Inundation Mapping of the Lower Illinois River Valley Using Synthetic Aperture Radar and Optical Satellite Imagery for Wetland Conservation and Restoration Prioritization Efforts

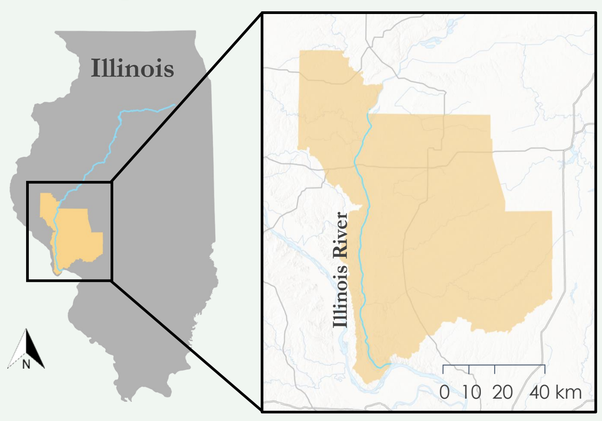
Abstract

The Lower Illinois River Valley (LIRV) is home to some of the richest agricultural lands in the United States and its wetlands provide key ecosystem services like clean water and flood reduction. It has also experienced extensive degradation due to development and urban pollution. The Great Rivers Land Trust (GRLT), the National Great Rivers Research & Education Center, Principia College, and the American Geophysical Union's (AGU) Thriving Earth Exchange sought to incorporate remotely sensed layers into their geodatabases to more accurately identify priority areas for wetland restoration. This project used remote sensing data to determine the feasibility of detecting inundation extent and duration along the valley. The team used Sentinel-1 C-band Synthetic Aperture Radar (SAR) data to classify open water, inundated vegetation, and not inundated vegetation within our study site. The open water classification was compared to calculated Dynamic Surface Water Extent (DSWE) derived from Landsat 8 Operational Land Imager. The team successfully created layers of inundation minimum and maximum extent, as well as inundation duration, across the study area for 2019 and 2020. The open water classification resulted in an overall accuracy of 91% when validated against DSWE classifications. These analyses will help end users in determining high priority areas along the LIRV for land conversions in the future.

Objectives

- **Generate** inundation extent and duration layers of the LIRV for 2019 and 2020
- **Compare** various metrics for detecting inundation
- **Determine** feasibility for further incorporation of remotely sensed products into GRLT's land acquisition decision-making practices beyond the study period.

Study Area

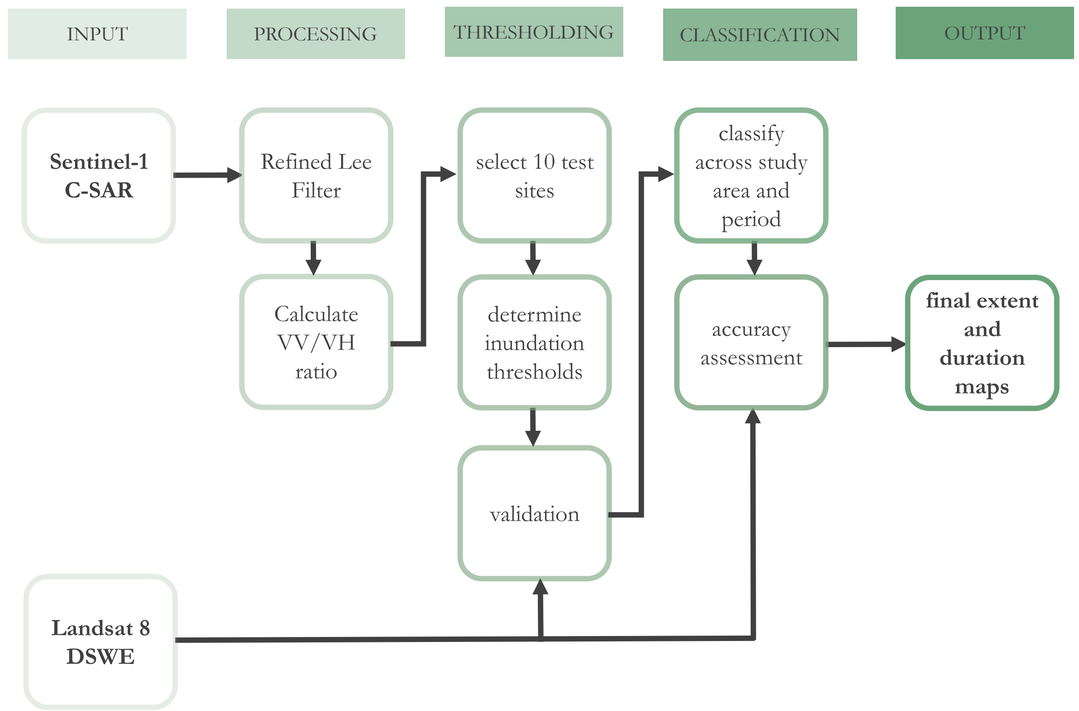


Earth Observations

Landsat 8 OLI
(Collection 2)
surface reflectance

Sentinel-1 C-SAR
surface roughness
& backscatter

Methodology

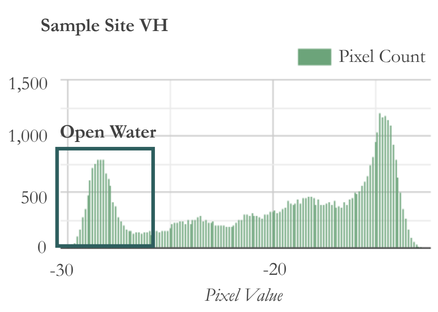


Results

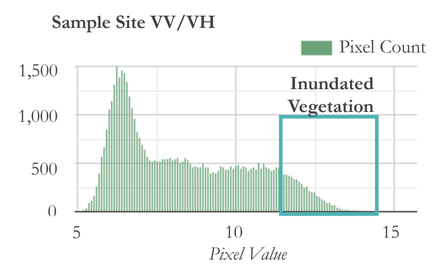
Pixel Thresholds

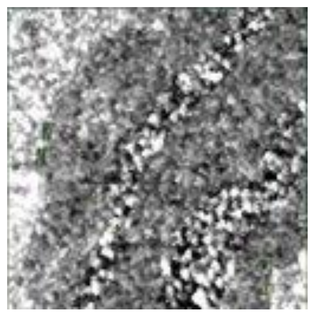
Using Sentinel-1 C-SAR

VH Polarization — isolate open water pixels



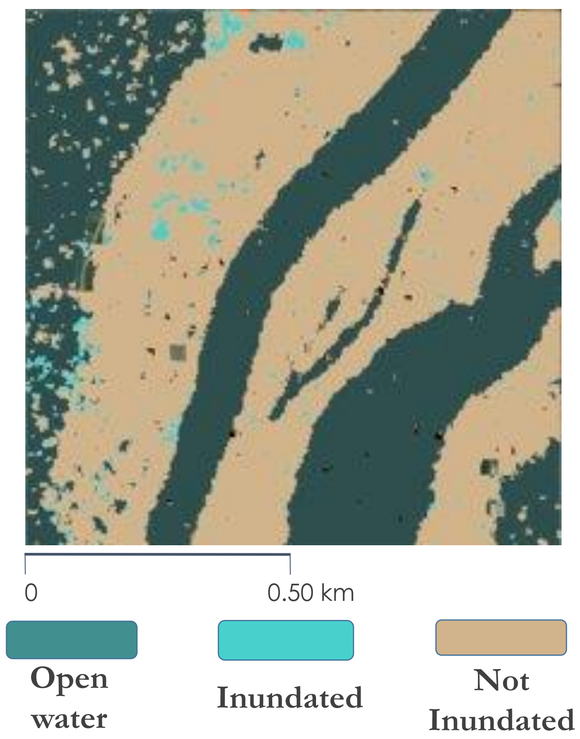
VV/VH Ratio — highlight inundated areas





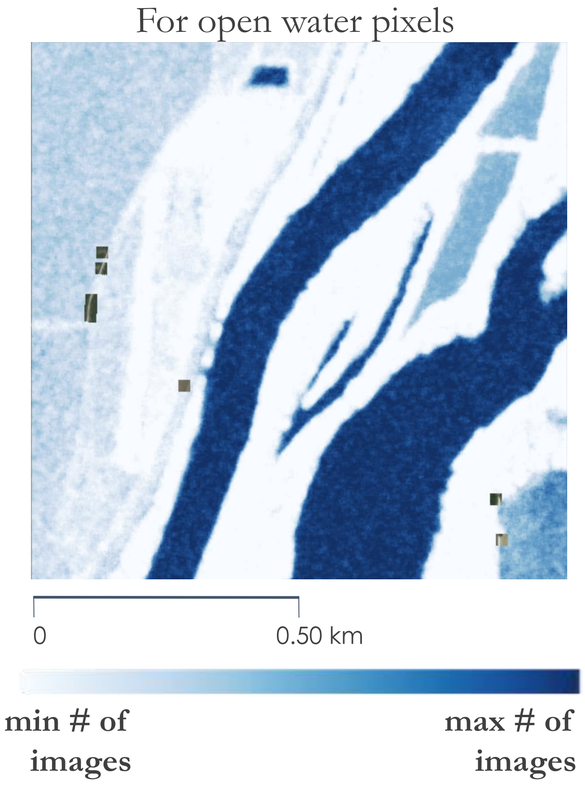
Inundation Extent Classification

Using Sentinel-1 C-SAR Thresholds



Inundation Duration

For open water pixels



Conclusions

- In comparison with DSWE classifications, our open water classifications were fairly accurate. We compared our open water class with DSWE's water (high confidence) and water (moderate confidence) classes to validate our open water classification. Our overall accuracy was 91% for ten 1 km^2 test sites chosen to represent our area of interest.
- Our inundation duration layers were able to capture inundation duration on a monthly temporal scale and for each of our study years. Given the temporal resolution of the C-SAR, we based inundation duration off of the frequency of inundation for images taken within each month (i.e. number of images).

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Lower Illinois River Valley Ecological Forecasting

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