Multi-factor Analysis for Recharge Mapping Suitability

(MARMapS)

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MARMaps is a free, open-source tool for making interactive and transparent suitability maps. It is currently in development. For questions, bugs, feedback or comments please contact [ggorski@ucsc.edu](mailto:ggorski@ucsc.edu). The following document is a tutorial to demonstrate the tool, for general guidelines please see the MARMapS Readme doc. The application can be found <https://ggorski.shinyapps.io/marmaps/>

This tool was developed in collaboration with Daniel Goode, Michael van der Valk, and Andrew Fisher. Some data for the tutorial were generated by Sarah Beganskas.

**Introduction and data sources**

In this tutorial, we will upload three individual factors, select suitability thresholds for each individual factor, and generate a composite suitability map based on the three factors and the weights that we assign them. The three factors are 1) Soil Infiltration Capacity (m/day) generated using the SSURGO database 2) Modeled Runoff Availability (cm/yr) generated using Precipitation Runoff Modeling Scenario (PRMS), for more details see[1] and 3) Land use from the National Land Cover Database. The mapped area is south of Santa Cruz, California, USA. All three factors have identical extent, resolution and geographical projection.

**Uploading factors**

1. Using the “Upload GeoTiff File” function select the file “01\_Soil\_IC.tif”.

A screenshot of a cell phone

Description automatically generated

1. Using the “Name” and “Unit” boxes on the left, title the factor *Soil IC* with units of *m/day*. *Soil IC* should appear above both maps, and *m/day* should appear above the legend and the slider bar.

A close up of a map

Description automatically generated

**Ranking data for suitability**

1. Using the “Choose Plotting Scale” drop-down menu, select a plotting scale that displays the data in the most effective way. In general, “Decile” is a good option as it selects the ranges based on the distribution of the data values, but other options are available.
2. Select a “Good Range” using the slider bar to the left, if you want two discontinuous ranges, click “Add New Range” and a new bar will appear.
3. Once you have selected your “Good Range”, click the “Classify” button and the suitability map on the right will update to reflect your selection.

A close up of a map

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1. Click the “Add Factor” button and select the file named “02\_Runoff.tif”. Name the factor *Runoff* with units of *cm/yr* and repeat steps 3-5 for the new factor.A close up of a map

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**Uploading categorical data with raster codes**

1. Click the “Add Factor” button and select the file named “03\_Landuse.tif”. Name the factor *Landuse*.
2. From the “Choose Plotting Scale” dropdown menu, select “Categorical”.
3. Click the “Upload Raster Codes” button and select the file “LU\_Codes.csv”
4. Check the Agriculture and Barren boxes and click “Classify”

A close up of a map

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**Aggregating factors for composite suitability**

1. Click over to the “Weighting and Composite Mapping” tab. The three classified factors have been overlaid onto one map, and each factor has been given an even weight of 0.33. The bar plot labeled “Area Composite Suitability” shows the distribution of values across the mapped area, notice that there are 4 categories, with this configuration (0,0.33,0.66,1). The actual suitability values are not displayed on the barplot or the map legend because it is most useful to compare suitability values qualitatively within a mapped area.

A close up of a map

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**Adjusting weights**

1. Now give the factors unique weights and observe how the map and the distribution change in real-time, making sure that the weights always add up to 1. Set the Landuse weight at 0.9, and the other two at 0.05. Observe how the final map begins to look much more like the original, classified Landuse map from the first tab.
2. Assign the following weights, Soil IC = 0.2, Runoff = 0.7, and Landuse = 0.1. Now click back on the “Factor Suitability Ranking” tab, and reclassify the Runoff factor such that everything from 0.1-10 cm/yr is suitable. Be sure to click the “Classify” button to reclassify the factor.
3. Click back on the “Weighting and Composite Mapping” tab, and reassign the weights in step 13. Observe, how the distribution of suitability shifted towards more suitable values in the barplot, and the map became more green. This was because we classified more values as having suitable Runoff values.

**Adding in site locations as point files**

1. On the “Weighting and Composite Mapping” tab, click the “Upload Site Locations” button and navigate to the folder labeled “Site\_Locations”. Select all six files in the folder and upload them together.
2. The sites will plot on the composite suitability map with a bar plot showing the number of sites that fall into each suitability category.

A close up of a map

Description automatically generated

**Map download**

1. Lastly, use the “Download Map” button to download the composite suitability map as a .tiff file