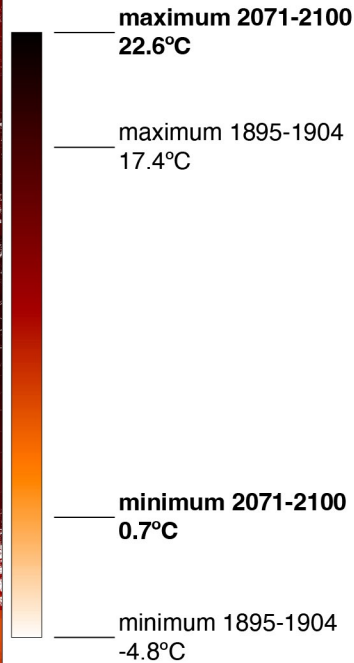
25 km

Data Gonzalez et al. 2018
Analyses Gonzalez and Verkerke 2026

Average Annual Temperature 2071-2100

Highest Emissions Scenario RCP8.5

Sequoia and Kings Canyon
National Parks, California, USA



25 km

Data Gonzalez et al. 2018
Analyses Gonzalez and Verkerke 2026

Average Annual Precipitation 1950-2023

Sequoia and Kings Canyon
National Parks, California, USA

— 1720 mm



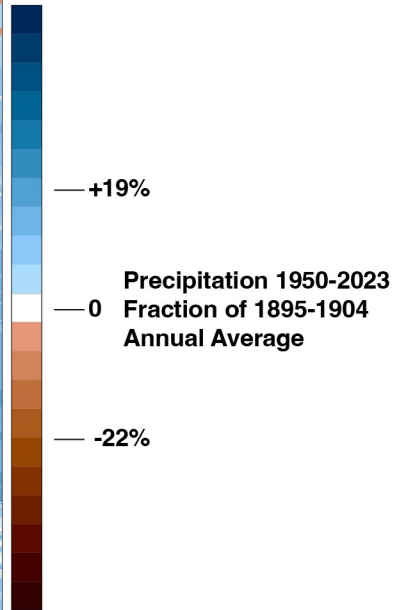
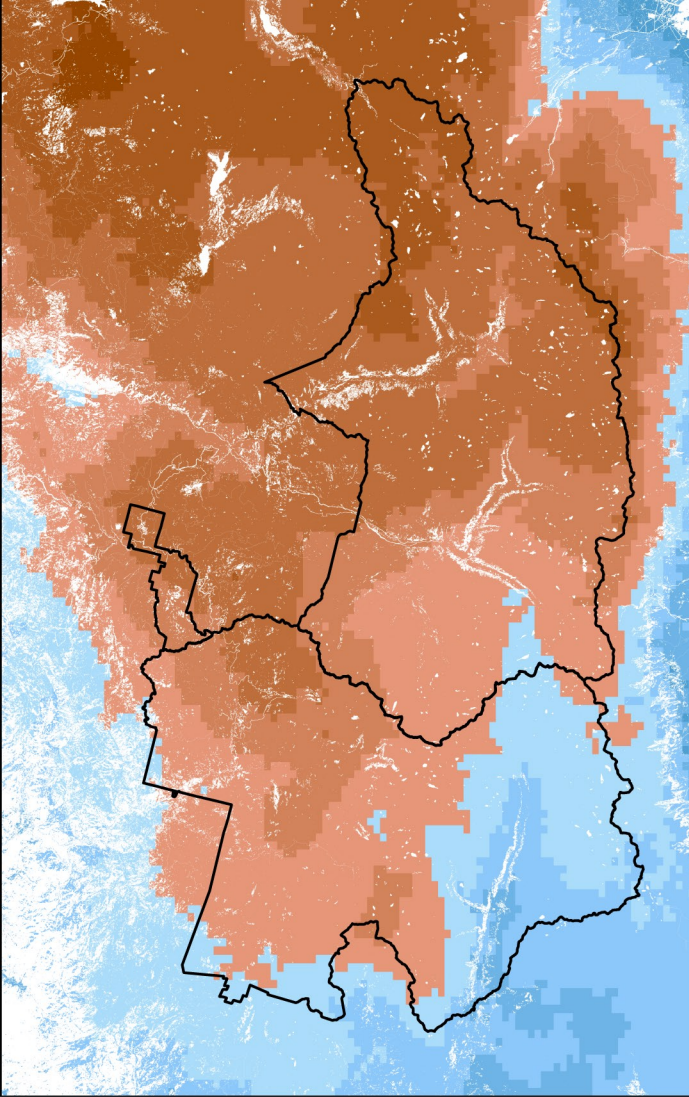
— 160 mm

25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Observed Precipitation Change 1895-1904–1950-2023

Sequoia and Kings Canyon
National Parks, California, USA

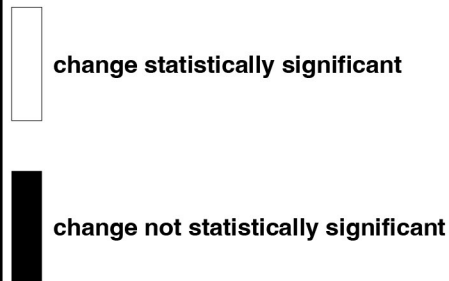


25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Significant Precipitation
Change 1895-1904–1950-2023
Summer

Sequoia and Kings Canyon
National Parks, California, USA

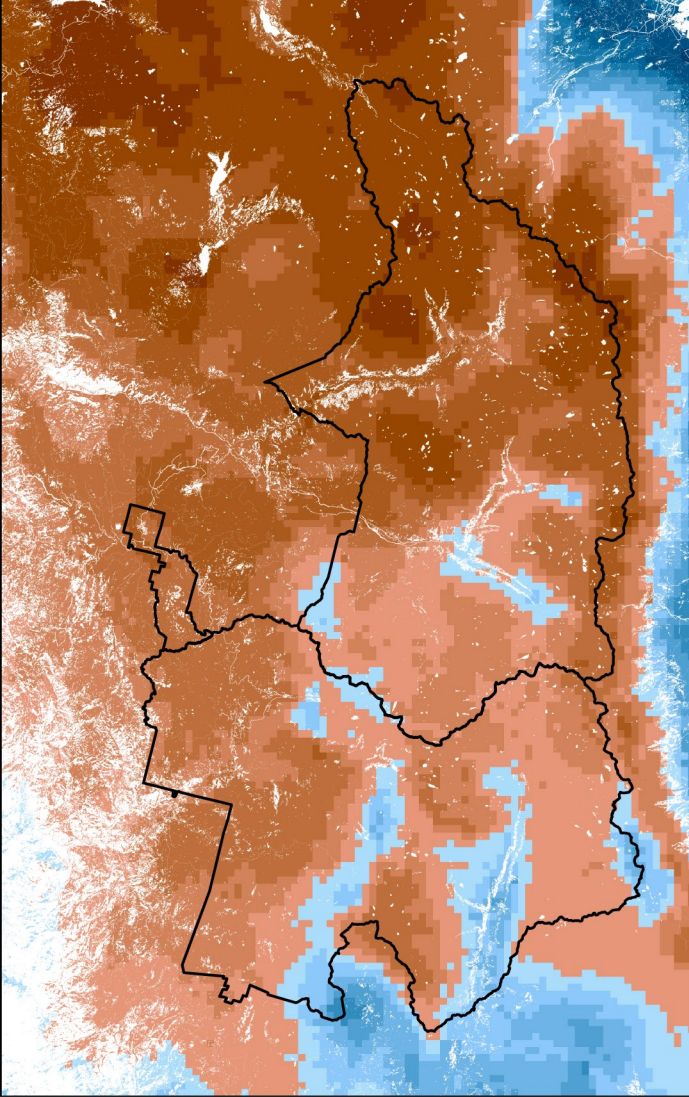


25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Observed Precipitation Change 1895-1904–2014-2023

Sequoia and Kings Canyon
National Parks, California, USA



— +41%

Precipitation 2014-2023
— 0 Fraction of 1895-1904
Annual Average

— -29%

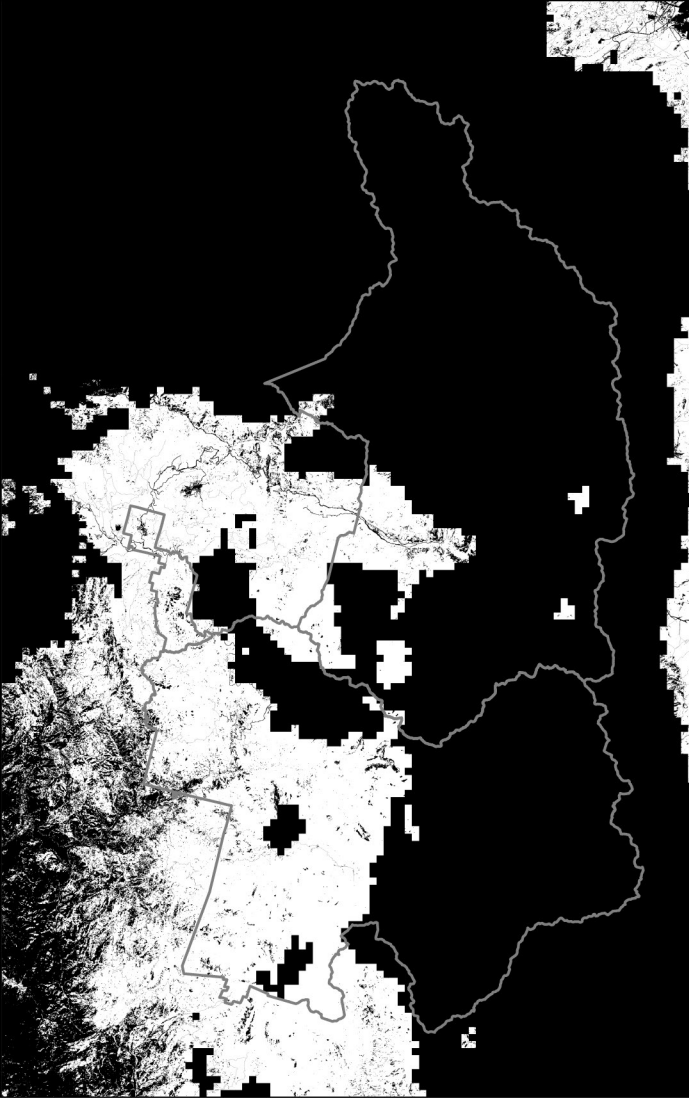
25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Significant Precipitation Change 1895-1904–2014-2023

Summer

Sequoia and Kings Canyon
National Parks, California, USA



change statistically significant

change not statistically significant

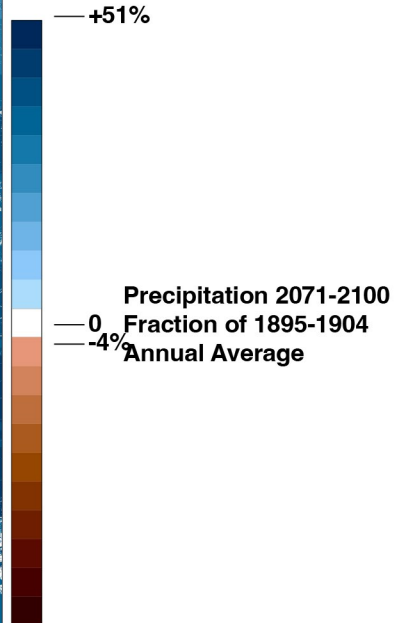
25 km

Data Prism, Daly et al. 2008
Analyses Gonzalez and Verkerke 2026

Projected Precipitation Change 1895-2100

Reduced Emissions Scenario RCP2.6
High Rainfall Projection

Sequoia and Kings Canyon
National Parks, California, USA



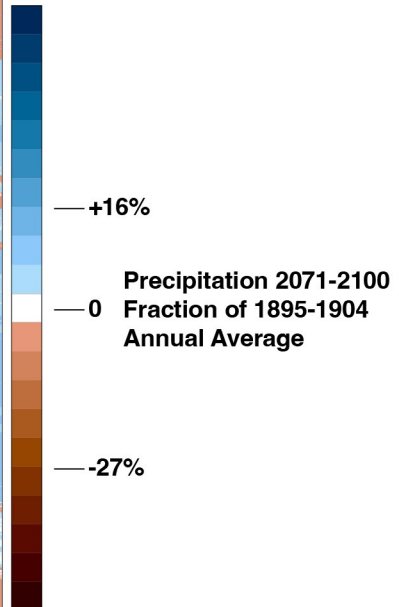
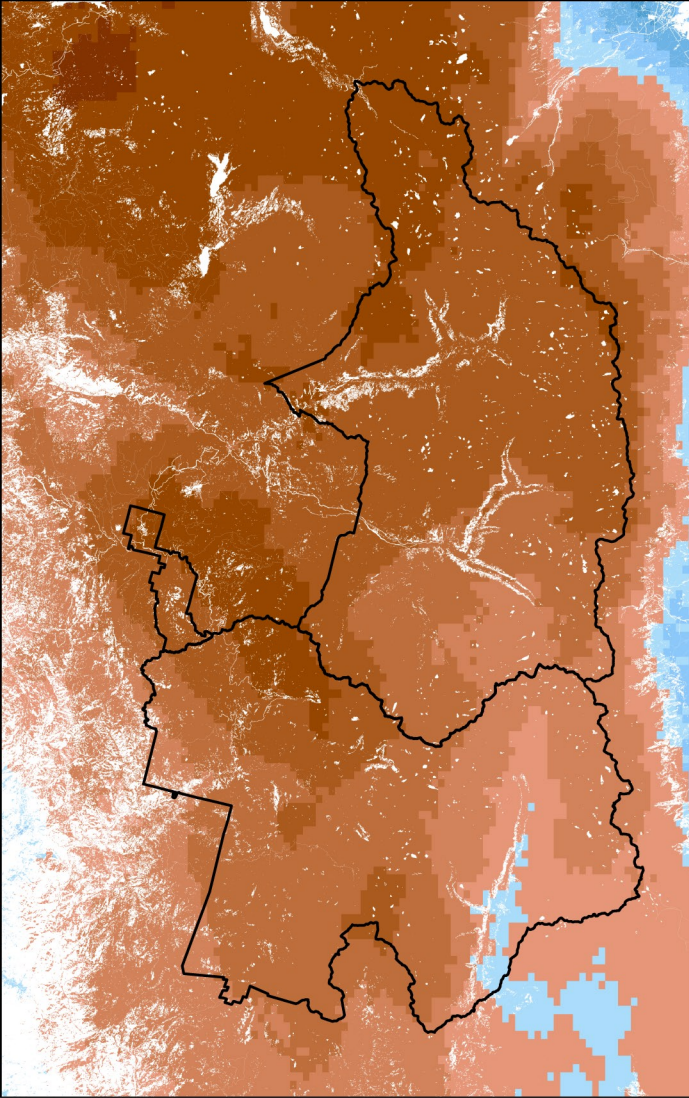
25 km

Data Gonzalez et al. 2018
Analyses Gonzalez and Verkerke 2026

Projected Precipitation Change 1895-2100

Highest Emissions Scenario RCP8.5
Low Rainfall Projection

Sequoia and Kings Canyon
National Parks, California, USA

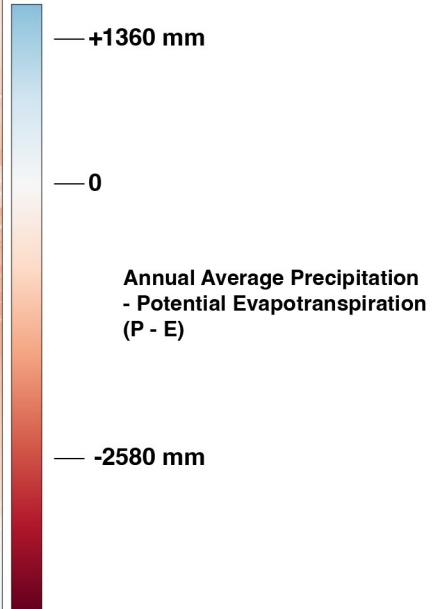
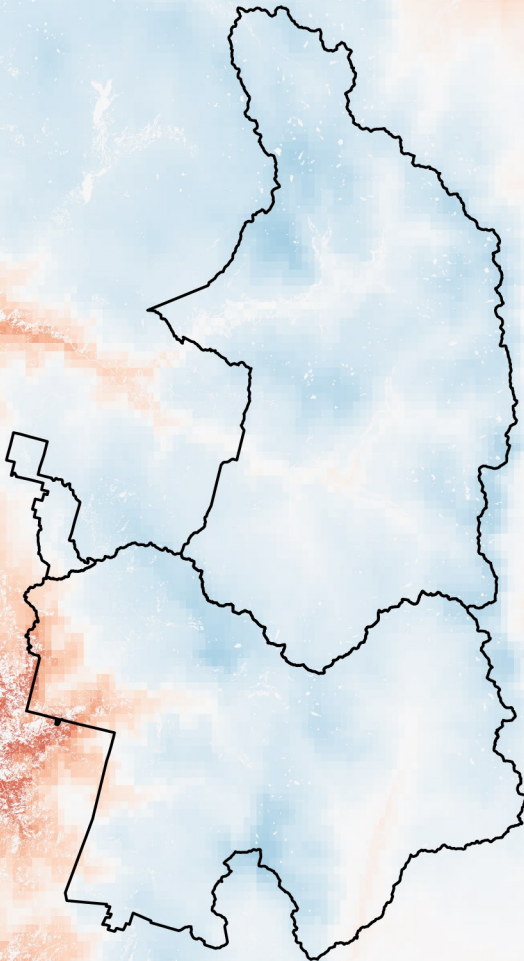


25 km

Data Gonzalez et al. 2018
Analyses Gonzalez and Verkerke 2026

Annual Moisture Balance 1950-2023

Sequoia and Kings Canyon
National Parks, California, USA



25 km

Analyses Gonzalez and Verkerke 2026

Annual Moisture Balance

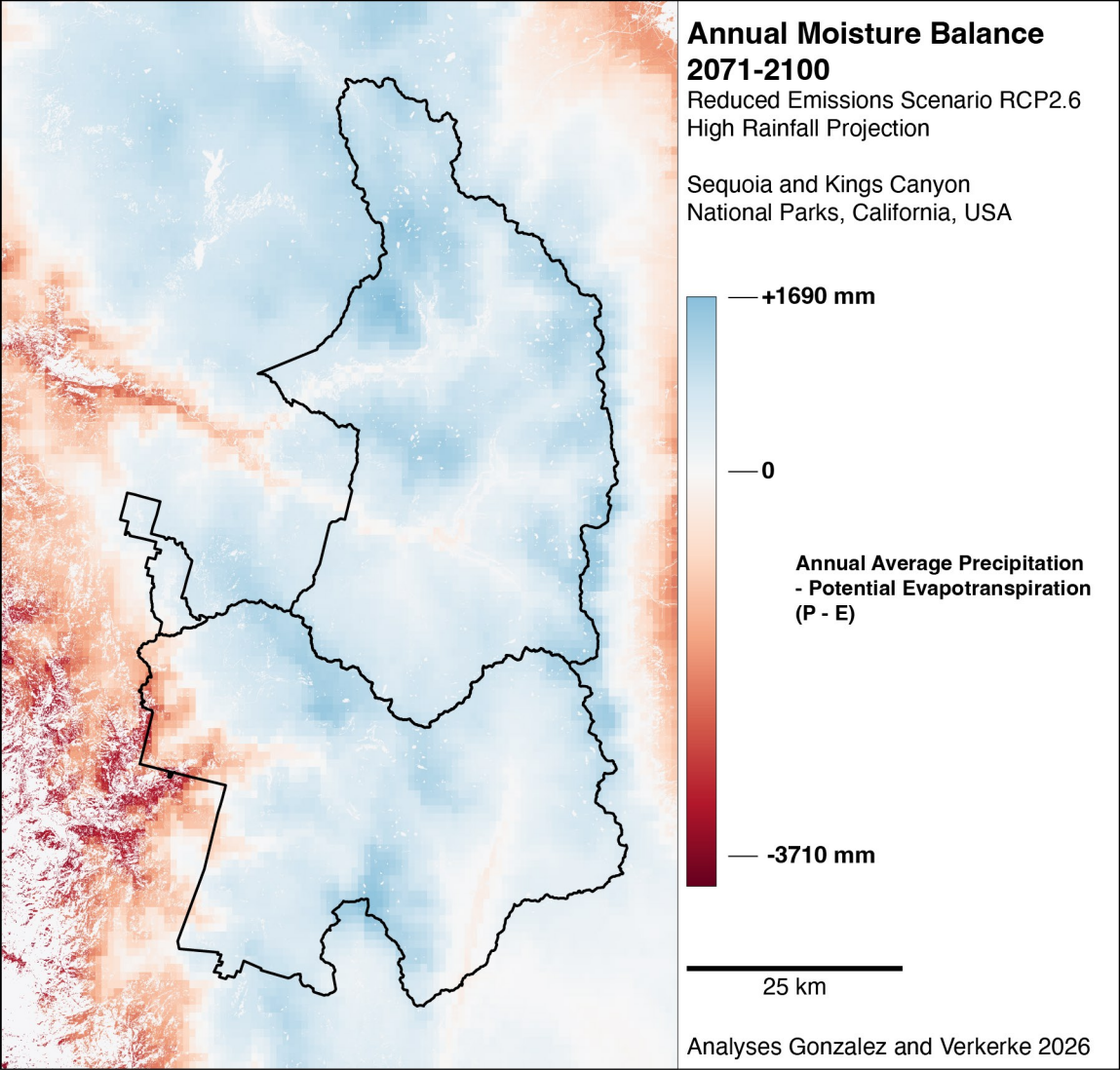
2071-2100

Reduced Emissions Scenario RCP2.6

High Rainfall Projection

Sequoia and Kings Canyon

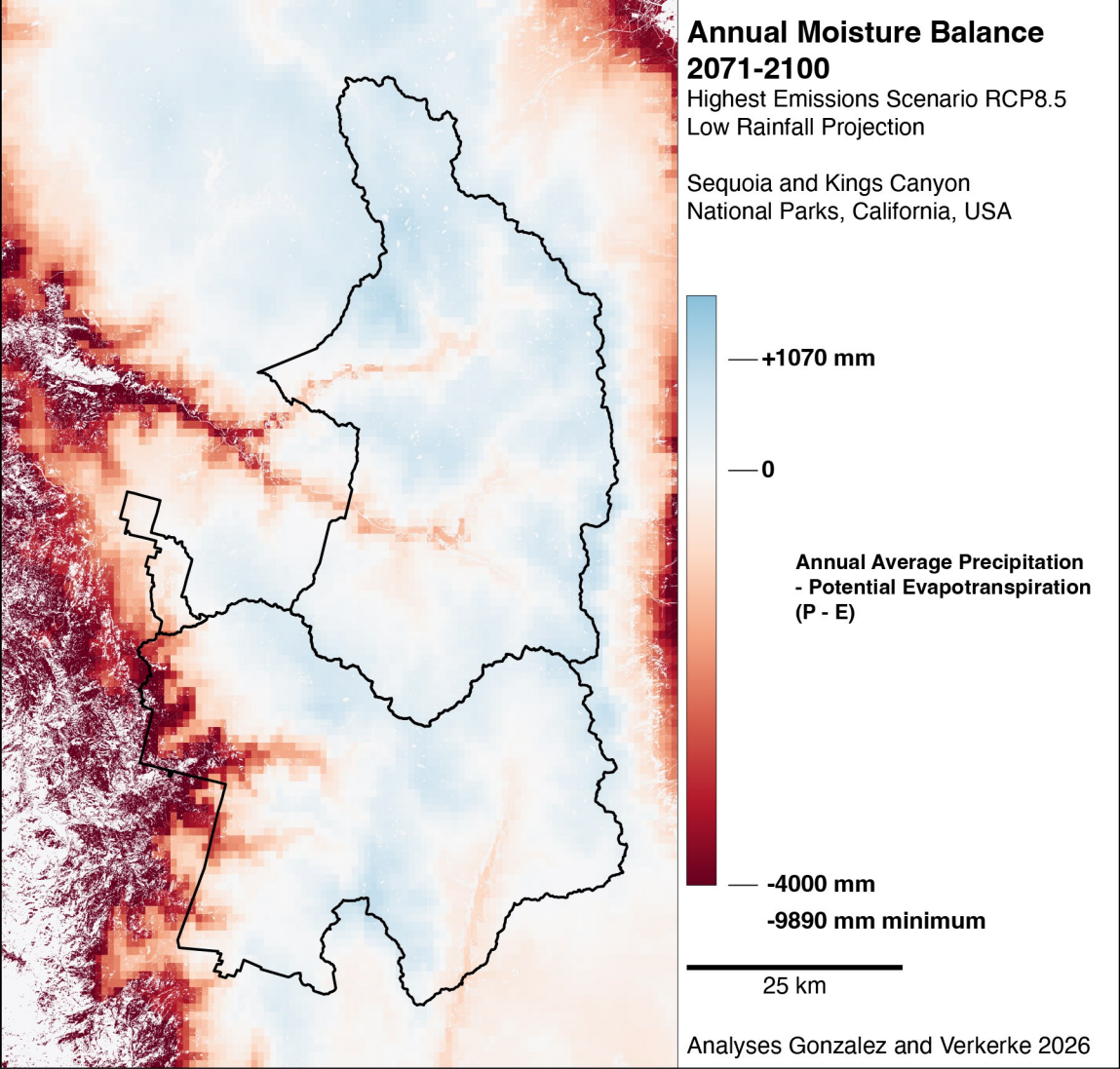
National Parks, California, USA



Annual Moisture Balance 2071-2100

Highest Emissions Scenario RCP8.5
Low Rainfall Projection

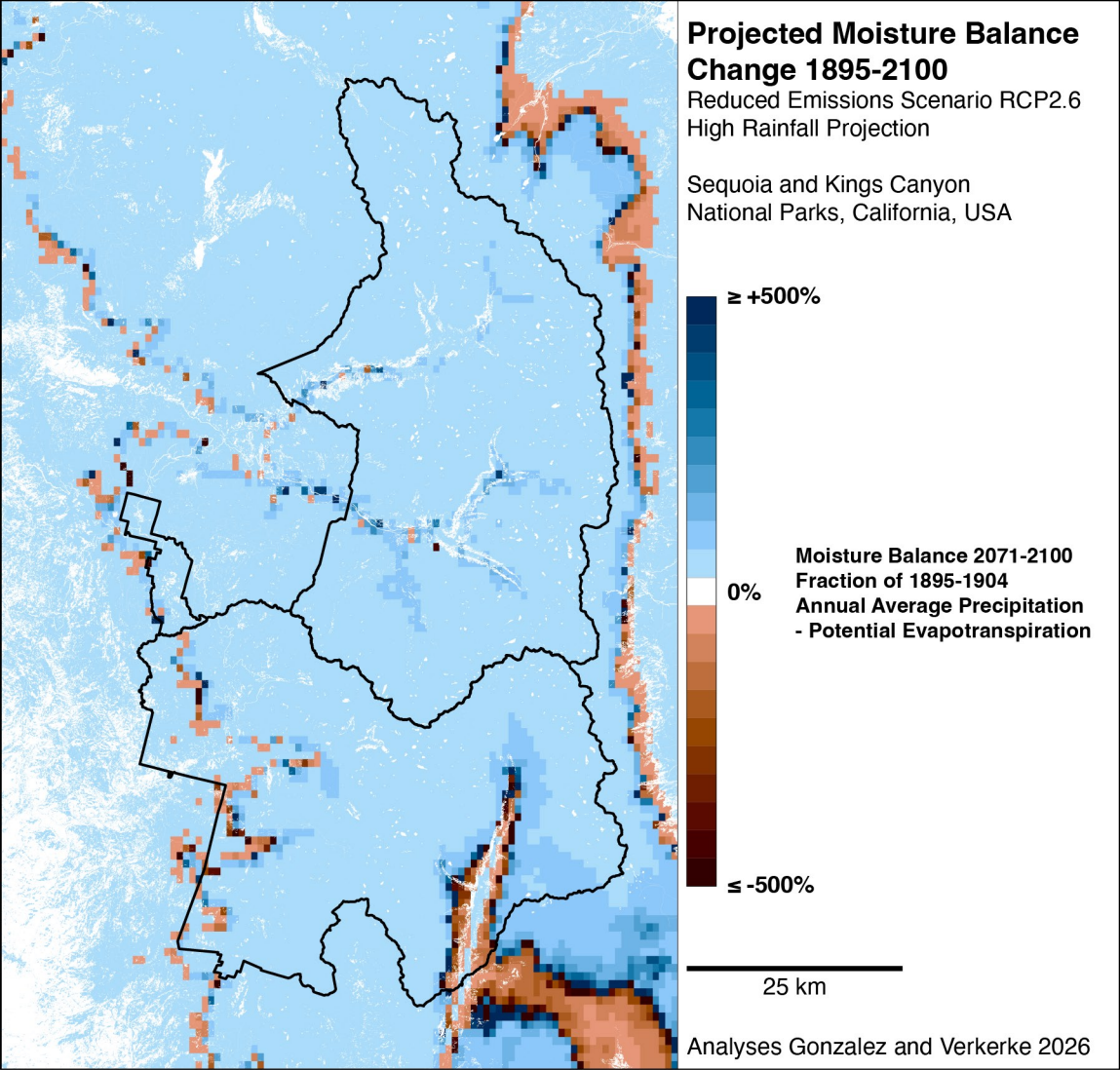
Sequoia and Kings Canyon
National Parks, California, USA



Projected Moisture Balance Change 1895-2100

Reduced Emissions Scenario RCP2.6
High Rainfall Projection

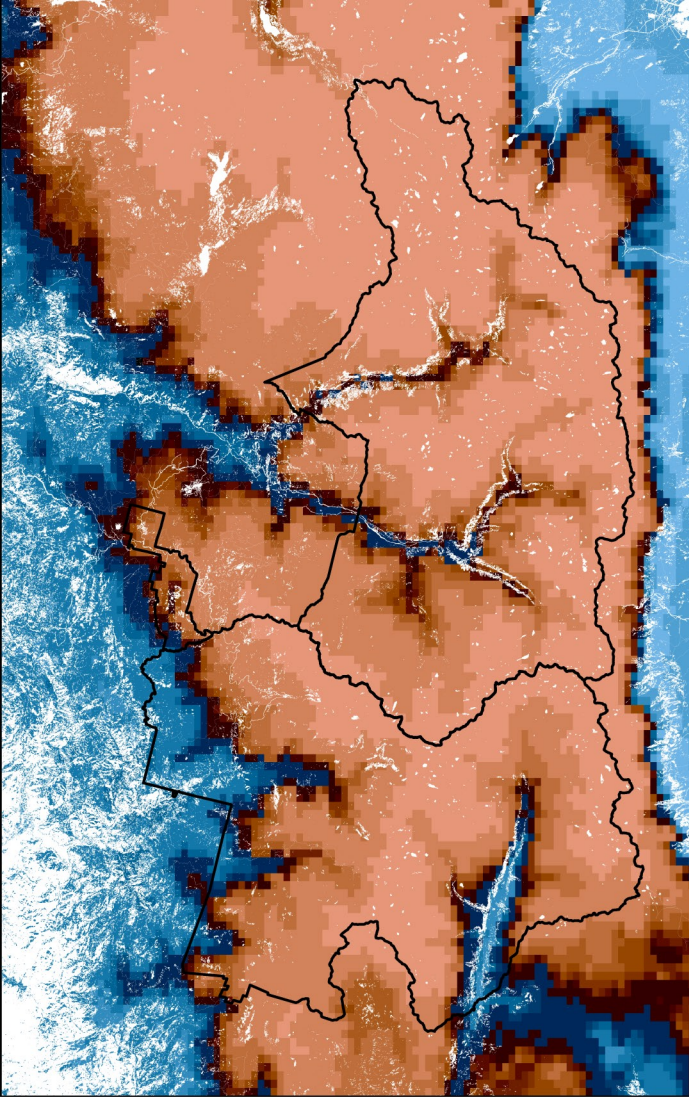
Sequoia and Kings Canyon
National Parks, California, USA



Projected Moisture Balance Change 1895-2100

Highest Emissions Scenario RCP8.5
Low Rainfall Projection

Sequoia and Kings Canyon
National Parks, California, USA



$\geq +500\%$

0%

$\leq -500\%$

Moisture Balance 2071-2100
Fraction of 1895-1904
Annual Average Precipitation
- Potential Evapotranspiration

25 km

Analyses Gonzalez and Verkerke 2026

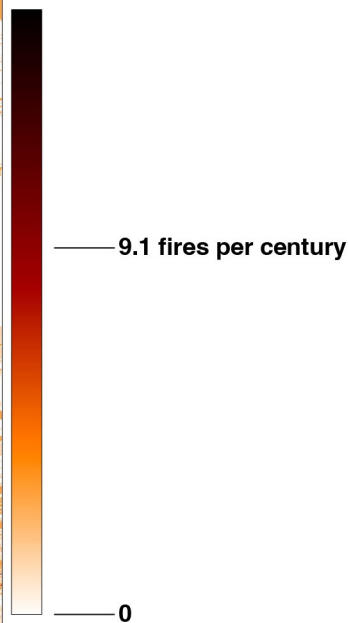
Fire Frequency 1849

Potential

Based on Estimated Vegetation

Sequoia and Kings Canyon

National Parks, California, USA



25 km

Data USDA Forest Service

Analyses Gonzalez and Verkerke 2026

Fire Frequency 1950-2023

Observed Burned Areas
Based on Field Surveys
and Remote Sensing

Sequoia and Kings Canyon
National Parks, California, USA

19 fires per century maximum

15



0

25 km

Data State of California CalFire
Analyses Gonzalez and Verkerke 2026

Fire Frequency 2023

Potential

Based on Observed Vegetation

Sequoia and Kings Canyon
National Parks, California, USA

25 fires per century maximum

15



0

25 km

Data U.S. Geological Survey
Analyses Gonzalez and Verkerke 2026

Fire Frequency 2100

Potential

Reduced Emissions Scenario RCP2.6

High Rainfall Projection

Sequoia and Kings Canyon

National Parks, California, USA

100 fires per century maximum



25 km

Analyses Gonzalez and Verkerke 2026

Fire Frequency 2100

Potential

Reduced Emissions Scenario RCP8.5

Low Rainfall Projection

Sequoia and Kings Canyon

National Parks, California, USA

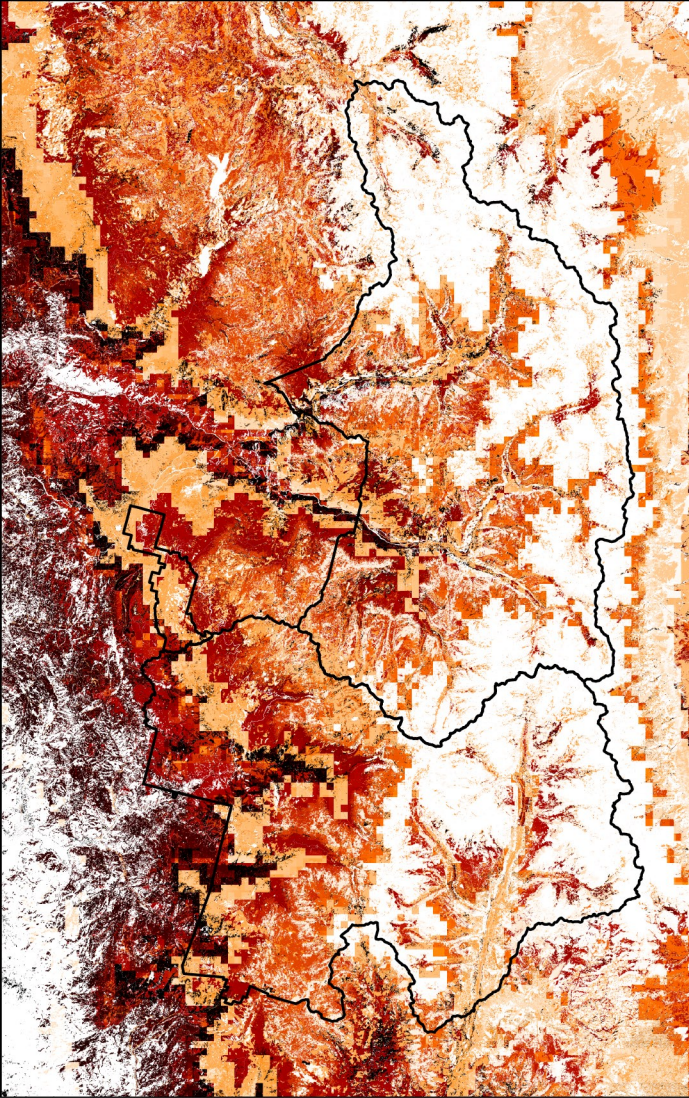
100 fires per century maximum

15

0

25 km

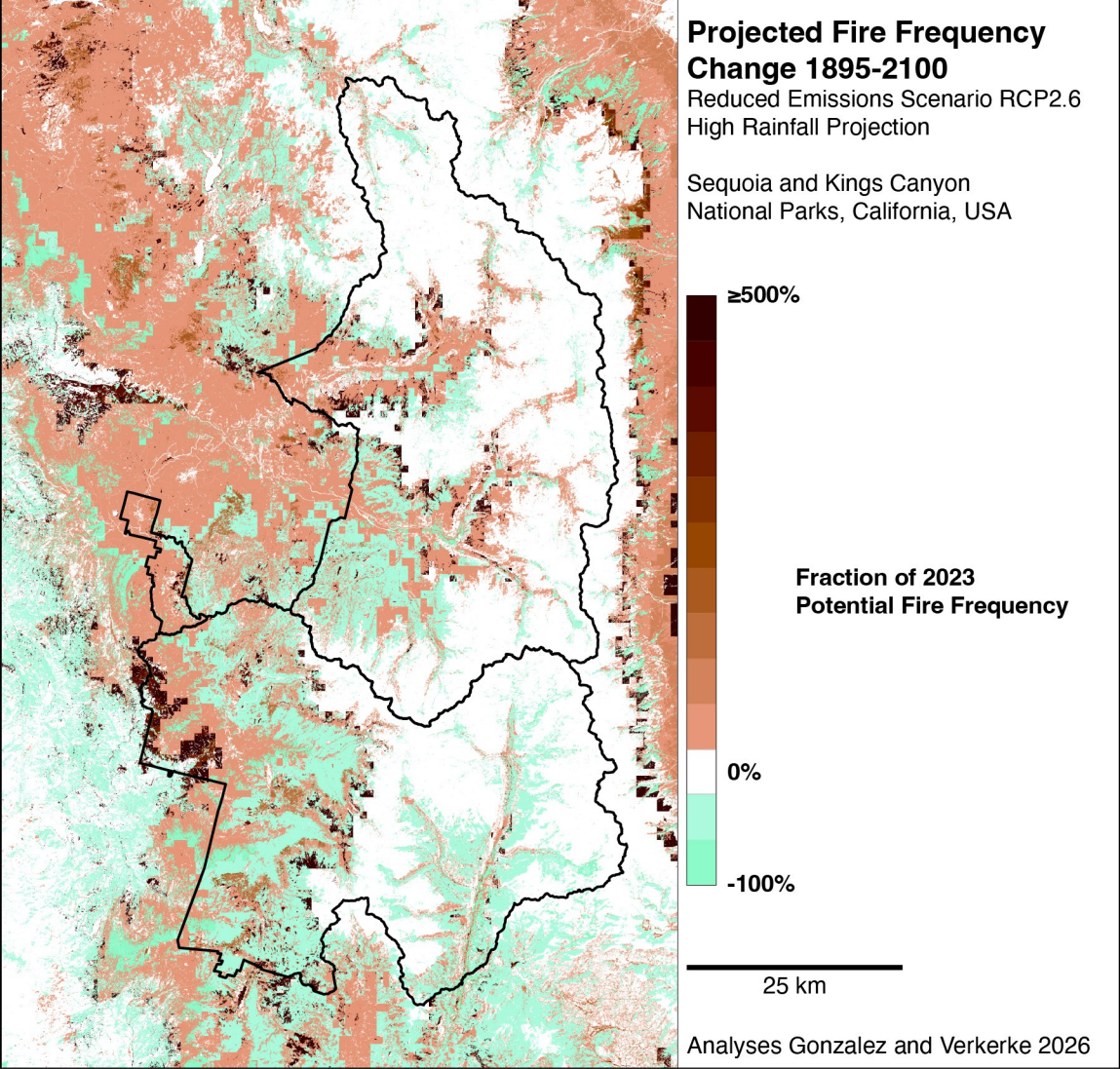
Analyses Gonzalez and Verkerke 2026



Projected Fire Frequency Change 1895-2100

Reduced Emissions Scenario RCP2.6
High Rainfall Projection

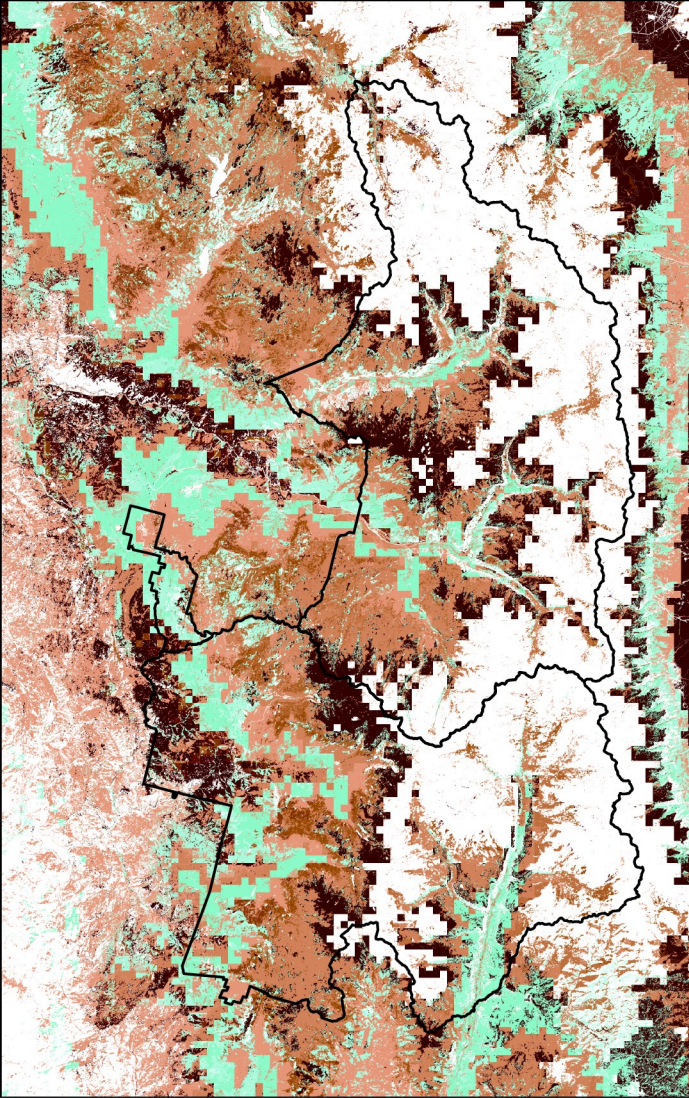
Sequoia and Kings Canyon
National Parks, California, USA



Projected Fire Frequency Change 1895-2100

Highest Emissions Scenario RCP8.5
Low Rainfall Projection

Sequoia and Kings Canyon
National Parks, California, USA



≥500%

Fraction of 2023
Potential Fire Frequency

0%

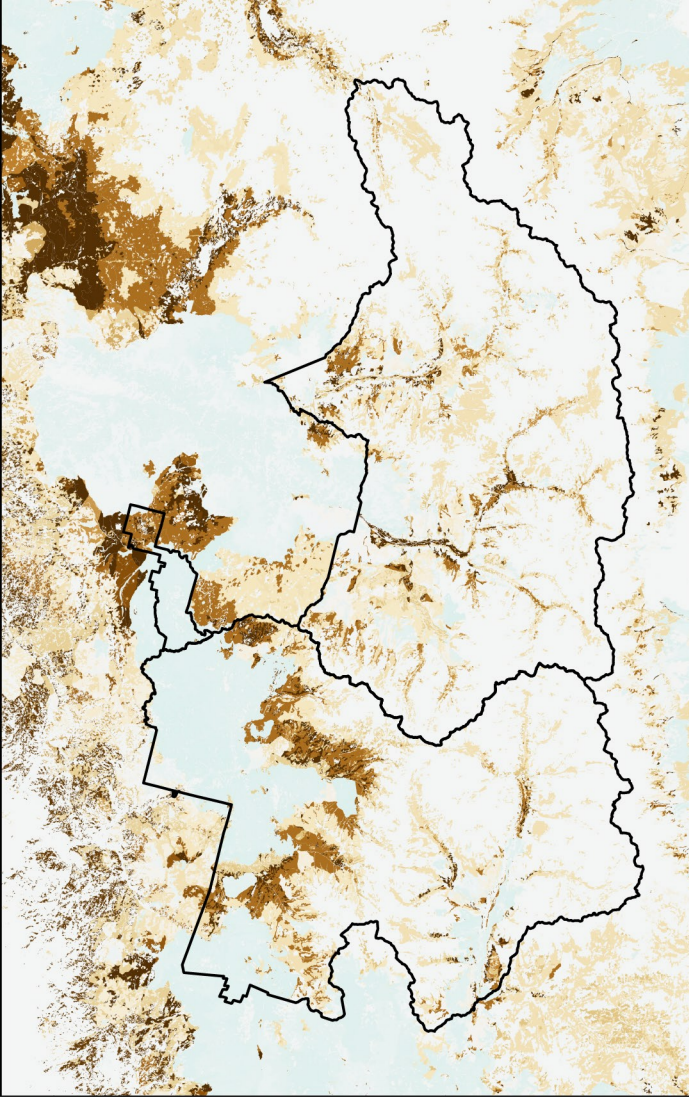
-100%

25 km

Analyses Gonzalez and Verkerke 2026

Fire Return Interval Departure 2024 compared to 1849

Sequoia and Kings Canyon
National Parks, California, USA



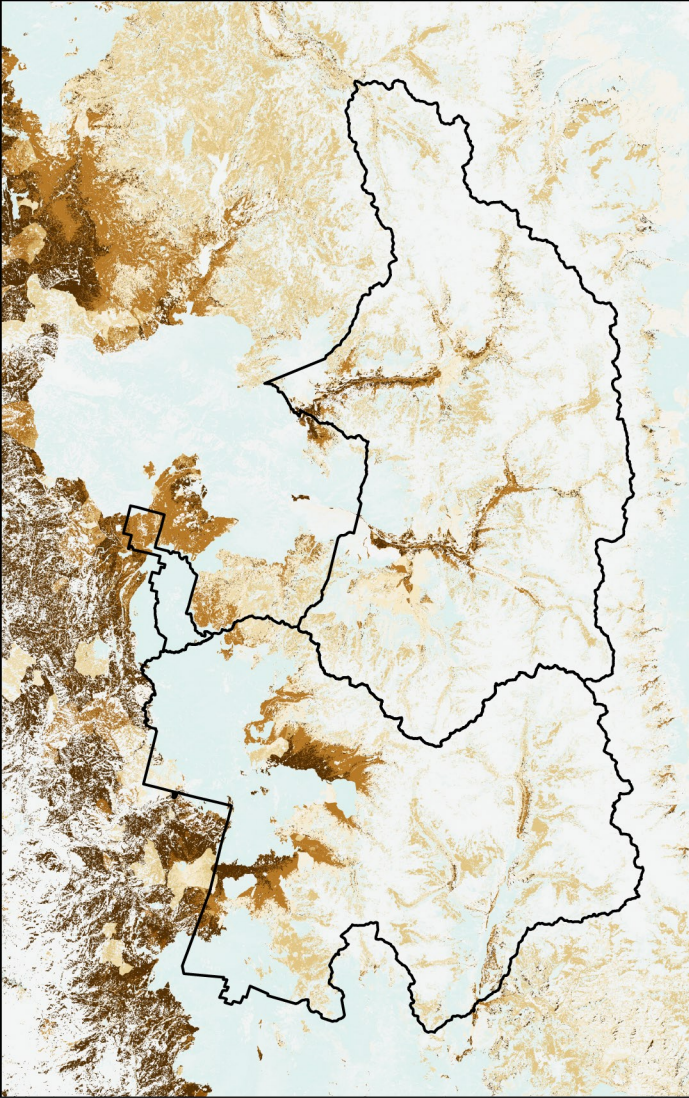
$$\frac{(\text{Reference fire return interval} - \text{Time since last fire in 2024})}{(\text{Reference fire return interval})}$$

— -10 intervals late

25 km

Fire Return Interval Departure 2024 actual vs. potential

Sequoia and Kings Canyon
National Parks, California, USA



1
0

$$\frac{(\text{Reference fire return interval} - \text{Time since last fire in 2024})}{(\text{Reference fire return interval})}$$

-10 intervals late
-30 intervals most severe

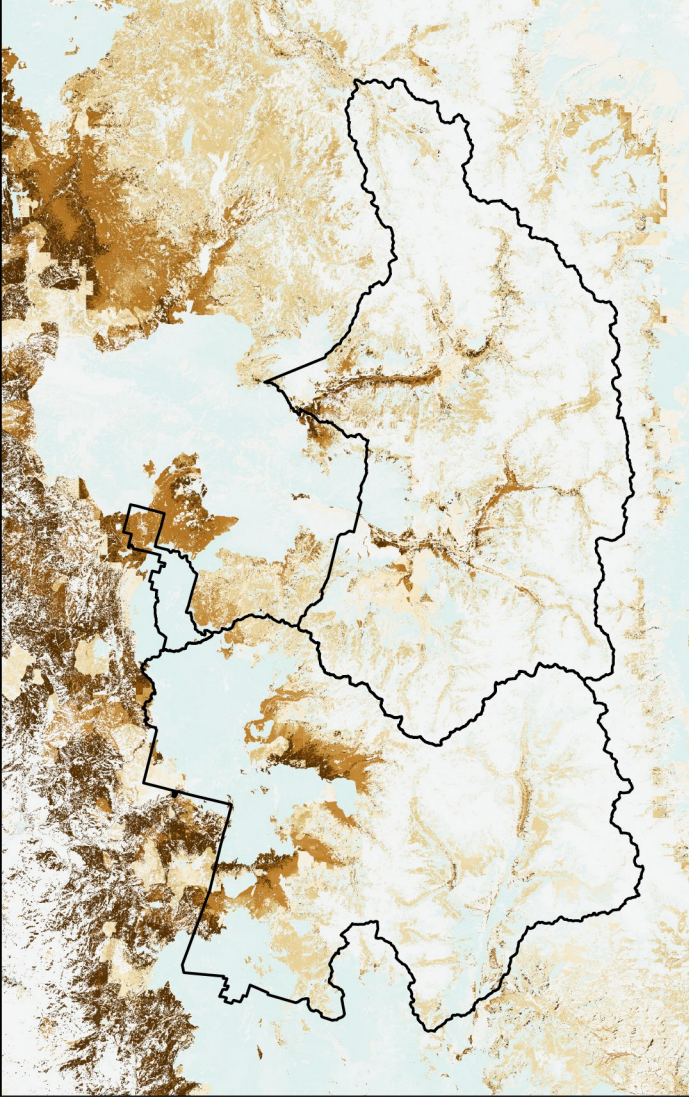
25 km

Analyses Gonzalez and Verkerke 2026

Fire Return Interval Departure 2024 compared to 2100

Reduced Emissions Scenario RCP2.6
High Rainfall Projection

Sequoia and Kings Canyon
National Parks, California, USA



$$\frac{(\text{Reference fire return interval} - \text{Time since last fire in 2024})}{(\text{Reference fire return interval})}$$

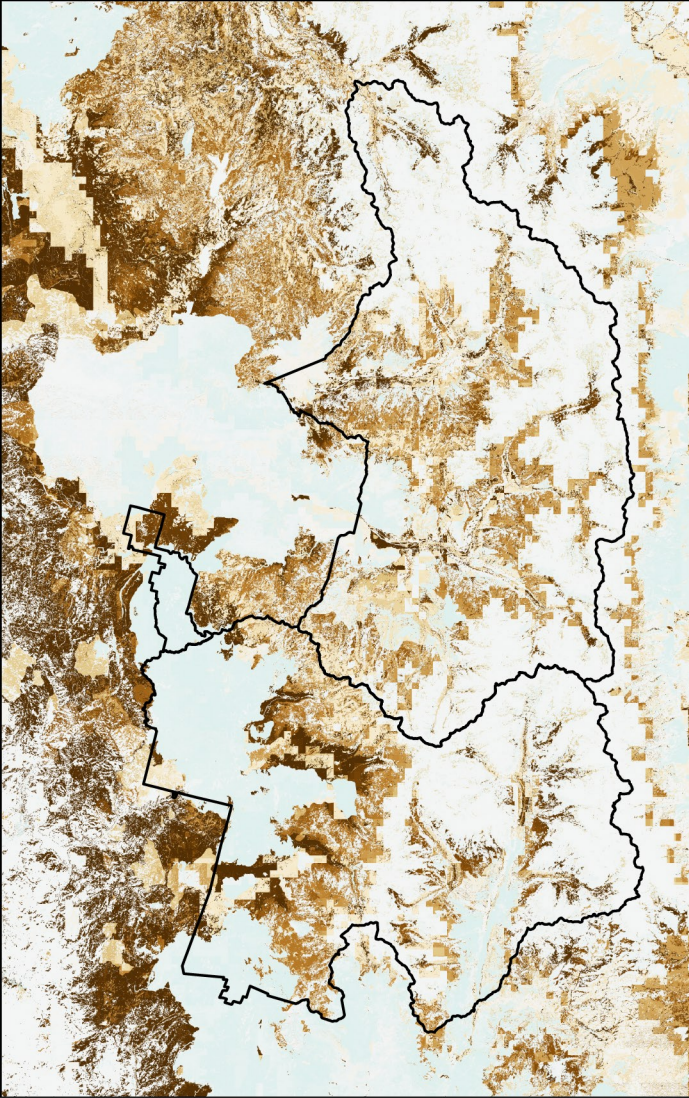
-10 intervals late
-120 intervals most severe

25 km

Fire Return Interval Departure 2024 compared to 2100

Highest Emissions Scenario RCP8.5
Low Rainfall Projection

Sequoia and Kings Canyon
National Parks, California, USA



$$\frac{(\text{Reference fire return interval} - \text{Time since last fire in 2024})}{(\text{Reference fire return interval})}$$

— -10 intervals late
— -120 intervals most severe

25 km

Severe Fire Risk Areas

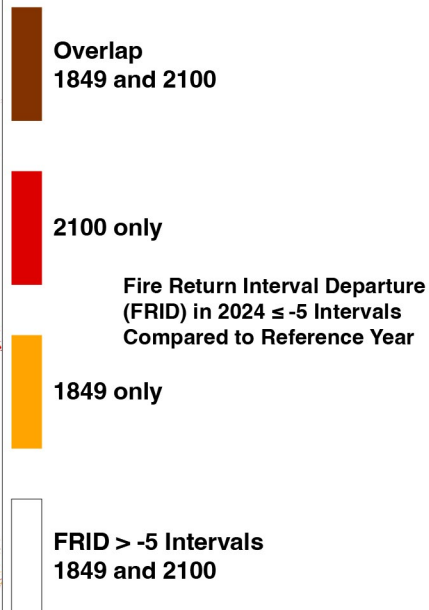
2024-2100

Reduced Emissions Scenario RCP2.6

High Rainfall Projection

Sequoia and Kings Canyon

National Parks, California, USA



25 km

Severe Fire Risk Areas

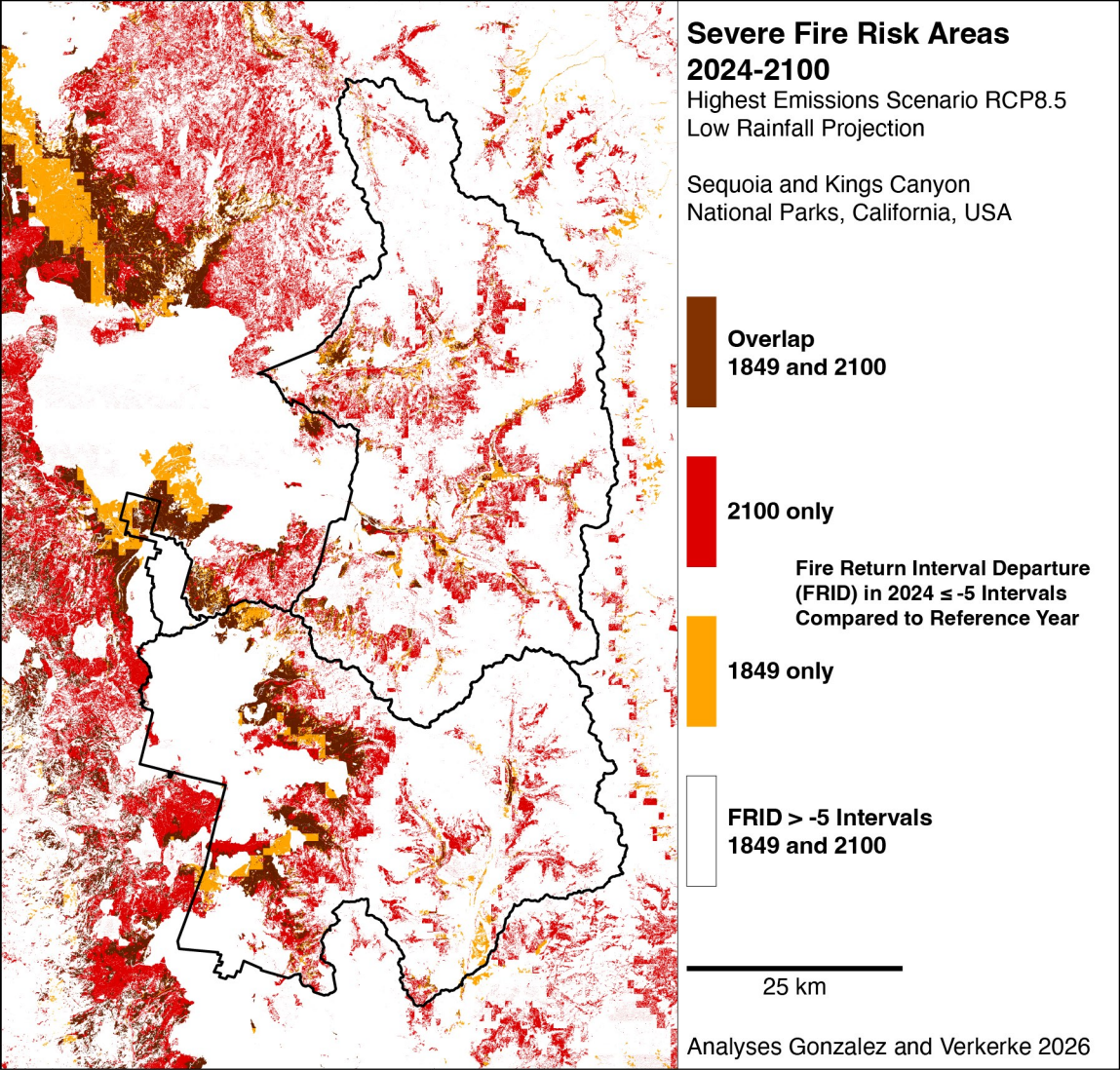
2024-2100

Highest Emissions Scenario RCP8.5

Low Rainfall Projection

Sequoia and Kings Canyon

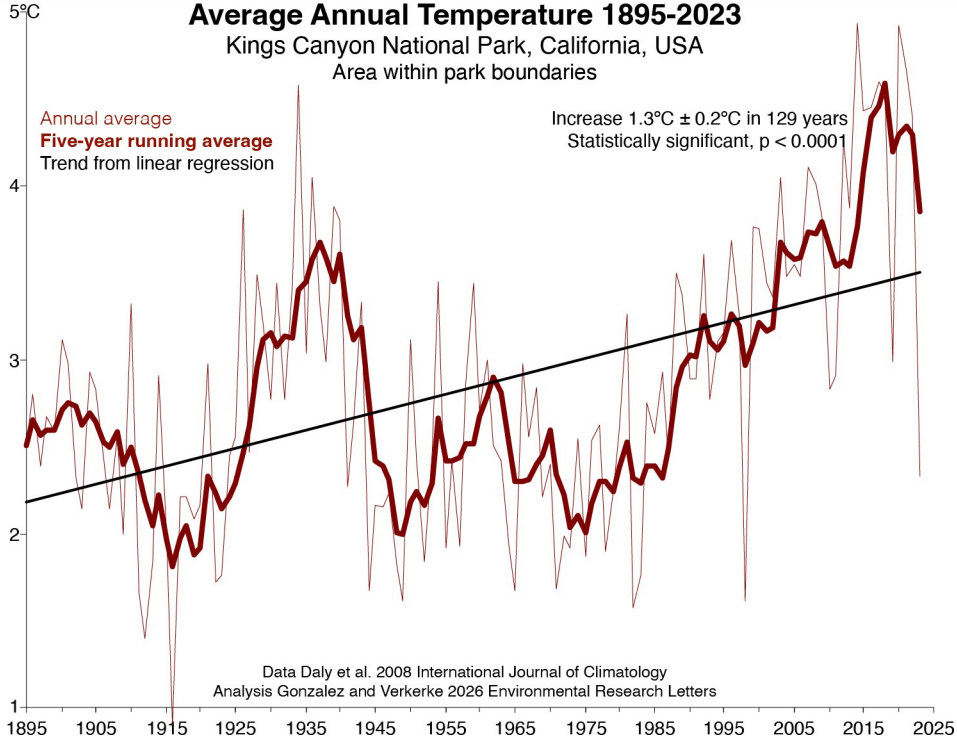
National Parks, California, USA



Average Annual Temperature 1895-2023

Kings Canyon National Park, California, USA

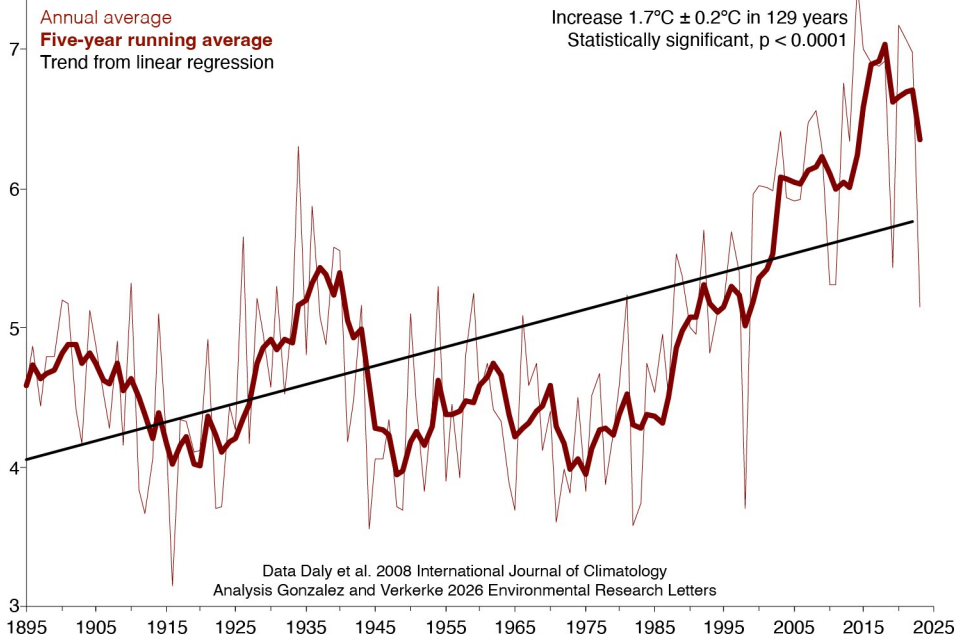
Area within park boundaries



Average Annual Temperature 1895-2023

Sequoia National Park, California, USA

Area within park boundaries



2100 mm y⁻¹

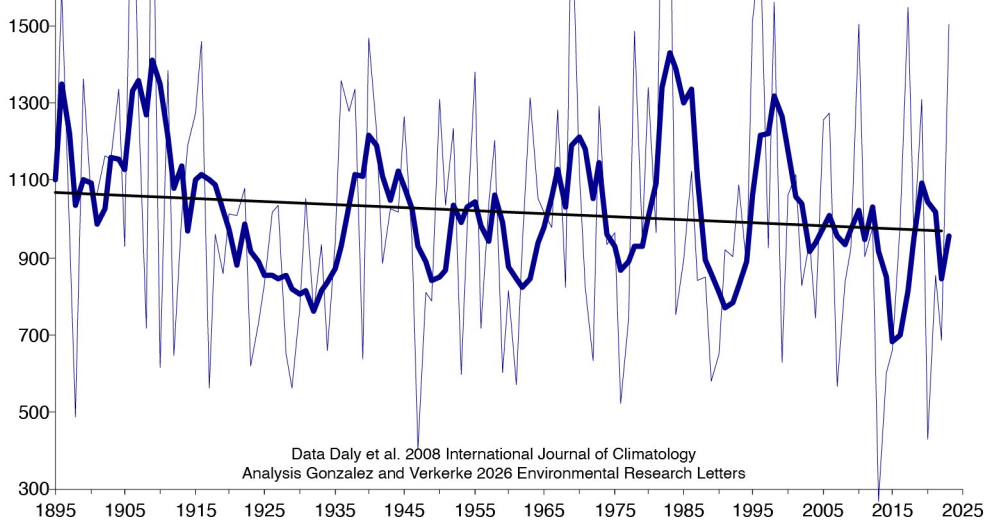
Total Annual Precipitation 1895-2023

Kings Canyon National Park, California, USA

Area within park boundaries

Annual average
Five-year running average
Trend from linear regression

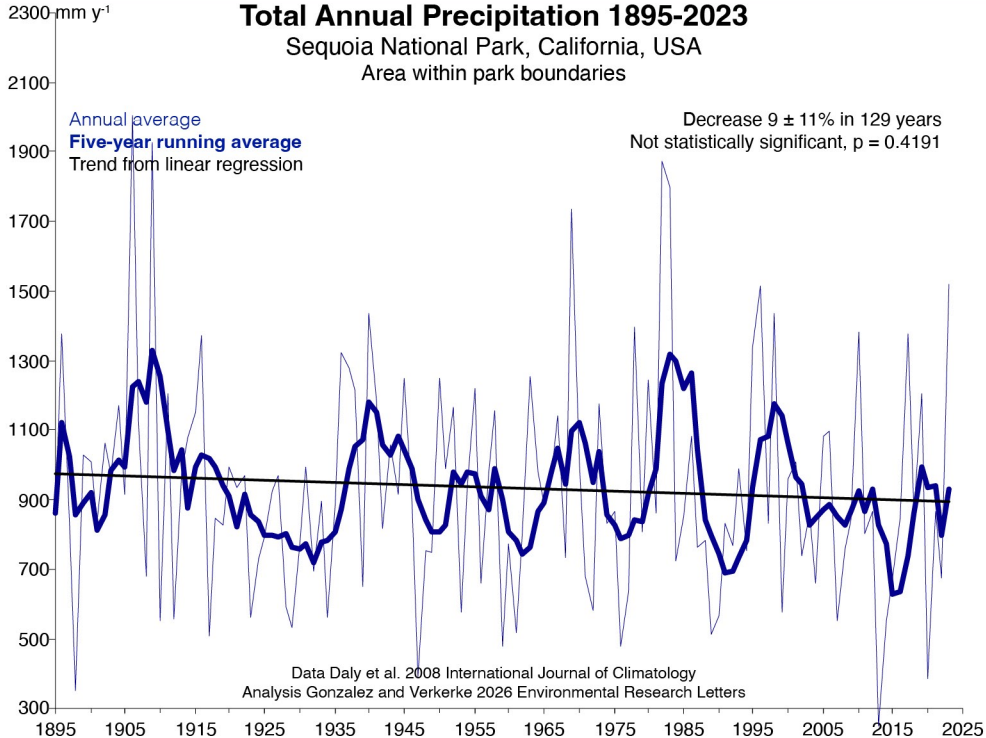
Decrease $10 \pm 10\%$ in 129 years
Not statistically significant, $p = 0.3393$



Total Annual Precipitation 1895-2023

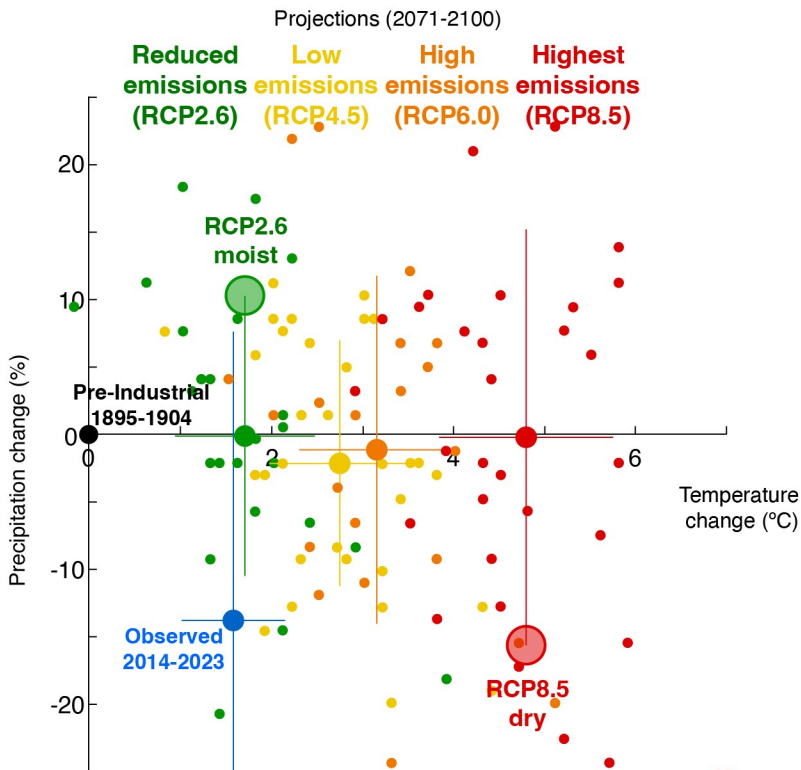
Sequoia National Park, California, USA

Area within park boundaries



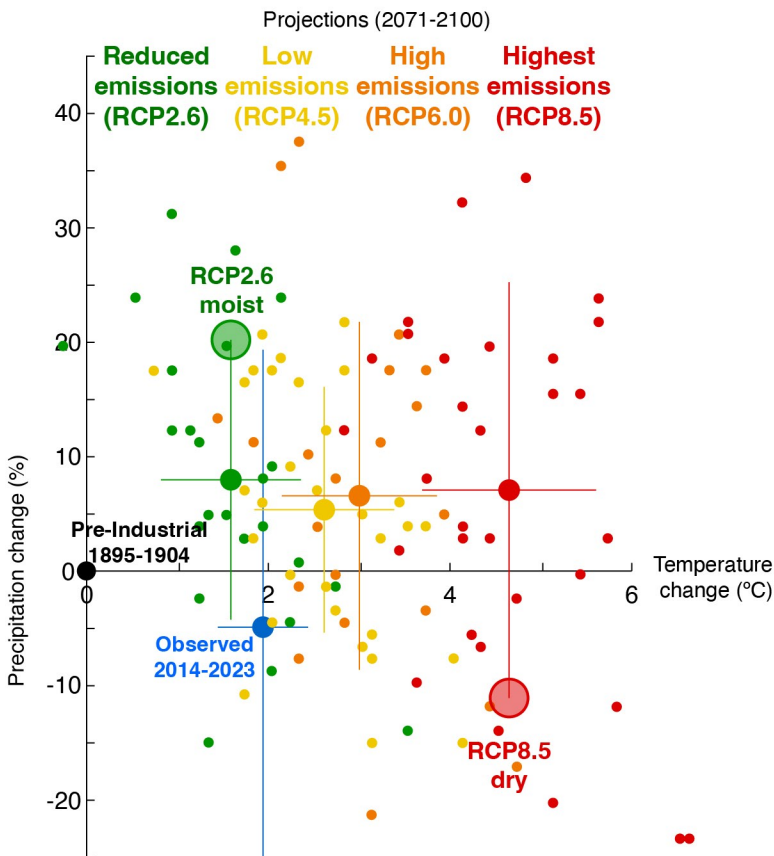
Climate Change

Kings Canyon National Park, California, USA
Change from Pre-Industrial (1895-1904)



Climate Change

Sequoia National Park, California, USA
Change from Pre-Industrial (1895-1904)



Biome Climate Shifts

Sequoia research area, California, USA

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