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DEPARTMENT OF FOOD, AGRICULTURAL AND BIOLOGICAL ENGINEERING

Cover crop mapping in Maumee River watershed

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INTRODUCTION

- Excessive nutrient loadings from agricultural lands are the major contributing factors to **water quality problems** at both regional and national scales.
- Increasing occurrences of **harmful algal blooms** pose serious threats to aquatic and human health.
- **Cover cropping** is one of the best management practices (BMPs) to improve water quality and promote soil conservation [1].
- **Cover crop benefits** include reduced soil erosion, compaction and nutrient loss; higher organic matter; and improved soil health.
- Despite substantial efforts to promote BMPs through conservation programs (e.g., conservation reserve program (CRP) and environmental quality incentive program (EQIP)), **widespread adoption of these practices has not followed**.
- There is **knowledge gap** from micro (soil microbiology) to macro (local to national policy) scales.
- Current estimates of cover crop adoption rate and benefits are based on **extensive field-based surveys**, which are costly, time consuming, and are not representative of the larger landscape [2].
- **Satellite remote sensing technology** provides a cost-effective solution for rapid estimation of cover crop presence, their growth and nutrient uptake at a watershed scale.

OBJECTIVES

- To leverage historical satellite time-series data to identify spatial and temporal trends in cover crop adoption practices in Maumee River Watershed, Ohio.
- To assess the impacts of cover crops on water quality.

STUDY AREA

- About 80% of the Maumee River watershed (Fig1) is mainly on corn and soybean production, which is estimated to contribute **>85% of the nutrient loads** to the Maumee River.
- The nutrients from Maumee River is the major contributor to **algal blooms** in the Lake Erie.

Data

- Sentinel 2A and Sentinel 2B satellites' imagery
- Raw data on cover cropping status by field for 2019 from Farm Service Agency
- USDA crop land data layer
- In-situ water quality data from 2015 for four winters

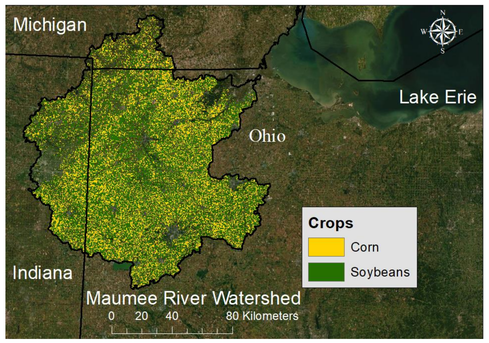

Figure1: Maumee River Watershed (17326 sq.km), OH

METHODS

Data Processing

- Compiled satellite imagery.
- Preprocessed to avoid snow cover and cloud cover.
- Estimated vegetation indices using various combinations of spectral bands of satellite imagery.
- Data processing and analyses in Google Earth Engine.

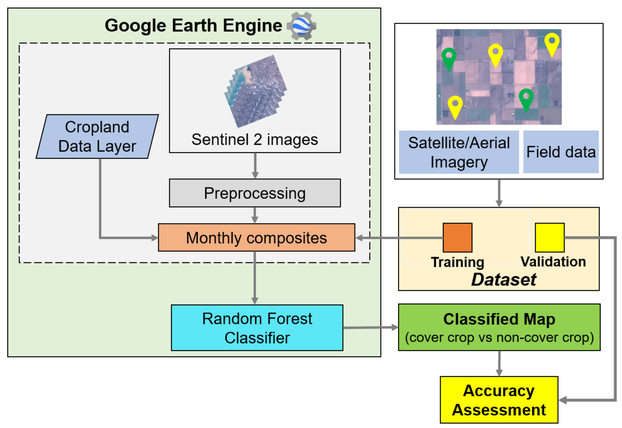

Figure 2: Data processing and classification framework

Table 1: Features of the images used in the classification

SWIR 1	Shortwave Infrared 1
SWIR 2	Shortwave Infrared 2
NDVI	Normalized Difference Vegetation Index
NGRDI	Normalized Green Red Difference Index
DVI	Difference Vegetation Index
RVI	Ratio Vegetation Index

Machine Learning Algorithm:

- *Random Forest* for supervised classification of satellite images.
- Overall classification accuracy > 80%.

RESULTS

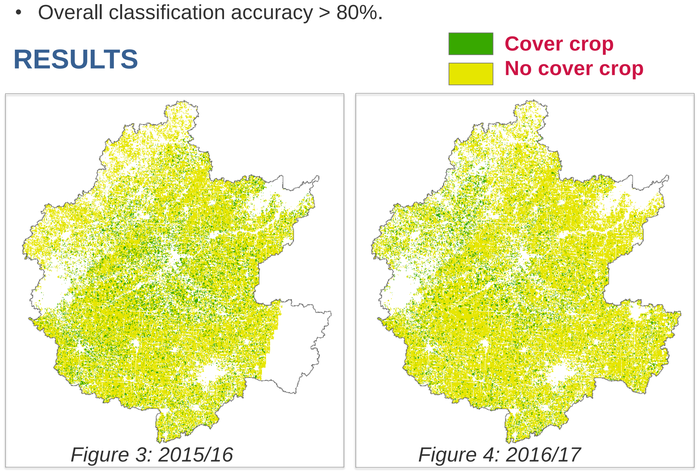

Figure 3: 2015/16

Figure 4: 2016/17

Figure 5: 2017/18

Figure 6: 2018/19

Table 2: Fraction of cover cropped area

Year	Cover crop area (%)
2015/2016	10.7%
2016/2017	8.8%
2017/2018	3.4%
2018/2019	13%

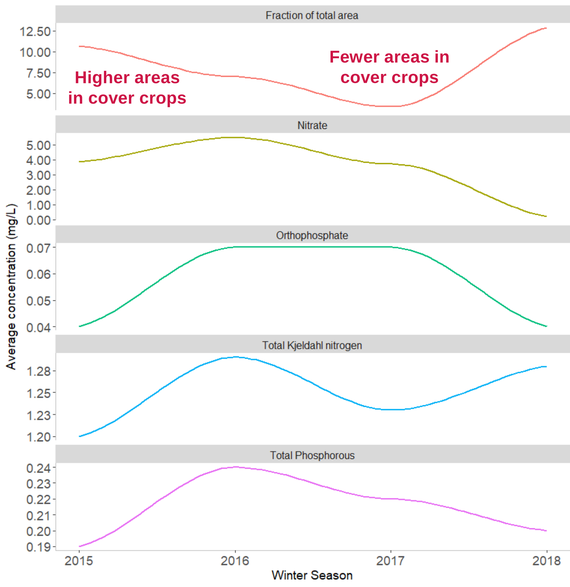

Figure 7: Relationship between cover cropping and water quality

- There is inconsistent trend in cover cropping practice in the Maumee River watershed.
- Increase in cover cropping practices seems to lower phosphorous and nitrogen concentration in the Maumee river.
- The analyses suggest the importance of cover cropping in reducing nutrient loadings from agricultural lands, thereby improving water quality.

CONCLUSIONS AND FUTURE WORKS

- Areas in winter cover crops classified using machine learning algorithm on satellite imagery.
- The total areas of agricultural land in cover crops declined suddenly after 2015/16 and increased during 2018/19 season.
- The trend in cover cropping practice seems to have direct implication on water quality.
- Future studies will involve in-depth assessment on the relationship with water quality and crop yields.

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