AQUACULTURE MAPPING IN THE LOWER MEKONG COASTAL REGION

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Overview:

- Motivation
- Background
- Data
- Methodology
- Results
- Validation
- Conclusion

Motivation:

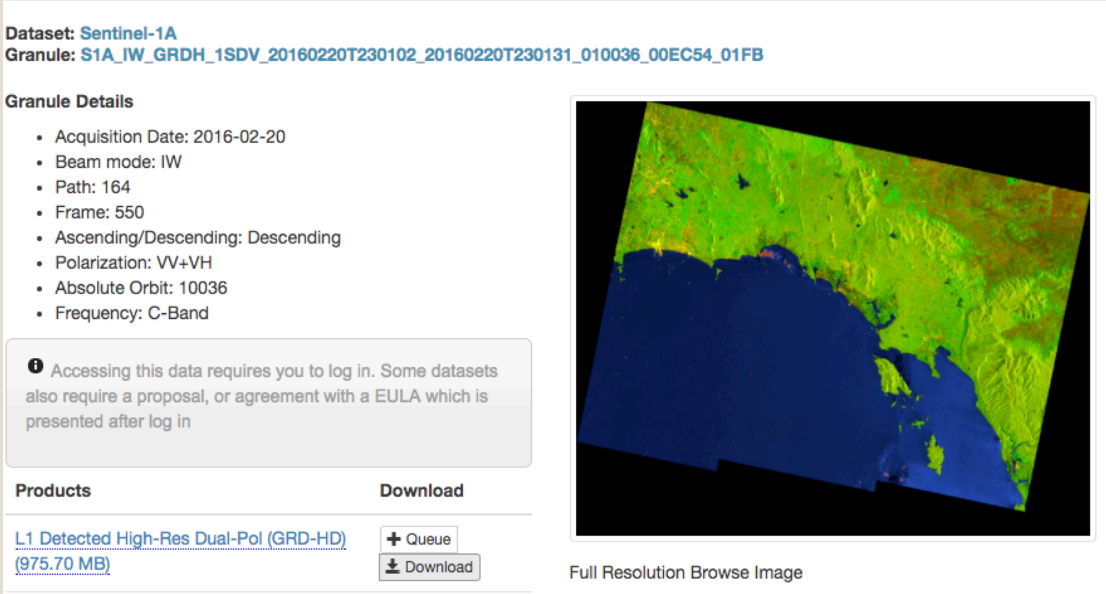
- The Mekong Region is a mecca for aquaculture
- Mapping is important for food security and agricultural land use planning
- Conversion of land into ponds can threaten ecosystem services and degrade soil quality
- No widely accepted aquaculture mapping database or methodology
- The SERVIR-Mekong Needs Assessment lists food security and land use mapping among their top priority GIS needs
- Distinct characteristics of ponds present unique remote sensing opportunity
- Synthetic Aperture Radar (SAR) resolution increasingly higher and more available
  - SAR also has the capability to penetrate clouds for all-season mapping

Use of Open Source:

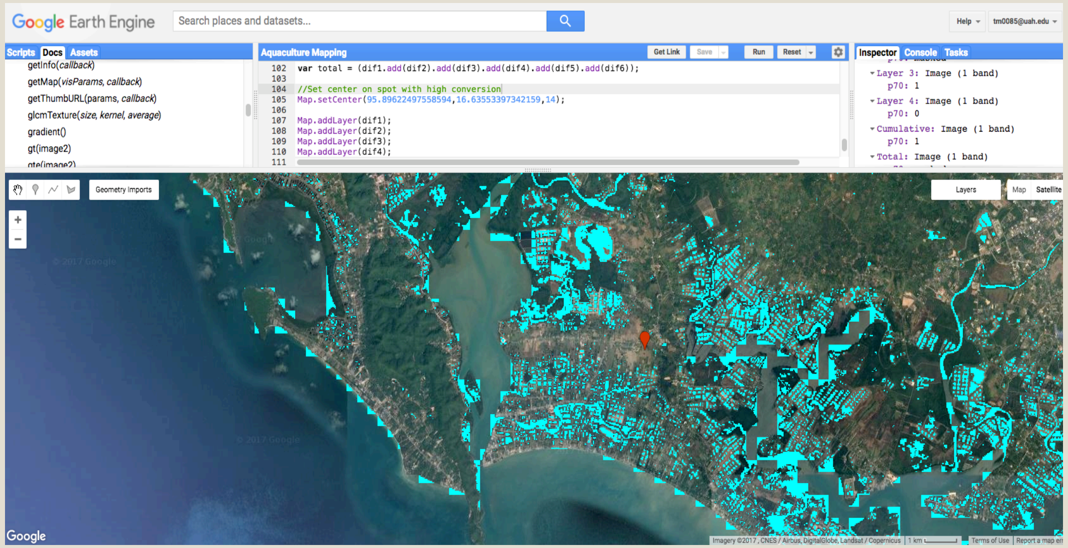
- Many local governments and non-profit organizations do not have access to licensed software
- Anyone, anywhere can download Python and SNAP
- Ottinger, et al (2017) recently published a preliminary methodology for large scale aquaculture mapping using SAR for large (spatial) scale mapping
- However, the study presented here evaluates a methodology that is less data and time consuming and can be used for smaller spatial and temporal scale mapping (i.e. seasonal ponds)
- Esri software is utilized in the accuracy assessment

Methodology:

- Use of Google Earth Engine to narrow down study area
- Download Sentinel-1A image from Alaska Satellite Facility Vertex and use SNAP (ESA) software to pre-process
- Download level 1 Landsat 8 OLI image from USGS EarthExplorer
- Use openCV Python package for feature extraction
- Use ArcPy for validation and accuracy assessment



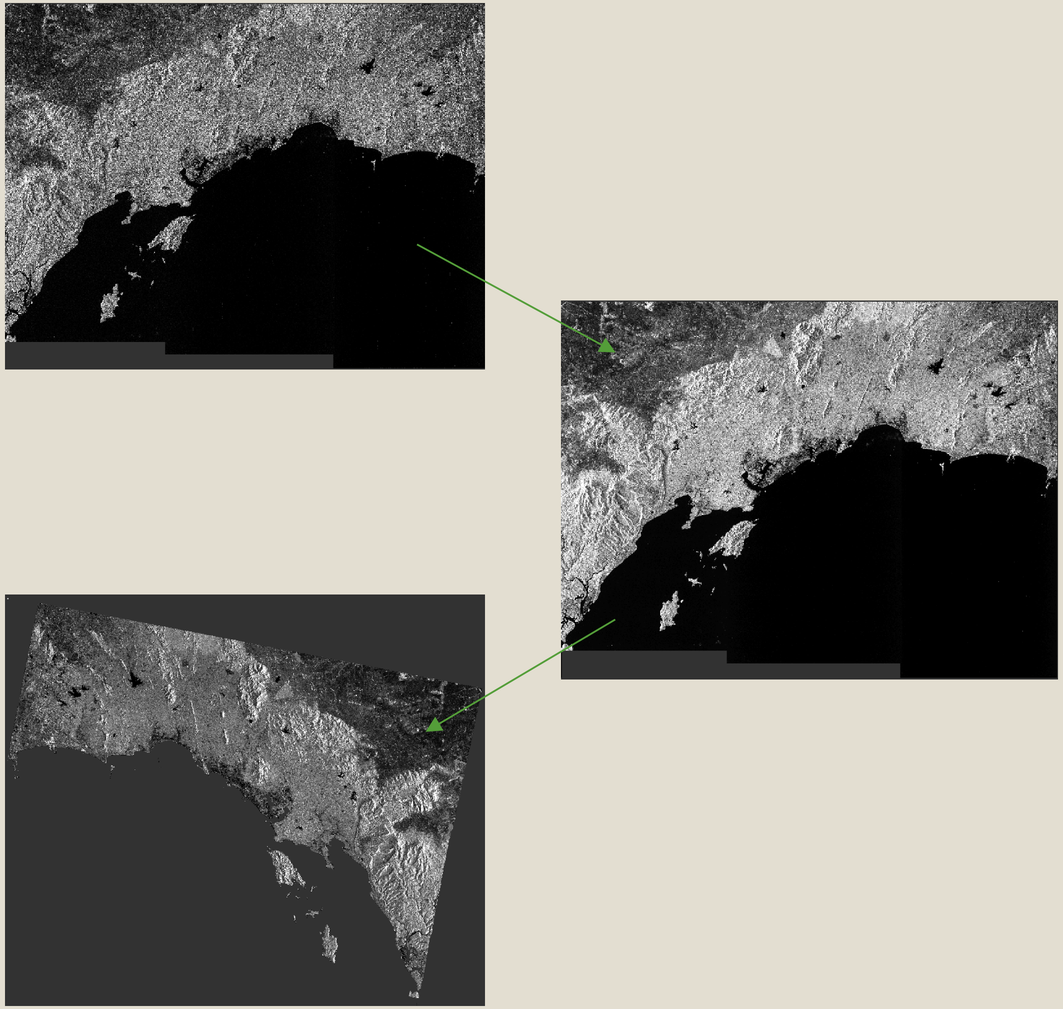
Google Earth Engine use:



- Read in Landsat 5 TM and Landsat 7 ETM+ images for years from 2010 to 2015
- Create annual composite of region masking clouds and using histogram percentiles
  - Assures occurrence of pixel value at least 70% of the time
- Create water mask for each year using Modified Normalized Water Difference Index (MNDWI): $\frac{Green-NIR}{Green+NIR}$
- Perform cumulative change detection from year to year finding areas where water has built up
- Visually select region with significant amount of water cover
- Narrowed region down to area surrounding Chantaburi, Thailand

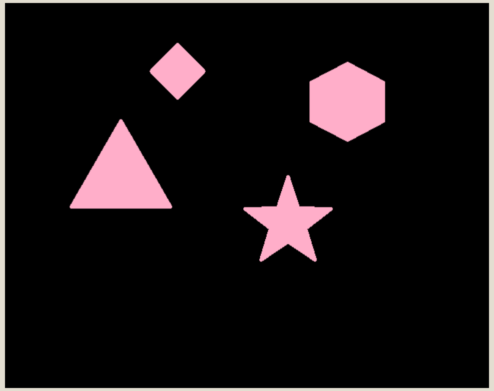
SNAP Preprocessing:

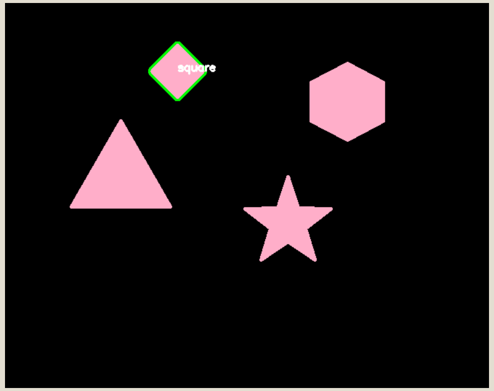
- Download Sentinel-1A IW GRDH image of study area from ESA Copernicus (~12m spatial resolution)
- Remove thermal noise
- Apply orbit file
- Radiometric calibration
- Speckle filter
- Range Doppler Terrain correction
- Convert to db



Object-based Feature Extraction:

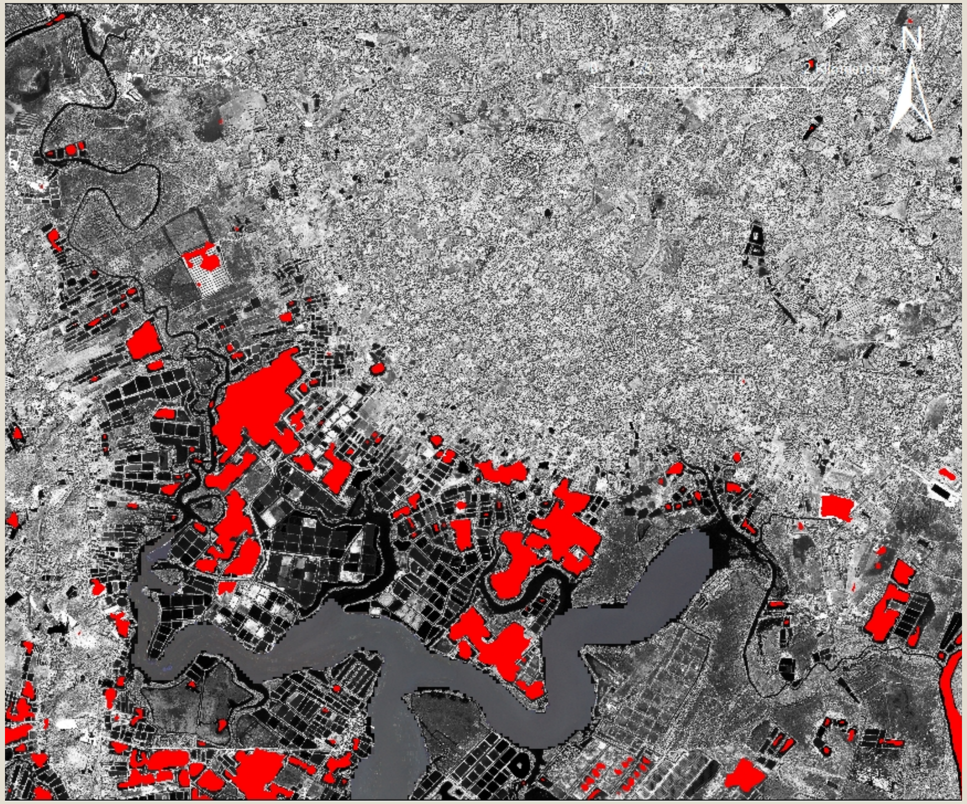
- A simple yet powerful computer visualization and detection package
- Create a binary threshold based on image histogram to distinguish water using Otsu thresholding
  - (thresholding based on bi-modal histogram of grayscale image)
- Find and draw “contours” of rectangles and squares
  - Calculate areas of drawn contour
- Slice area from array and save to local disk
- Use Rasterio Python module to preserve geospatial metadata
- Open raster in ArcMap



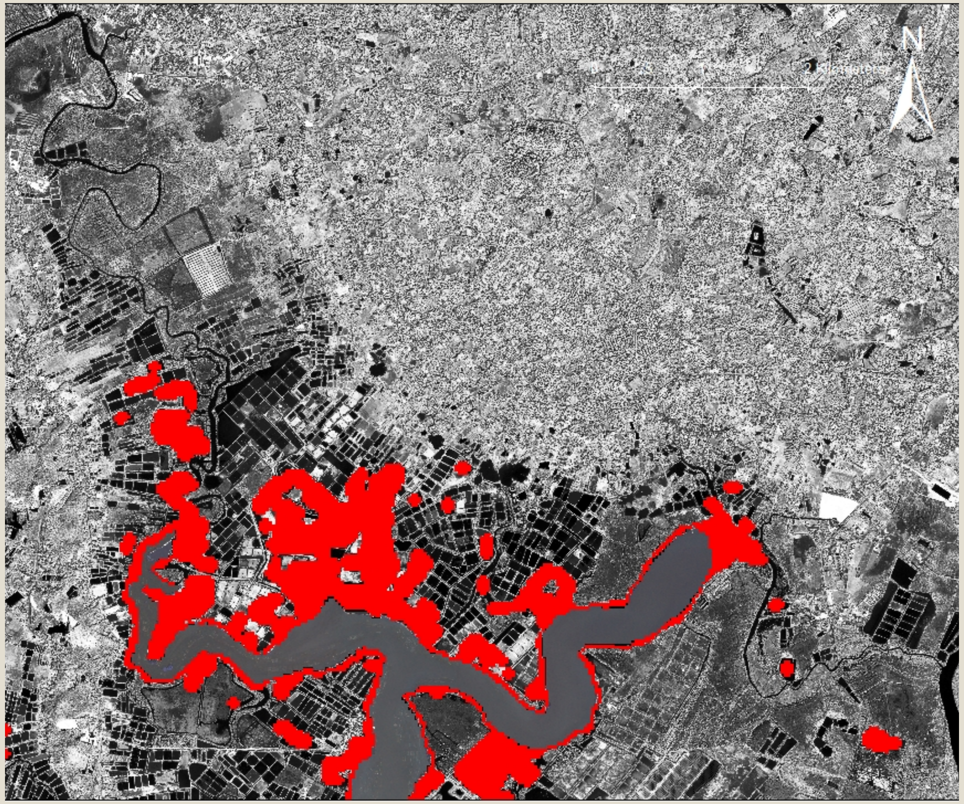


Python Results:

Mask on Sentinel-1A VH band:

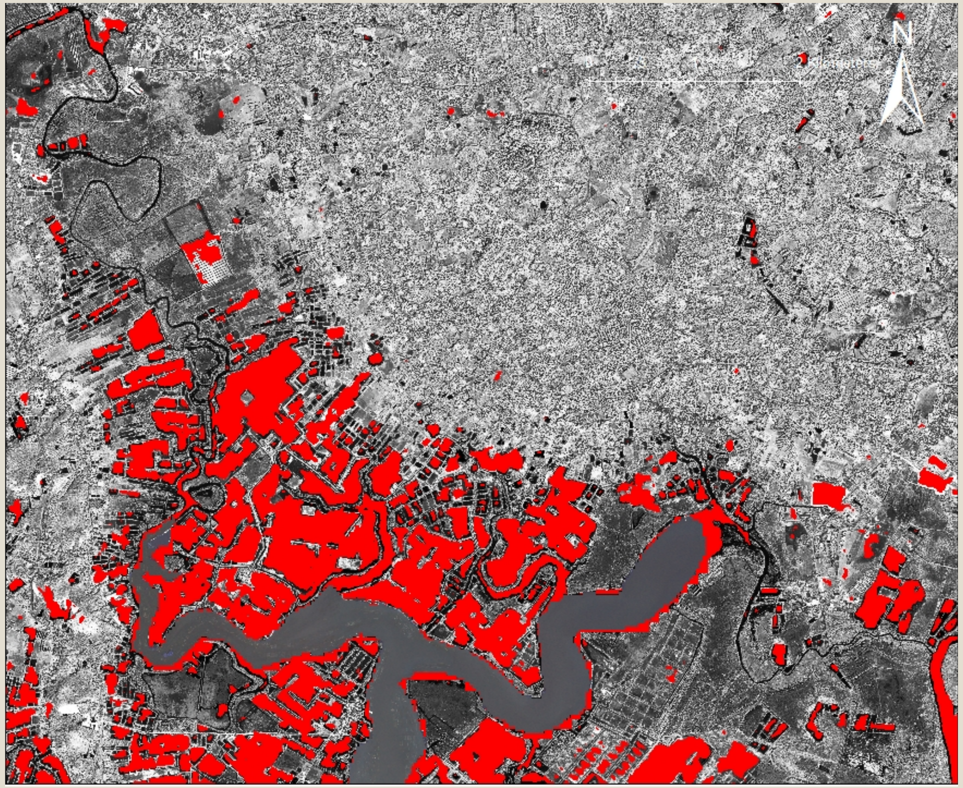


Mask on Landsat 8 OLI NIR band:

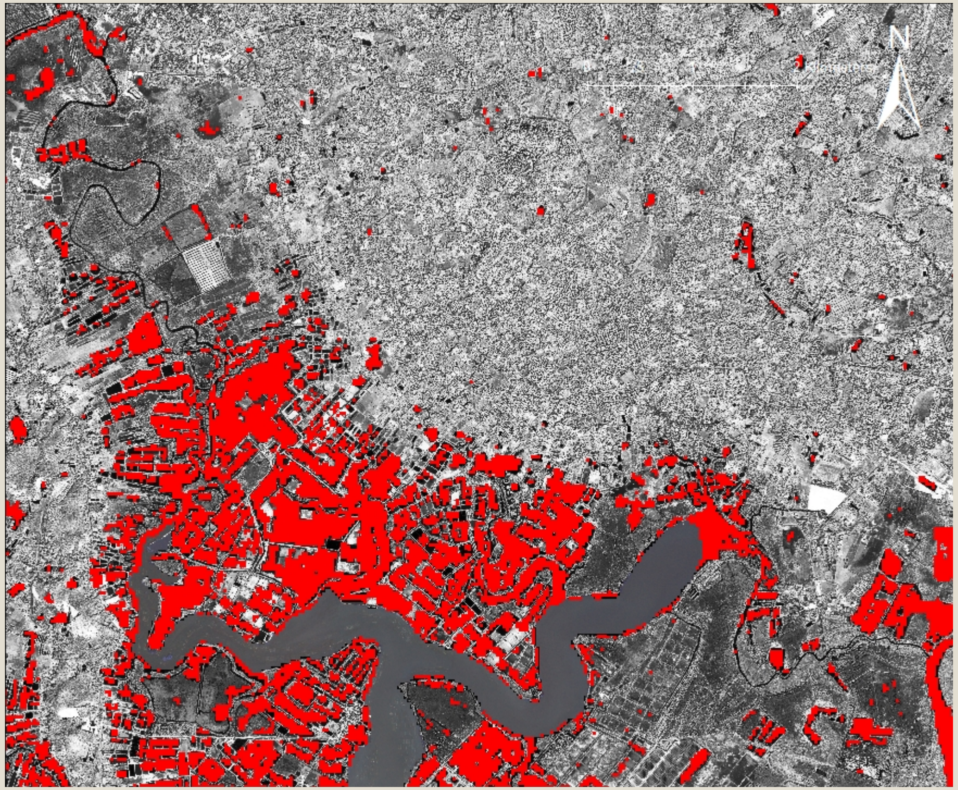


Manual threshold optimization results:

Mask on Sentinel-1A image:



Mask on Landsat 8 OLI image:



ArcPy Accuracy Assessment:

- WorldView 30 cm resolution imagery
- Accuracy of OpenCV segmentation of ponds with Sentinel-1A SAR : ~67%
- Accuracy of manual thresholding SAR: ~84%
- Accuracy of OpenCV segmentation of ponds with Landsat 8 OLI NIR band: ~58%
- Accuracy of manual thresholding Landsat 8: ~79%
- Many false negatives
- Many true positives
- Contours are only being drawn around bodies of water, but not all of them

Conclusions

- The Otsu thresholding part of the algorithm not better than manual threshold
  - Better to manually optimize threshold based on image histogram
  - SAR image histogram not bi-modal
- If the ponds are too small, then thresholding creates a strange shape that doesn't become a contour
- Much higher accuracy when masking the permanent water and manually thresholding (due to study area)
- Spatial resolution still an issue
- Need to test with different thresholding methods
- More case studies