Surface Water Mapping of the Mississippi Delta Region using UAVSAR

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Abstract

The Mississippi Delta is one of the largest coastal ecosystems in North America and has enormous ecological and economic significance. About 25% of the wetlands in the delta were lost during the 20th century primarily as a result of human activities, and recent projections indicate that most of the remaining wetlands will disappear in this century if we continue current patterns of management. The aim of my research this summer was to create a waterbody map of the Mississippi delta derived from remote sensing imagery. I used datasets collected by the UAVSAR mission to produce an algorithm for mapping surface inundation. Using software like ENVI and Mapready, I experimented with various band ratios to produce a land cover classification algorithm to create surface water maps for this region that can potentially help conservationists and environmental scientists monitor this sensitive region in the future.

Materials and Methods

- I analyzed 2 polarimetric radar images of segments of the Mississippi delta collected by the NASA Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) mission
- Data files were then converted to decibels through ENVI using the equation 10*ALOG10(B1).
- Using POLSARPro software, polarimetric decompositions were created following the Van Zyl model:

The covariance matrix *C* is decomposed as odd-bounce, even-bounce, or diffuse scatterers

$$C = f_s C_s + f_d C_d + f_v C_v(\sigma,\theta) + C_r$$

Where σ and θ correspond to the roughness and orientation of the dipole cloud distribution, respectively.

- Regions of interest were selected and histograms of backscatter values were created for each polarization (HH, HV, VV) as well as band ratios HH-HV, HH-VV.
- Thresholds were defined based on these histograms, and a decision tree classifier was created in ENVI.
- The execution of the decision tree gives us the waterbody map for the selected regions of Mississippi delta.

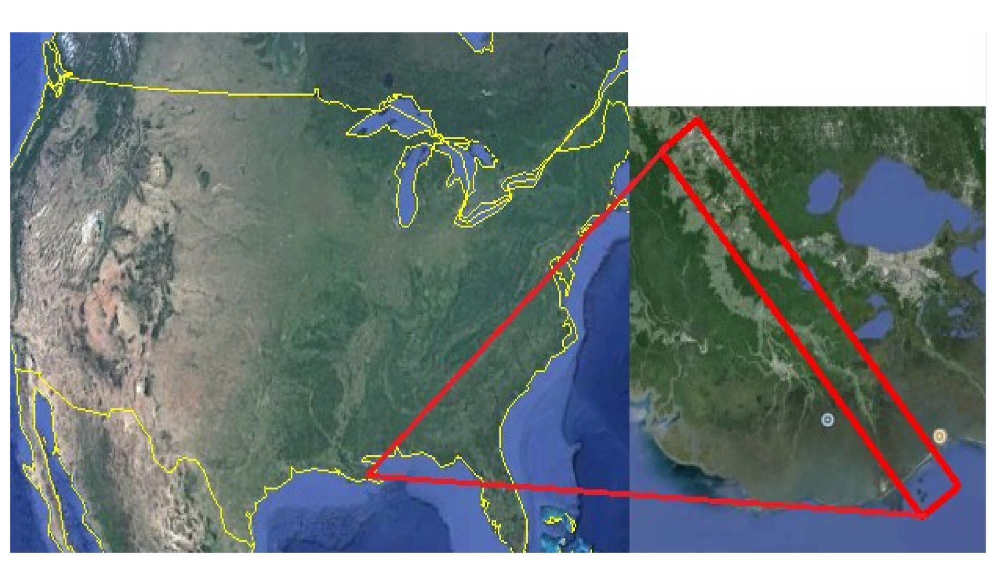

Fig. 1. The area of research, a section of the Mississippi delta

Results

- HV was determined to yield the best separability between regions of interest (ROIs) selected in the histograms (Fig. 2)
- The completed waterbody map shown below (Fig. 5) is the execution of a decision tree that was built upon threshold values derived from these histograms. Backscatter values generally ranged from -35 to -30 dB for water, -25 to -20 dB for inundated vegetation. Through ENVI, these backscatter values are used to create the final waterbody map.

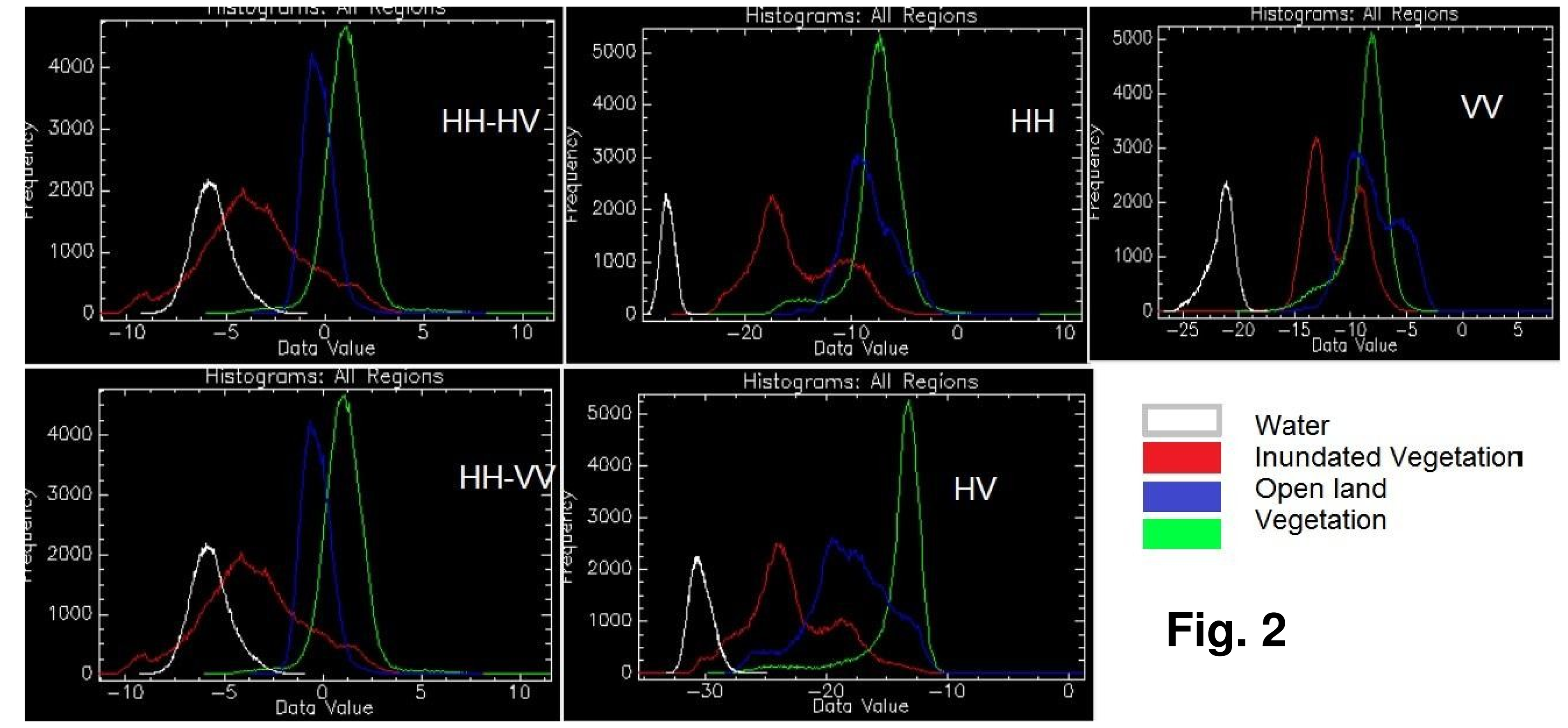

Fig. 2

Fig. 2. Distributions of polarization backscatter from four ROIs. The histograms that yield the best results in a decision tree exhibit little overlap, allowing for clear delineation of land cover classes. These backscatter threshold values are applied in the decision tree (Figs. 5 & 6).

3a: ROIs **3b: Van Zyl Decomposition** **3c: Backscatter Composite**

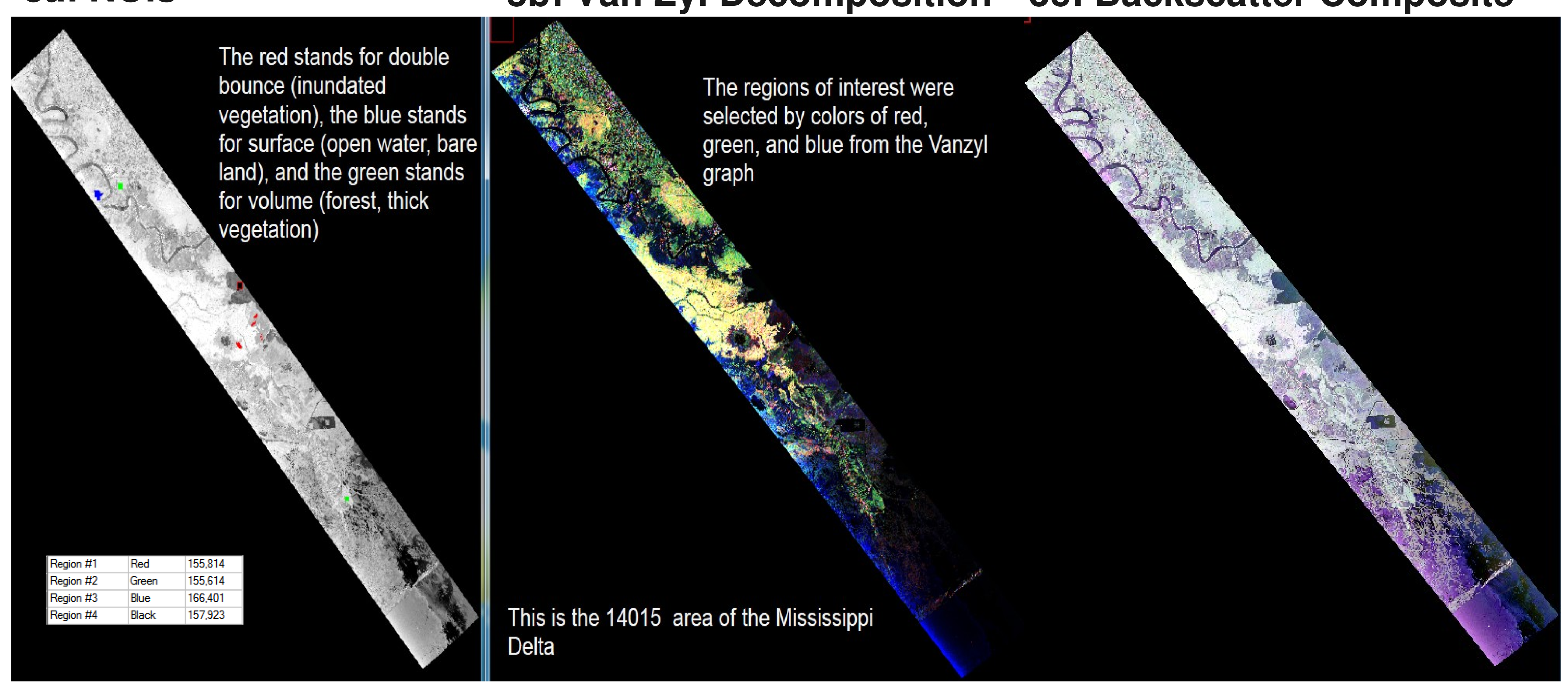

Fig. 3a. Regions of interest (ROIs) overlaid on HV polarization backscatter. The regions of interests were chosen from the Van Zyl decomposition. The distribution of each image polarization's backscatter is shown in the histograms in Fig. 2.

Fig. 3b. Van Zyl decomposition image of dominant scattering mechanisms for each pixel, where red: double bounce, blue: surface, and green: volume scattering.

Fig. 3c. RGB composite of backscatter from different polarizations: red: HH, blue: VV, and green: HV

Final Product

Fig. 4. Decision tree that was applied to the HV backscatter image. As a result, the colors of the threshold map representing missing data, water, inundated vegetation, vegetation, and land are best estimated in the final waterbody map.

Fig. 5. The completed waterbody map displaying best estimates for land, inundated vegetation, non-classified vegetation, and open water.

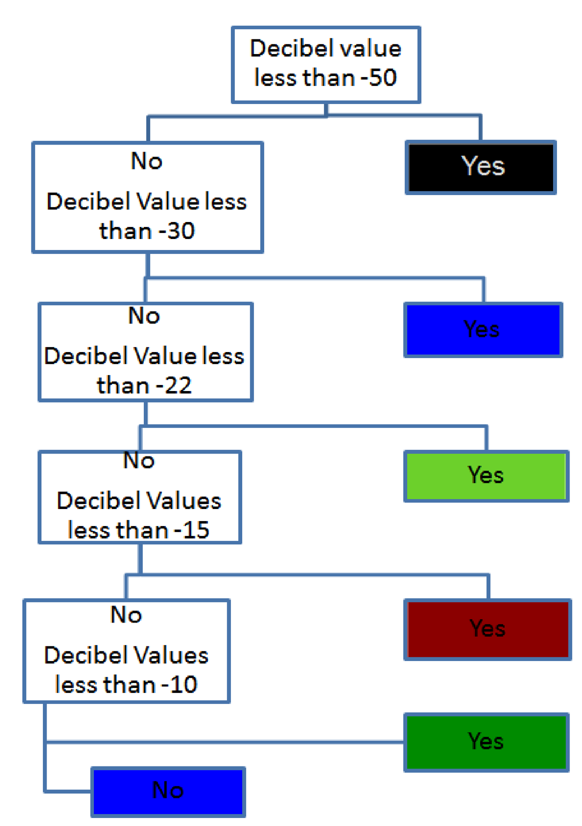

Fig. 4

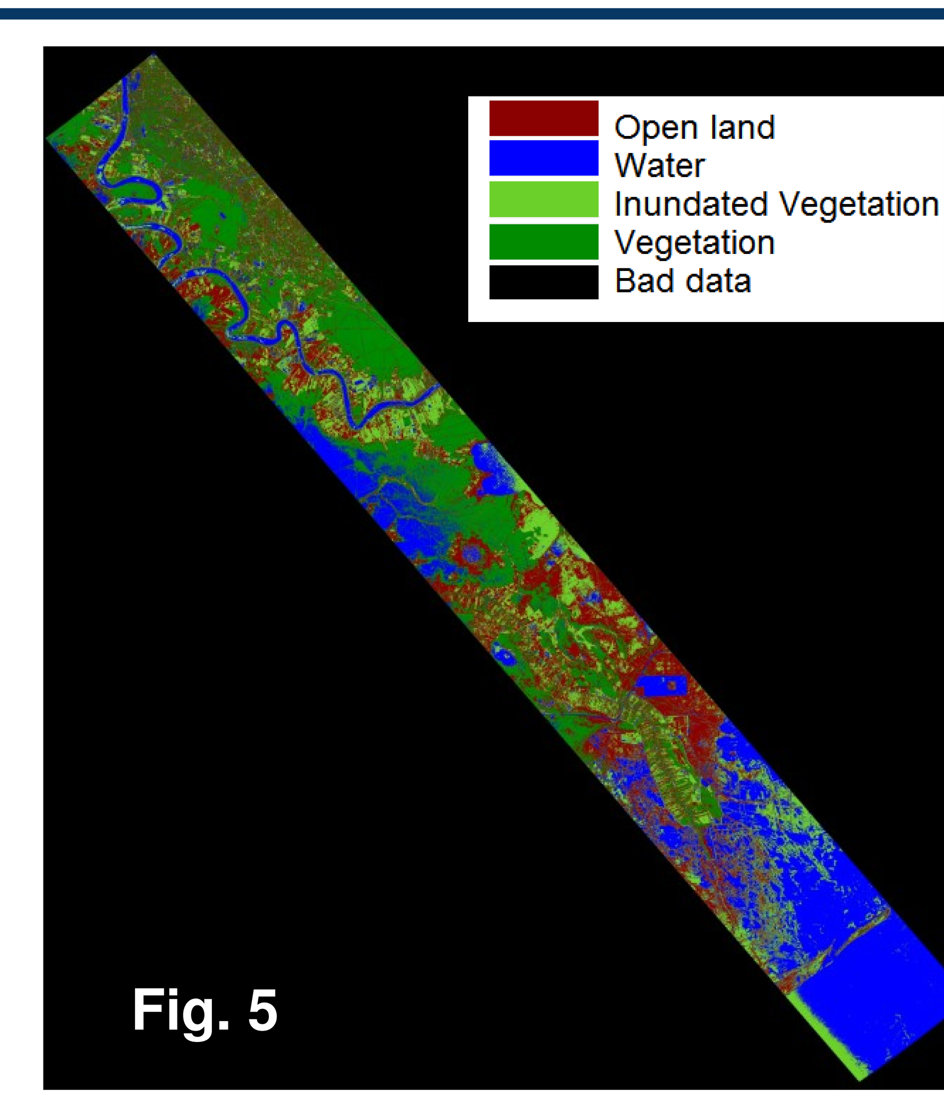

Fig. 5

Discussion

This final map I created is based on a single polarization (HV) that I determined to produce the most reliable results derived from a single polarization band. A more complex map could be derived based on multiple layers, such as backscatter values from other polarizations or decomposition components. Comparison with ground data, or classified high resolution optical data, could help validate this map.

One disadvantage of UAVSAR image data is the large range of local incidence angles across the image (about 40 degrees in our data). Future work to improve these classifications could correct for this issue.

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