Land Cover Classification of Lake Ontario Shore Using Sentinel 2 of 10m Resolution

MUSA 650 Final Project

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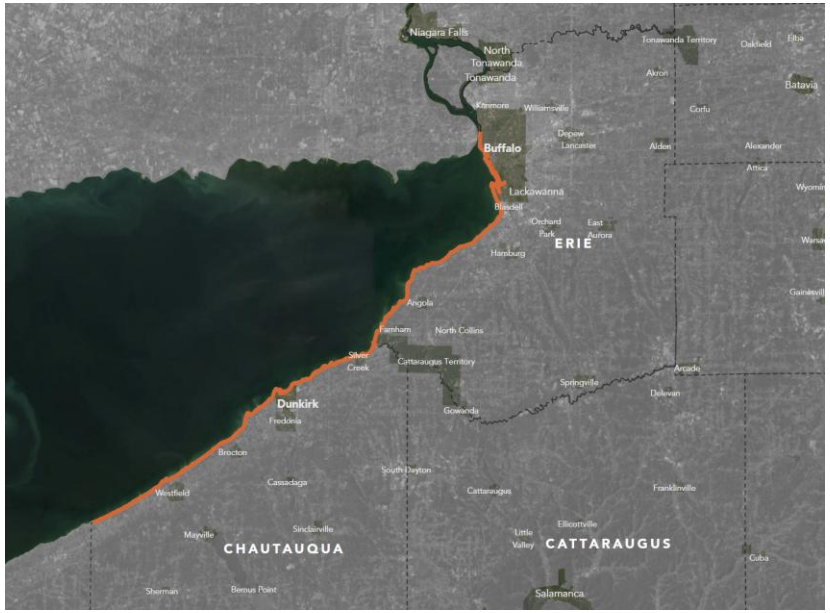
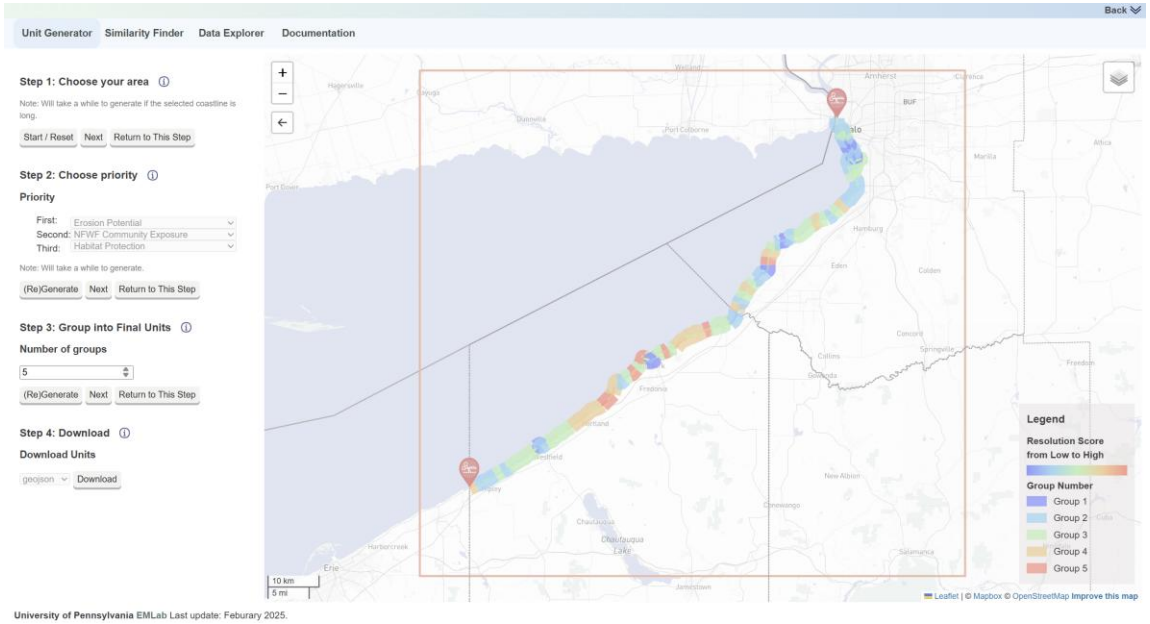
Precedent

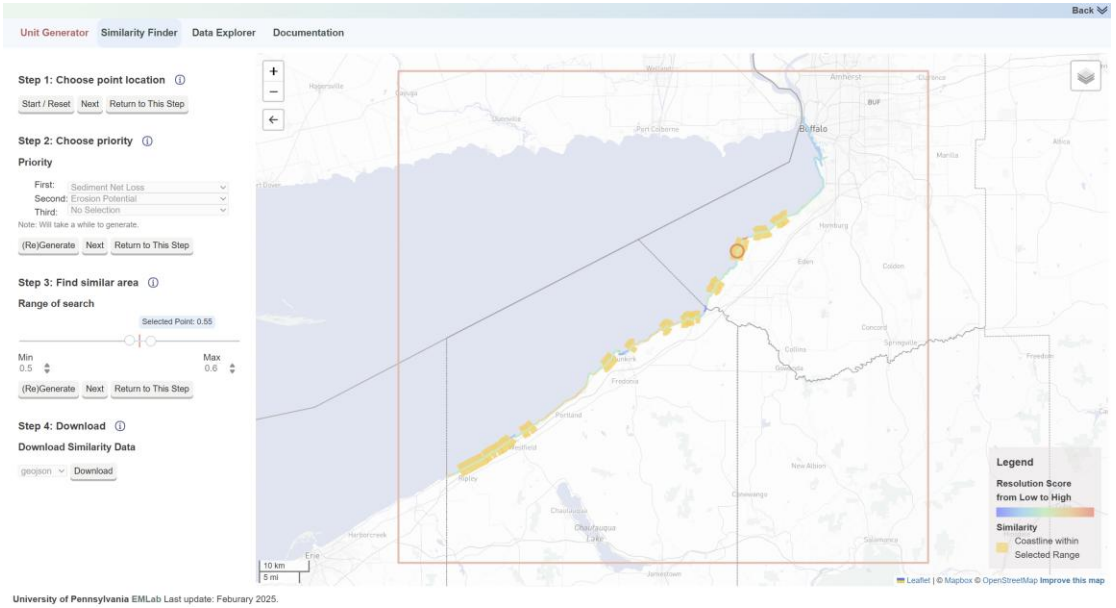
This project is based on my current RA project, *New York Healthy Coasts and Communities: Passive Sediment Management Study for New York's Lake Erie Shoreline*

Application of an Operational Landscape Unit (OLU) process to assist in identifying and prioritizing particular sites and coastal resilience-related strategies that might be most applicable in certain areas.

The area of study is the Lake Erie shore of New York

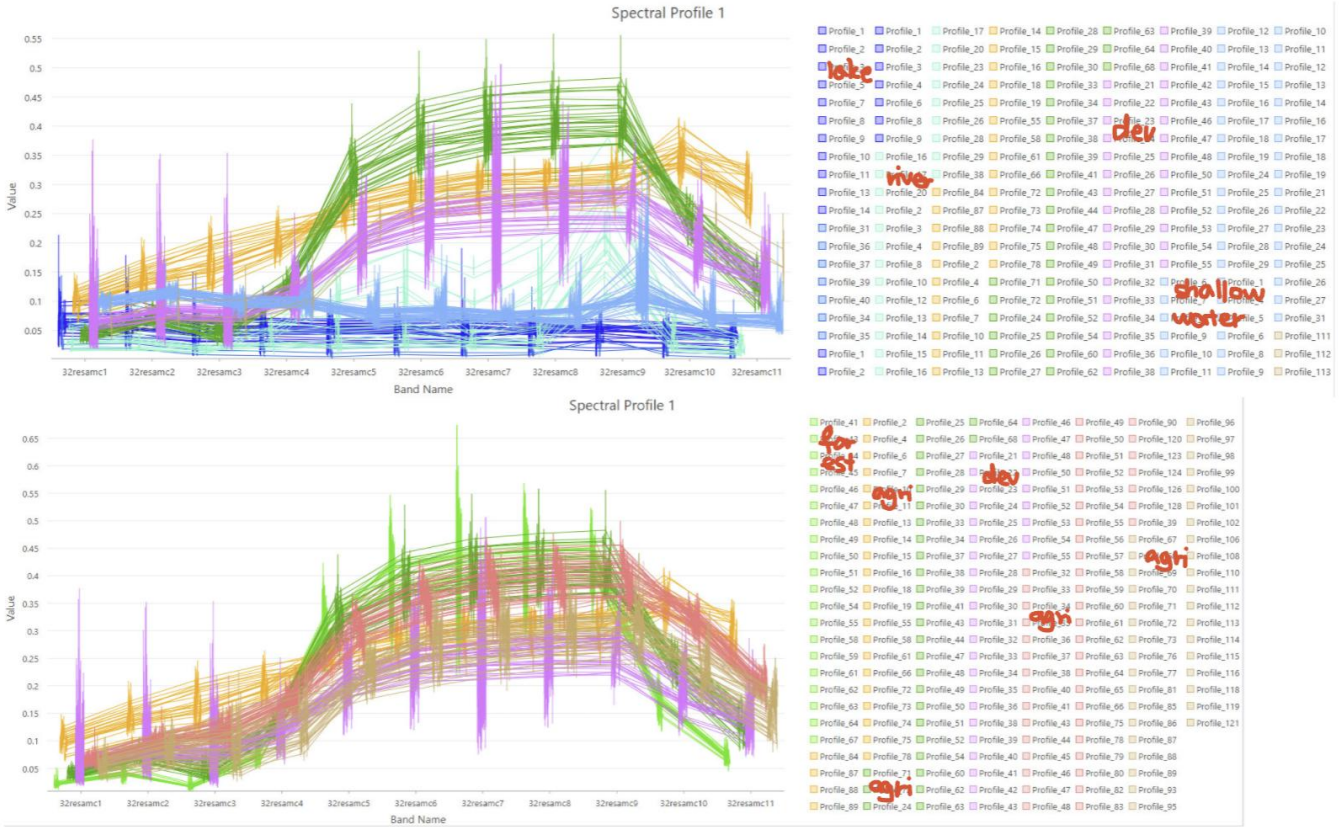


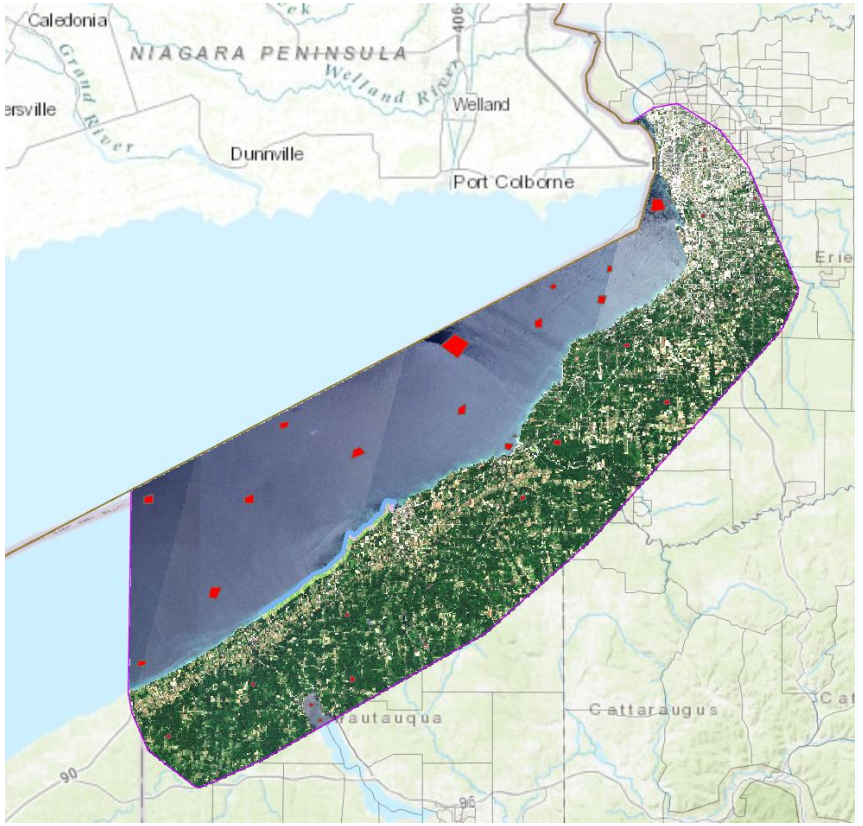




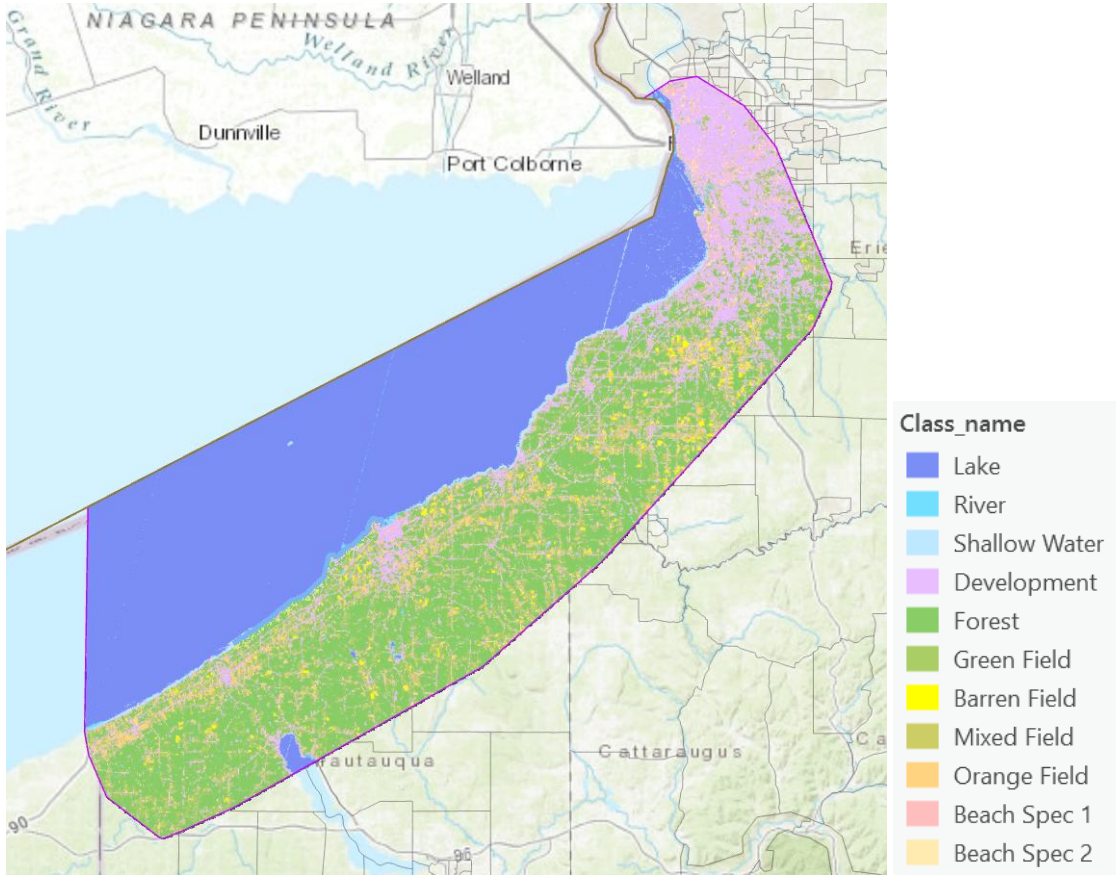
Landcover classification is one of the data used in this project to help decide on place similarity.

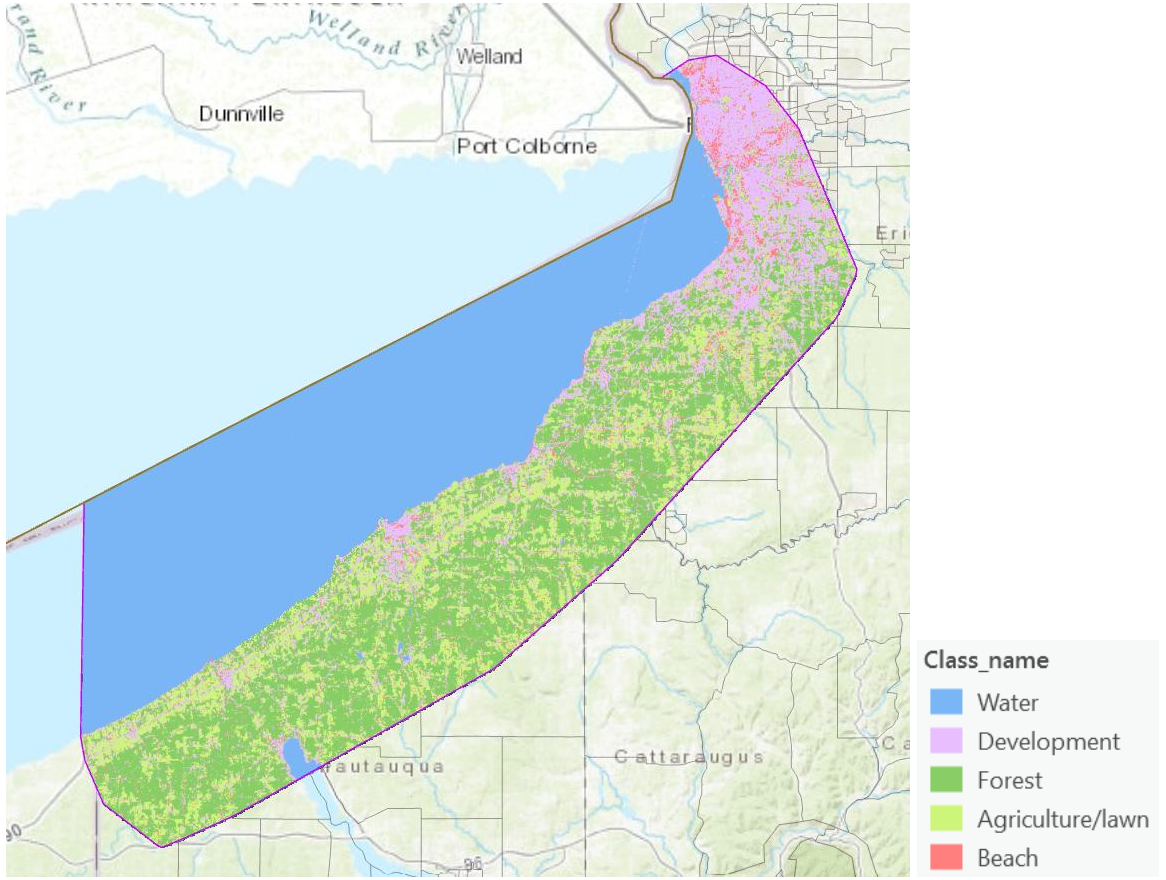
Data: Sentinel 2
Label: hand labeling
Model: SVM in ArcGIS Pro
Why not use NLCD:
30m resolution is too course for this project, Sentinel 2 is 10m resolution





Process:
First run categories: Lake, River, Shallow Water, Development, Forest, Green Field, Barren Field, Mixed Field, Orange Field, Beach Spectrum 1, Beach Spectrum 2
Combined categories : Water, Development, Forest, Agriculture, Beach

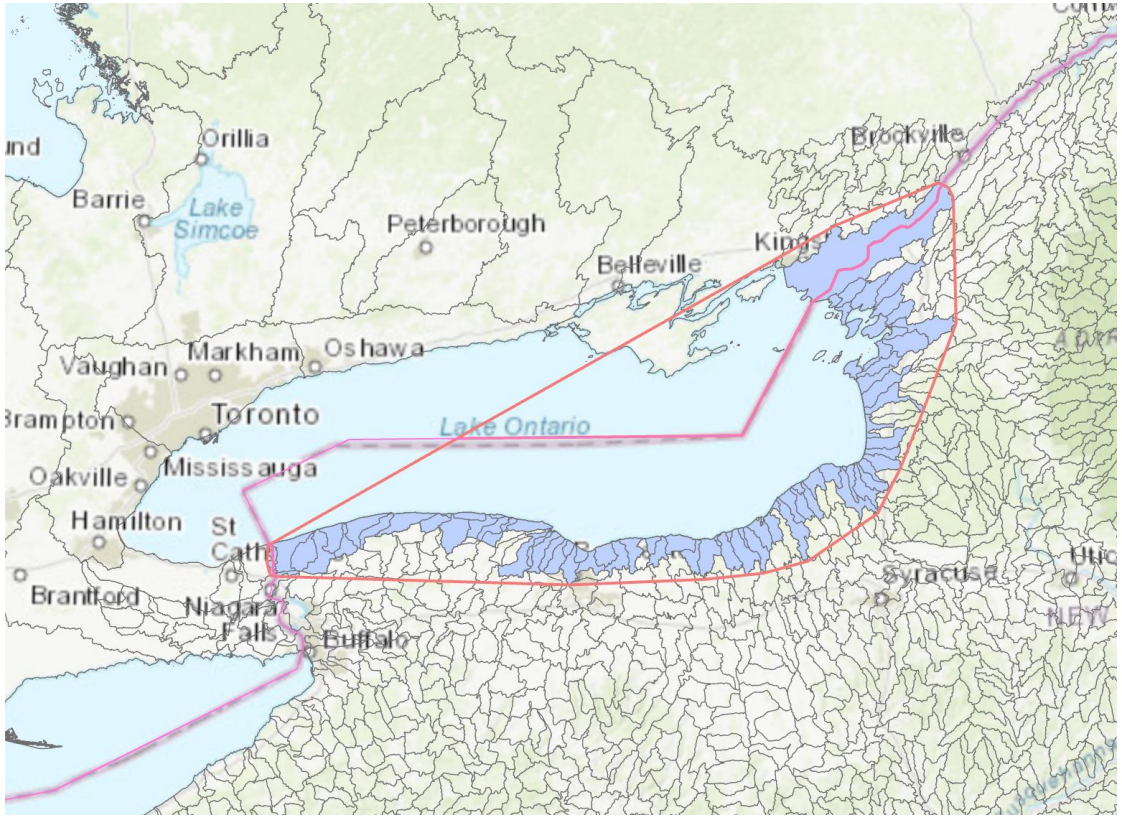




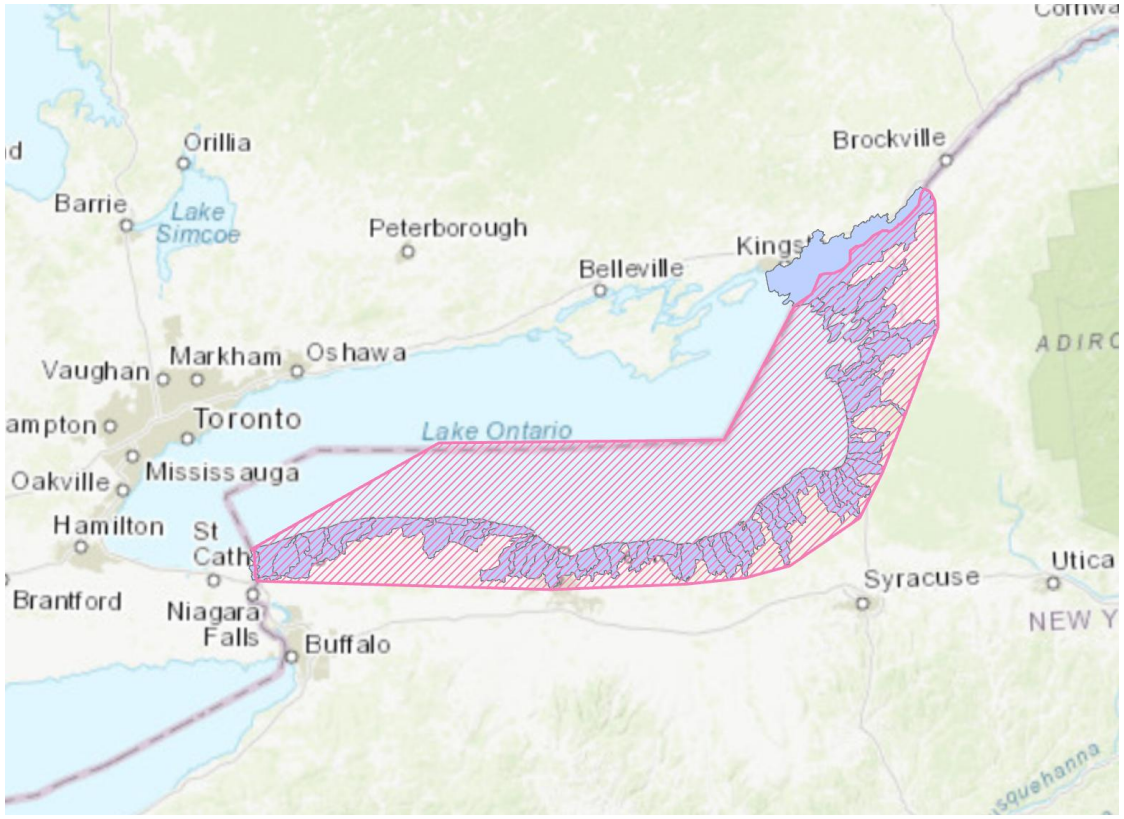
Next Phase

The next phase of this project is to transfer the method used in Lake Erie to Lake Ontario in NYS.

Define the area for remote sensing



Minimum bounding geometry for HUC 12 along the shore.



Remove the Canada area from the original bounding shape to get the final area of interest.

Gather data

Sentinel 2 Level-2A Surface Reflectance Data (Summer & Winter)

11 bands, B02-B08, B08A, B09, B11, B12

Harmonized Sentinel-2 MSI: MultiSpectral Instrument, Level-2A (SR)

Dataset Availability
2017-03-28T00:00:00Z–2025-04-23T21:00:48.792000Z

Revisit Interval
5 Days

Dataset Provider
European Union/ESA/Copernicus

Tags
copernicus | esa | eu | msi | reflectance | satellite-imagery | sentinel | sr

Earth Engine Snippet
`ee.ImageCollection("COPERNICUS/S2_SR_HARMONIZED")`

Description | Bands | Image Properties | Terms of Use

After 2022-01-25, Sentinel-2 scenes with PROCESSING_BASELINE '04.00' or above have their DN (value) range shifted by 1000. The HARMONIZED collection shifts data in newer scenes to be in the same range as in older scenes.

Sentinel-2 is a wide-swath, high-resolution, multi-spectral imaging mission supporting Copernicus Land Monitoring studies, including the monitoring of vegetation, soil and water cover, as well as observation of inland waterways and coastal areas.

The Sentinel-2 L2 data are downloaded from CDSE. They were computed by running sen2cor. WARNING: 2017-2018 L2 coverage in the EE collection is not yet global.

The assets contain 12 UINT16 spectral bands representing SR scaled by 10000 (unlike in L1 data, there is no B10). There are also several more L2-specific bands (see band list for details). See the Sentinel-2 User Handbook for details.

QA60 is a bitmask band that contained rasterized cloud mask polygons until 2022-01-25, when these polygons stopped being produced. Starting 2024-02-28, legacy-consistent QA60 bands are constructed from the MSK_CLASSI cloud classification bands. For more details, see the full explanation of how cloud masks are computed.

EE asset ids for Sentinel-2 L2 assets have the following format: COPERNICUS/S2_SR/20151128T002653_20151128T102149_T56MNN. Here the first numeric part represents the sensing date and time, the second numeric part represents the product generation date and time, and the final 6-character string is a unique granule identifier indicating its UTM grid reference (see MGRS).

For datasets to assist with cloud and/or cloud shadow detection, see COPERNICUS/S2_CLOUD_PROBABILITY and GOOGLE/CLOUD_SCORE_PLUS/V1/S2_HARMONIZED.

For more details on Sentinel-2 radiometric resolution, see this page.

10m dem

USGS

USGS 3DEP 10m National Map Seamless (1/3 Arc-Second)

Dataset Availability
1998-08-16T00:00:00Z–2020-05-06T00:00:00Z

Tags
3dep | dem | elevation | elevation-topography | geophysical | topography | usgs

Dataset Provider
United States Geological Survey

Earth Engine Snippet
`ee.Image("USGS/3DEP/10m")`

Description | Bands | Terms of Use | Citations

This is the seamless 3DEP DEM dataset for the U.S. with full coverage of the 48 conterminous states, Hawaii, and U.S. territories. Alaska coverage is partially available now and is being expanded to statewide coverage as part of the Alaska Mapping Initiative. Ground spacing is approximately 10 meters north/south, but variable east/west due to convergence of meridians with latitude.

Spatial metadata dataset is ingested as a separate asset USGS_3DEP_10m_metadata.

The 1m dataset is ingested as USGS_3DEP_1m.

Dataset uploaded by Farmers Business Network.

Training data

Gather NLCD 2016 data through google earth engine

↓

Reclassify **NLCD** into the categories I want (urban, agriculture, water, vegetation, and sand)

→

Generate 1200-1400 training points for each category in google earth engine based on reclassed categories

↓

Export the points and sentinel image to ArcGIS

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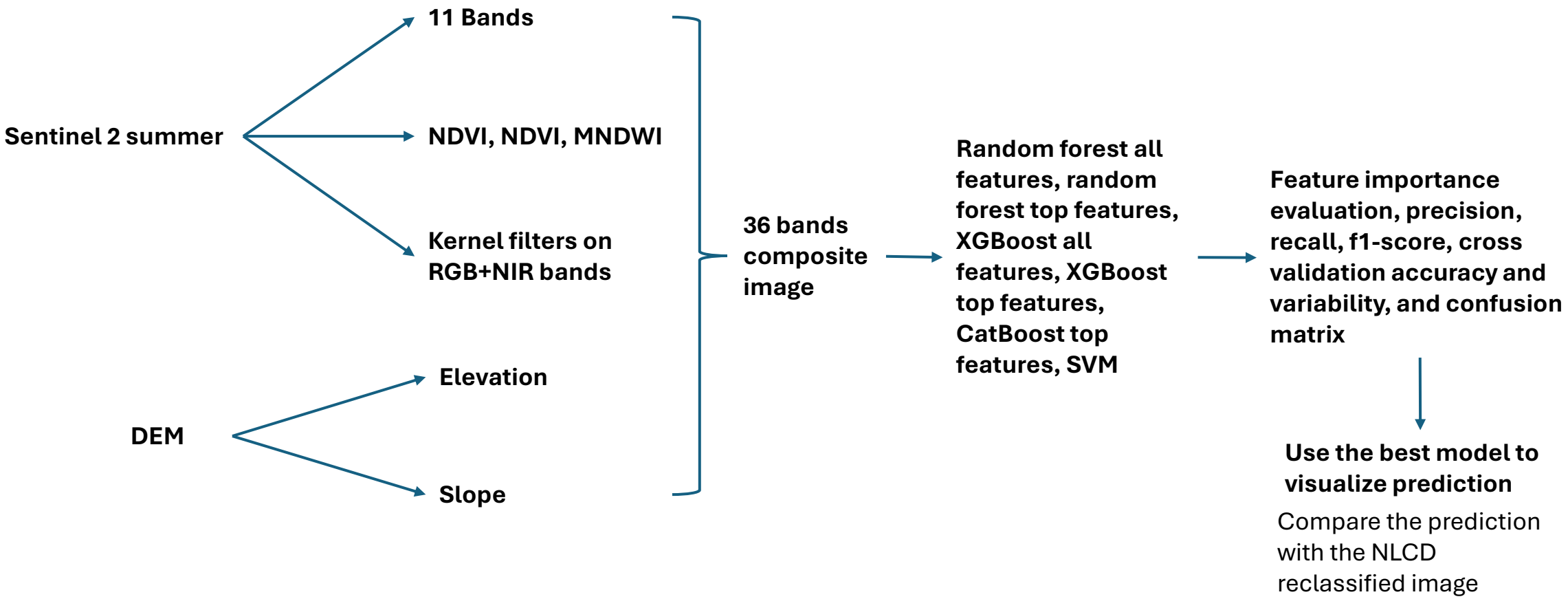
Manually check if the points are correct. Remove wrong points / add new points for category with insufficient data, e.g. sand

↓

Import back the updated training points

Modeling


Sentinel 2 summer
11 Bands
NDVI, NDVI, MNDWI
Kernel filters on RGB+NIR bands
DEM
Elevation
Slope
36 bands composite image
Random forest all features, random forest top features, XGBoost all features, XGBoost top features, CatBoost top features, SVM
Feature importance evaluation, precision, recall, f1-score, cross validation accuracy and variability, and confusion matrix
Use the best model to visualize prediction
Compare the prediction with the NLCD reclassified image