Coastal Marsh Classification and Hydroperiod Estimation Using Sentinel-1 Backscatter

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SAR backscatter for Marshes classification and hydroperiod !

Wetlands are ecologically important ecosystems that play a vital role in biodiversity preservation, water quality improvement and flood mitigation. **The hydroperiod of marshes, which refers to the duration and timing of water presence in a wetland ecosystem,** impact the distribution of vegetation, nutrient cycling processes, and carbon sequestration capacities. As such, understanding and monitoring the hydroperiod of coastal wetlands is important.

When the SAR wavelength interacts with vegetation and the underlying water surface the backscattered signal increases, conversely, the backscatter substantially decreases when the vegetation is submerged.

For this study we used Sentinel-1 Ground Range Detected High resolution (GRDH) images covering 2016 and 2021 over Virginia's Coastal Wetlands to classify the marshes of Virginia into High marshes and low marshes and we estimate the hydroperiod of each class. The estimation is based on the number of acquisitions available through the year.

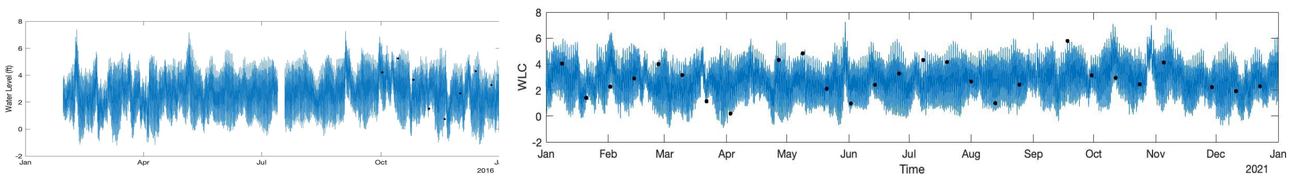
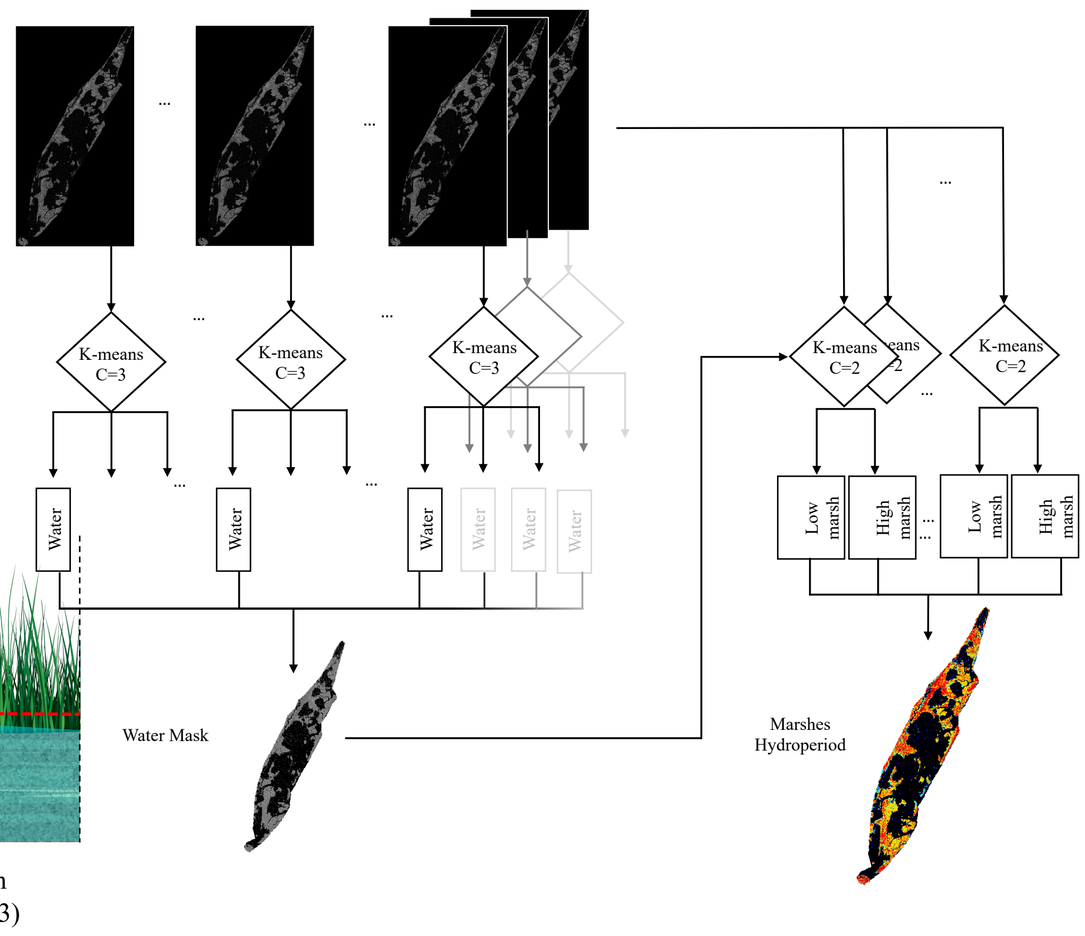
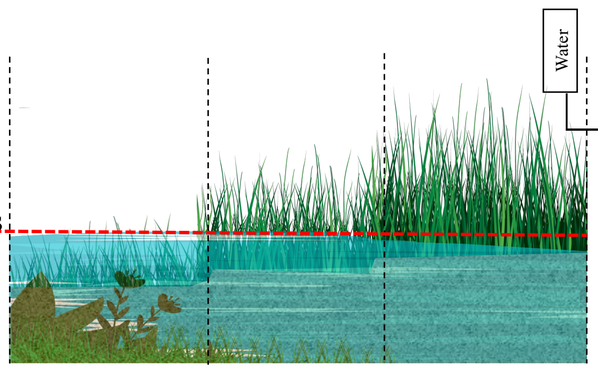


Figure1: Acquisitions used for 2016 and 2021 plotted over water level from water gauge station

Methods:

1. Discern acquisitions from high tide and low tide periods using in-situ water gauge.
2. Utilize data acquired during low tide periods to construct water/marshes mask.
3. Utilize images obtained during high tide occurrences to classify pixels within VH images as either submerged or partially/non submerged. This classification is guided by their relative backscatter values, knowing that VH polarization image primarily emphasizes volumetric backscatter (associated with vegetation).
4. Determine the hydroperiod through this refined process.

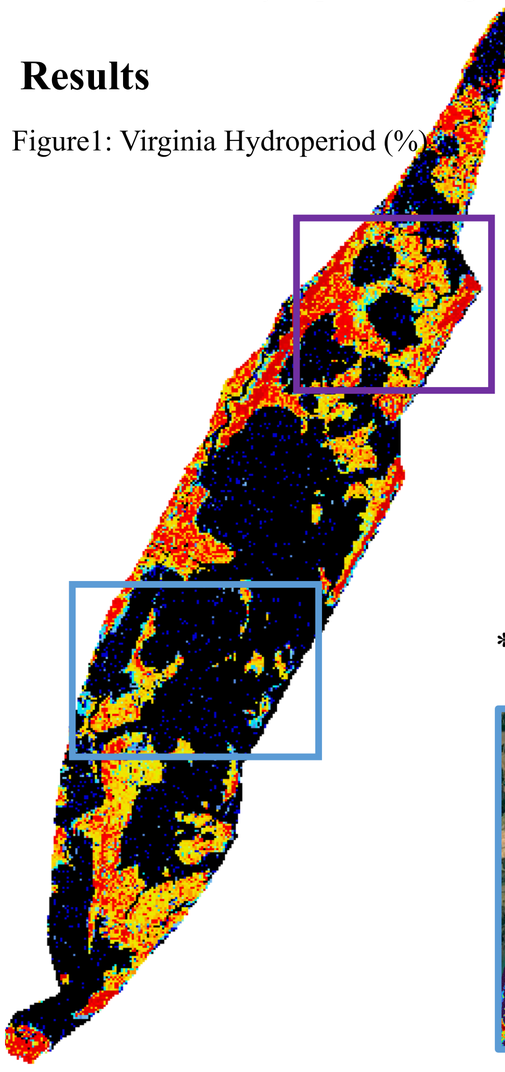


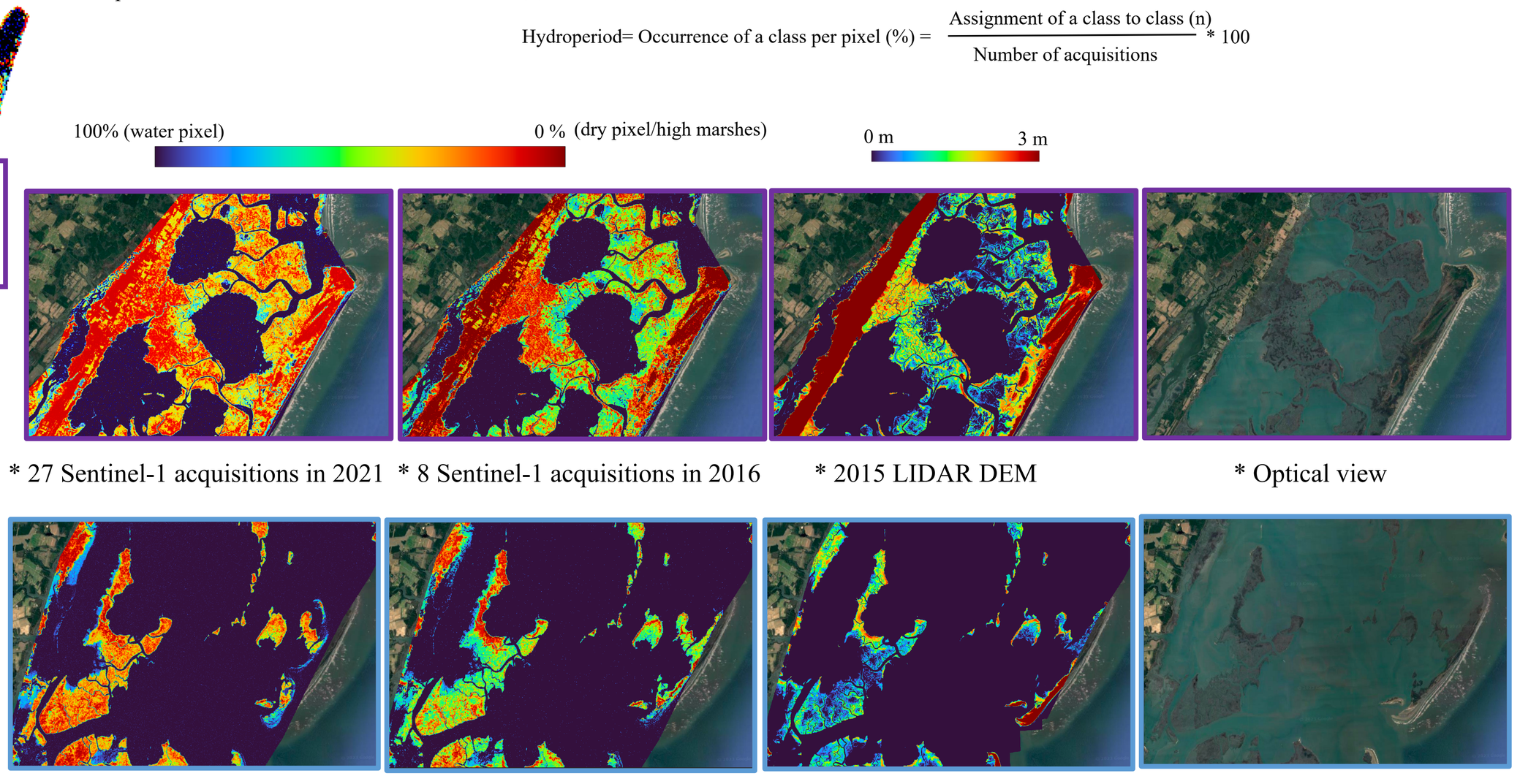


$$\text{Hydroperiod= Occurrence of a class per pixel (\%)} = \frac{\text{Assignment of a class to class (n)}}{\text{Number of acquisitions}} * 100$$

Results

Figure1: Virginia Hydroperiod (%)





Takeaway:

Using the relative backscatter classification, We were able to distinguish between high and low marshes along the Virginian coast, this statement is supported by the comparison with a LIDAR dem. The remaining steps is to validate the hydroperiod estimated against hydrodynamic models. The use of SAR backscatter as a tool to generate high resolution classification maps of coastal wetlands and eventually to estimate the hydroperiod allow a better and global understanding of coastal marshes resilience to sea level rise and enables new insights into marsh migration.

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