Very High Resolution Mapping and Modeling of Agricultural Land-Cover/Land-Use Change in An Giang and Dong Thap, Vietnam

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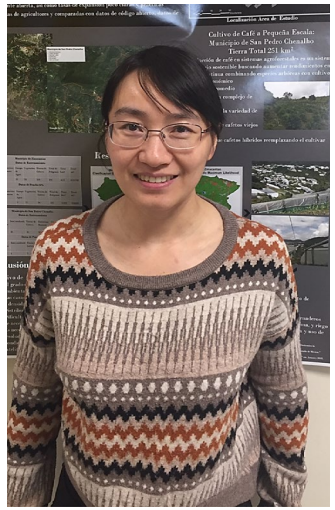

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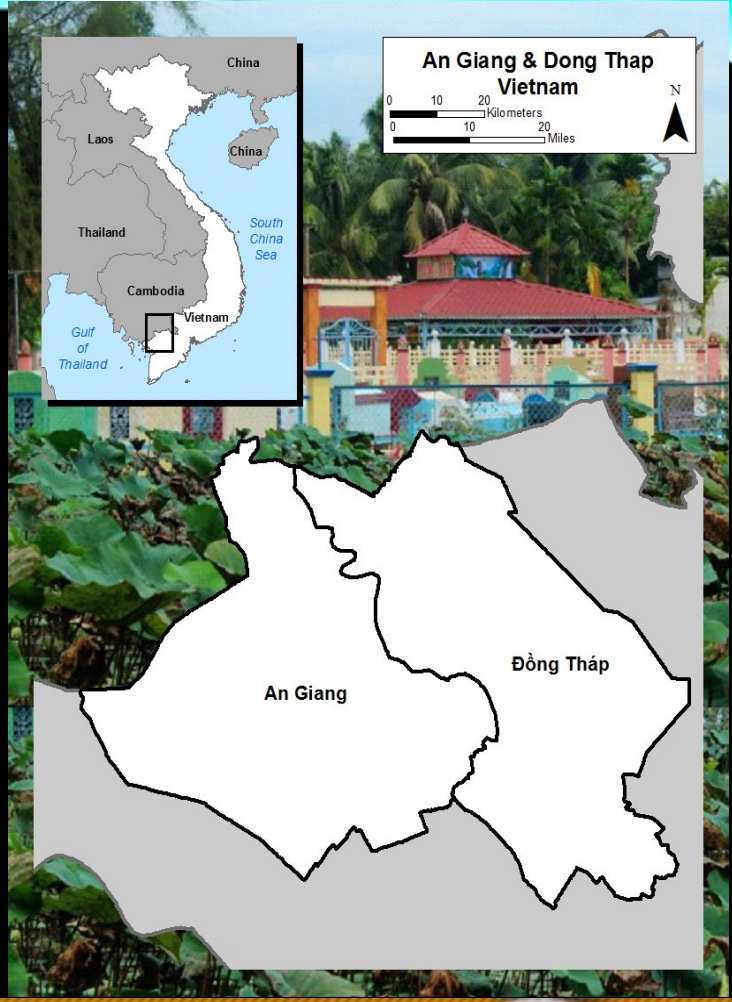
Not pictured: Nathan Thomas, Margaret Wooten, Alfred Hubbard of NASA GSFC



PGHH

PHẬT GIÁO HÒA HẢO

HÒA HẢO BUDDHISM

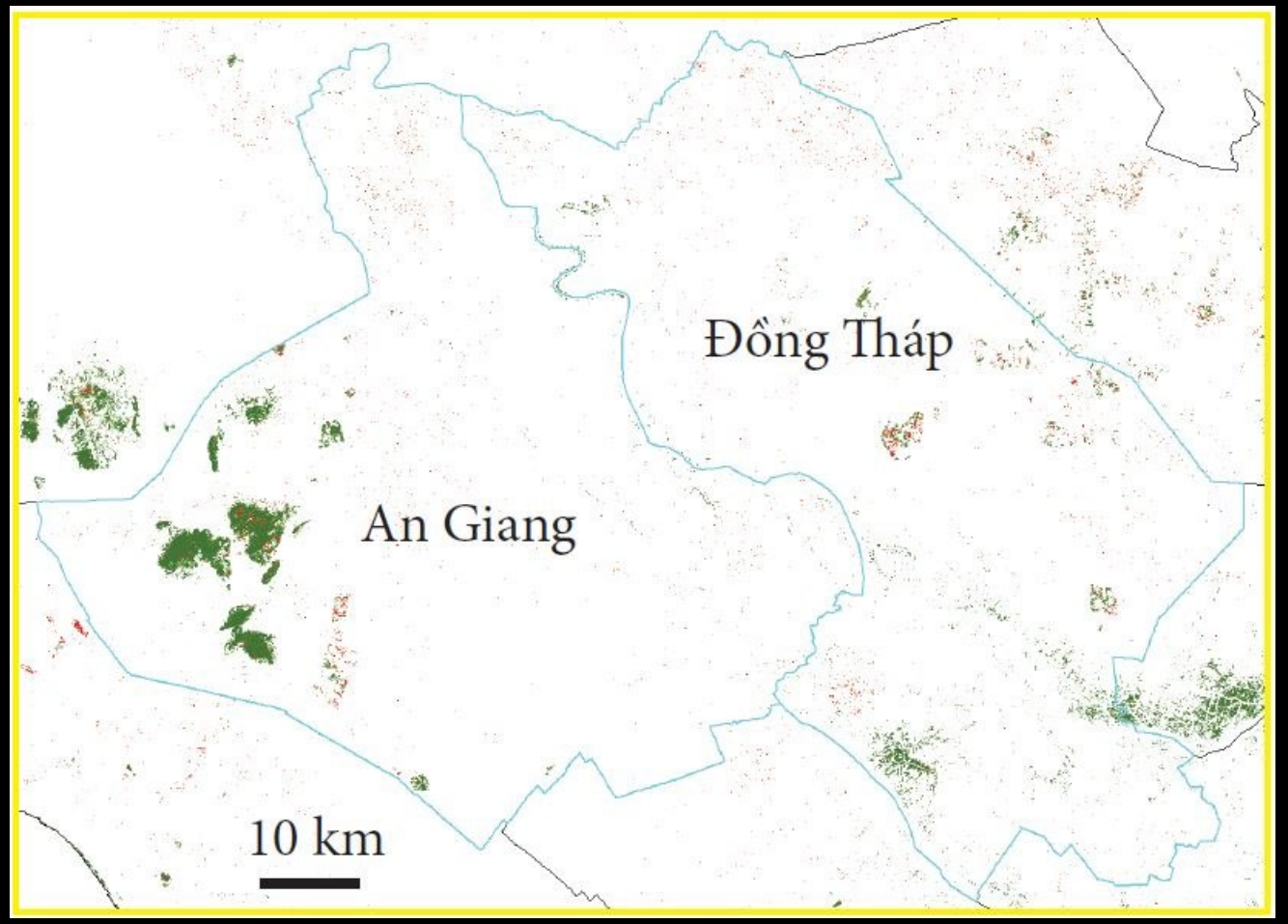
Biết làm sao gieo đạo khắp đại đồng, đưa nhân loại đi vào vòng hạnh phúc.

EARTH OBSERVATIONS: MODERATE TO VERY HIGH RESOLUTION

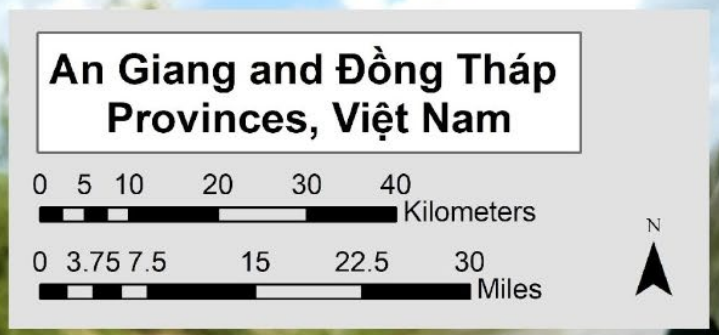
Use multitemporal remote sensing to map **forest, agriculture, wetland, and urban change**

Moderate-scale for circa 1985, 1990, 2000, 2005, 2010, 2015, and 2018-19

Very high resolution for 2010, 2015, and 2018-19



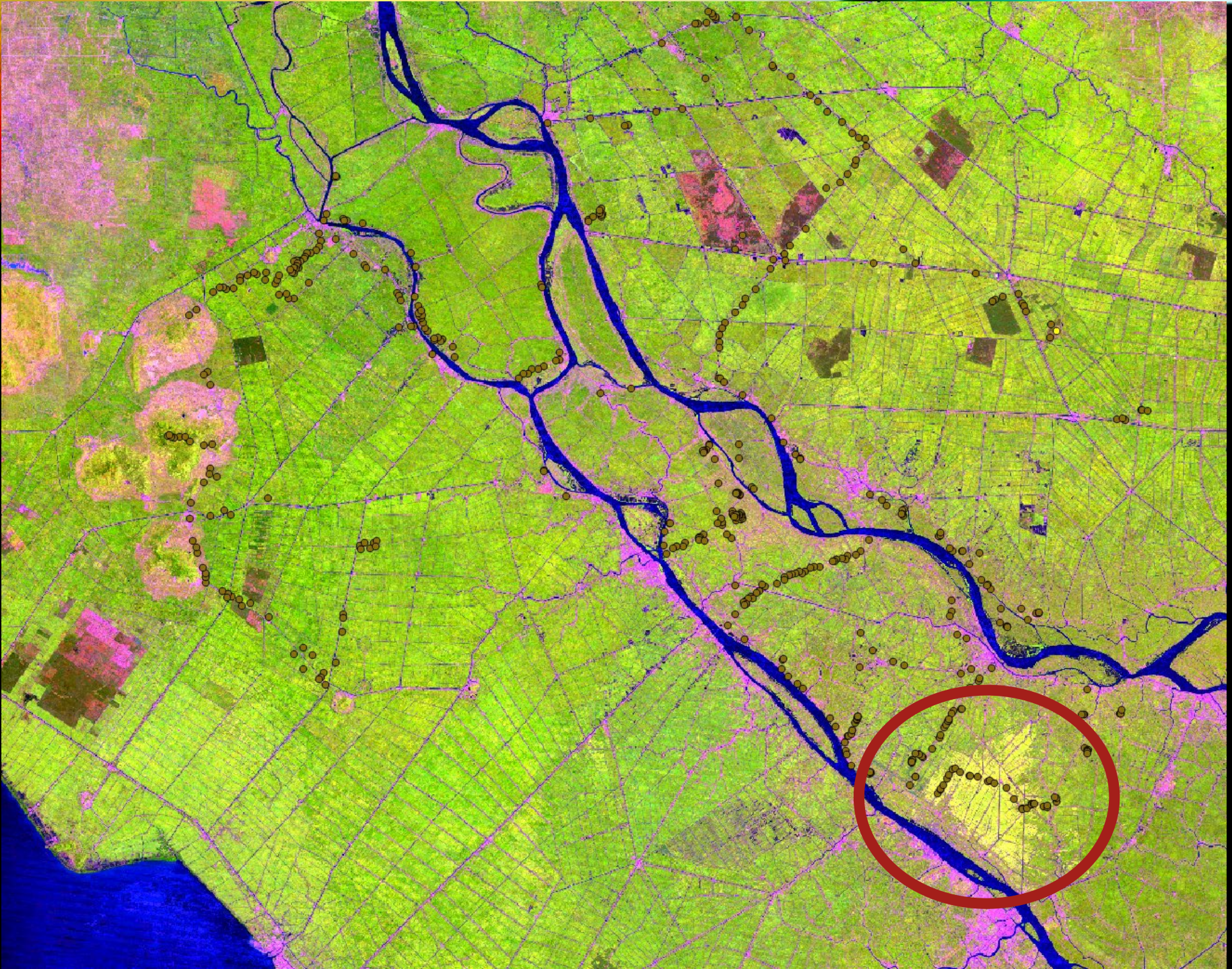
Landsat-based tree cover loss from 2000 to 2015 (red) compared to year 2000 canopy cover (green).



Integrating in-situ with VHR data

20 MAY – 20 JULY 2019

HUMANISTIC, SOCIAL SCIENCE, & NATURAL SCIENCE FIELD METHODS



Beyond Rice

TRAM CHIM NATIONAL PARK

Tràm Chim National Park

Website Directions Save

4.1 ★★★★☆ 1,945 Google reviews

National park in Vietnam

Tràm Chim National Park is a national park in the reed fields Đồng Tháp Mười, Tam Nông District, Đồng Tháp Province of Vietnam. This national park was created to protect several rare birds, especially the sarus crane, a species listed in the IUCN Red List. Wikipedia

Address: Khóm 4, Tam Nông District, Đồng Tháp Province, Vietnam

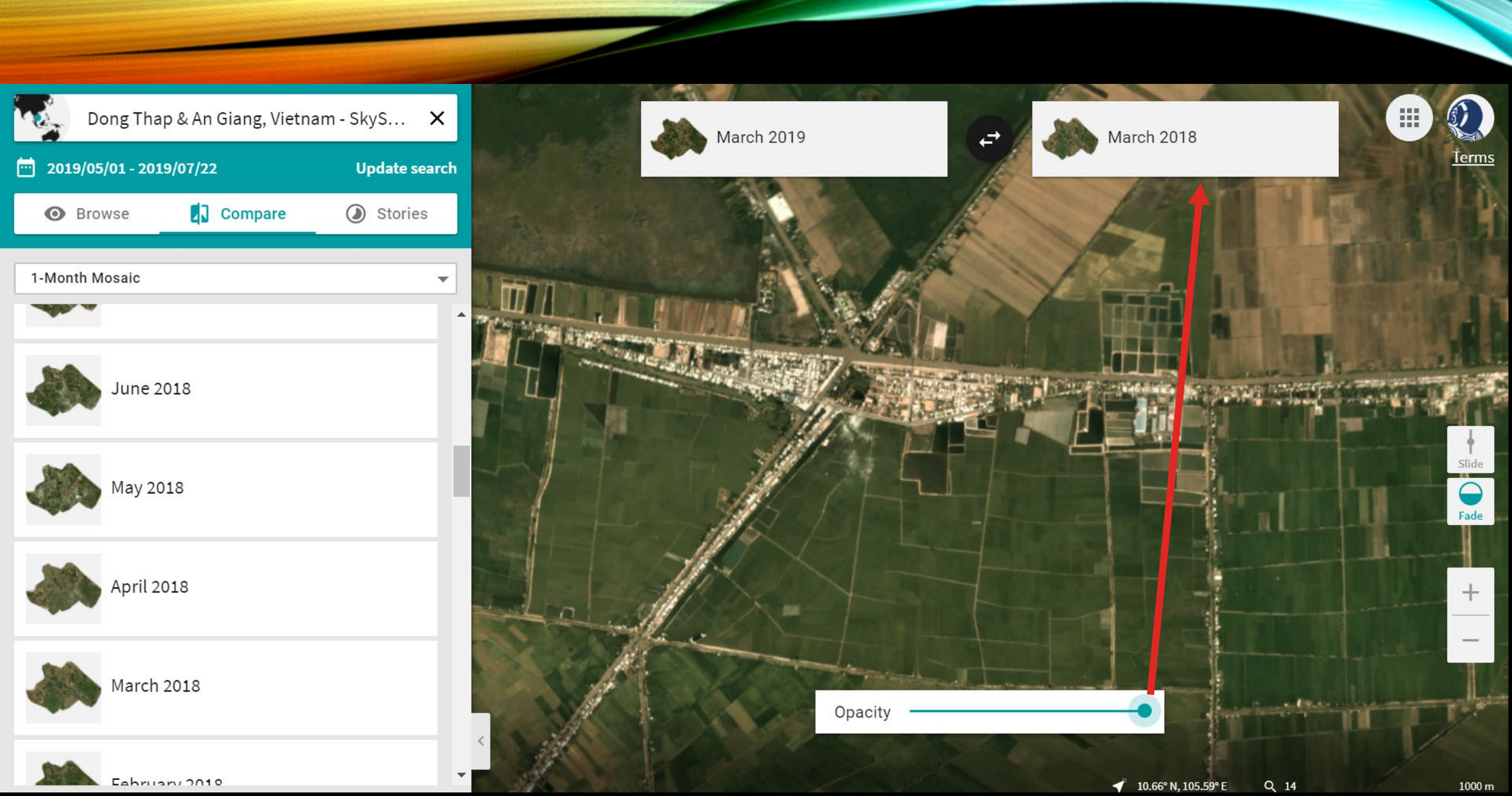
Area: 29.3 mi²

Province: Đồng Tháp Province

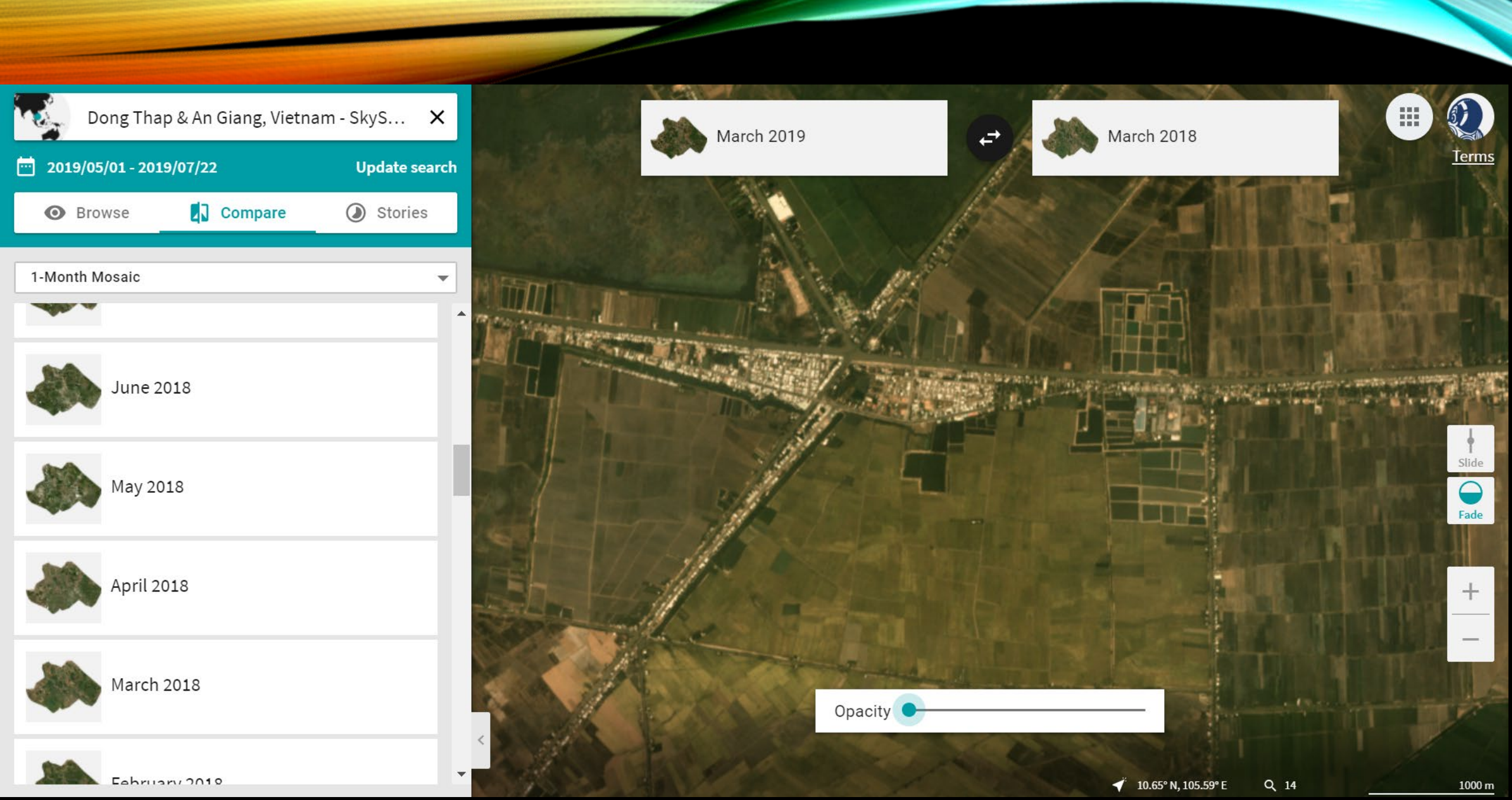
Established: 1998

Phone: +84 277 3827 436

Phu To Commune



Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com



Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com


Tân Châu
Mekong River
Mekong River
Hồng Ngự
ĐỒNG THÁP PROVINCE
3D
Google
CNES / Airbus DigitalGlobe Maxar Technologies
Camera : 21 km 10°47'16"N 105°19'09"E 5 m 100%

Example Farm on Long Khan A

Formerly mostly rice. Now trees for construction, bamboo, melon, corn, mango, fodder for cattle, & medicinal herbs. **Can make more money than rice.**

Erosion and Livelihoods

Erosion rate
7 m per year

Erosion

Deposition

2007
102 m to river bank

2019
18.6 m to river bank

What about deposition?

- Planet Scope comparison

Erosion

Deposition

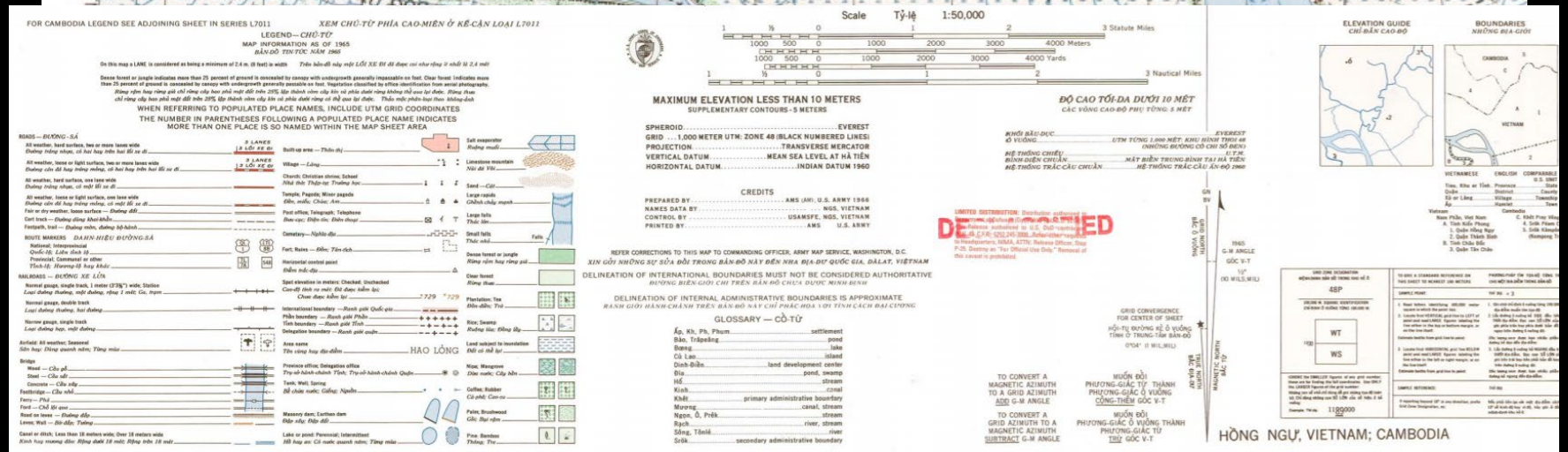
~0.8 m SkySat
20 July 2019

Planet Team (2017). Planet Application Program Interface: In Space for Life on Earth. San Francisco, CA. https://api.planet.com

June 2019 vs 1960

1960 declassified CIA map of Long Khanh

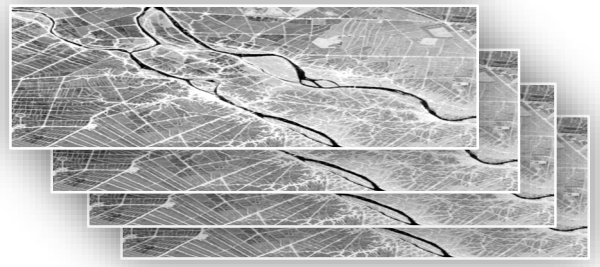
http://legacy.lib.utexas.edu/maps/topo/vietnam/hong_ngu-6030-1.pdf



Sentinel-1 SAR: Rice Mapping

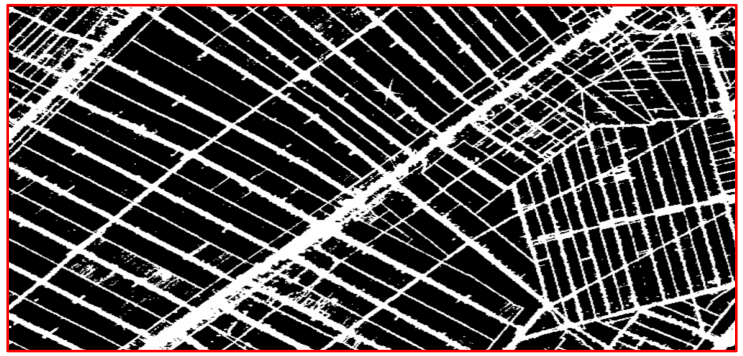
Method

Interferometric Wide Swath Mode (IW) images that were Vertically transmitted Horizontally received (VH) polarization.



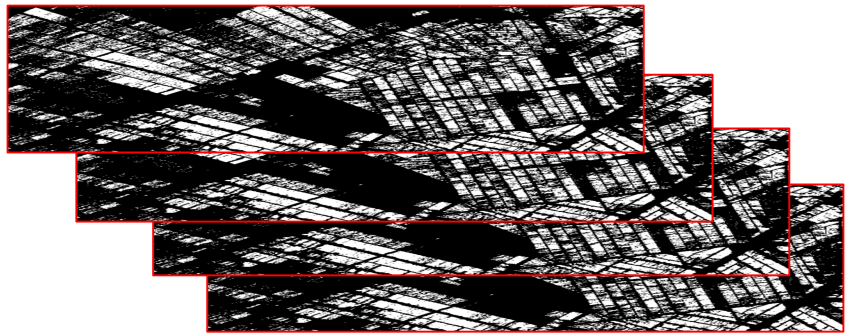
Sentinel-1 VH dB images

Thresholds on an annual sum backscatter image to mask out non-rice pixels



Binary Non-rice mask

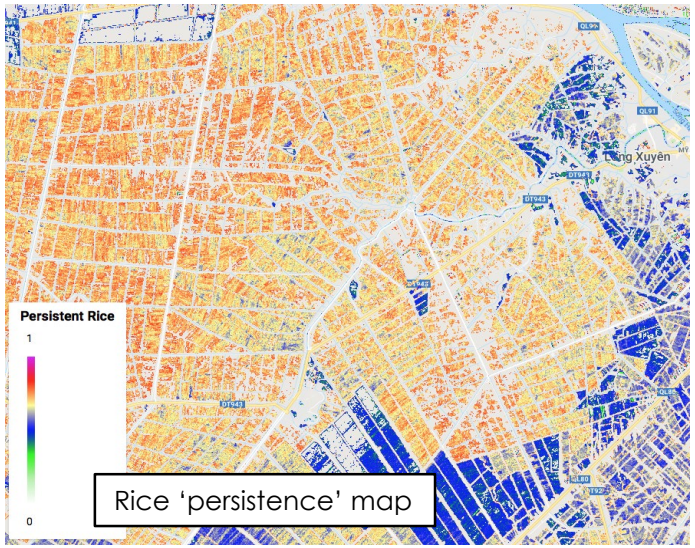
For each image in the annual stack, rice was mapped using thresholds and the presence of the non-rice mask



Rice 'presence' binary maps

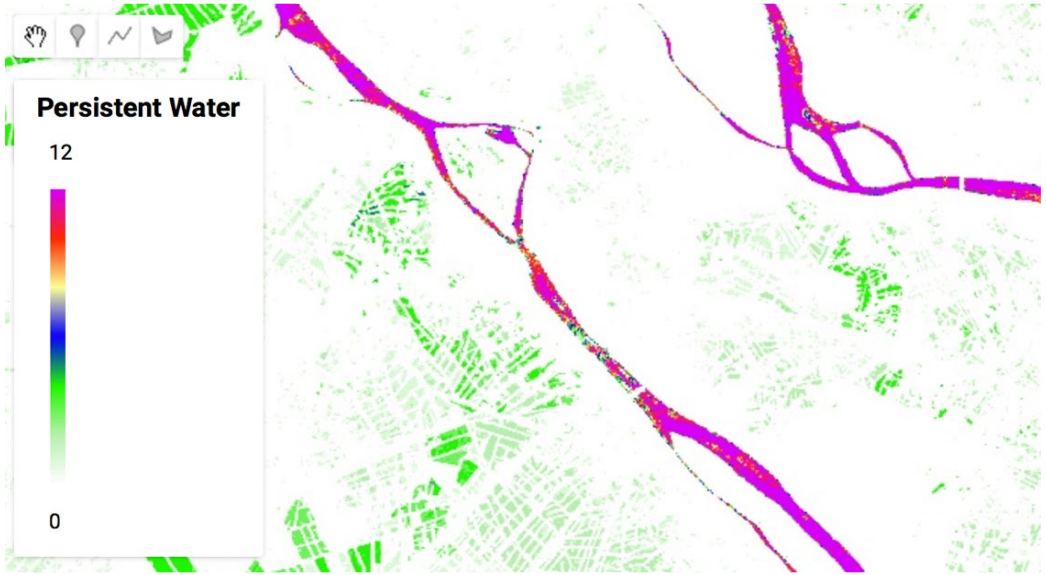
Results

Normalized Rice Persistence: The rice binary maps were summed and divided by number of images in stack, for each pixel generating a normalized measure of 'rice persistence'.

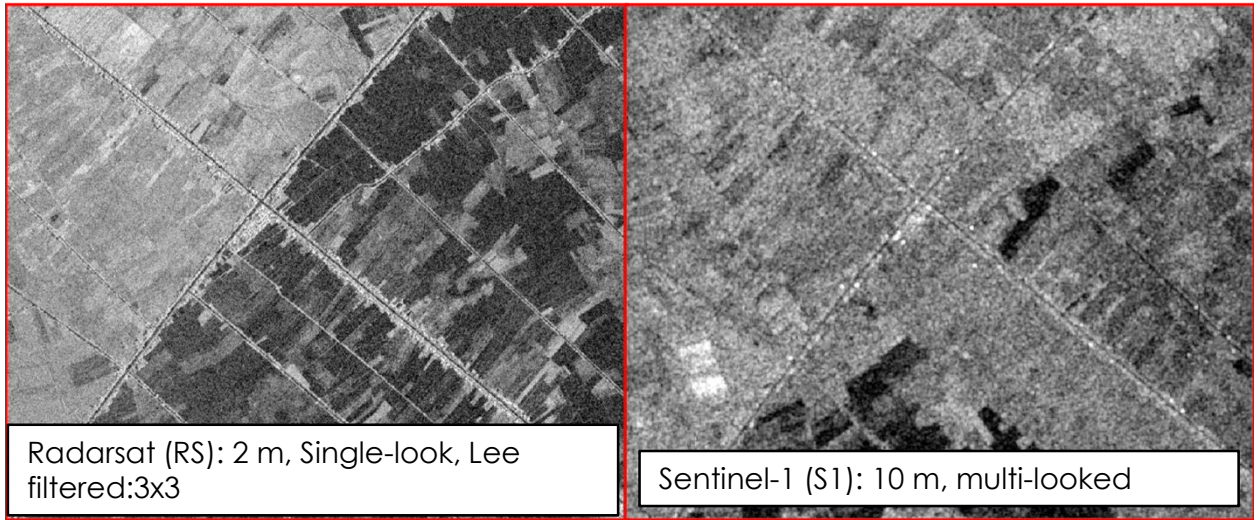


Rice 'persistence' map

Normalized Water Persistence: An inverse method to rice mapping also enables a normalized water persistence image to be generated



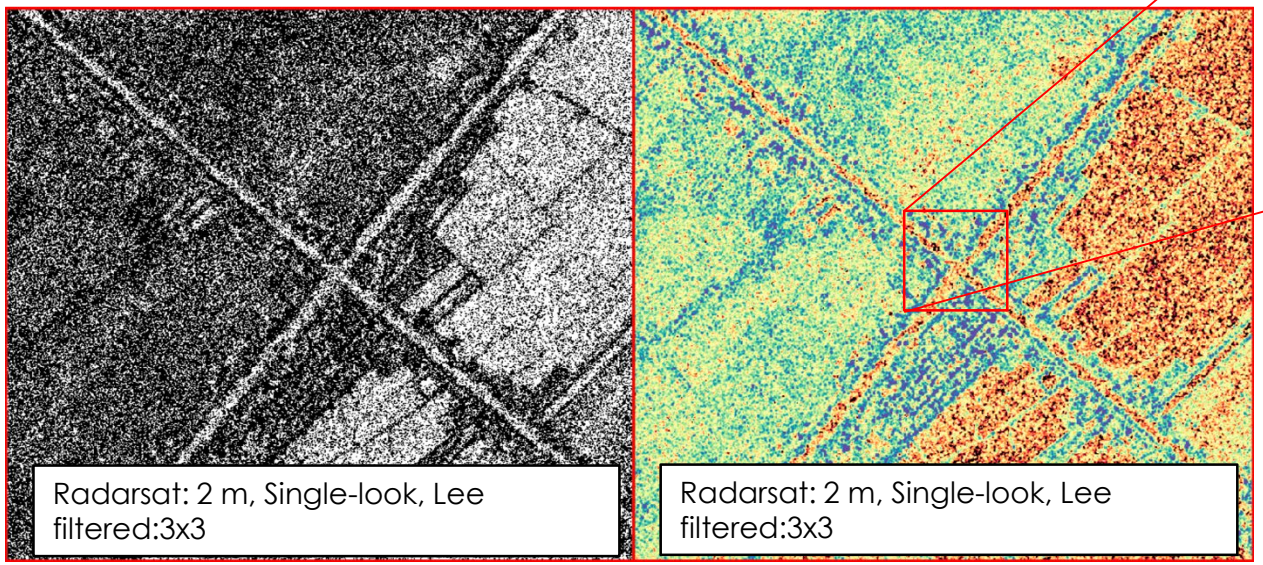
Radarsat



Radarsat (RS): 2 m, Single-look, Lee filtered:3x3

Sentinel-1 (S1): 10 m, multi-looked

Differences in the resolution of RS (left) and S1 (right) are clear, with the RS2 appearing to be a much 'sharper' image then the S1



Radarsat: 2 m, Single-look, Lee filtered:3x3

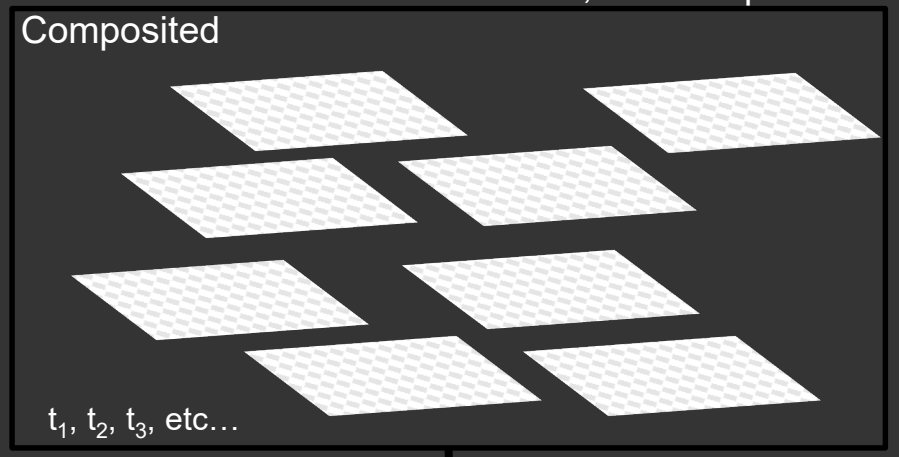
Radarsat: 2 m, Single-look, Lee filtered:3x3

The noise within RS data despite being Lee filtered. The 'salt and pepper; effect is visible in the channels and within the ponds/rice fields. Left: Greyscale image. Right: Spectral stretch

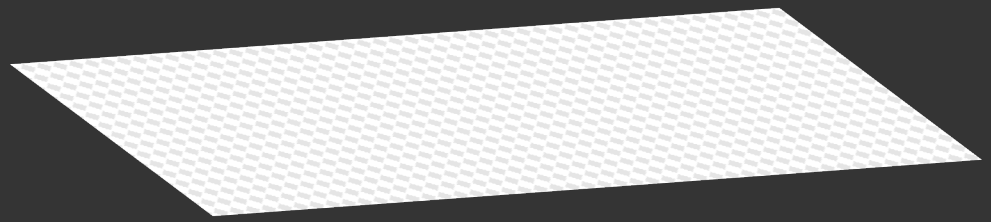
- Despite the increased resolution over S1, the speckle in the RS single-look imagery prevented further details being classified (channels between rice fields)
- RS has a much smaller swath size then S1 and much lower temporal archive than S1
- **Benefits of RS resolution do not provide overall advantages to S1 when noise, temporal frequency and swath size are considered**

Methods - VHR Texture Implementation

½° x ½° 1 m Pan Mosaics of VHR, Min Per-pixel Value Composited

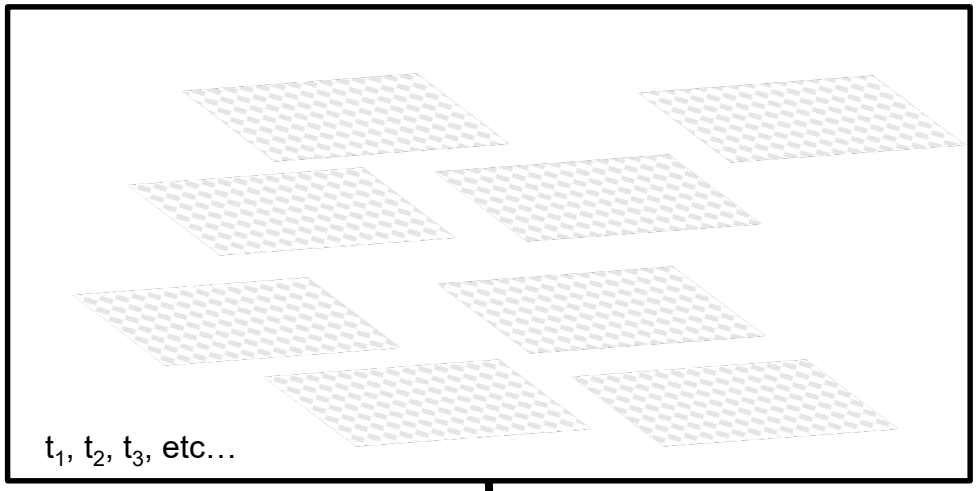


Metadata

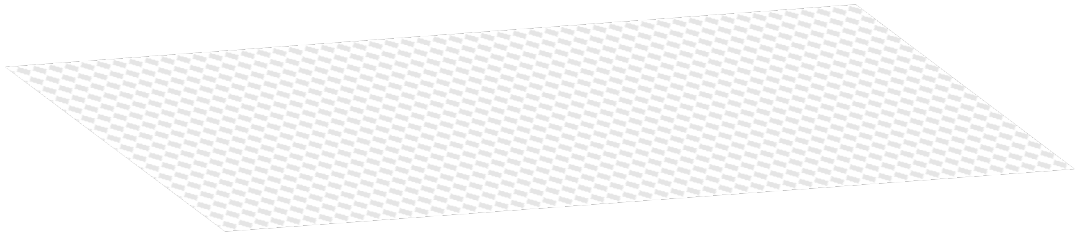


Wall-to-Wall VHR Texture used in Segmentation

½° x ½° 1 m Pan Mosaics of VHR, Min Per-pixel Value Composited Using coefficient of variation, ratio of the standard deviation and mean.



$cv = \sigma/\mu$



Wall-to-Wall VHR CV used as a metric to understand the reflectance stability over time within a designated epoch from the source images in the mosaic.

Methods – Double Pass Histogram
Segmentation Approach: Otsu multi-thresh

1st Pass Segmentation using Otsu multi-thresh

In computer vision and image processing, **Otsu's method**, named after Nobuyuki Otsu (大津展之 *Otsu Nobuyuki*), is used to automatically perform clustering-based image thresholding, or the reduction of a gray level image to a binary image.

The algorithm assumes that the image contains two classes of pixels following bi-modal histogram (foreground pixels and background pixels), it then calculates the optimum threshold separating the two classes so that their combined spread (intra-class variance) is minimal, or equivalently (because the sum of pairwise squared distances is constant), so that their inter-class variance is maximal. The extension of the original method to multi-level thresholding is referred to as the Multi Otsu method.

- In Otsu's method we exhaustively search for the histogram threshold that minimizes the intra-class variance (the variance within the class), defined as a weighted sum of variances of the two classes.
- Weights are the probabilities of the two classes separated by a threshold and are variances of these two classes.

2nd Pass Objects mean TOA value is placed into a histogram per ½ degree tile and tails are trimmed

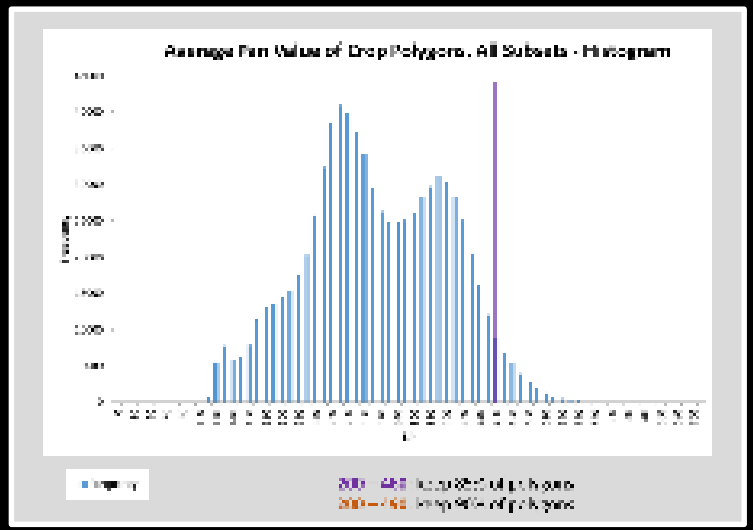
- Low values of objects are typically water bodies or dark cloud shadows with a homogenous texture.
- High values of objects are typically clouds were image density was low and clouds passed through the minimum per-pixel compositing.

Original B&W Image

Otsu Segmented Image

https://en.wikipedia.org/wiki/Otsu%27s_method

Otsu 1979. IEEE Trans on Systems, Man, and Cybernetics



Matlab Otsu multi-thresh Implementation on ADAPT

DigitalGlobe WorldView Big Data Processing

- First iteration used only a single pass approach.
- Required multiple toolboxes: image processing, computer vision, parallel processing.
- > 32,000 (All of Ethiopia 2008-2013) WV-1 images were processed with Otsu multi-thresh matlab function.
- Preprocessing included gdal reprocessing of NITFs, to be able to ingest in Matlab: othorectified, resampled to 1 m & converted to uncompressed geotiff.
- Matlab inherently parallel implementation: 3 VMs (20 cores 60 gigs of ram) = 1 node

Advanced Data Analytics Platform (ADAPT)

- 5 WV-1 images at a time per VM
  - Broken into 16 tiles on one node,
  - Radiometric resolution adjusted, min/max stretched
  - Smoothing kernel was applied, 5 kernels avail only processed 1
  - = 1 minute to process 5 images on one node
  - 3 nodes = 15 images a minute/32,000 images = 1.5 days (with no hardware hiccups!)
  - > 1 week realistically with 5 kernels

Development of HR Mosaics

McCarty, J.L., Neigh, C.S.R., Carroll, M.L., & Wooten, M.R. (2017). Extracting smallholder cropped area in Tigray, Ethiopia with wall-to-wall sub-meter WorldView and moderate resolution landsat 8 imagery *Remote Sensing of Environment,* 202: 142-151.

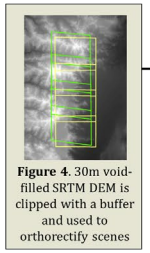


Figure 4. 30m void-filled SRTM DEM is clipped with a buffer and used to orthorectify scenes

Orthorectify
by Individual Scene

Neigh, C.S.R., Carroll, M., Wooten, M.R., Powell, B., McCarty, J.L., Husak, G.J., Enenkel, M., & Hain, C. (2018). Smallholder crop area mapped with wall-to-wall WorldView sub-meter panchromatic image texture: a test case for Tigray, Ethiopia. *Remote Sensing of Environment,* 212: 8-20.

First Iteration

Individual WV strips segmented.
Segmented WV strips mosaiced.
Post-processing NDVI amplitude from Landsat 8 used to mask commission errors.
3 evaluators of classification accuracy.

METHOD 1

Segmentation
on Individual Orthorectified WV-1 Scene

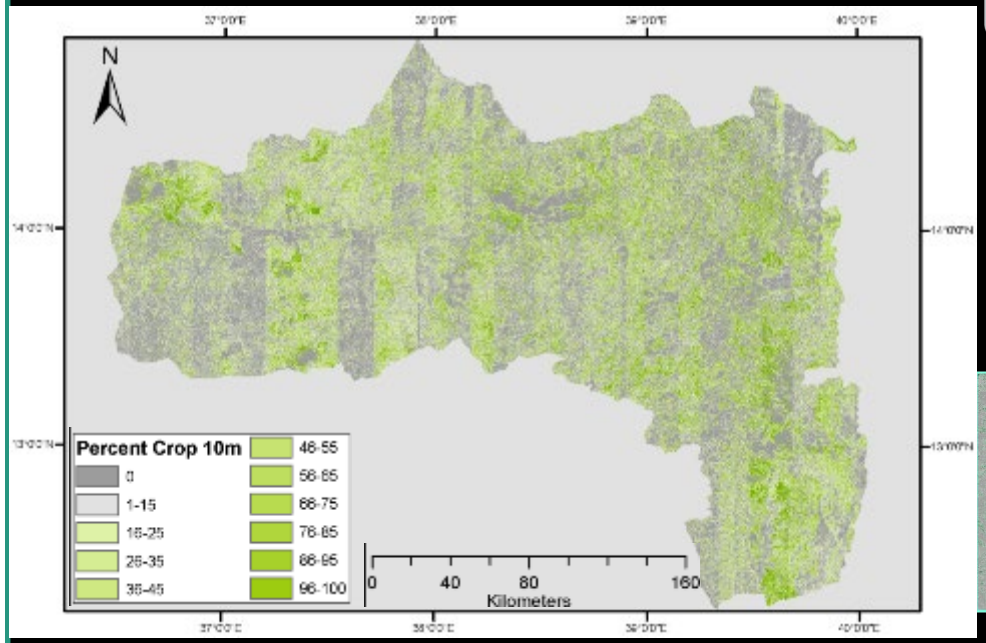
Mosaic
Segmented Scenes into Quarter Tiles

METHOD 2

Mosaic
Orthorectified WV-1 Scenes into Quarter Tiles

Segmentation
On Orthorectified Quarter Tile Mosaic

Post-processing



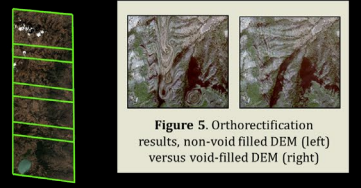
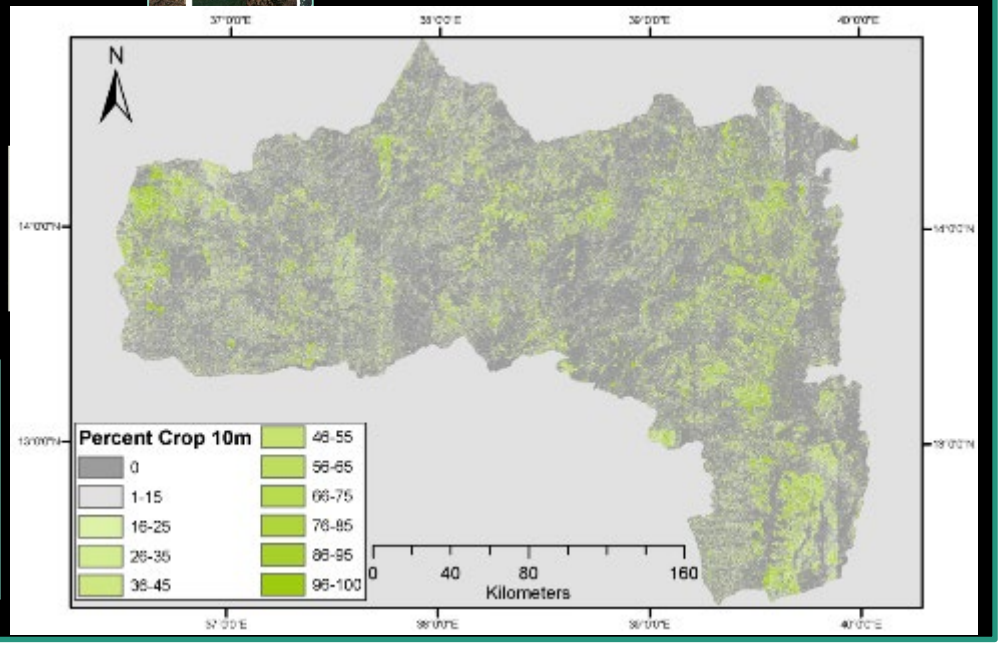


Figure 5. Orthorectification results, non-void filled DEM (left) versus void-filled DEM (right)

Mosaic
Orthorectified WV-2 Scenes into Quarter Tiles



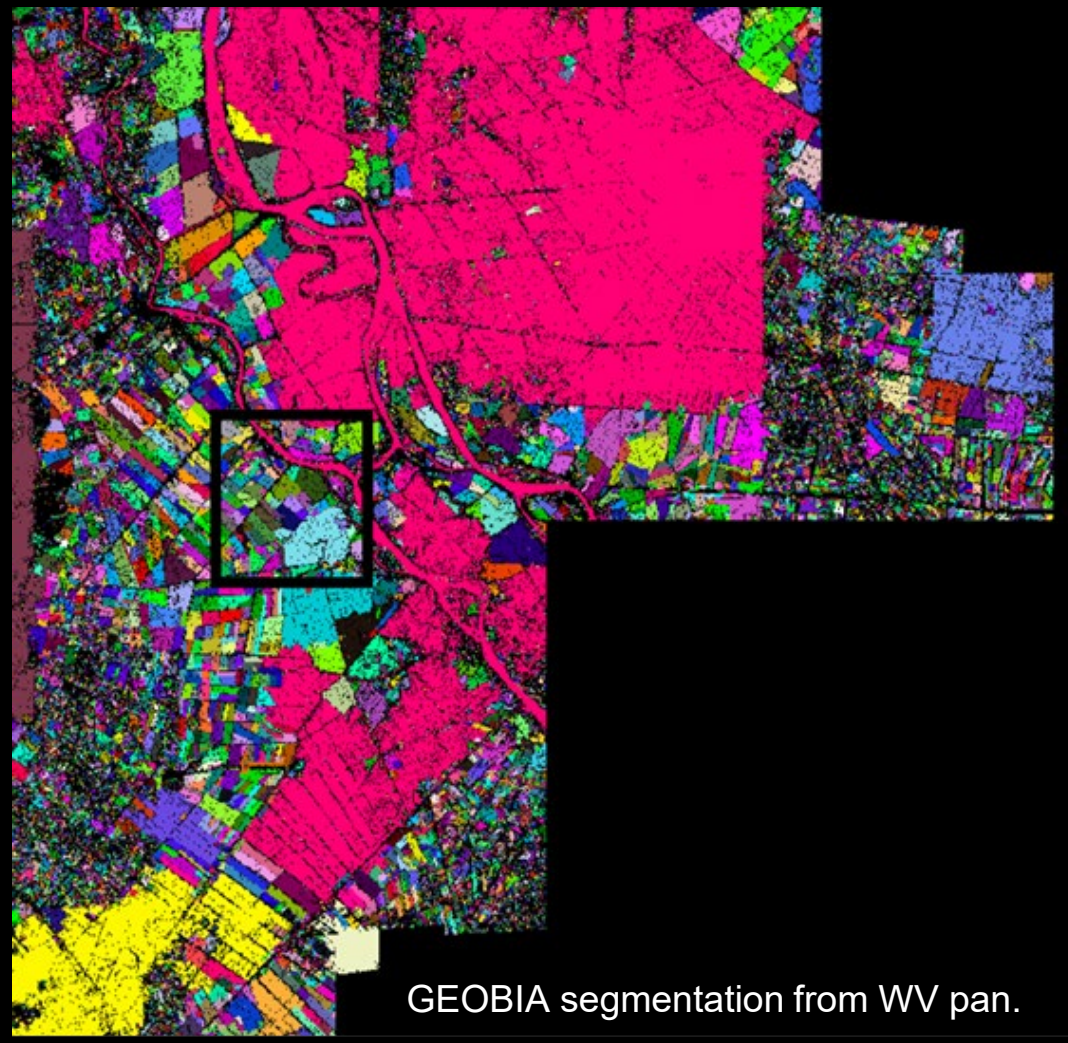
Second Iteration

WV strips mosaiced.
WV mosaics segmented.
Post-processing 2-nd pass histogram approach median object values tails trimmed.
7 evaluators of classification accuracy.

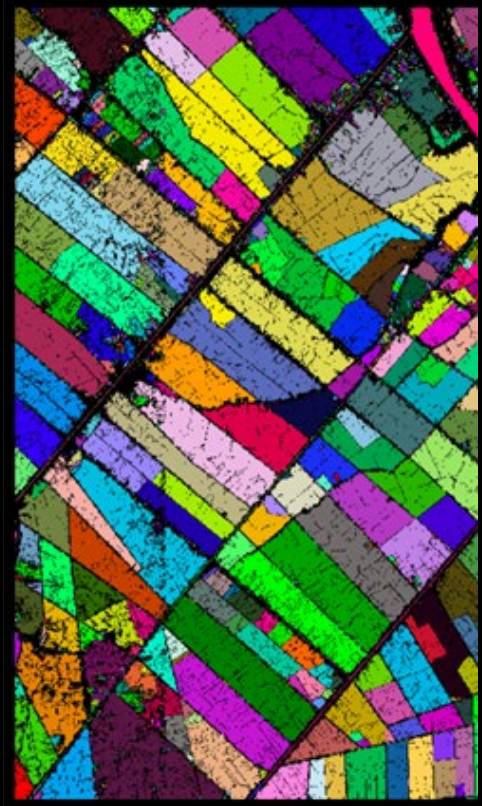
New Methods: Matlab Otsu multi-thresh on ADAPT for An Giang and Dong Thap, Vietnam

DigitalGlobe WorldView Big Data Processing

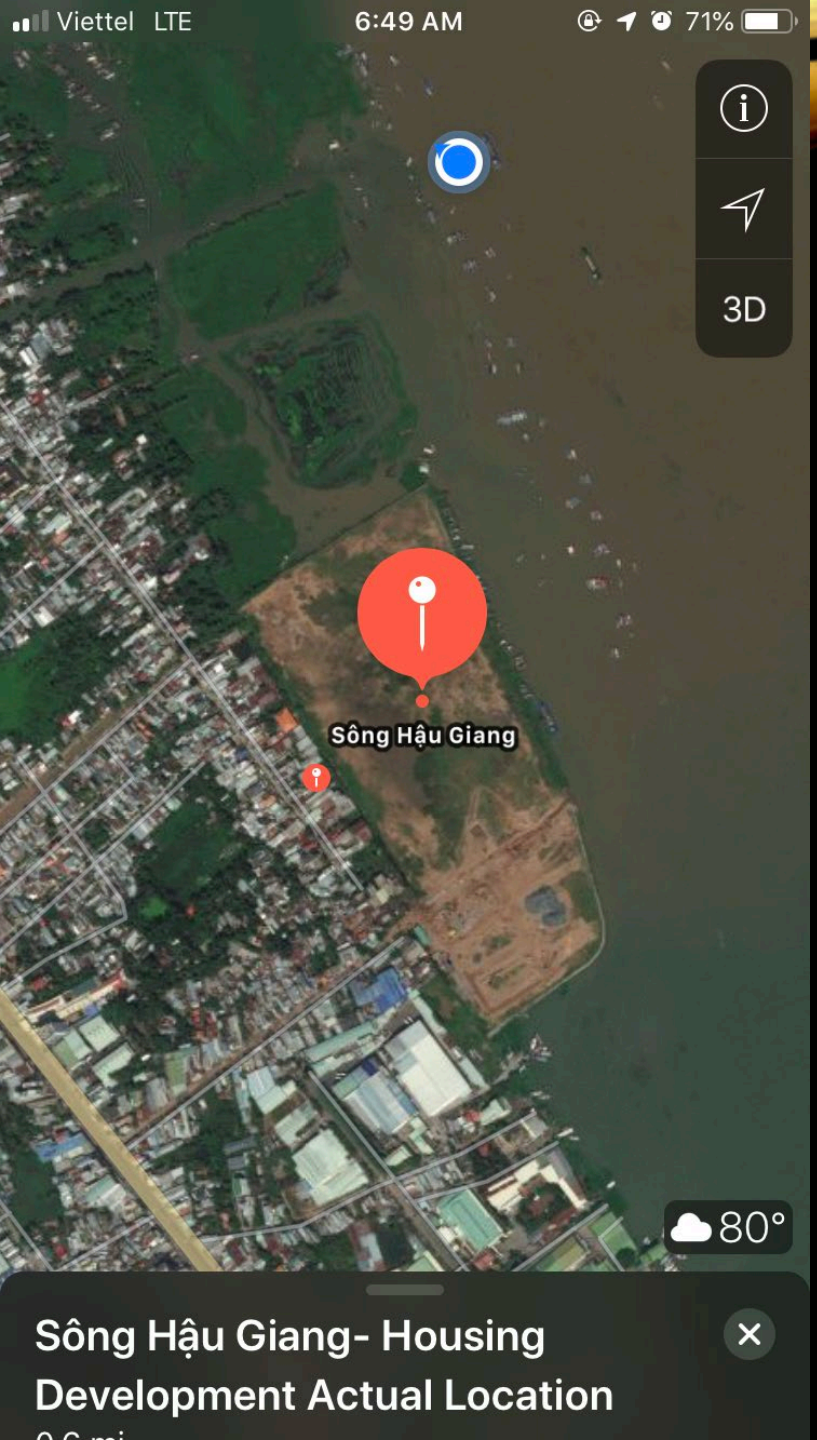
- Multispectral WV2 & WV3, 8-band, 2 m resolution composites currently being compiled.
  - Data are in house, testing AIST-API for preprocessing to ortho TOA geotiffs.
  - Otsu's method will be run on each band, quantized and thresholds determined.
  - Goal is to refine object boundaries.
- Sentinel-1 SAR signal being used to understand cropping cycles with VHR field objects.
- Next Steps – apply Otsu's method on cloud-free ortho SkySat mosaic on ADAPT



GEOBIA segmentation from WV pan.

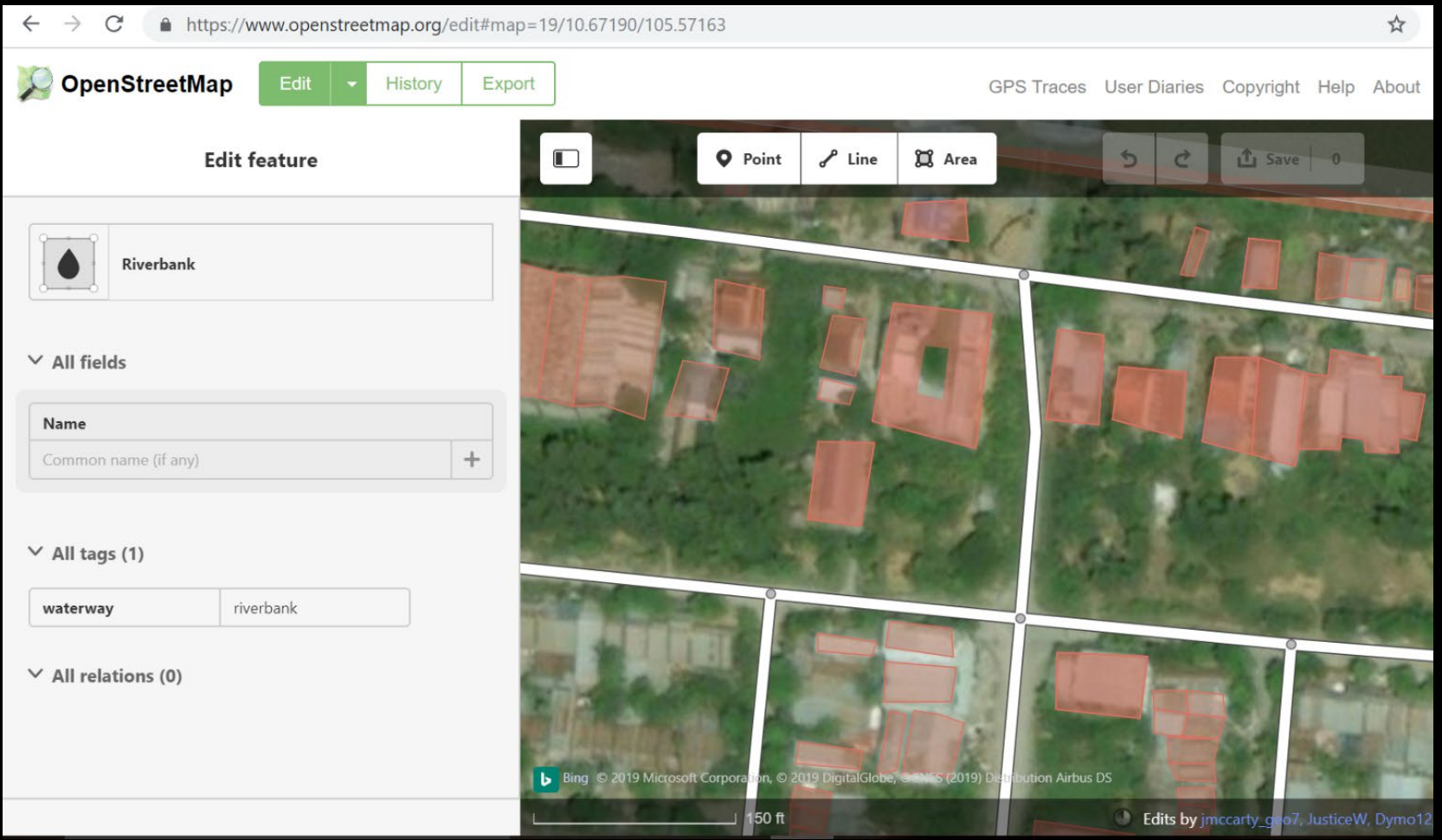


Urban Change



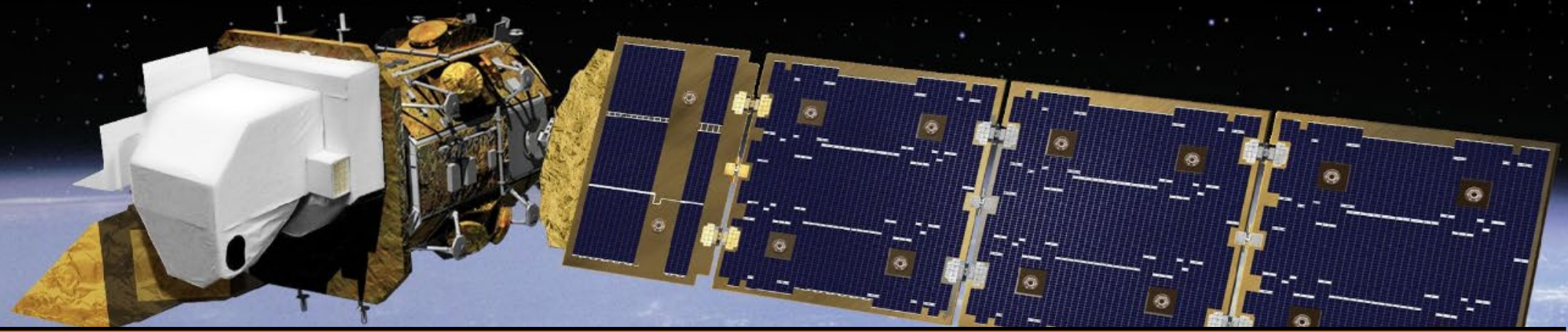
PlanetScope Comparison

MCCARTY UNDERGRADUATE RESEARCH GROUP



Compare buildings and roads created in OSM to SkySat and Google Earth

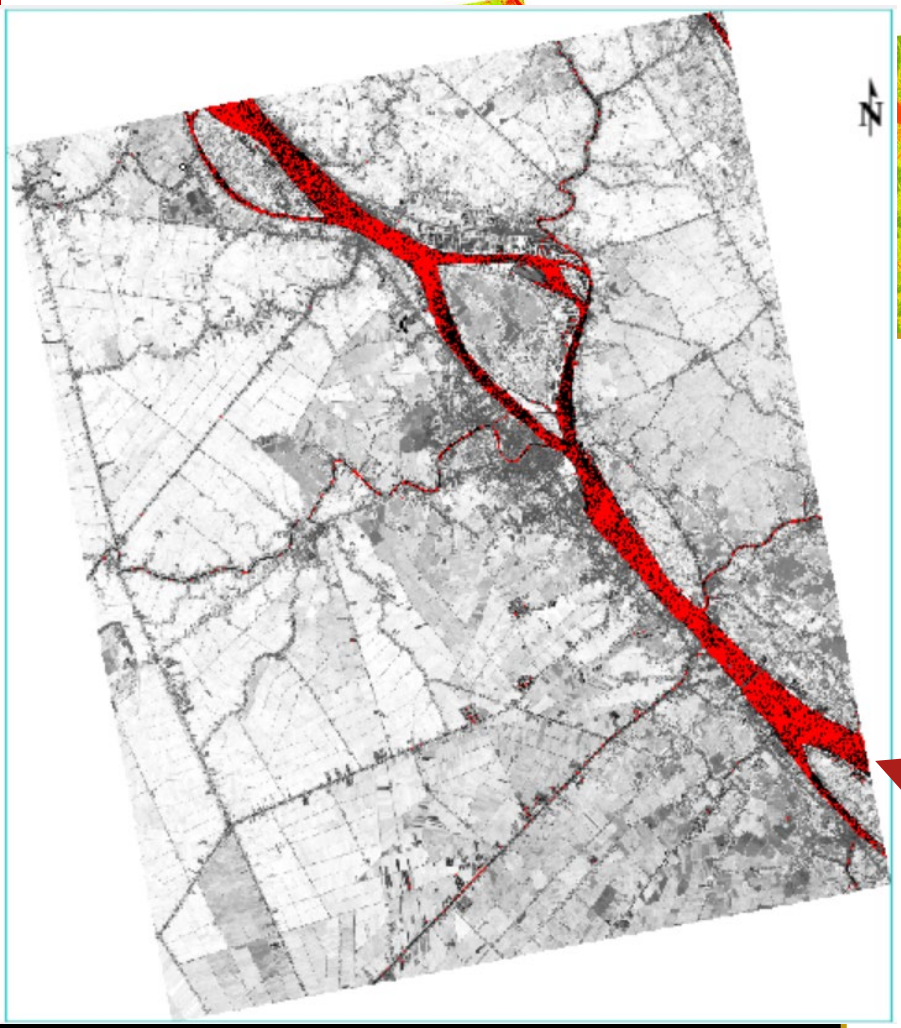
Value of Planet Data vs. Open Source for urban change



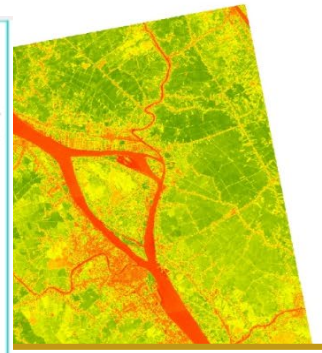
Sensor	Red Band Wavelength (µm)	NIR Band Wavelength (µm)
PlanetScope (3 m)	0.59 to 0.67	0.78 to 0.86
Sentinel-2A (10 m)	0.65 to 0.68	0.785 to 0.899
Landsat 8 (30 m)	0.636 to 0.673	0.851 to 0.879

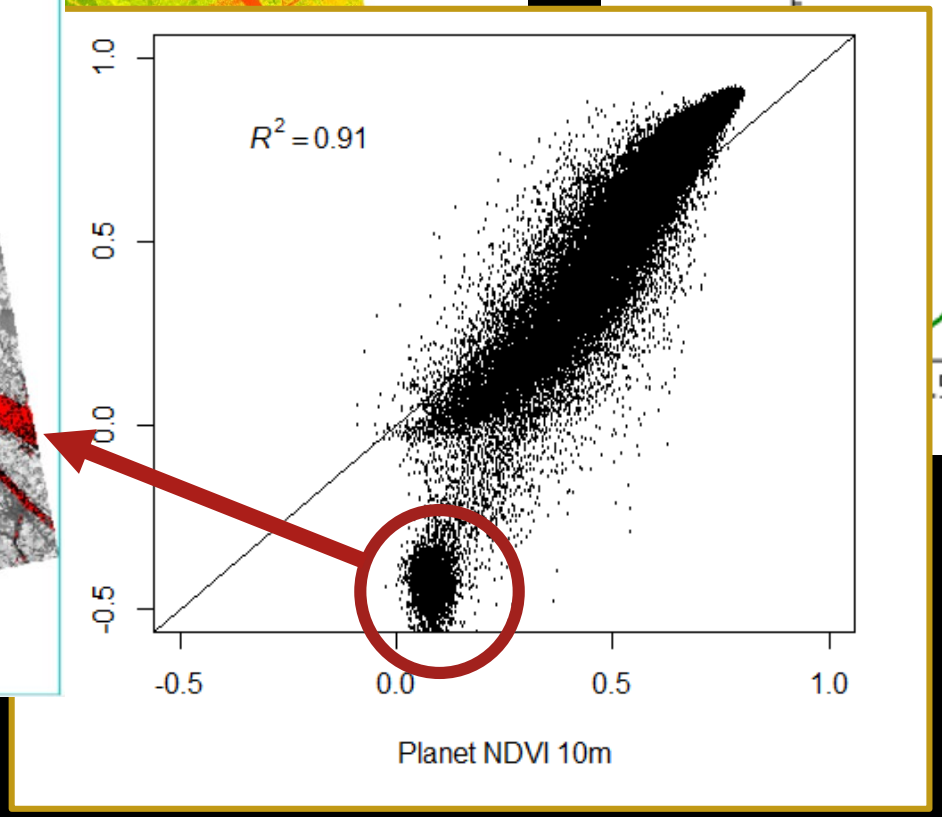
PLANETSCOPE VS. SENTINEL-2A

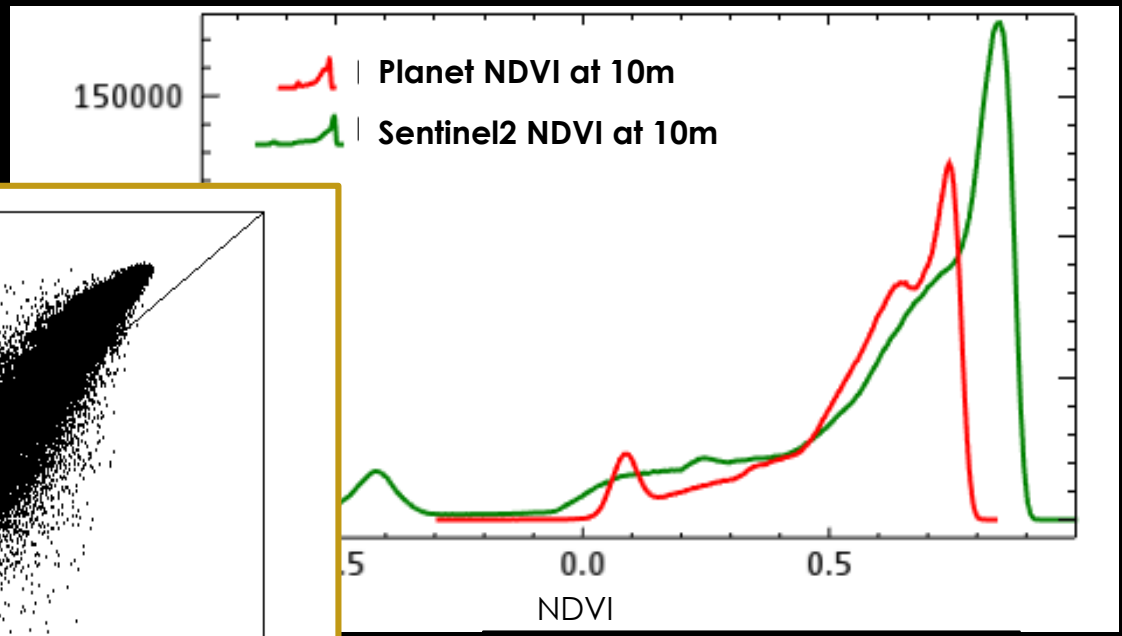
Sentinel2 NDVI
Long Xuyen on 20190215



Planet NDVI
Long Xuyen on 20190213







Questions?