Seasonal Inundation Analysis of the Sacramento Delta using UAVSAR

Anika Anna[1,4] ,Dr. Kyle McDonald[2,4], Kat Jensen[2,3,4], Stivaly Paulino[2,4]

[1]Manhattan Center for Science and Mathematics , [2] The City College of New York,

[3] CUNY Graduate Center, [4]CUNY CREST

Introduction

The Sacramento Delta is an inland river delta. Annually, the delta produces crops which are worth 500 million dollars, and provides seven million acre feet of water. The Sacramento Delta is home to an estimated 500 species of plants and animals. The delta inhabits 22 species of fish.

For my research, I will be analyzing polarimetric radar images from the NASA UAVSAR mission to observe the inundation, vegetation, and open water extent in different areas of the delta during the winter and summer. UAVSAR is an imaging radar instrument which accumulates deformation measurements of the Earth. For example, UAVSAR is used to examine the deformations of the Earth after severe earthquakes and volcanic eruptions. UAVSAR has also been utilized to study climate changes in the Artic.

The UAVSAR uses microwave radiation to acquire polarimetric images. Microwaves are a form electromagnetic radiation with wavelengths that range from one millimeter to one meter and frequencies which range from 0.3 GHz to 300 GHz.

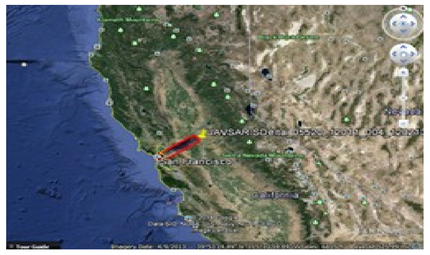
Scientists analyze the vegetation, inundation, and open water areas in order to predict potential flooding and droughts. I will use ENVI to create a land cover classification algorithm based on a combination of co-pol (HH, VV) and cross-pol (HV) backscatter that identifies surface water. I will create land cover maps in order to analyze the difference in the inundation levels caused by seasonal changes.

Methods

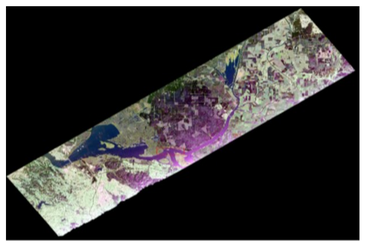
- Import the UAVSAR images in PolsarPRO and create decompositions of the images. There are two forms of decompositions, freeman and Vanzyl
- Open up the HH, HV, and VV polarizations of the images in ENVI. Create polarization ratios: HH-VV and HH-HV
- Load each of the polarizations, in Gray Scale, onto the display
- Open the Dbl, Vol, and Odd decompositions on ENVI [Red = Dbl, Green=Vol, and Blue= Odd]
- Use the decomposition image to choose regions of interest (ROIs). Maintain the same ROIs for all five polarizations.
- Create histograms according to the ROIs for the polarizations. Combine the graphs for each polarization
- Create thresholds based on the histograms in order to create decision trees
- Execute the decision trees to attain maps. The maps estimate vegetation, inundated vegetation, and open water regions.

Results

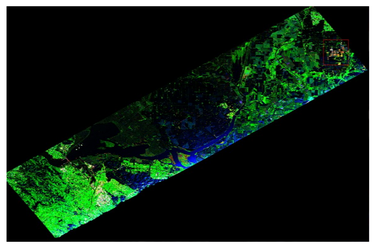
Sacramento Delta (Google Maps)



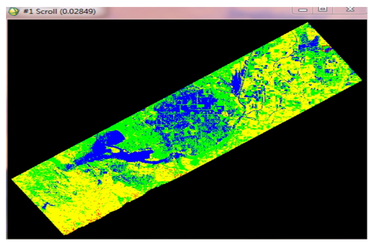
August 15,2012



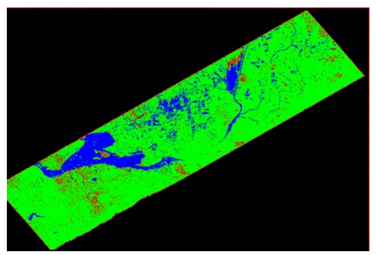
RGB Backscatter Composite
Red = HH
Blue = VV
Green = HV



Freeman Decomposition
Red= Double Bounce
Green=Volume
Blue=Surface



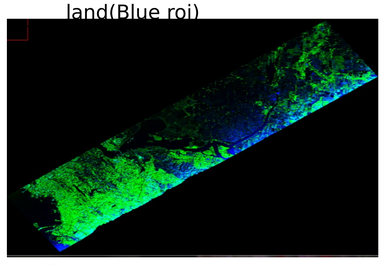
HV classification
Blue= db< -34 (water)
Green= db<-23 (vegetation)
Yellow= db< -10 (vegetation)
•Blue and Green are parts of open water plus land(Blue roi)



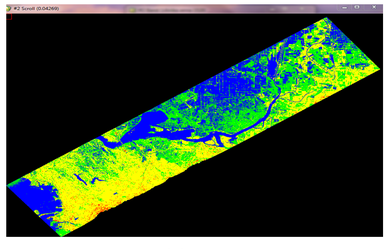
HH-VV Classification
Blue= db<-2 (open water)
Green= db<5 (vegetation)
Yellow=db<3 (vegetation)
*Blue and Green are parts of open water plus land(Blue roi)

February 13, 2013

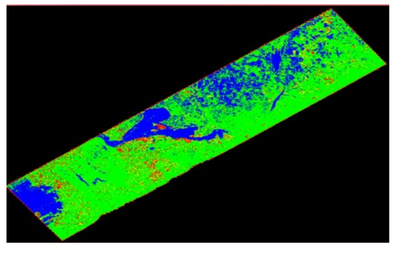
RGB Backsactter Composite
Red = HH
Blue = VV
Green = HV



Decomposition
Red= Double Bounce
Green=Volume
Blue=Surface



HV composition
Blue=db<-29 (water, red roi)
Green=db<-20 (vegetation, red roi)
Yellow=<-7 (vegetation, blue roi)
*Red roi is open water plus vegetation
*Blue roi is pure land



HH-VV Composition
Blue= db< -3 (red roi) (water)
Green= db<3 (red roi) (vegetation)
Yellow= db<4 (blue roi) (vegetation)
*Red roi is open water plus vegetation
*Blue roi is pure vegetation

Results

After processing the data on PolSarPRO and ENVI, the HV and HV-VV histograms of the ROIs showed overlaps. For the two seasons, the values for the blue regions (open water) of the composites range from -34 to -2 dB. The threshold values for the green regions (land) of the composites range from -23 to 5. The threshold values of the yellow regions (also land) range from -10 to 4.

Discussion

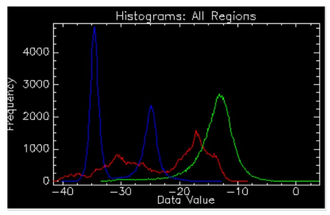
There are two forms of polarimetric decompositions in PolSAR, Van Zyl and Freeman. I used Freeman decomposition to create my maps because it provides a better visual distinction between open water and vegetation. I chose regions of interest based on the decomposition. In the decomposition images, red, green, and blue stand for inundated vegetation, vegetation, and open water respectively. The region I focused on was not composed of inundated vegetation so instead of classifying three variables I classified two variables, open water and unclassified vegetation.

I used HV and HH-VV backscatter values to create my classification maps because the HV and HH-VV histograms showed better distinction between water and land. The threshold values I picked were based on the vegetation and open water plus vegetation histograms. The graph for open water plus vegetation is composed of two peaks; one peak represents open water and the other peak represents vegetation. I split the graph according to where the peaks start in order to classify water and land. The blue region on the composite maps depicts open water and the green and yellow regions represent land. I derived the blue and green threshold values based on the backscatter graphs for open water plus vegetation graph. I derived the yellow thresholds values based on the pure land graph of my backscatters. I used the threshold values to create a composite map to distinguish land from water for a region of the Sacramento Delta.

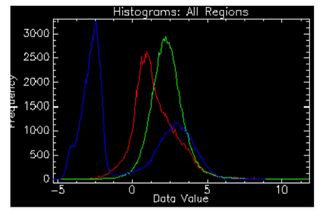
In the future, I plan to distinguish between the types of vegetation in the region which I classified. Also, I would like to add more complexity to my maps by including more layers.

Histograms

August 15,2012

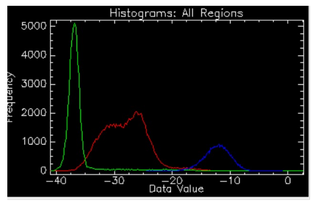


HV Backscatter
Red= land
Green=land
Blue=open water with land

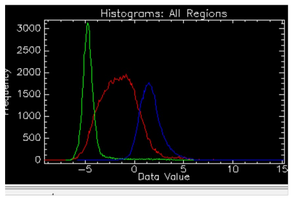


HH-VV Backscatter
Red= land
Green=land
Blue=open water with land

February 13, 2013



HV Backscatter
Red= land and open water
Green = open water
Blue = land



HH-VV Backscatter
Red= land and open water
Green = open water
Blue = land

Acknowledgements

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❖ My advisors Dr. Kyle Mc Donald, Kat Jensen, and Stivaly Paulino for their guidance, patience, and support during the duration of the research.

❖ The information on UAVSAR have been provided by the Jet Propulsion Lab (JPL) within NASA.

❖ The data used and Map Ready Software was provided by the Alaska Satellite Facility (ASF) within the University of Alaska - Fairbanks (UAF). (https://vertex.daac.asf.alaska.edu/)