WET Water Resources

A Google Earth Engine Python API Tool to Automate Wetland Extent Mapping Using Radar Satellite Sensors for Wetland Management and Monitoring

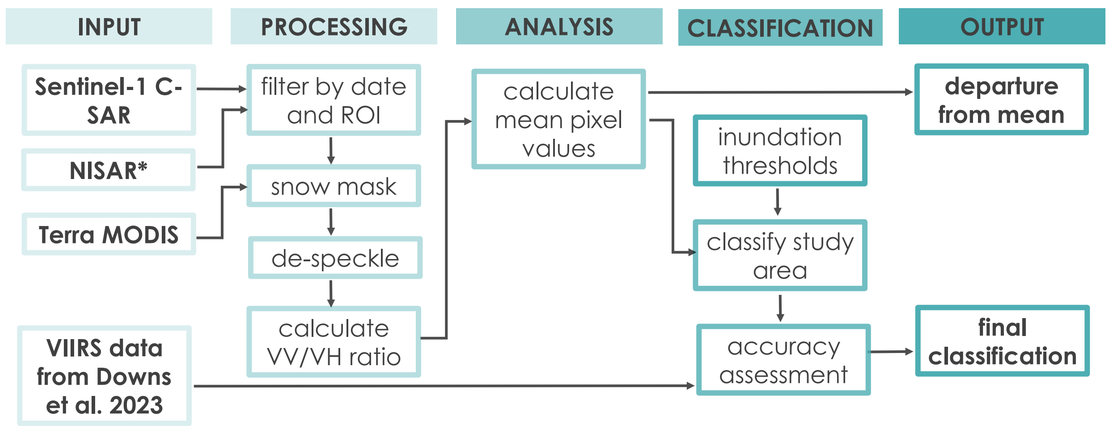
Abstract

Wetland ecosystems are annually or seasonally wet transition zones between land and water. They provide a range of ecosystem services such as water filtration, flood mitigation, and carbon sequestration, as well as hosting biodiversity hotspots. Although they fulfill fundamental physical and natural processes, wetland extent and health are threatened by anthropogenic influences related to urbanization, population increase, pollution, and climate change. Recognizing the need to quantitatively monitor changes in these recently threatened ecosystems in a timely and cost-effective way, we developed a Google Earth Engine (GEE) Python API tool for automated wetland extent mapping using optical and radar satellite sensors that can be applied globally. The tool will significantly improve wetland change analysis and monitoring as the optical and SAR data proves high resolution (5-10 m) imagery, and SAR data is_unaffected by cloud cover and light availability (day vs. night), which are common limitations for other remotely sensed sensors. The tool utilizes Copernicus Sentinel-1 C-band and NISAR L-band synthetic aperture radar (SAR) imagery. During image preprocessing, we applied a MODIS snow mask product to mask global snow coverage, which would affect land classification sensitivity. Calibration and validation were conducted through a historical change and sensitivity analysis of the Sudd watershed located in central Sudan. The tool was the first of its kind, as it enables NISAR data processing through an open-source GEE repository, further expanding and improving the utility of NASA Earth observations and contributing to NASA Open Science initiatives. We anticipate the tool will be used by researchers and practitioners interested in wetland monitoring and management..

Objectives

- **Develop** a tool to quantify wetland extent on a global scale using Google Earth Engine in the Python API
- **Create** user-friendly interface for visualizing and analyzing wetland extent
- **Improve** remote sensing applications for water resources using optical and SAR sensors
- **Establish** a methodology that can easily integrate NISAR products upon launch

Methodology

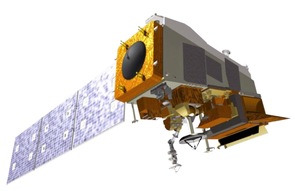


Earth Observations

Terra MODIS

Sentinel-2

Sentinel-1 C-SAR

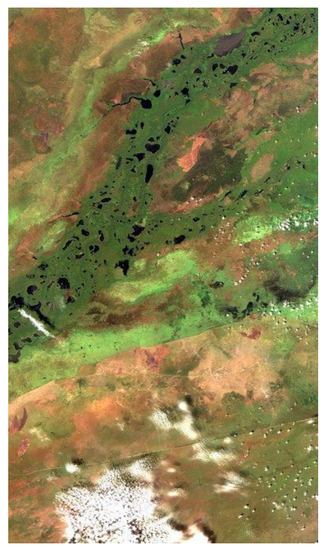


Suomi-NPP VIIRS

NISAR (set to launch in 2024)

Study Area

Sudd Wetland, South Sudan

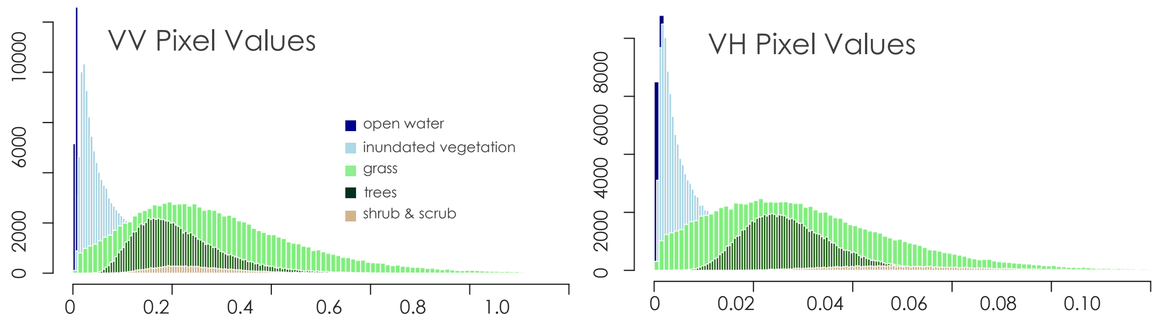


Satellite image of the Sudd Wetland in October 2018

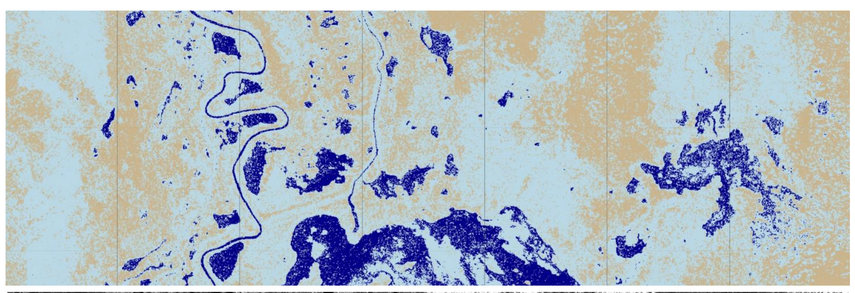
- **Test** the precision and accuracy of our tool against Downs et al. 2023, a wetlands classification study conducted across South Sudan.
- **Understand** a regionally important freshwater environment

Results

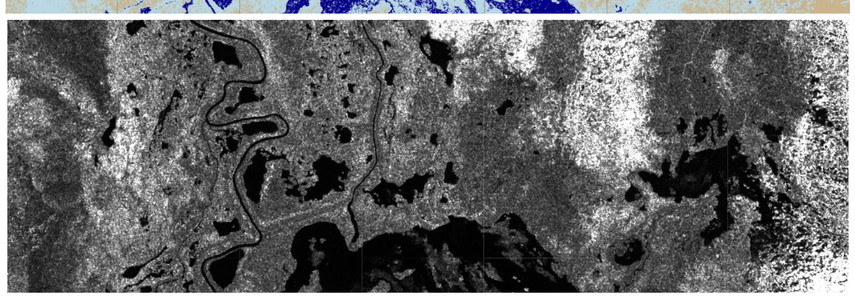
We obtained thresholding values for land classification by drawing training polygons based on known land cover from the Dynamic World land cover product and plotting histograms of each land cover type. Backscatter threshold values selected by histogram analysis are approximately an order of magnitude difference for VV and VH bands.



VV threshold values are dark water < 0.01 < inundated vegetation < 0.11 < no water. VH threshold values are dark water < 0.0015 < inundated vegetation < 0.011 < no water. The threshold values were applied to classify wetland inundation extent from Sentinel-1 imagery.



October 16, 2021
Classified Image
open water
inundated vegetation
no water



Sentinel-1 C-SAR VV Image
Backscatter
0
0.5

Team Members

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Conclusions

- Developed a user-friendly tool for regional wetland inundation assessment
- Contributed to a dense time series used for detecting wetlands, a particularly important application during rainy seasons
- The WET 3.0 tool will implement and utilize future NISAR data with current Sentinel-1 data
- Promoting the use of the Python API will allow users to eventually move off of Google Earth Engine and use other open-source platforms through the use of Python

Acknowledgements

The team would like to show our gratitude to Bruce Chapman, Ben Holt, and Michael Pazmino at (NASA Jet Propulsion Laboratory) for their contributions to this technology and innovation project. We would also like to recognize the Wetlands Water Resources 2.0 team, and Brandi Downs et al. (2023). This material contains modified Copernicus Sentinel data processed by ESA, Dynamic World V1 data produced by Google in partnership with National Geographic Society and the World Resources Institute, and MODIS Terra data processed by NASA National Snow and Ice Data Center

This material is based upon work supported by NASA through contract NNL16AA05C. Any mention of a commercial product, service, or activity in this material does not constitute NASA endorsement. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration and partner organizations.