**Time Series & Spatial Analysis README**

**Author**: Olivia Cronin-Golomb

**Contact**: [emb8xg@virginia.edu](mailto:emb8xg@virginia.edu)

**Institution**: University of Virginia; Computational Biogeochemistry Lab

**PI**: Dr. Scott Doney

**Purpose**

Extract and compile Secchi disk depth estimates at sites distributed throughout the Virginia Coastal Reserve Long Term Ecological Research station. Create figures showing spatiotemporal trends in the data.

**Inputs**

The initial scripts use the Landsat 8 and Sentinel 2 imagery preprocessed in L2gen and MATLAB. The rest of the scripts use the outputs from the initial scripts.

**Contents**

*Create\_sampling\_schema –* Creates the shapefiles and associated tables containing the coordinates of the sample sites, random, stratified, and regular sampling schema

* Extract\_coords: R script that creates the sample sites, random, stratified, and regular sampling schema.
* SHPs – Output folder for ‘Extract\_coords’ script that contains the shapefiles of sample sites, random, stratified, and regular sampling schema.
* Tables – Output folder for ‘Extract\_coords’ script that contains the CSVs of coordinate values for the sample sites, random, stratified, and regular sampling schema.

*L8 –* Scripts for extracting and compiling Secchi data from Landsat 8 imagery

* L8\_Zsd\_Extract\_Timeseries: R script that extracts Secchi disk values from points overlayed on preprocessed Landsat 8 images (images are grouped by year in file structure). It exports those values in CSVs with the columns being the coordinates of each sample and associated extracted raster values.
* L8\_Merge\_Years: R script that merges the CSVs of yearly Secchi depth values extracted from the L8 sampling schema into one CSV.
* L8\_Timeseries\_Tables: R script that extracts time markers from the L8 raster filename and transposed CSVs generated L8\_Zsd\_Extract\_Timeseries. It also creates another CVS containing stats associated with each sample over the course of the target years. This script can be used with either the yearly CSVs or the combined year CSVs, the file path and dimensions of the variable ‘meta\_info’ (pointed out in the comments).

*S2 –* Scripts for extracting and compiling Secchi data from Sentinel 2A & 2B imagery

* S2\_Zsd\_Extract\_Timeseries: R script that extracts Secchi disk values from points overlayed on preprocessed Sentinel 2A & 2B images (images are grouped by year and sensor in file structure). It exports those values in CSVs.
* S2\_Merge\_Years: R script that merges the CSVs of yearly Secchi depth values extracted from the S2 sampling schema into one CSV.
* S2\_Timeseries\_Tables: R script that extracts time markers from the S2 raster filename and transposed CSVs generated S2\_Zsd\_Extract\_Timeseries. It also creates another CVS containing stats associated with each sample over the course of the target years. This script can be used with either the yearly CSVs or the combined year CSVs, the file path and dimensions of the variable ‘meta\_info’ (pointed out in the comments).

*Merge –* Scripts for compiling L8 and S2 Secchi data, computing statsbased on that data, and creating figures to visualize spatiotemporal trends

* Merge\_L8\_S2\_Sensors: R script that combines L8 and S2 data. S2 rasters are resampled to the same cell resolution as L8.
* Merge\_Years: R script that merges rasters and CSVs from each year. Inputs are rasters and CSVs of the previously merged-by-sensor outputs from the ‘Merge\_L8\_S2\_Sensors.
* Merge\_Sensor\_Timeseries\_Stats: R script that merges the statistics and transposed timeseries CSVs (generated in ‘\*\_Timeseries\_tables') from each year.
* Zsd\_Figures: R script that produces figures showing spatiotemporal trends in the Sechhi disk depth data.

**Procedure**

1. Extract the coordinates of each site in the sample sites, random sampling, stratifies random sampling, and regular sampling schema using the Extract\_coords script.
2. Use the L8\_Zsd\_Extract\_Timeseries and the S2\_Zsd\_Extract\_Timeseries scripts to calculate the mean, maximum, minimum, range, median, and standard deviation of Secchi disk depth values across the area of interest throughout the study period. Also extract the time series of Secchi disk depth values for each site at each available date.
3. Compile the timeseries values by year and sensor
4. Create figures.

**Comments & Suggestions**

* Secchi disk depth value are extracted by averaging the pixel values that fall within a 30m buffer of each point. This is the main variable that will influence outputs. The input images are resampled up so that the cell resolution of Sentinel is the same as Landsat (30mx30m).
* Many of the outliers were found in areas of cloud shadow, which were not masked out. Some outliers were found directly on the coastline.