Identifying grassed waterways and riparian buffers over agricultural areas using high resolution satellite images

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INTRODUCTION & AIM:

Conservation buffers are small areas or strips of land with permanent vegetation cover, designed to intercept pollutants, reduce soil erosion and manage other environmental concerns. There are two types of major conservation buffers in the Champaign county of Illinois:

Grassed Waterway:
A shaped or graded channel that is established with suitable vegetation to convey surface water at a non-erosive velocity using a broad and shallow cross section to a stable outlet

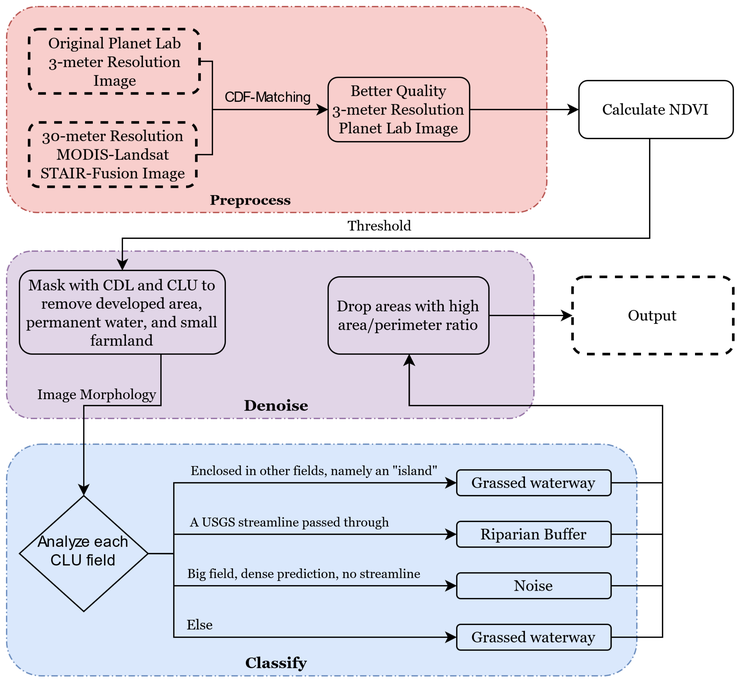
Riparian Buffer:
Grasses, edges, rushes, ferns, legumes and forbs tolerant of intermittent flooding or saturated soils, established or managed as the dominant vegetation in the transitional zone between upland and aquatic habitats

Due to the environmental significance of these terrace, we want to propose methods to identify these areas in satellite images for environmental survey and easier monitoring. Since labels of conservation areas are unavailable, we want to develop an unsupervised methods to identify these areas.

Our method analyzes maps of early spring before crops sprout, and vegetation indicator — normalized difference vegetation index (NDVI) — would provide sufficient information for our task. Together with expert-knowledge-based classification rules and image denoising methods, we aim to create precise and clear identification of grassed waterways and riparian buffers over large areas.

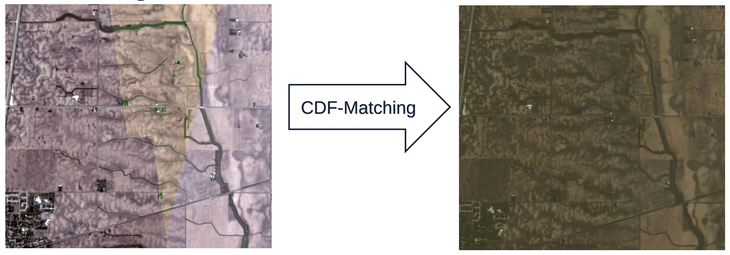
METHOD:

We created an end-to-end pipeline that consist of preprocessing, predicting, denoising and classification to generate the final outputs.

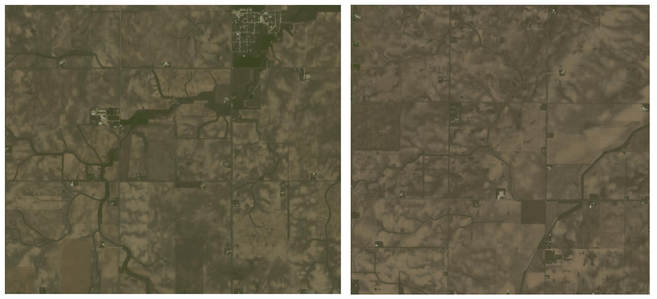


DATA:

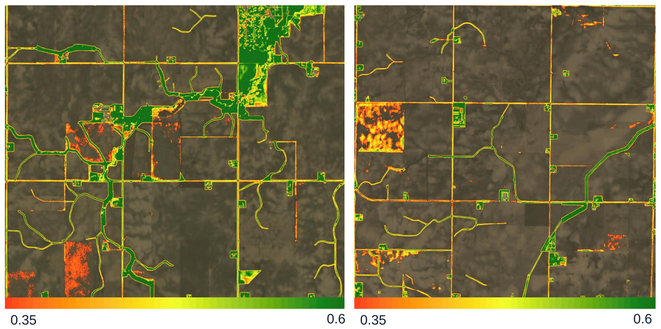
We used 3m resolution surface reflectance images from Planet Labs. Since these data are inconsistent between different swaths, we normalized it w.r.t proprietary MODIS-Landsat STAIR Fusion dataset to generate a more consistent image.



RESULTS:



Original Satellite images

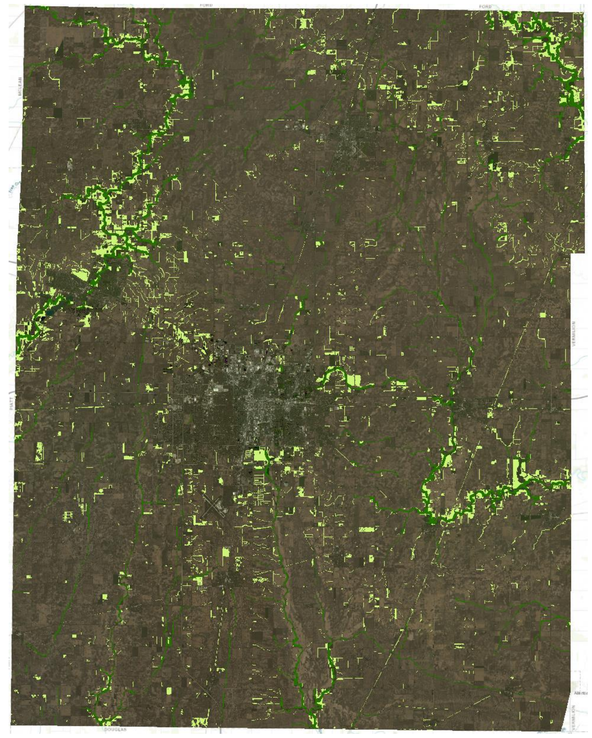


Raw NDVI value. Note that value below 0.35 are dropped and value above 0.6 are clipped for visualization

Final Output. Light green represents grassed waterway, dark green represents Riparian Buffer, bluelines are USGS streamline

RESULTS:

An overview of the classification results over Champaign indicates that even though our methodology creates decent quality result in farmlands, predictions near wide streams still need improvements.



CONCLUSIONS:

By exploiting the land features of the pre-planting season, our methodology can identify the potential areas of conservation buffers. With a carefully planned decision tree and supplemental dataset of cropland data layer (CDL) and common land unit (CLU), our method successfully classifies different types of conservation buffers and removes most noises, resulting in a clear segmentation of grassed waterway and riparian buffer.

Despite working with large images (~300m pixels), a parallelized algorithm could accomplish the mapping within a couple of minutes, implying that our method is efficient and thus scalable for large-scale applications.

FUTURE WORKS

State-of-the-art deep learning models such as U-Net are known to perform well in similar tasks. For future work, we are planning to manually label conservation buffers in the satellite images. This would enable us to create a quantitative analysis of our proposed methods and train a deep learning model. We are hoping to see on par performance of two methodologies.