

Report: Terrain and Vegetation in Santa Monica Mountains National Recreation Area

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UCLA GIS 181B

Introduction

This report focuses on topography and vegetation in Santa Monica Mountains National Recreation Area (SMMNRA). In order to better understand how topographic properties impact vegetation habitats, 9 maps as well as a table of statistics were created.

Methods of Analysis

In order to create the maps, the provided data layers were used: [a DEM raster file](#) of Santa Monica Mountains National Recreation Area (SMMNRA), [a vegetation shapefile](#), and [the NPS Boundary shapefile](#) of SMMNRA. The vegetation overview map and DEM Hillshade map, figures 1 and 2, were created using standard mapmaking techniques and include base maps for context. The maps representing slope and aspect, figures 3-4, were calculated using the elevation values within the DEM raster. Slope, a measure of the change in elevation at any particular location, is calculated for each individual pixel using the relative values of the surrounding 3x3 grid. Aspect, a measure of the direction of the slope, is also calculated using these relative values. The next set of maps, figures 5-8, depict seasonal insolation for SMMNRA - a measure of the amount of solar radiation received by each pixel of the raster in a season. For each season, a representative date was selected for which radiation values were calculated. For each date, the [NOAA Solar Position Calculator](#) was used to determine the sun's position in the sky. See "Seasonal Insolation Data" in appendix for detailed information. Using the azimuth and elevation information obtained from this calculator, a hillshade layer was created for each date to represent the area's relative illumination by the sun. This layer was then "normalized" by projecting all values onto the range (0,1). For each season, a relative solar constant was estimated using the provided chart, and each pixel of each raster was multiplied by the appropriate value. After this process, the resulting raster files' values are representative of the insolation for the given season. On all seasonal maps, all colors have been scaled relative to the maximum radiation value across all four: 450 w/m², in order to better represent seasonal differences. Finally, the average annual radiation map (figure 9) was calculated by averaging the seasonal values for each pixel. After these maps were created, the table of vegetation statistics, table 1, and charts were obtained by analyzing each layer in conjunction with the provided vegetation shapefile.

Results

When analyzing the created maps and table, it is clear that terrain and topography has a large impact on vegetation. Chamise-Redshank Chaparral vegetation grows at a higher elevation and slope than other vegetation types, as per plots 1 and 3. Annual Grass vegetation grows at the lowest average elevation, and notably has the highest mean radiation of any vegetation type as per plot 2. This could mean that annual grass requires lots of sunlight to thrive. Urban-Agriculture vegetation has high mean radiation, as well as the lowest mean slope of any type. This could indicate that agricultural fields and human cities tend to require sunny, flat areas of land in order to function. Coastal Scrub vegetation occupies a central area, both statistically and geographically. It serves as a transition point between annual grass/urban-agriculture and chaparral areas geographically, and its mean elevation and slope lie in between these other vegetation types' stats as well.

Conclusion

Overall, the created maps and statistics provide a comprehensive overview of the vegetation in Santa Monica Mountains National Recreation Area. It is clear that topography and solar exposure play large roles in the type of vegetation which grows in a given area.

Appendix

Formulae

Slope Derivation Formula:

$$\text{Slope \%} = \varsigma = \sqrt{\left(\frac{\Delta z}{\Delta x}\right)^2 + \left(\frac{\Delta z}{\Delta y}\right)^2}$$

Aspect Derivation Formula:

$$\text{Aspect angle} = \theta = \arctan \begin{pmatrix} -\frac{\Delta z}{\Delta x} \\ \frac{\Delta y}{\Delta z} \end{pmatrix}$$

Solar Irradiance Formula:

$$I = S * \text{Hillshade}/254$$

(using 254 rather than 255, as arcGIS hillshade layers begin at 0)

Seasonal Insolation Data:

For each season, a representative date was selected on which all calculations were performed. The average insolation map was obtained by averaging results from all four seasons. A time of 12:00pm was used. Additionally, a lat/long located in Agoura Hills, near the center of the study area, was used: 34°08'36.4"N 118°47'12.1"W. On all seasonal maps, all colors have been scaled relative to the maximum radiation value across all four: 450 w/m^2, in order to better represent seasonal differences. The following is information on the representative date selected from each season, the solar position data for the given day at 12:00pm, and an estimate of the solar constant for the date obtained from the provided graph.

Spring: Vernal Equinox, March 20, 2021

| <u>Equation of Time (minutes):</u> | <u>Solar Declination (degrees):</u> | <u>Solar Azimuth:</u> | <u>Solar Elevation:</u> | <u>cosine of solar zenith angle</u> |
|------------------------------------|-------------------------------------|-----------------------|-------------------------|-------------------------------------|
| -7.28 | 0.16 | 178.91 | 56.03 | 0.8293 |

Solar Constant Estimate: 350 W/m^2

Summer: Summer Solstice, June 20th, 2021

| <u>Equation of Time (minutes):</u> | <u>Solar Declination (degrees):</u> | <u>Solar Azimuth:</u> | <u>Solar Elevation:</u> | <u>cosine of solar zenith angle</u> |
|--|---|---------------------------|-----------------------------|---|
| -1.72 | 23.43 | 183.87 | 79.27 | 0.9825 |

Solar Constant Estimate: 450 W/m²

Autumn: Autumnal Equinox, September 22, 2021

| <u>Equation of Time (minutes):</u> | <u>Solar Declination (degrees):</u> | <u>Solar Azimuth:</u> | <u>Solar Elevation:</u> | <u>cosine of solar zenith angle</u> |
|--|---|---------------------------|-----------------------------|---|
| 7.45 | -0.02 | 185.46 | 55.73 | 0.8264 |

Solar Constant Estimate: 375 W/m²

Winter: Winter Solstice, December 21, 2021

| <u>Equation of Time (minutes):</u> | <u>Solar Declination (degrees):</u> | <u>Solar Azimuth:</u> | <u>Solar Elevation:</u> | <u>cosine of solar zenith angle</u> |
|--|---|---------------------------|-----------------------------|---|
| 1.64 | -23.44 | 181.76 | 32.42 | 0.5361 |

Solar Constant Estimate: 150 W/m²

Maps, Tables, and Plots

The following pages contain the following maps, tables, and figures. All maps, tables, and figures are original and created by George Owen.

Fig. 1: Vegetation Overview of Santa Monica Mountains National Recreation Area

Fig. 2: DEM Hillshade of Santa Monica Mountains National Recreation Area

Fig. 3: Slope in Santa Monica Mountains National Recreation Area

Fig. 4: Aspect in Santa Monica Mountains National Recreation Area

Fig. 5: Seasonal Insolation of Santa Monica Mountains National Recreation Area (Summer)

Fig. 6: Seasonal Insolation of Santa Monica Mountains National Recreation Area (Fall)

Fig. 7: Seasonal Insolation of Santa Monica Mountains National Recreation Area (Winter)

Fig. 8: Seasonal Insolation of Santa Monica Mountains National Recreation Area (Spring)

Fig. 9: Total Annual Radiation Map of Santa Monica Mountains National Recreation Area (Average of 4 Seasons)

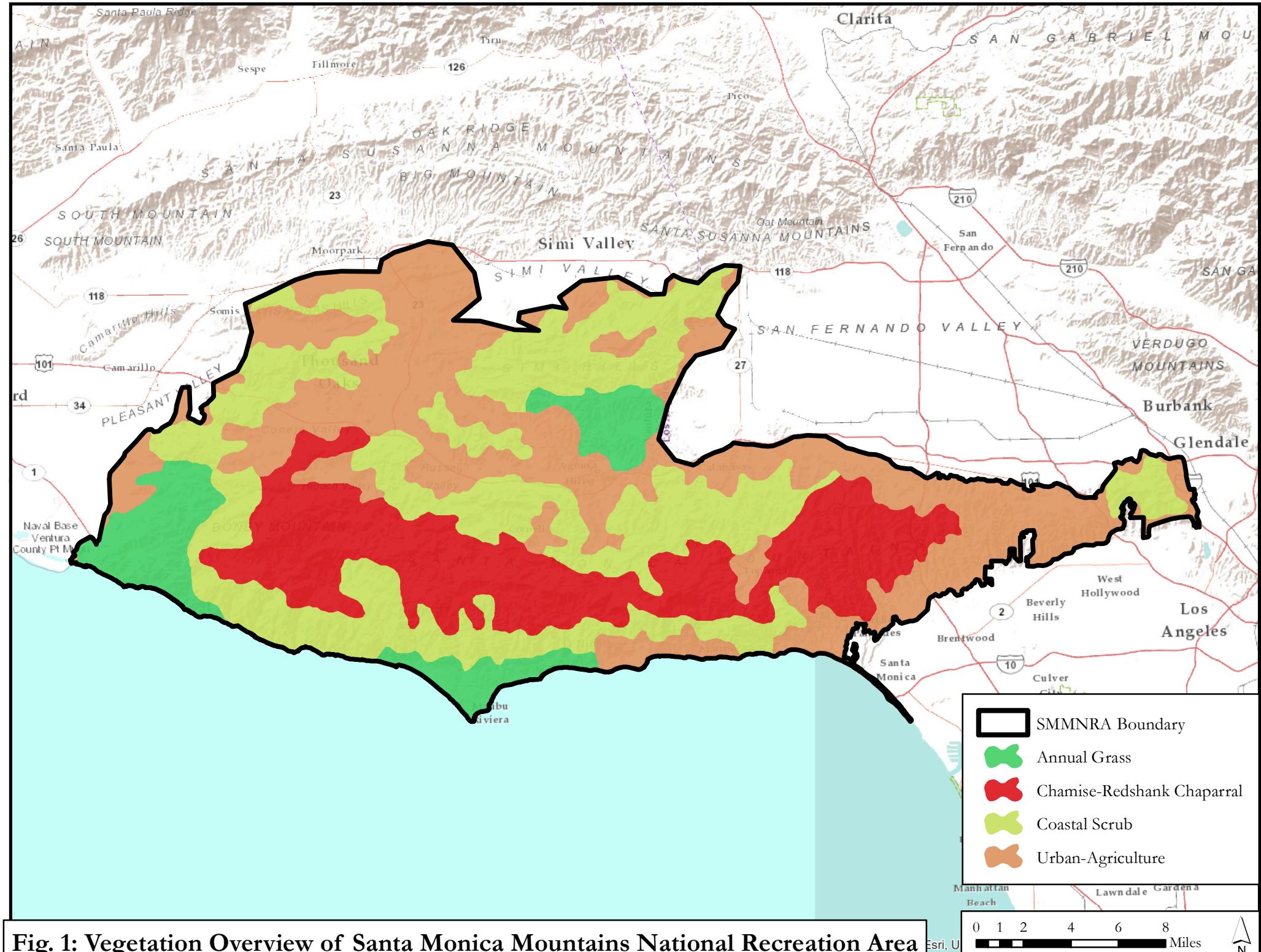
Table 1: Impact of Terrain and Insolation on Vegetation

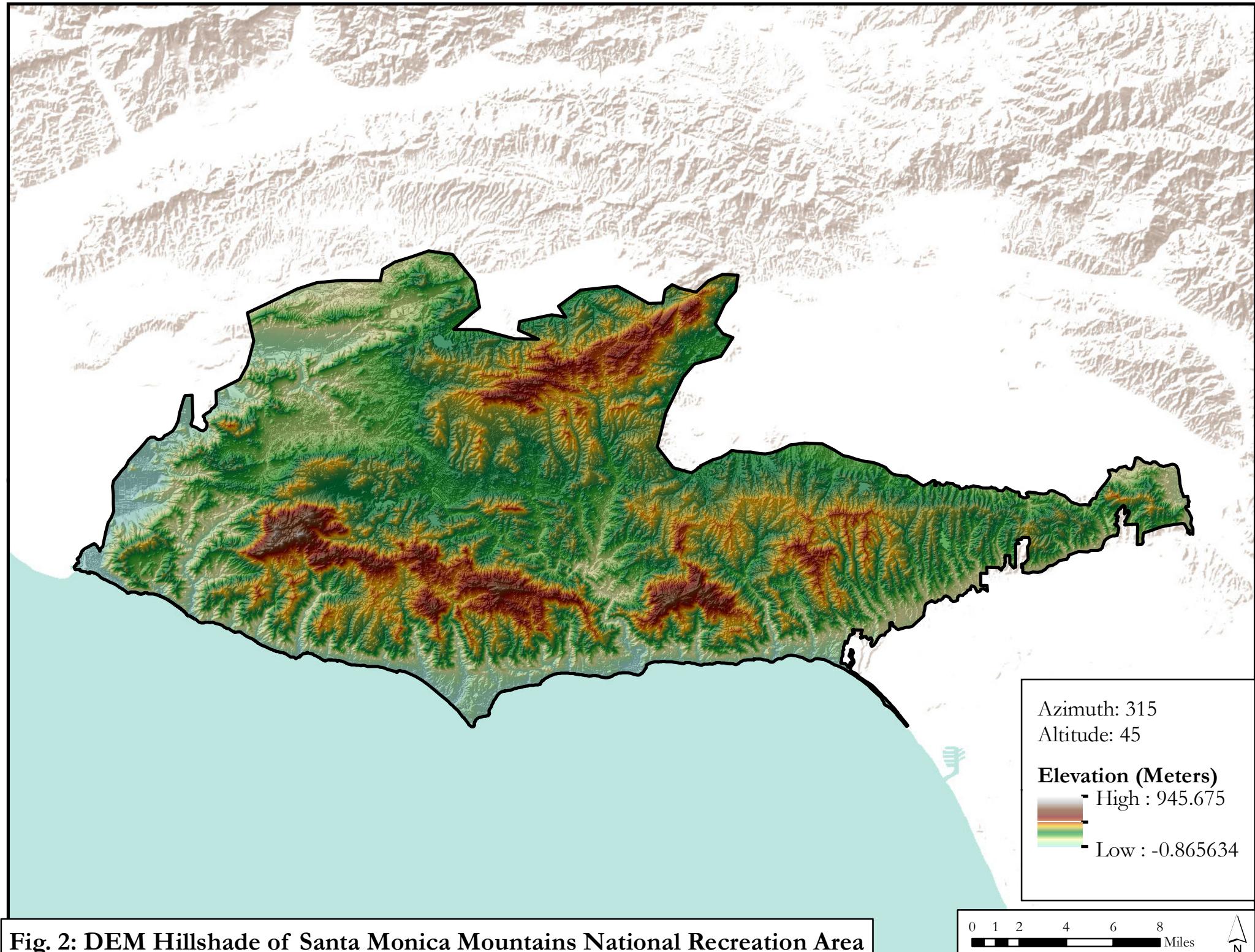
Plot 1: Mean Elevation vs Vegetation Type

Plot 2: Mean Radiation vs Vegetation Type

Plot 3: Mean Slope vs Vegetation Type

Plot 4: Aspect Standard Deviation vs Vegetation Type





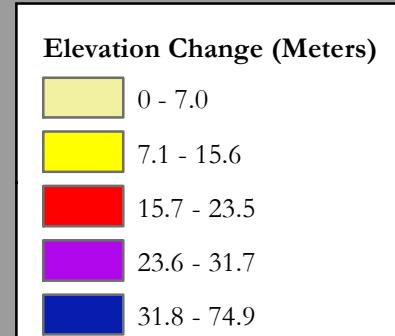
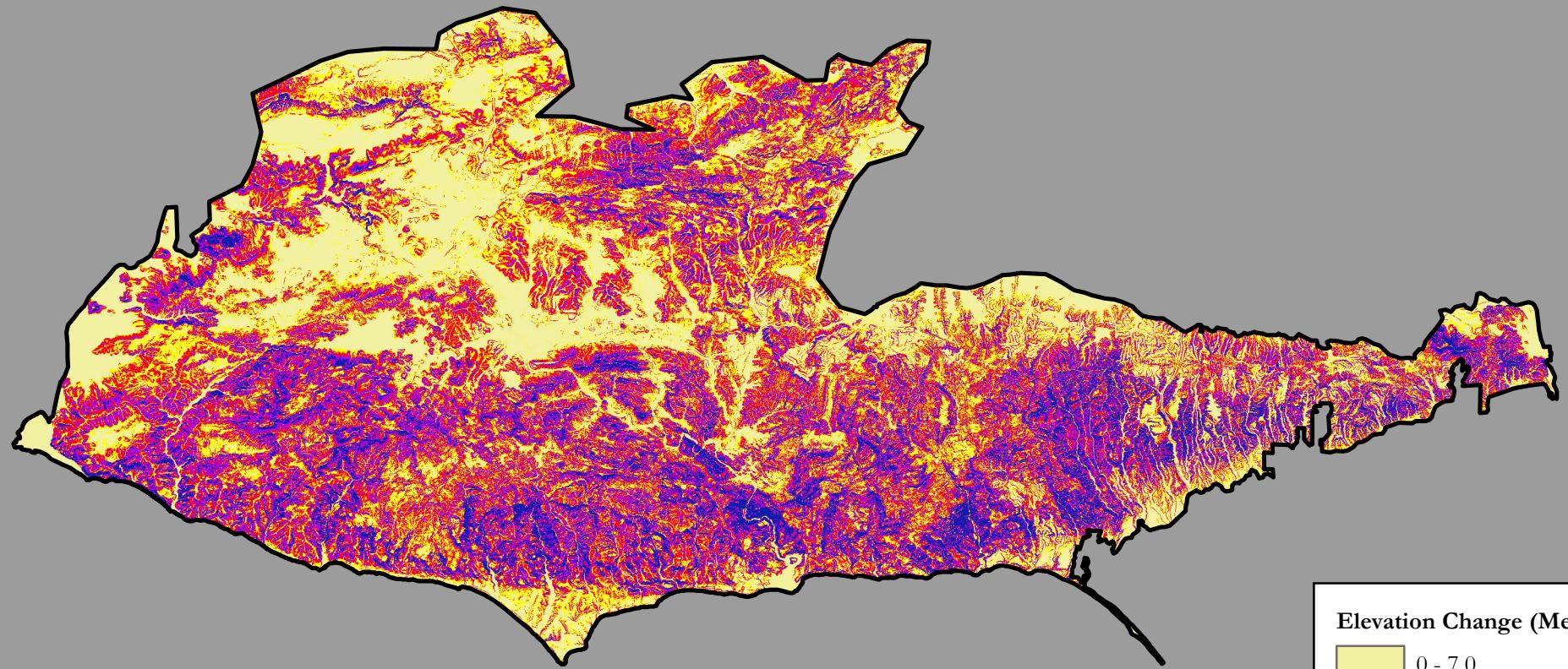
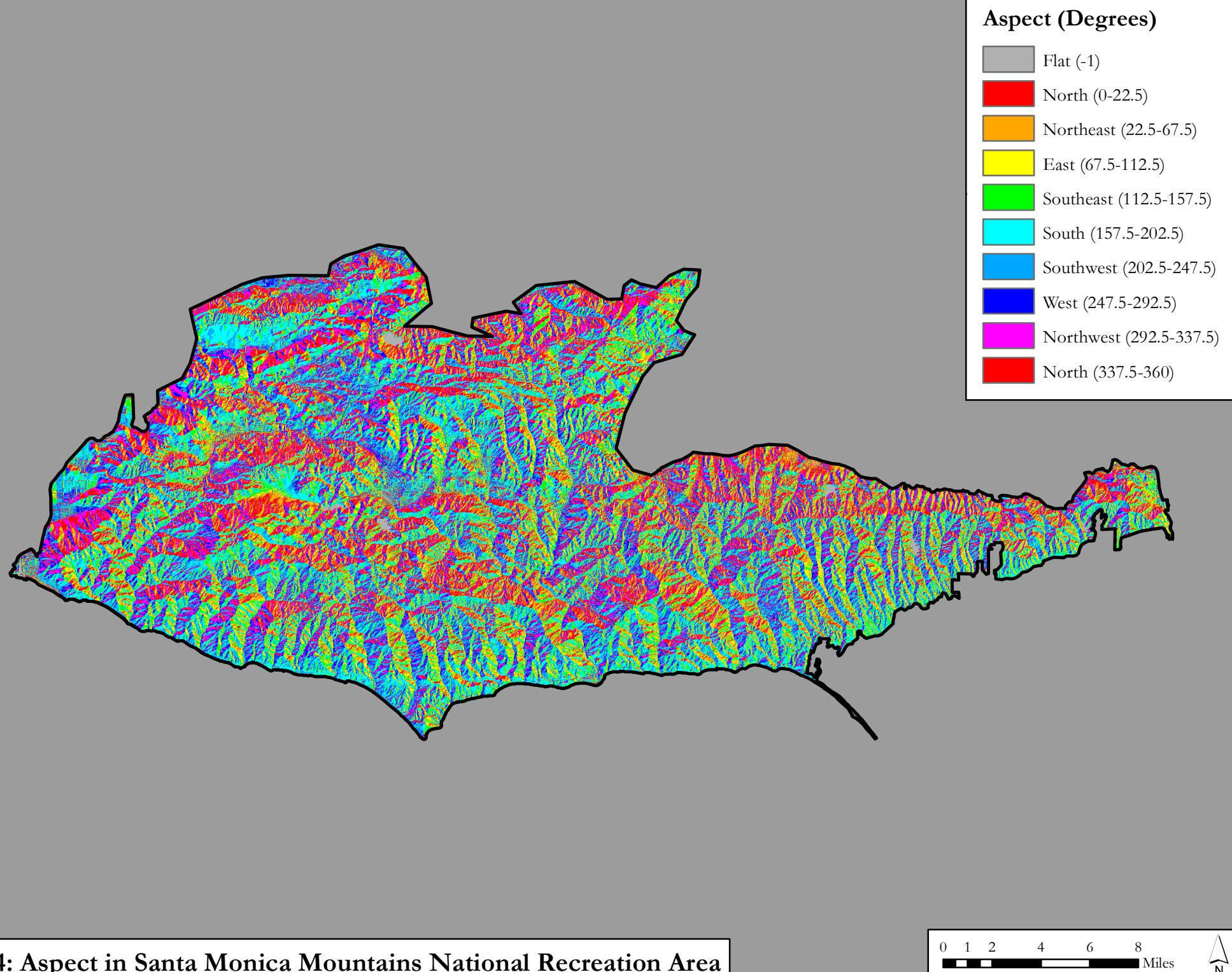
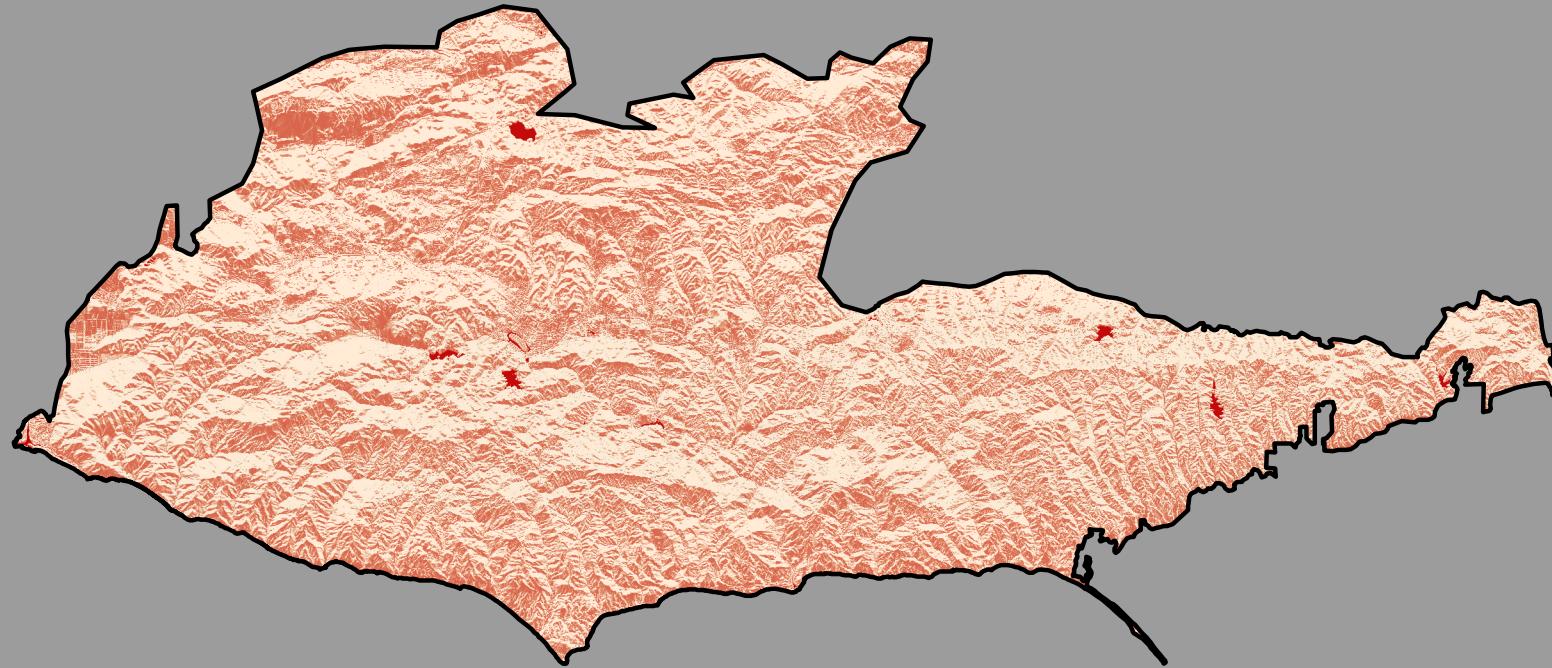


Fig. 3: Slope in Santa Monica Mountains National Recreation Area





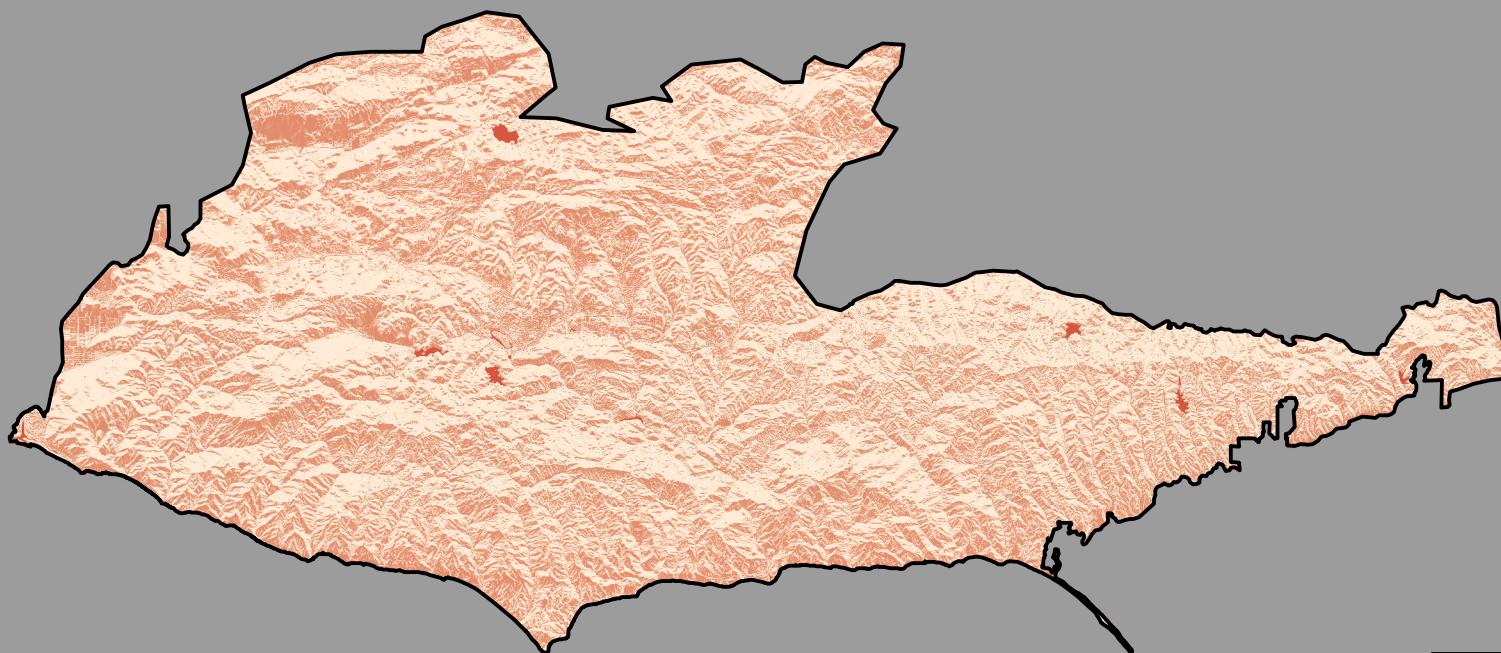
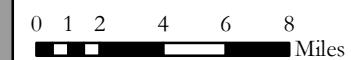
June 20th, 2021

Radiation (W/m^2)

High : 450

Low : 0

Fig. 5: Seasonal Insolation of Santa Monica Mountains National Recreation Area (Summer)



September 22nd, 2021

Radiation (W/m^2)

High : 375

Low : 0

Fig. 6: Seasonal Insolation of Santa Monica Mountains National Recreation Area (Fall)



December 21st, 2021

Radiation (W/m^2)

High : 150

Low : 0



Fig. 7: Seasonal Insolation of Santa Monica Mountains National Recreation Area (Winter)



March 20th, 2021

Radiation (W/m^2)

High : 350

Low : 0

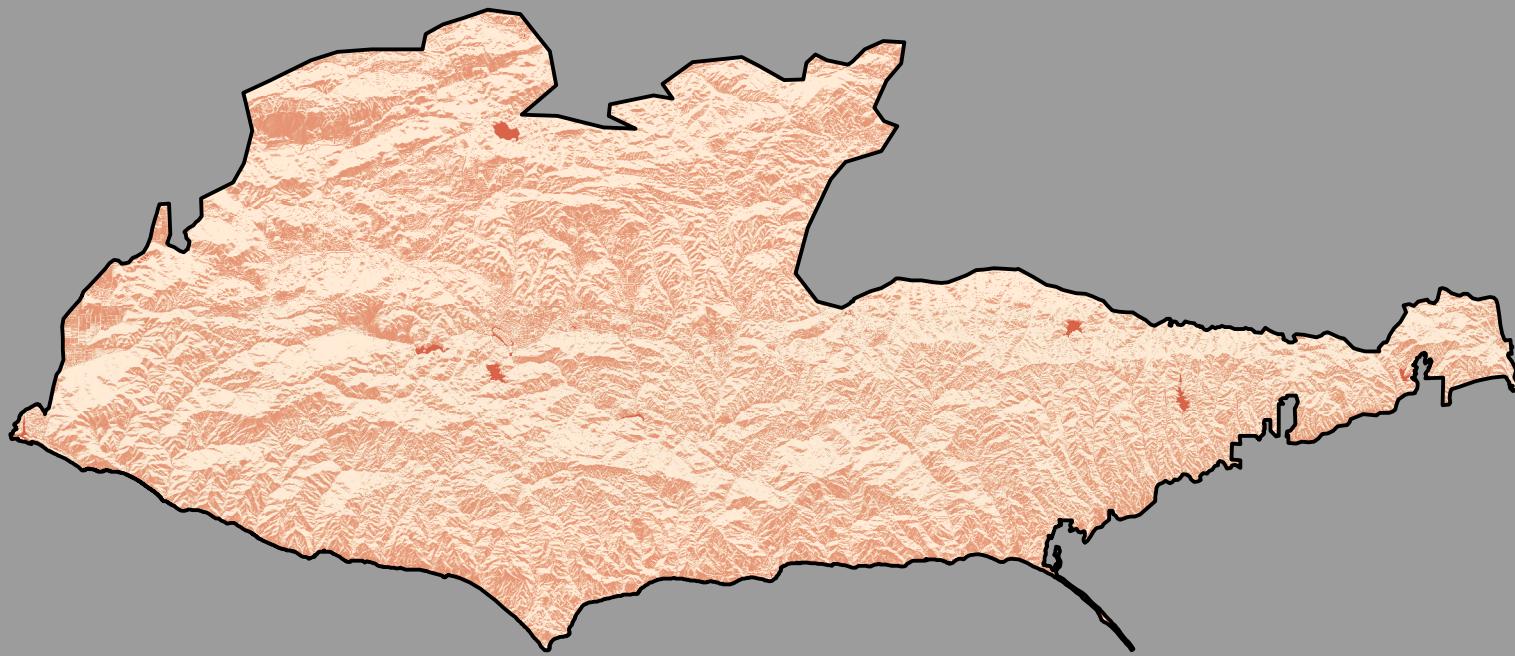


Fig. 8: Seasonal Insolation of Santa Monica Mountains National Recreation Area (Spring)



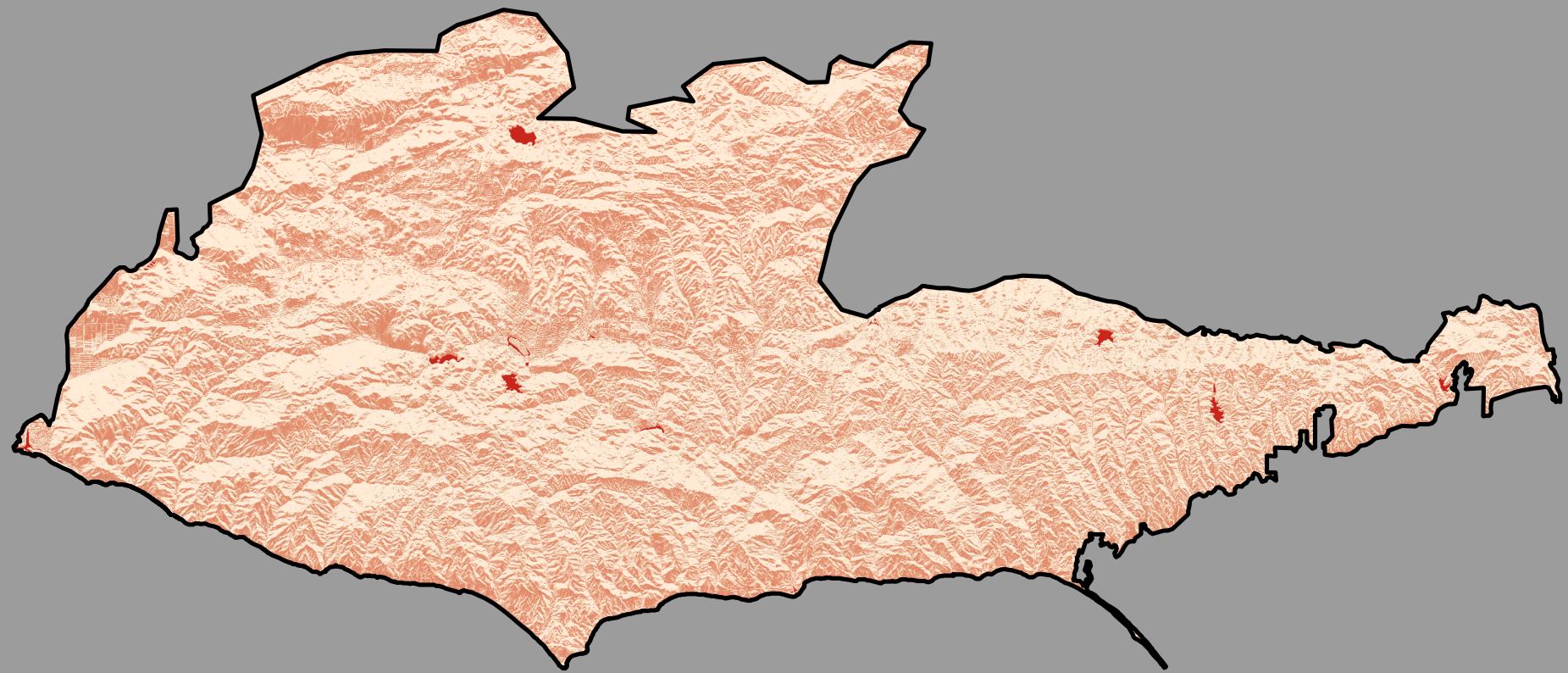
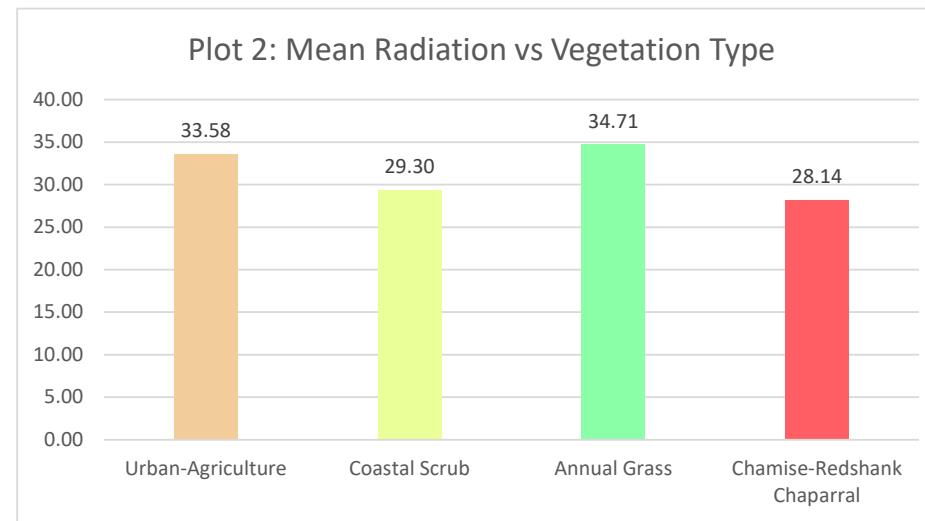
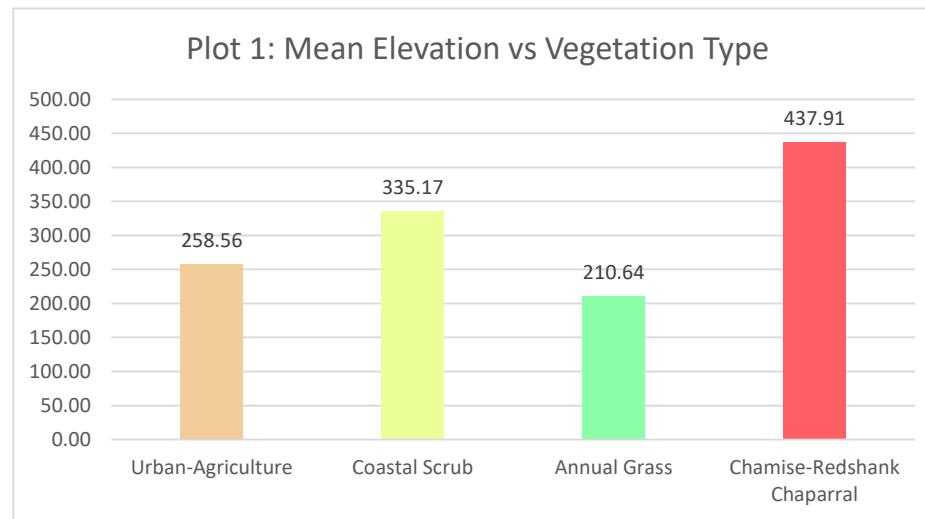
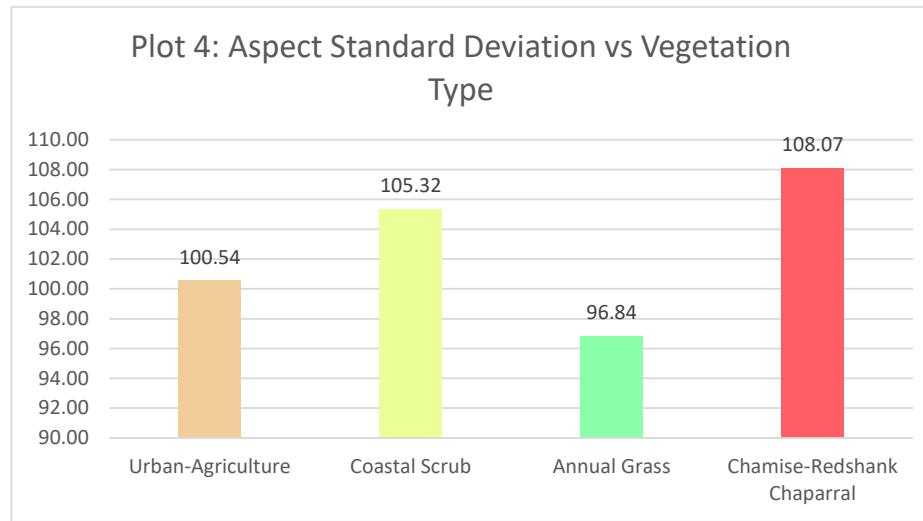
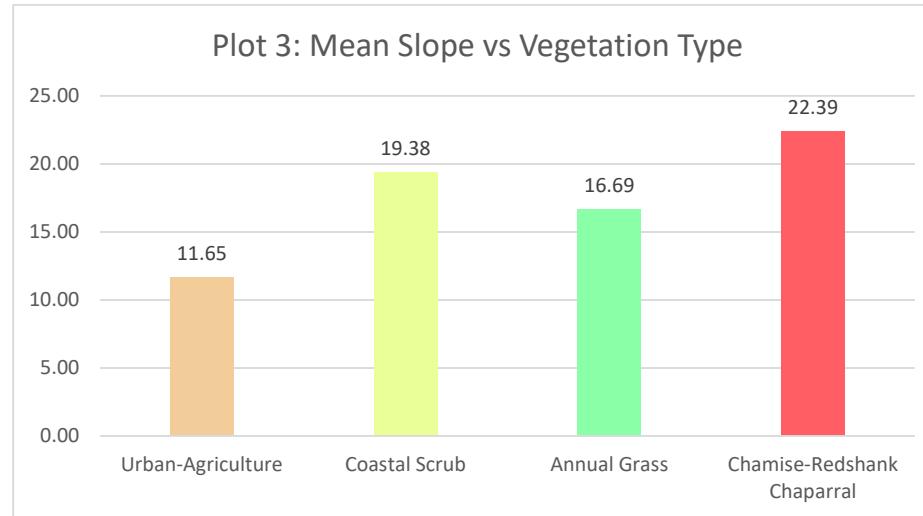


Fig. 9: Total Annual Radiation Map of Santa Monica Mountains National Recreation Area (Average of 4 Seasons)

Table 1: Impact of Terrain and Insolation on Vegetation

| Rowid | Vegetation | Slope:MIN | Slope:MAX | Slope:RANGE | Slope:MEAN | Slope:STD |
|-------|---------------------------|---------------|---------------|-----------------|----------------|---------------|
| 1 | Urban-Agriculture | 0.00 | 67.20 | 67.20 | 11.65 | 10.38 |
| 2 | Coastal Scrub | 0.00 | 73.15 | 73.15 | 19.38 | 10.14 |
| 3 | Annual Grass | 0.00 | 67.64 | 67.64 | 16.69 | 10.14 |
| 4 | Chamise-Redshank Chaparra | 0.00 | 74.89 | 74.89 | 22.39 | 10.18 |
| | | | | | | |
| Rowid | Vegetation | Aspect:MIN | Aspect:MAX | Aspect:RANGE | Aspect:MEAN | Aspect:STD |
| 1 | Urban-Agriculture | -1.00 | 360.00 | 361.00 | 182.89 | 100.54 |
| 2 | Coastal Scrub | -1.00 | 360.00 | 361.00 | 184.99 | 105.32 |
| 3 | Annual Grass | -1.00 | 360.00 | 361.00 | 183.44 | 96.84 |
| 4 | Chamise-Redshank Chaparra | -1.00 | 360.00 | 361.00 | 176.82 | 108.07 |
| | | | | | | |
| Rowid | Vegetation | Elevation:MIN | Elevation:MAX | Elevation:RANGE | Elevation:MEAN | Elevation:STD |
| 1 | Urban-Agriculture | -0.30 | 685.84 | 686.15 | 258.56 | 103.30 |
| 2 | Coastal Scrub | 0.13 | 758.12 | 757.99 | 335.17 | 131.67 |
| 3 | Annual Grass | -0.87 | 655.21 | 656.08 | 210.64 | 145.55 |
| 4 | Chamise-Redshank Chaparra | 28.14 | 945.67 | 917.54 | 437.91 | 142.79 |
| | | | | | | |
| Rowid | Vegetation | Radiation:MIN | Radiation:MAX | Radiation:RANGE | Radiation:MEAN | Radiation:STD |
| 1 | Urban-Agriculture | 0.00 | 450.00 | 450.00 | 33.58 | 42.96 |
| 2 | Coastal Scrub | 0.00 | 450.00 | 450.00 | 29.30 | 37.55 |
| 3 | Annual Grass | 0.00 | 450.00 | 450.00 | 34.71 | 40.11 |
| 4 | Chamise-Redshank Chaparra | 0.00 | 450.00 | 450.00 | 28.14 | 39.70 |





Standard Reference

DEM Study Area:

<https://drive.google.com/file/d/1JCNK5fzu7uom6qqrDvDJ8ahJuG6I5t3E/view?usp=sharing>

Vegetation Shapefile:

<https://drive.google.com/file/d/1nQnqlSNuVrIcERPwggyVbBCLuAZbR0zg/view?usp=sharing>

NPS Boundary Shapefile:

<https://drive.google.com/file/d/1BwYOLoJcQXkFaB6s2-khzjIkj7992GaS/view?usp=sharing>

NOAA Solar Position Calculator: <https://gml.noaa.gov/grad/solcalc/azel.html>