

Calculation of Slope and reclassification

The Slope tool identifies the steepness at each cell of a raster surface. The lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. Two methods are available for slope computation - the planar or the geodesic method. The planar method, also known as the Cartesian method, treats the earth as a flat surface. This method is computationally simpler and faster because it uses Euclidean geometry for calculations and is easier to compute, making it suitable for small-scale, localized analyses. It provides reasonable accuracy for areas that are not large enough for the earth's curvature to have a significant impact and works well with data in projected coordinate systems where distances and angles are consistent [1].

With the geodesic method, the calculation will be performed in a 3D Cartesian coordinate system by considering the shape of earth as an ellipsoid [2]. The slope value is calculated by measuring the angle between topographic surface and the referenced datum. This method provides more accurate measurements for large-scale analyses and long distances where the earth's curvature significantly affects results. And is suitable for global datasets or analyses that span large geographic extents [2].

In our study we used the planar method since the area of interest is relatively small and the curvature of the earth can be ignored. Additionally, we use data in a projected coordinate system (UTM 35N) for high-detail mapping and analysis, therefore this method was the preferable option. For the planar method, the slope is measured as the maximum rate of change in value from a cell to its immediate neighbors. The calculation is performed on a projected flat plane using a 2D Cartesian coordinate system. The slope value is calculated using a third-order finite difference estimator.

The slope is computed as the rate of change (delta) of the surface in the horizontal (dz/dx) and vertical (dz/dy) directions from the center cell to each adjacent cell. The basic algorithm used to calculate the slope (in degrees) is as follows [1,2]:

$$\text{slope_degrees} = \text{ATAN} (\sqrt{[\text{dz/dx}]^2 + [\text{dz/dy}]^2}) * 57.29578$$

This algorithm is derived from the following formula:

$$\text{Slope} = \arctan \left(\sqrt{\left(\frac{\partial z}{\partial x}\right)^2 + \left(\frac{\partial z}{\partial y}\right)^2} \right) \times 100\%$$

The **Reclassify** tool in ArcGIS Pro is used to reassign or change the values in a raster dataset to new values based on specified criteria. This tool is particularly useful for simplifying raster data, grouping values into categories, or preparing data for further analysis. The reclassify tool's algorithm works by mapping the original raster values to new values based on the user-defined reclassification table. In this study, we reclassified our slope values into five classes, (1) 0°-5°, (2) 5°-15°, (3) 15°-30° and (4) >30° with each class representing flat to gentle slope, gentle slopes, medium slopes, and steep slopes respectively.

Wind Conditions

The provided wind rose diagram (Figure S1) for Santorini is based on observations from January 1, 2000, to July 24, 2024, from the Santorini airport's weather station (LGSR) [3]. The prevailing wind directions at Santorini are the north and northwest, often at higher speeds. Calm conditions are relatively infrequent, and the average wind speed over the observed period is 12.4 mph, suggesting a consistently windy location.

North and northwest winds include a significant number of high-speed occurrences (orange, red, and dark red segments) while winds from other directions (e.g., west and southwest) are less frequent and generally have lower speeds (more blue and green segments).



Windrose Plot for [LGSR] Thira

Obs Between: 01 Jan 2000 08:50 AM - 24 Jul 2024 07:50 AM Europe/Athens

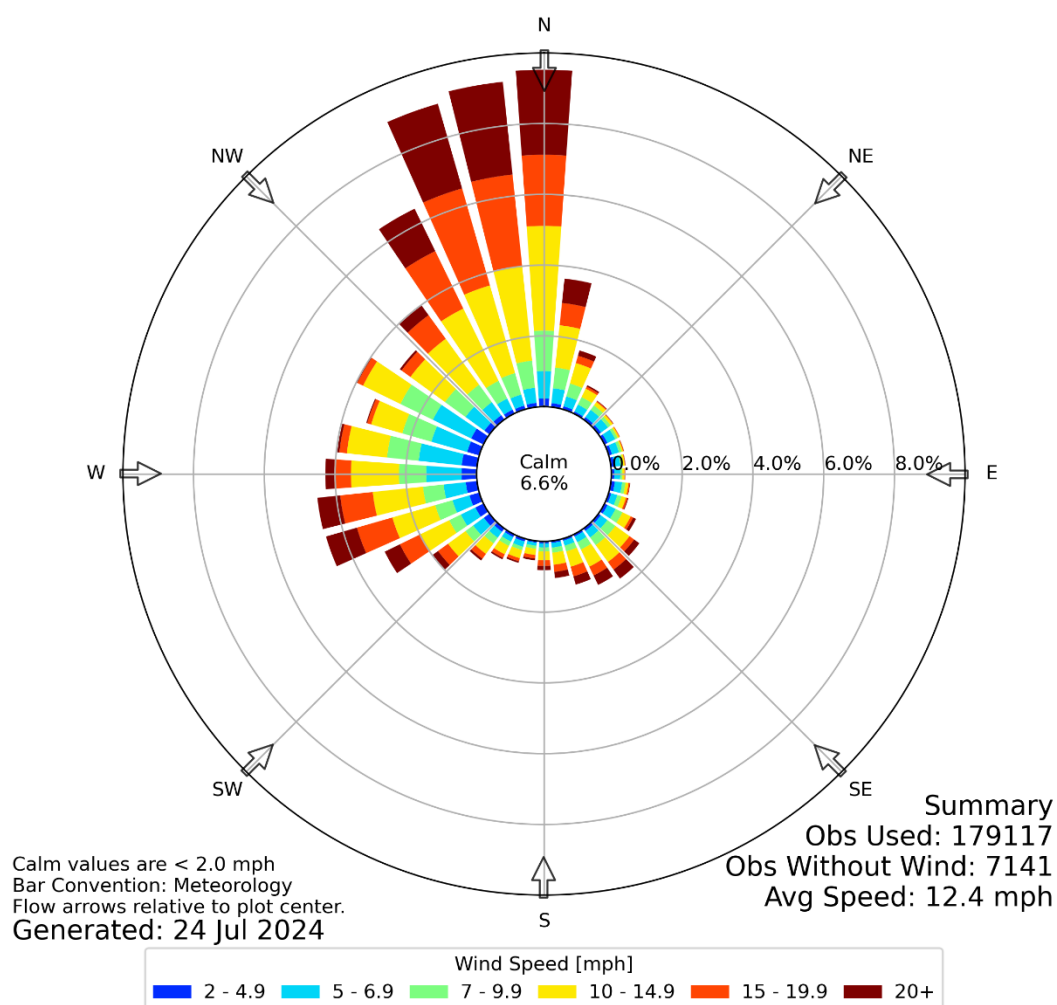


Figure S1. Rose diagram showing the prevailing wind conditions in Santorini based on observations from January 1, 2000, to July 24, 2024.

References

1. Esri. (2023b). How Slope Works. Retrieved from ArcMap Documentation

2. Esri. (2023a). Slope (Spatial Analyst). Retrieved from ArcGIS Pro Documentation
3. Iowa Environmental Mesonet. 2024. "Iowa State University." Accessed July 24, 2024.
<http://mesonet.agron.iastate.edu/>.