

# Developing a Platform to Assess Hydrological Performance of Conservation Lands in Nebraska



**Jahangeer Jahangeer; Zhenghong Tang**

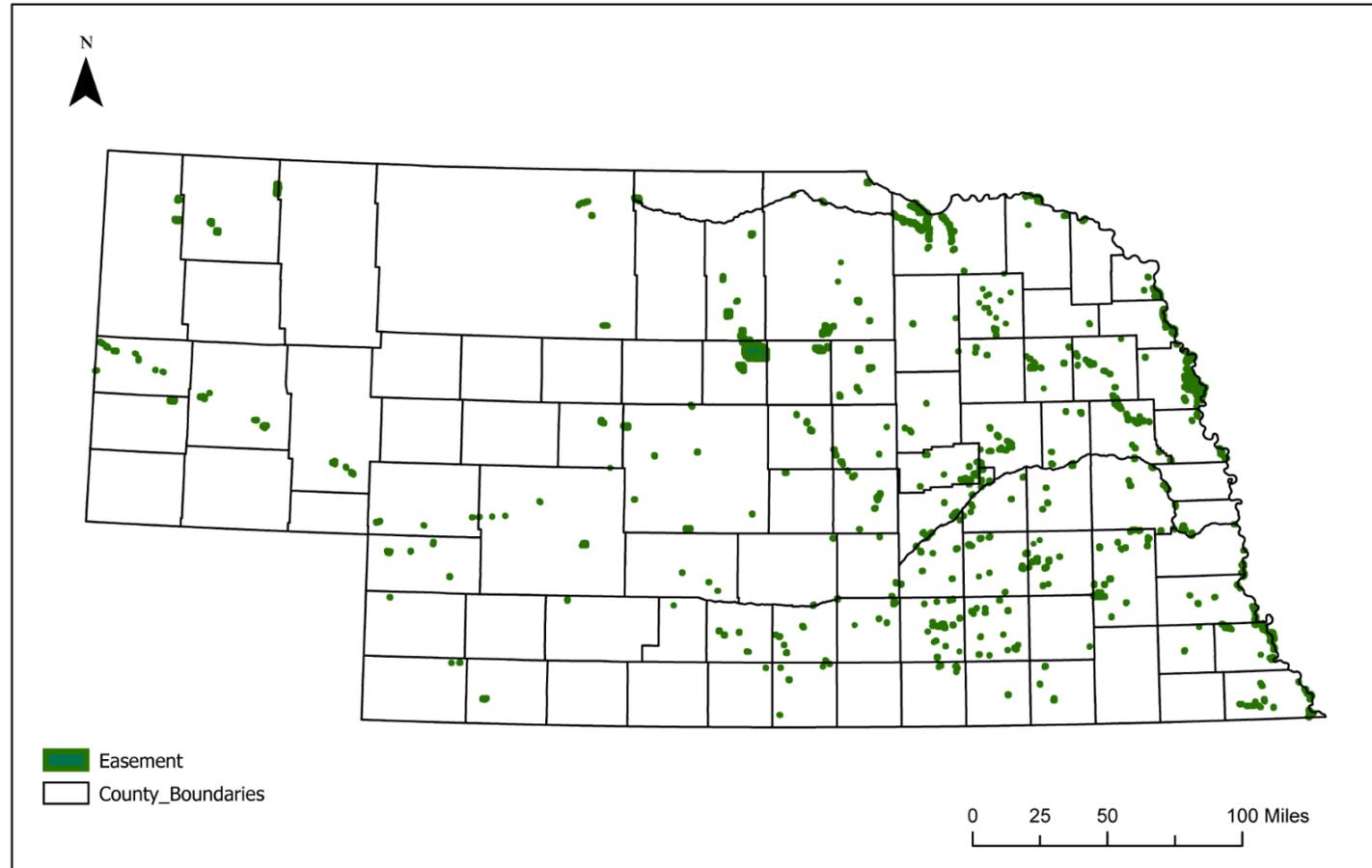
**University of Nebraska-Lincoln**

Rainwater Basin Joint Venture Annual Seminar

Grand Island, NE; March 12, 2026

# Overall Goals

1. Evaluate the hydrological performance of **current conservation easements**
2. Prioritize potential land areas for **future enrollment in conservation easement programs**



863 conservation easements (164,836 acres) in Nebraska in 2024  
(USDA NRCR Geospatial Data Gateway)

# Research Questions

1. How well did the Nebraska's wetlands in conservation easements perform with hydrological inundation coverage during the past years?
2. Which agricultural lands are most suitable for conservation programs targeting wetland conservation?

# Part I: Existing Conservation Site Assessment



# Introduction: Sentinel-2

- Sentinel-2: European Space Agency
- Systematic global acquisitions of **high-resolution**, multispectral images allied to a **high revisit** frequency
- Wide-swath high-resolution multispectral imagery with **13 spectral bands**
- Sentinel-2A : 23 June 2015
- Sentinel-2B : 7 March 2017
- Temporal resolution: **5 days**



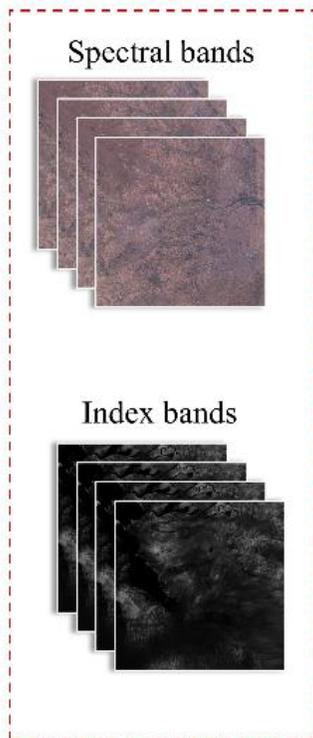
[https://www.esa.int/Enabling\\_Support/Operations/Sentinel-2\\_operations](https://www.esa.int/Enabling_Support/Operations/Sentinel-2_operations)

# Hydrological Performance Analysis Methodology

## Stage 1: Image Acquisition & Data Selection

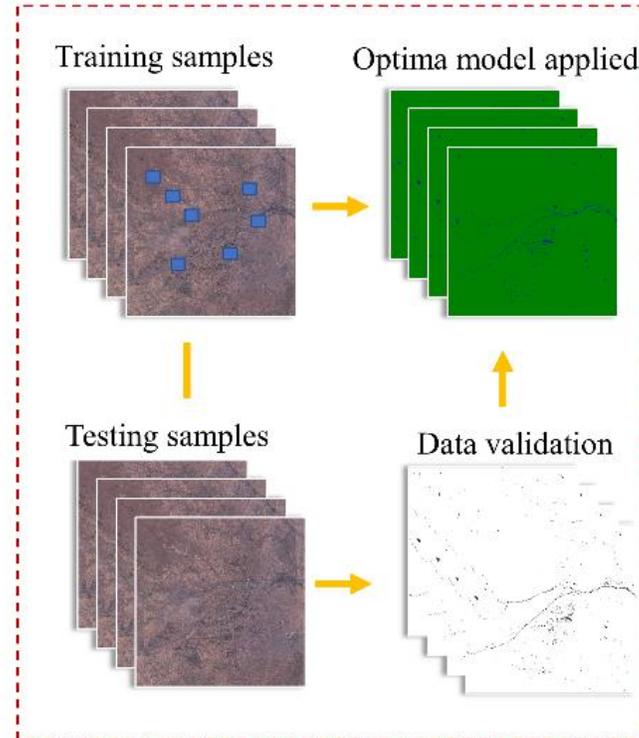
Sentinel-2

GEE



## Stage 2: Data processing using GEE code editor

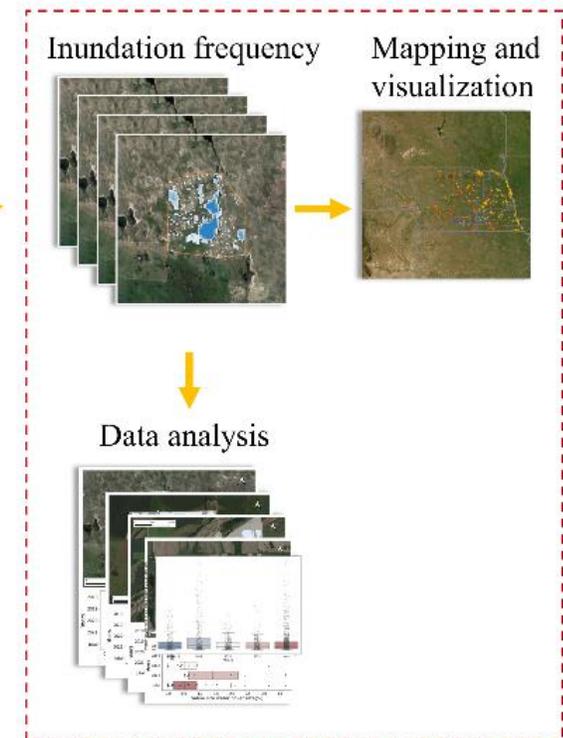
GEE



## Stage 3: Mapping and data analysis

QGIS

ArcGIS Online



# Results: Hydrological Performance

**Table 1: Percentage of inundated areas in each category of conservation easements**

	2018	2019	2020	2021	Category mean
ACEP-WRE	2.88%	5.36%	3.68%	4.56%	<b>4.12%</b>
EWPP	19.75%	44.60%	8.33%	2.21%	<b>18.72%</b>
GRP	0.91%	0.60%	1.00%	1.35%	<b>0.96%</b>
WRP	6.99%	12.99%	6.44%	5.87%	<b>8.07%</b>
Other	1.81%	4.76%	1.89%	2.97%	<b>2.86%</b>
<b>Year Mean</b>	<b>6.82%</b>	<b>12.82%</b>	<b>6.17%</b>	<b>5.61%</b>	<b>7.85%</b>

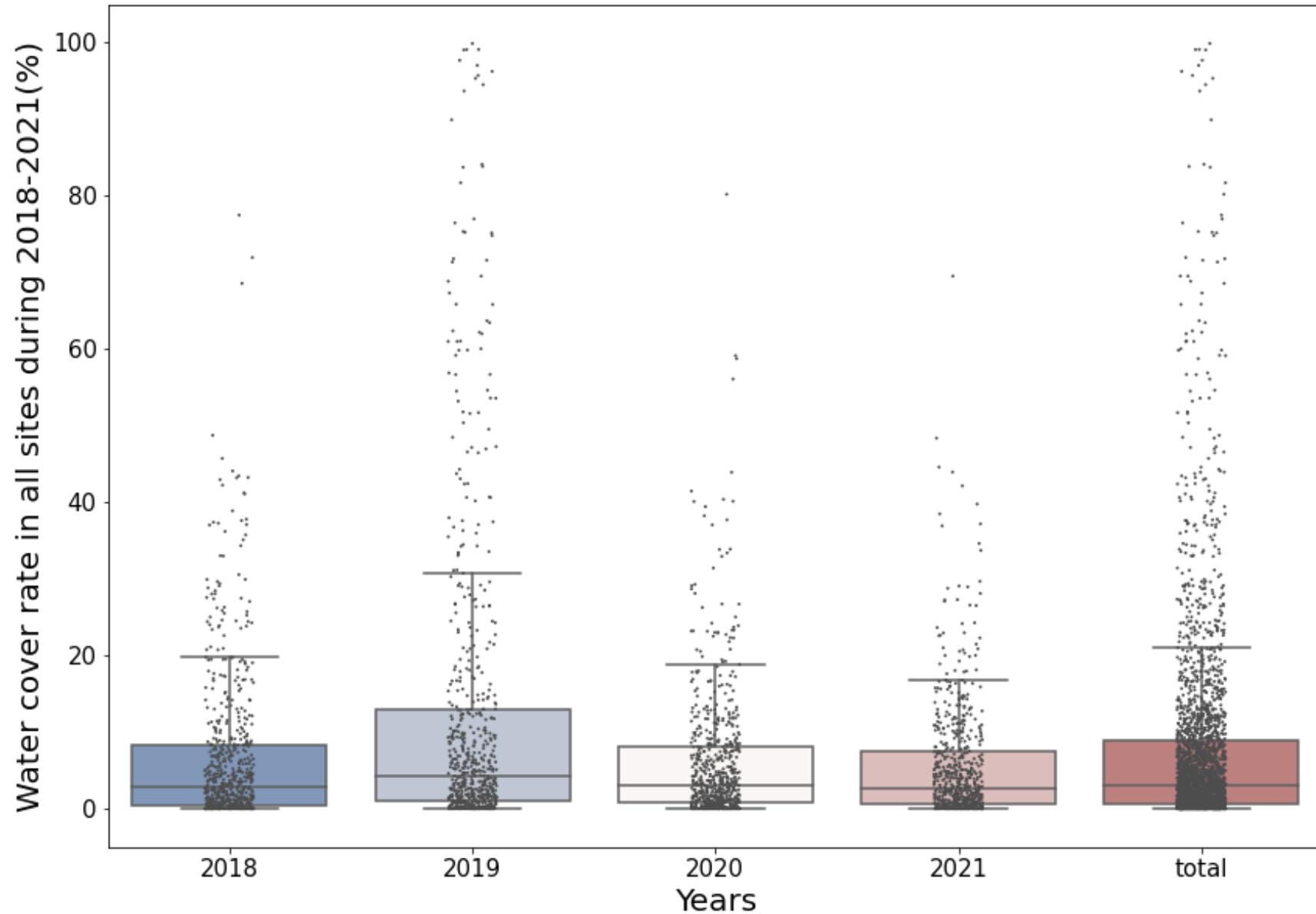
*ACEP-WRE: Agricultural Conservation Easement Program- Wetlands Reserve Easements*

*EWPP: Emergency Watershed Protection Program*

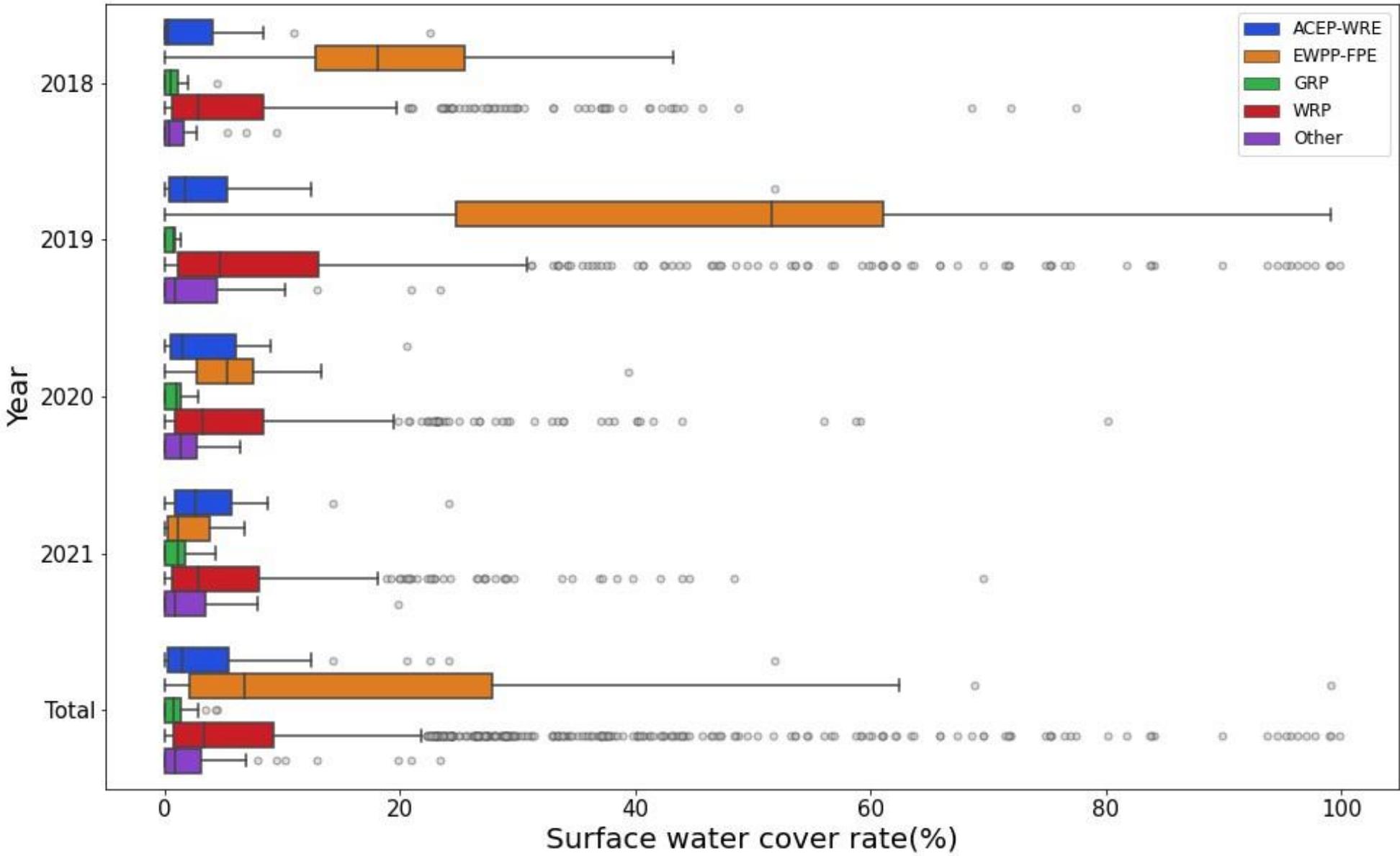
*GRP: Grassland Reserve Program*

*WRP: Wetlands Reserve Program*

# Surface water cover rate for each site in the four-year study period

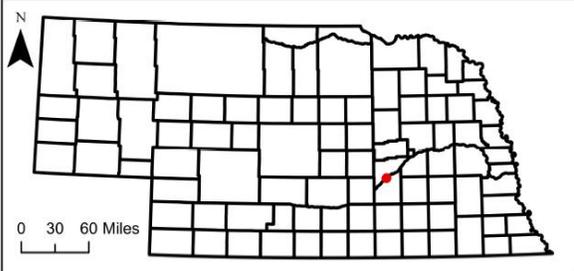
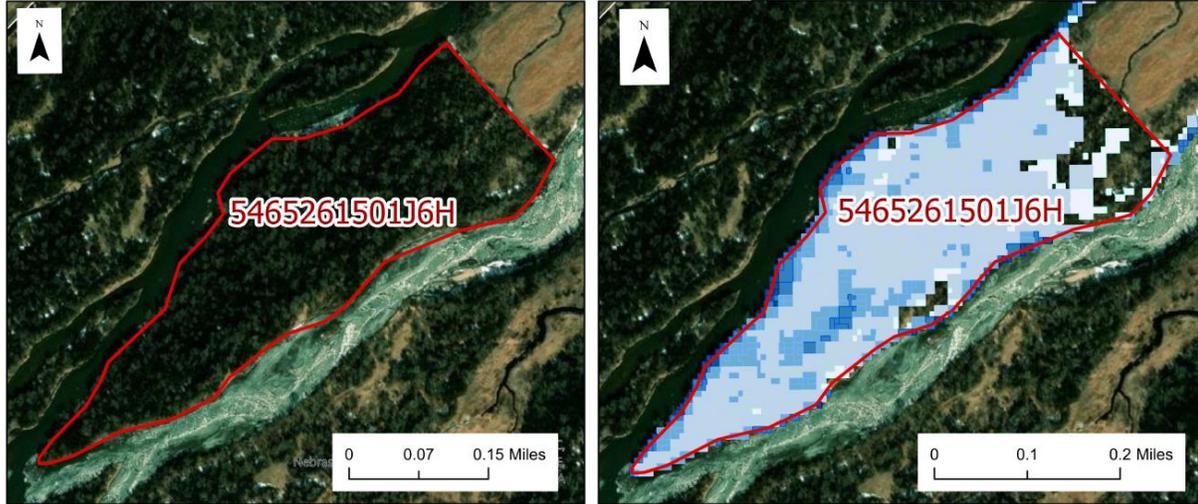


# Surface water cover rate by area for each category of conservation easements



# Demonstration Maps (1/5) : Inundation Condition for Conservation Easements

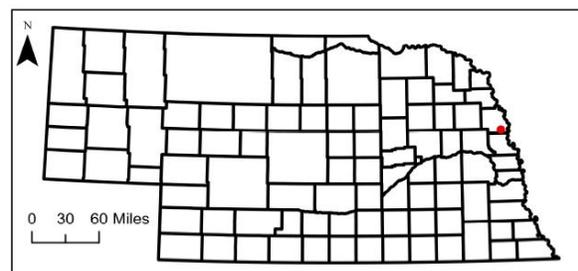
**Inundation Condition Map for Conservation Easements in Nebraska  
(Observations from the Sentinel Satellites during 2018-2021)**



**Inundation conditions**  
By percentage of inundated times

- <=5%
- 6-25%
- 26-50%
- 51-75%
- >75%

**Inundation Condition Map for Conservation Easements in Nebraska  
(Observations from the Sentinel Satellites during 2018-2021)**

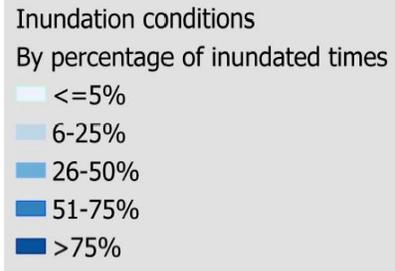
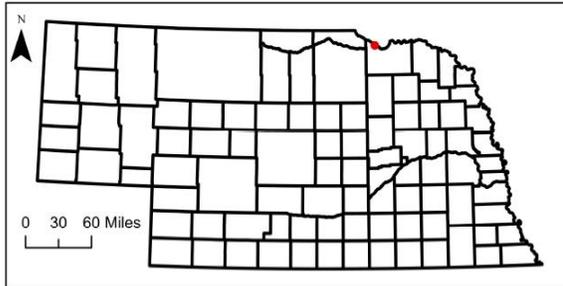
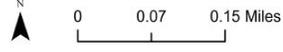
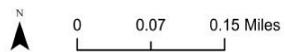
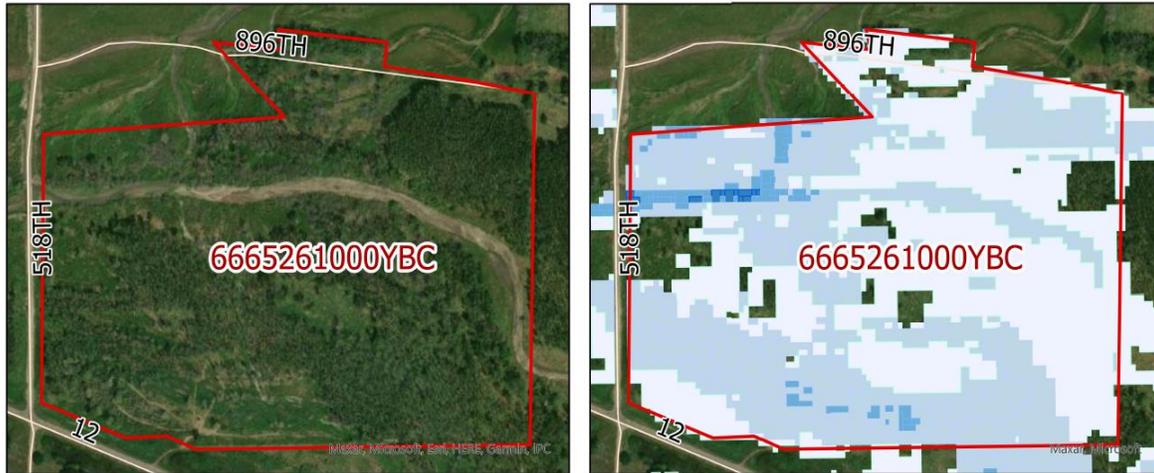


**Inundation conditions**  
By percentage of inundated times

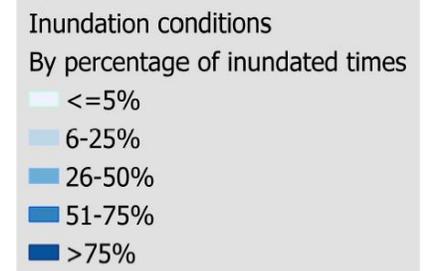
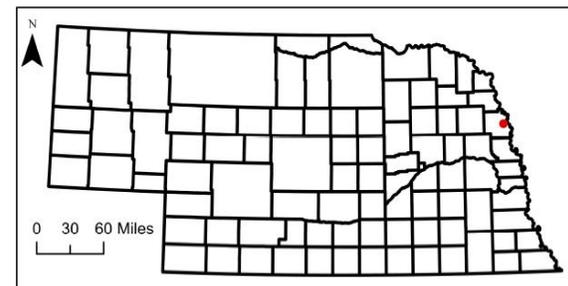
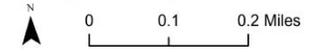
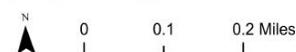
- <=5%
- 6-25%
- 26-50%
- 51-75%
- >75%

# Demonstration Maps (2/5) : Inundation Condition for Conservation Easements

**Inundation Condition Map for Conservation Easements in Nebraska  
(Observations from the Sentinel Satellites during 2018-2021)**



**Inundation Condition Map for Conservation Easements in Nebraska  
(Observations from the Sentinel Satellites during 2018-2021)**



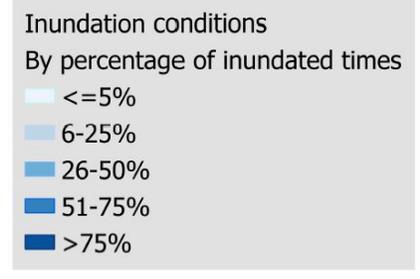
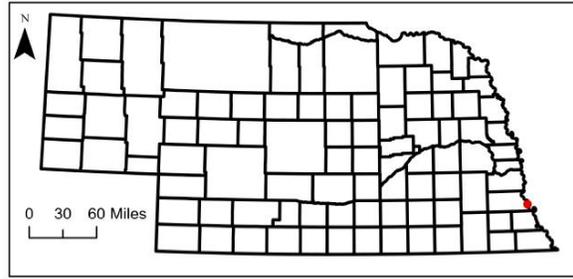
# Demonstration Maps (3/5) : Inundation Condition for Conservation Easements

**Inundation Condition Map for Conservation Easements in Nebraska**  
 (Observations from the Sentinel Satellites during 2018-2021)



0 0.13 0.25 Miles

0 0.13 0.25 Miles

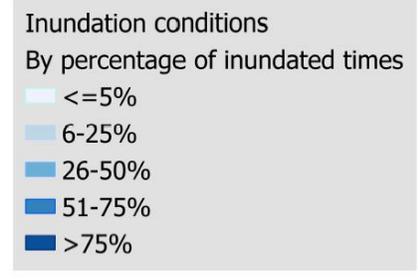
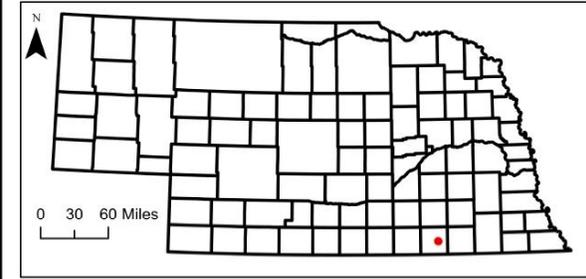


**Inundation Condition Map for Conservation Easements in Nebraska**  
 (Observations from the Sentinel Satellites during 2018-2021)



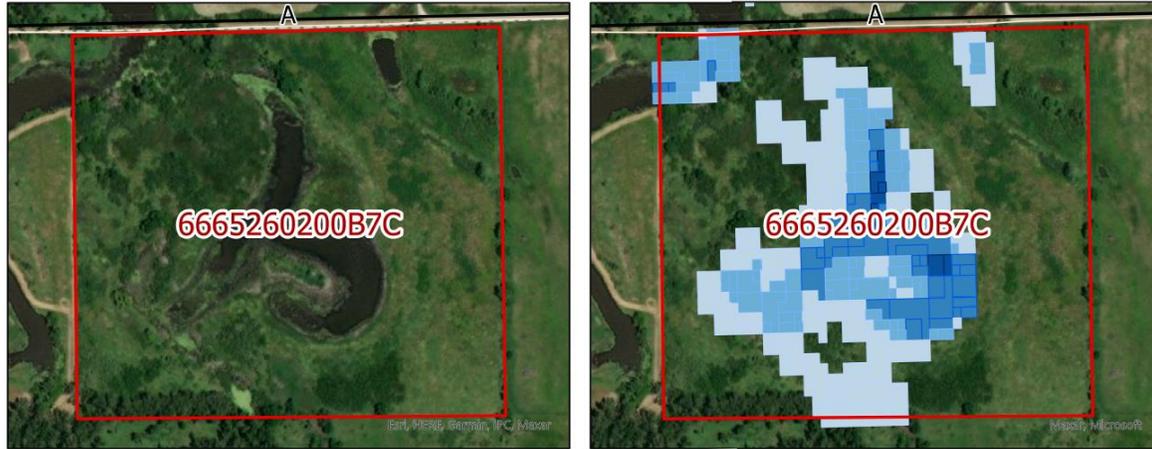
0 0.1 0.2 Miles

0 0.1 0.2 Miles



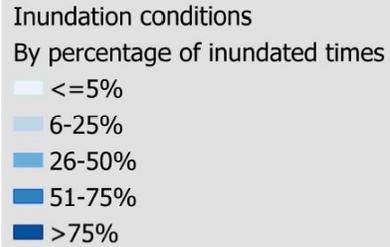
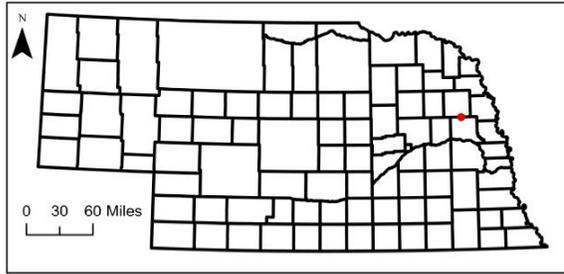
# Demonstration Maps (4/5) : Inundation Condition for Conservation Easements

**Inundation Condition Map for Conservation Easements in Nebraska**  
(Observations from the Sentinel Satellites during 2018-2021)



0 0.05 0.1 Miles

0 0.05 0.1 Miles

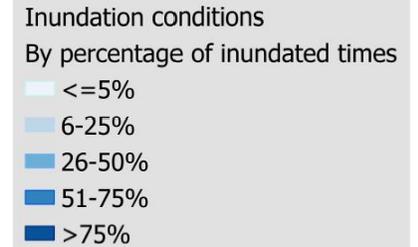
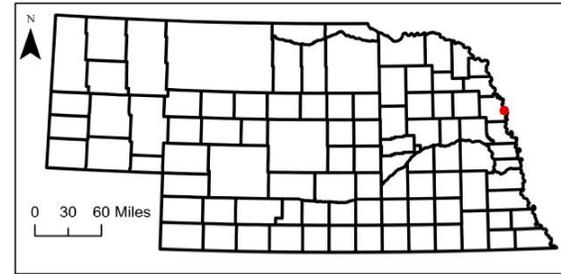


**Inundation Condition Map for Conservation Easements in Nebraska**  
(Observations from the Sentinel Satellites during 2018-2021)



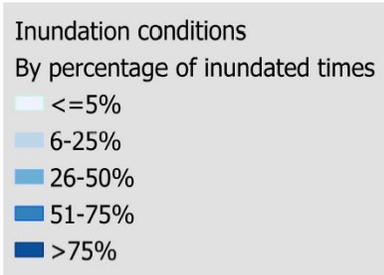
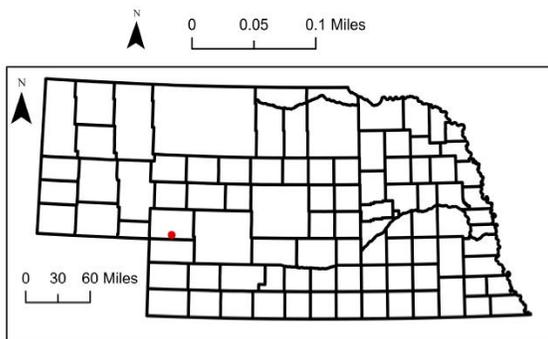
0 0.04 0.08 Miles

0 0.04 0.08 Miles

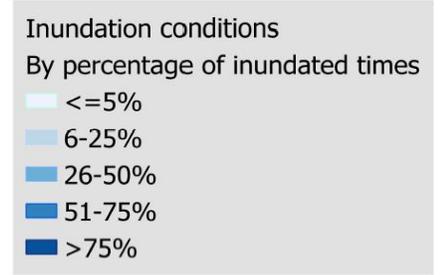
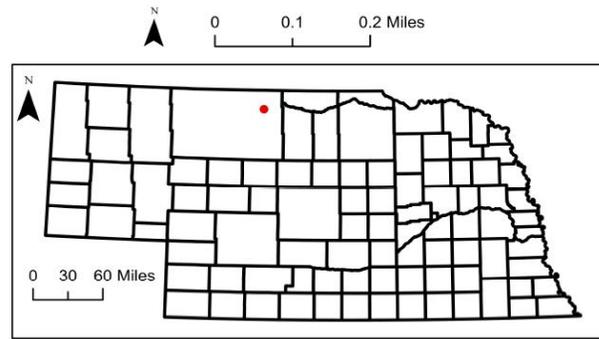
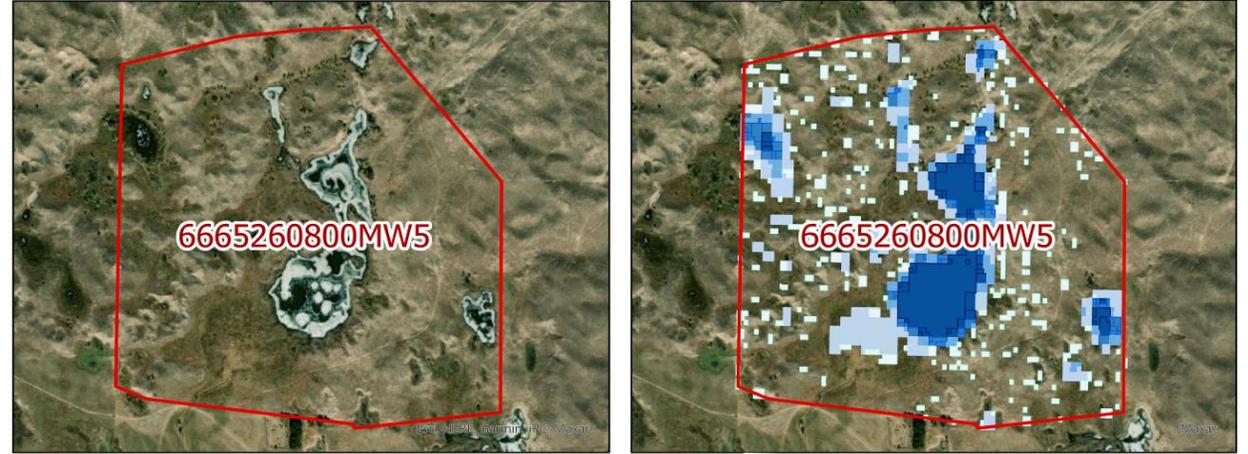


# Demonstration Maps (5/5) : Inundation Condition for Conservation Easements

**Inundation Condition Map for Conservation Easements in Nebraska  
(Observations from the Sentinel Satellites during 2018-2021)**



**Inundation Condition Map for Conservation Easements in Nebraska  
(Observations from the Sentinel Satellites during 2018-2021)**



# Results

- The sites in Emergency Watershed Protection Program (EWPP-FPE) had the highest inundated area rate of 18.72%, indicating **active hydrological inundation in the floodplain areas.**
- The sites in Wetlands Reserve Program (WRP) reached the mean annual surface water cover rate by area at 8.07%, indicating the **core wetland areas were inundated periodically or regularly.**
- The mean annual surface water cover rate is 0.96% for the sites under the **Grassland Reserve Program (GRP).**

# Summary

- The results confirmed **effective inundation performance in these floodplain or wetland-related conservation sites.**
- Other types of conservation easements serving for upland conservation purpose had a lower level of inundation while these **uplands conservation provided critical needs in soil erosion control.**
- The conservation for the easements on **uplands** is an important component to reduce soil erosion and improve downstream wetland hydrological inundation performance.

## **Part II: Site Selection for Future Conservation Easements**



# Research Methodology for Potential Site Selection

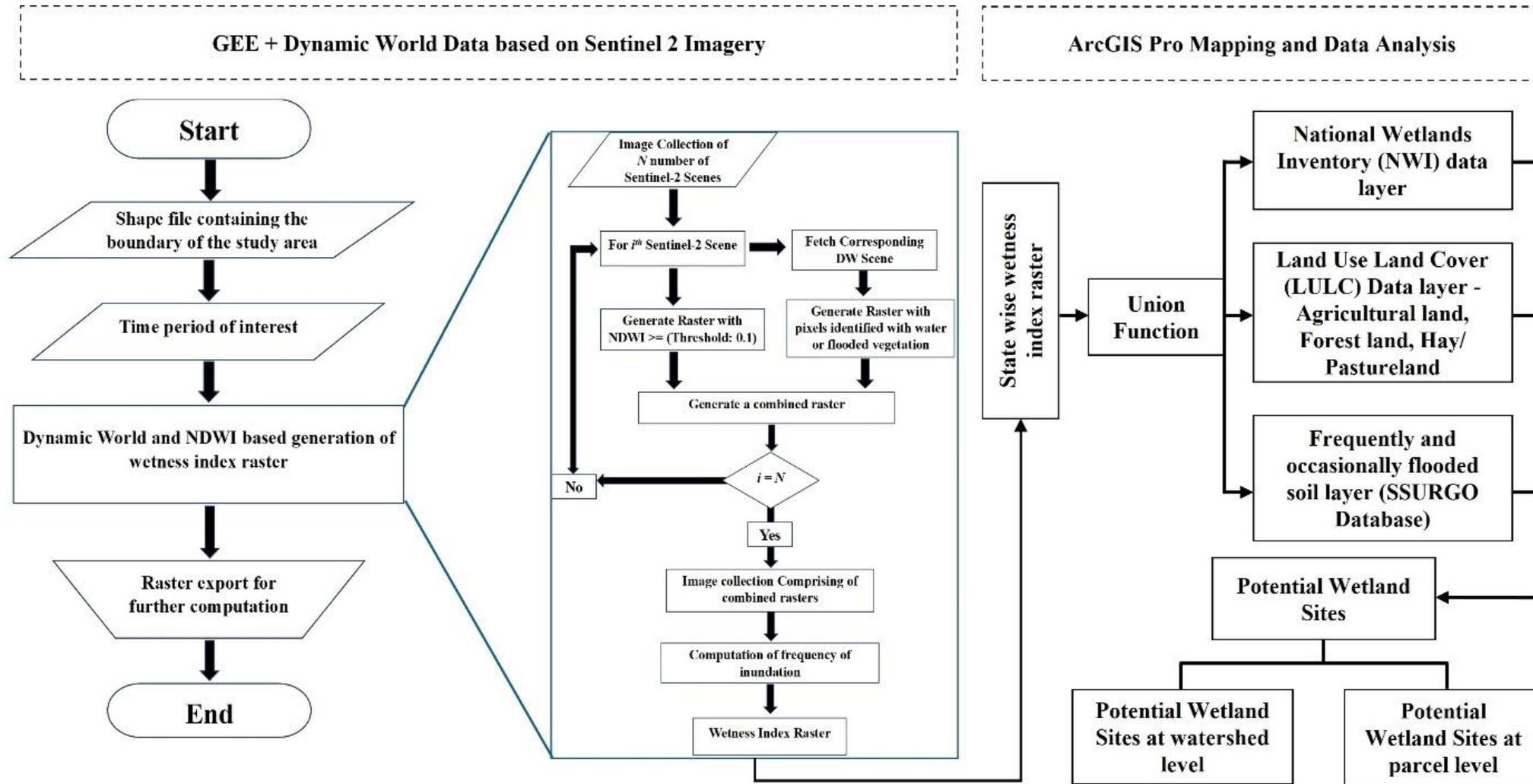


Figure: Flowchart for GEE-based methodology employed for computing the wetness index of the study area. Wetness raster file exported to ArcGIS Pro for identification of potential wetland sites in the study area.

# Results

## ✓ Spatial distribution of frequency of periodic inundation on agricultural land

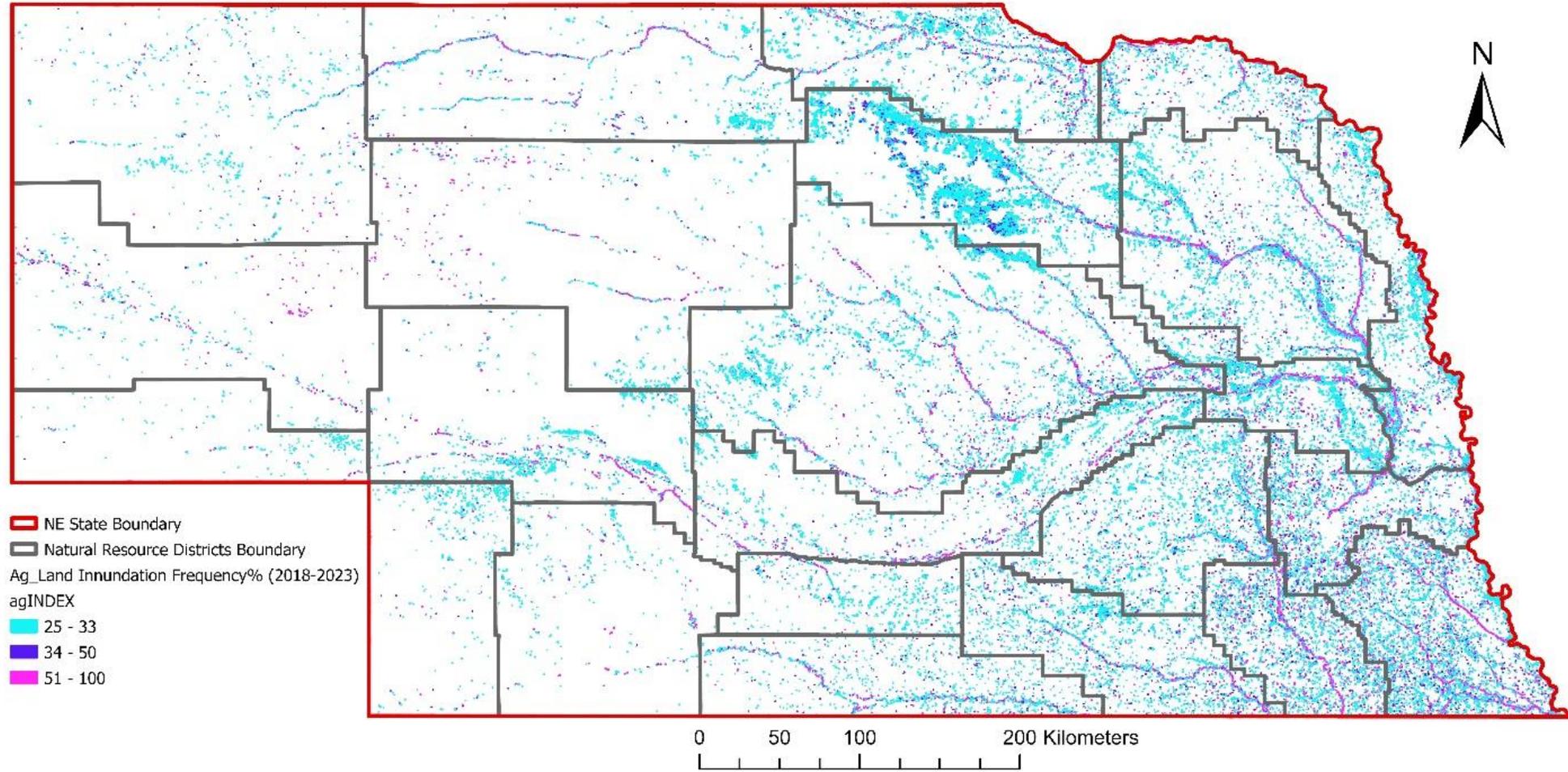
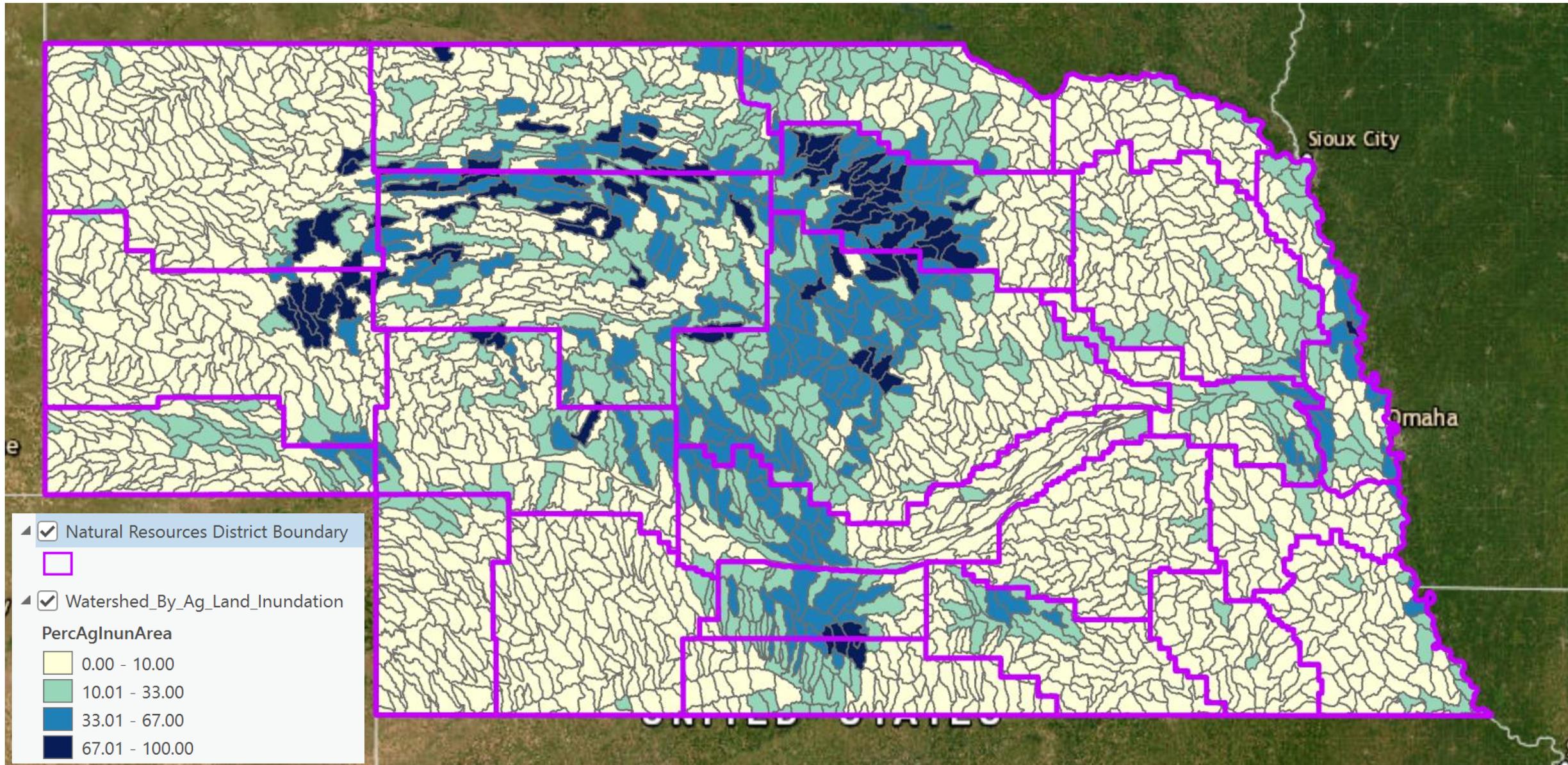


Figure: Spatial distribution of frequency of periodic inundation on agricultural land in Nebraska from 2018 to 2023

# Watersheds ranks by the percentage of inundated agricultural lands



# Watershed wetness index at hydrological unit level in Nebraska

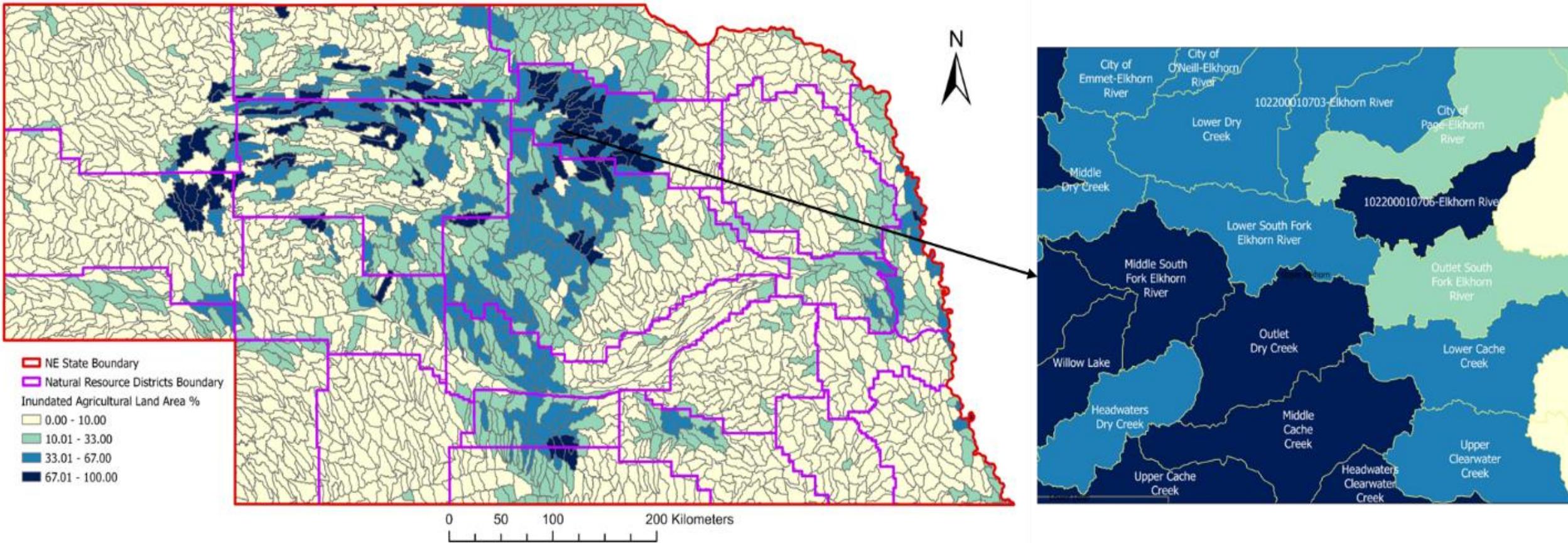


Figure: Watershed wetness index at hydrological unit level in Nebraska

# Inundated agricultural land area in all NRDs in Nebraska

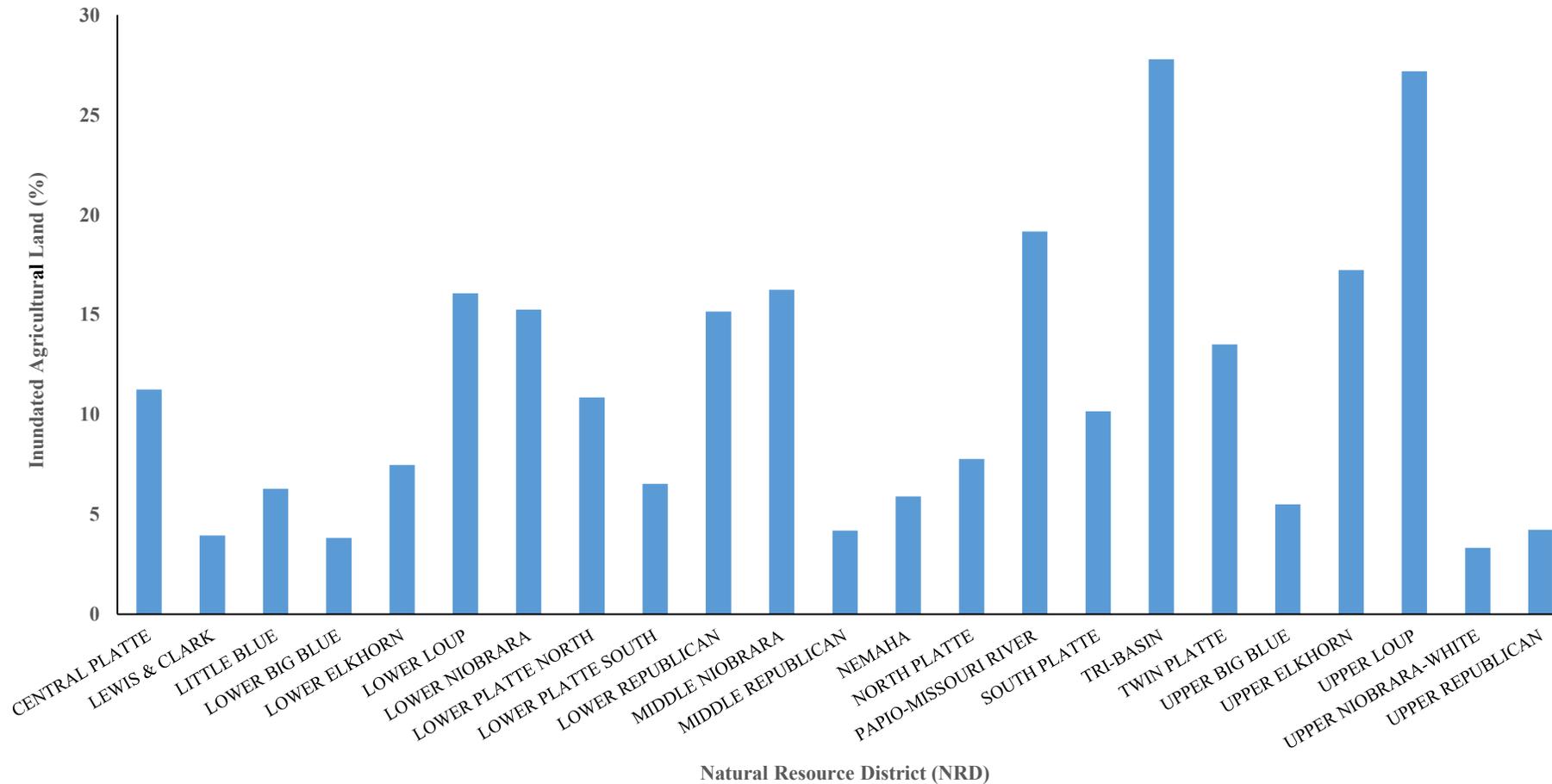


Figure: Inundated agricultural land area in all NRDs in Nebraska. We accounted agricultural land, which has more than 25 percent frequency of periodic inundation throughout the study period

# Inundated agricultural land with a frequency of periodic inundation of 25% or higher across all HUCs in Nebraska

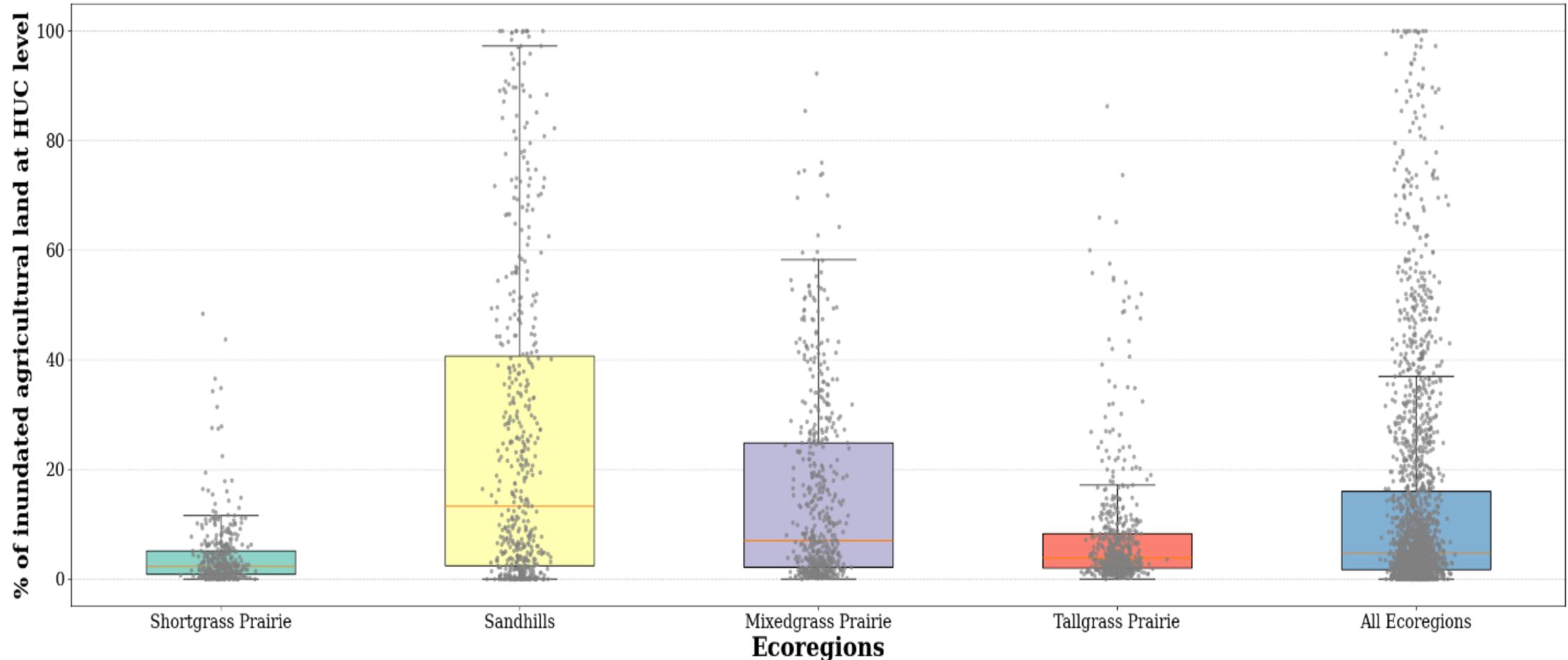


Figure: Percentage of inundated agricultural areas across HUCs in four ecoregions in Nebraska

# Parcel-Level Site Selection for Potential Wetlands in Conservation Programs

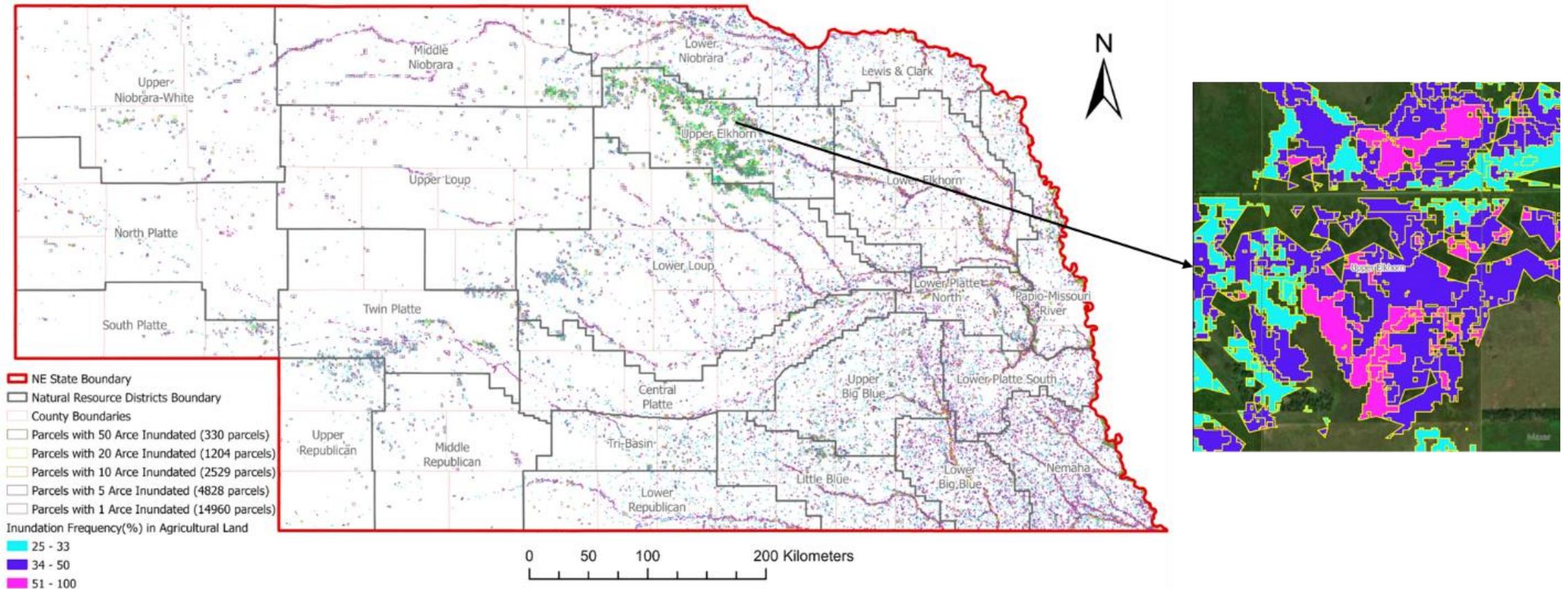
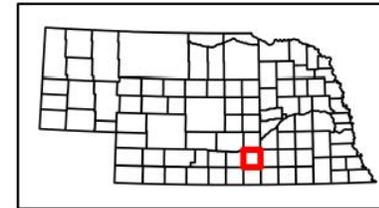
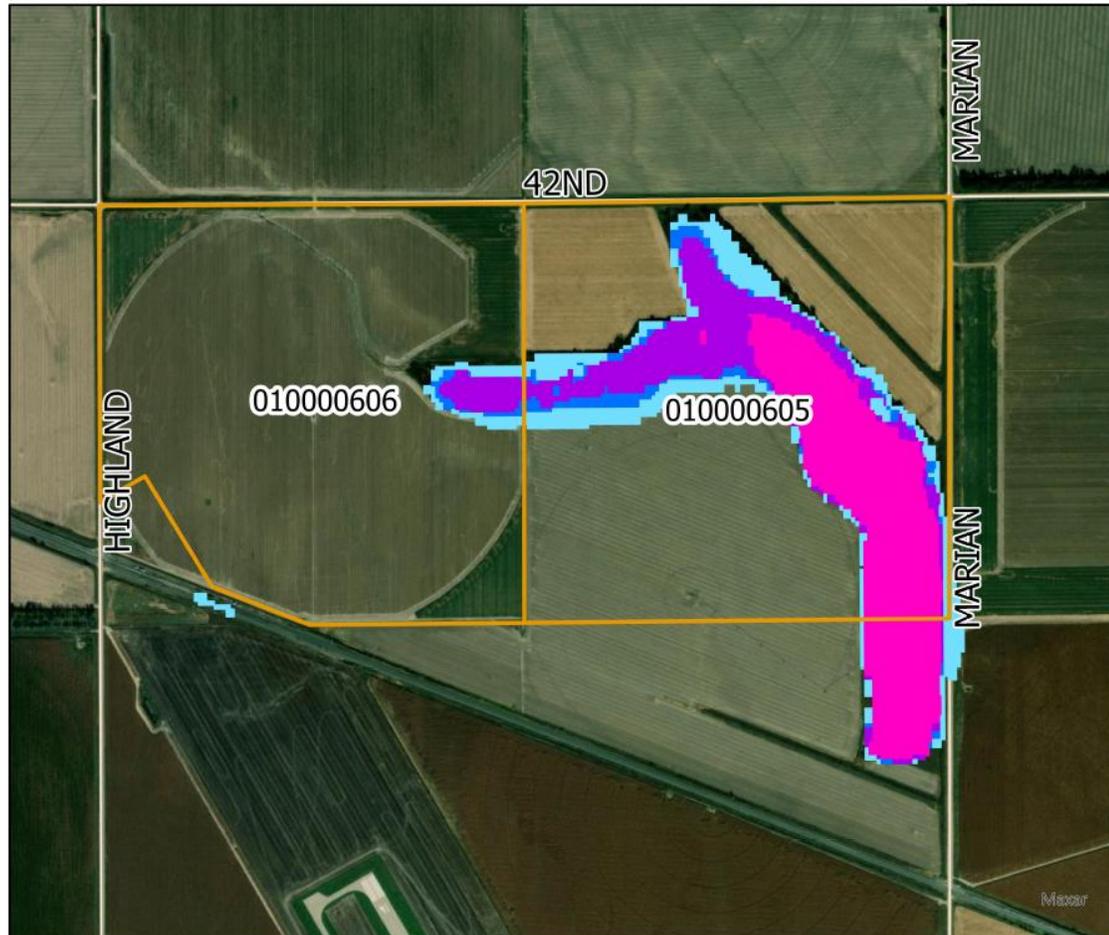


Figure: Frequency of periodic inundation in agricultural land at parcel level throughout Nebraska from 2018-2023.

# Potential Conservation Easements

Antelope  
County,  
NE

## Parcels in Adams County, Nebraska With Frequent Inundation Conditions for Potential Wetland Conservation (Observations from the Sentinel Satellites during 2018-2023)



### Legend

- Targeted Parcels
- Inundation Conditions Frequency (%)
- 8 - 25
- 26 - 33
- 34 - 50
- 51 - 100

This map highlights agricultural parcels across Nebraska that experienced frequent periods of inundation, as observed by Sentinel Satellites from 2018 to 2023. These areas present opportunities for consideration in future conservation programs.

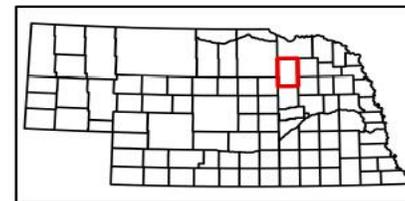
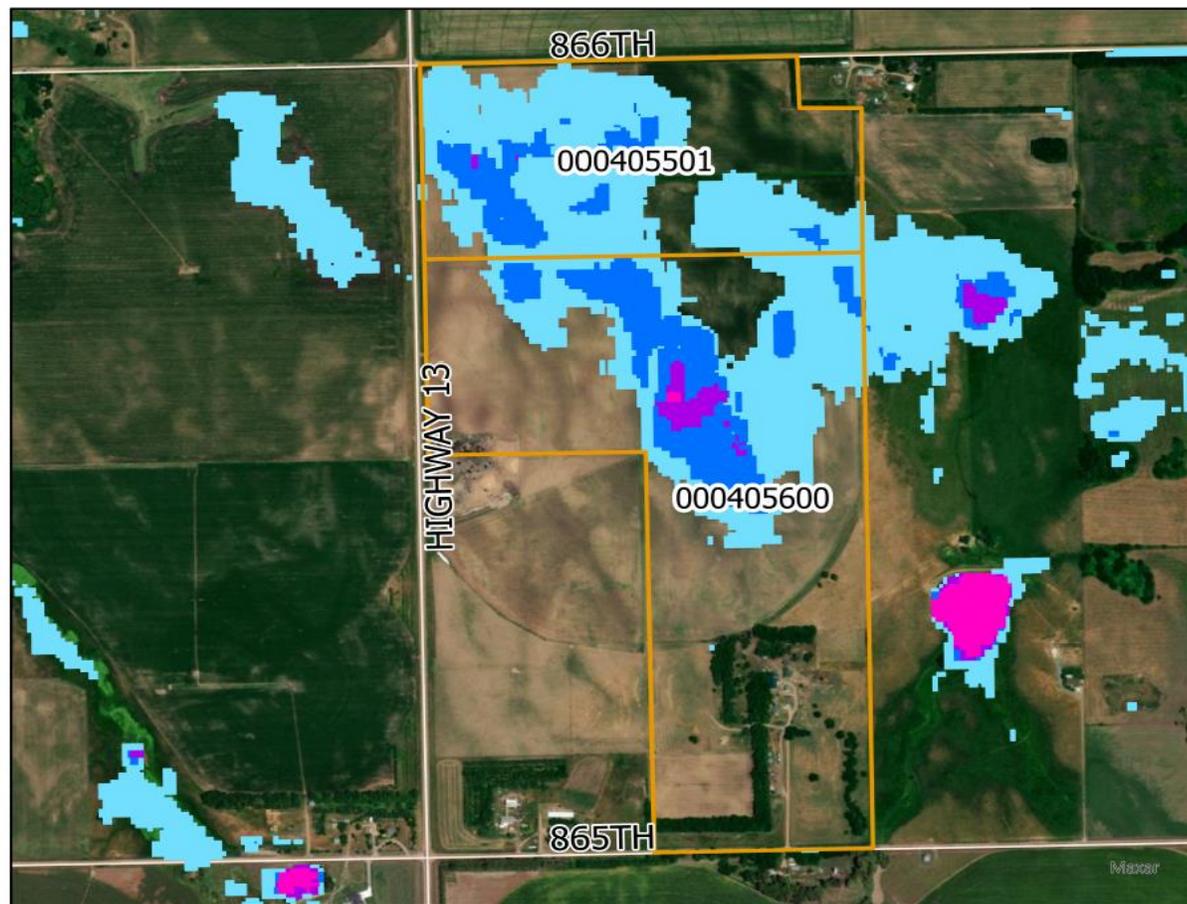


0 0.13 0.25 0.5 Miles

# Potential Conservation Easements

Antelope  
County,  
NE

Parcels in Antelope County, Nebraska  
With Frequent Inundation Conditions for Potential Wetland Conservation  
(Observations from the Sentinel Satellites during 2018-2023)



### Legend

- Targeted Parcels
- Inundation Conditions Frequency (%)
  - 8 - 25
  - 26 - 33
  - 34 - 50
  - 51 - 100

This map highlights agricultural parcels across Nebraska that experienced frequent periods of inundation, as observed by Sentinel Satellites from 2018 to 2023. These areas present opportunities for consideration in future conservation programs.

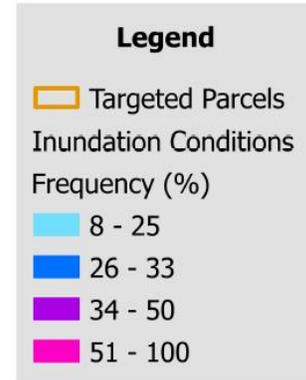
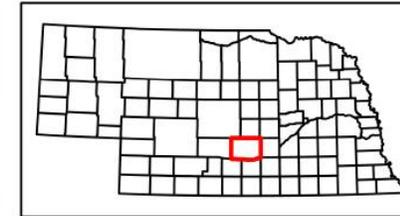
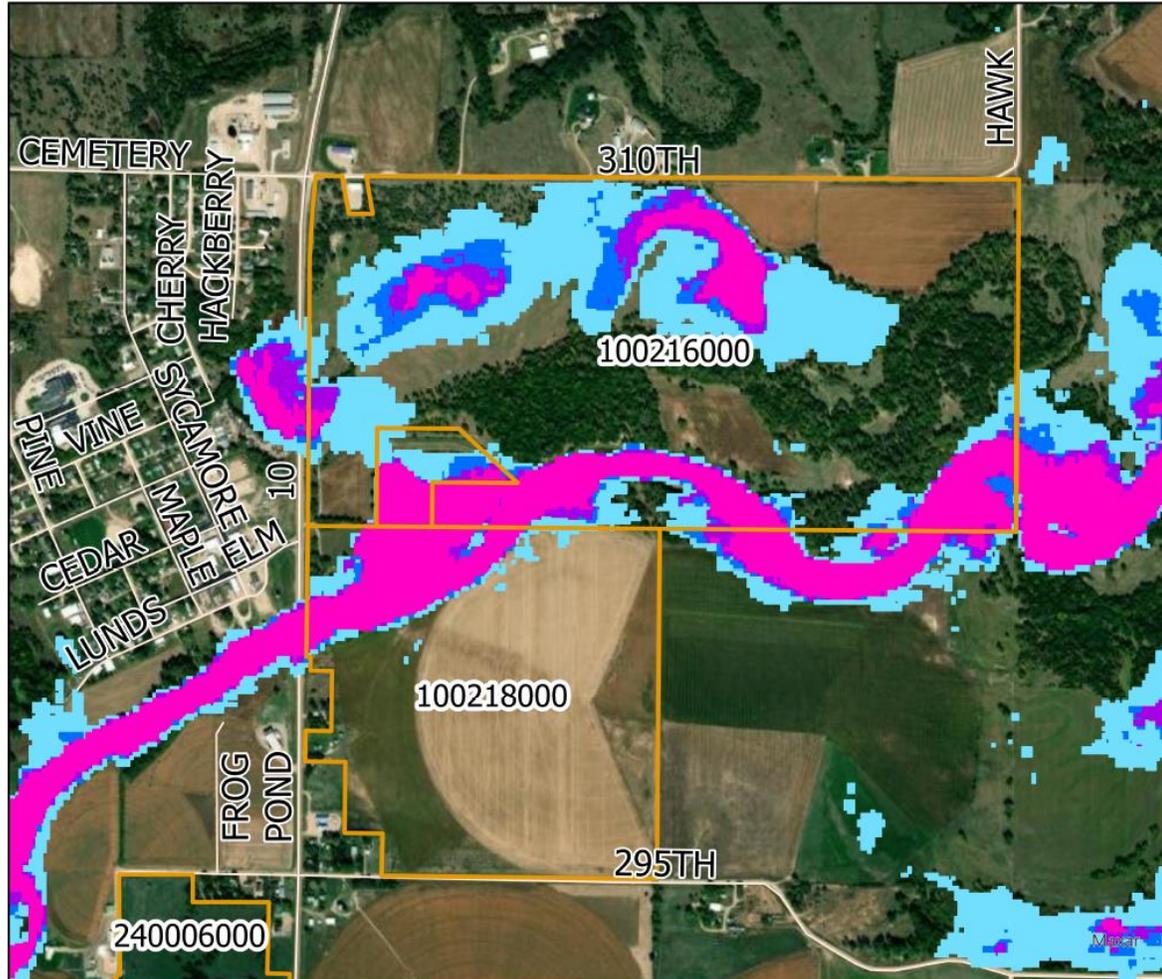


0 0.13 0.25 0.5 Miles

# Potential Conservation Easements

Buffalo  
County,  
NE

Parcels in Buffalo County, Nebraska  
With Frequent Inundation Conditions for Potential Wetland Conservation  
(Observations from the Sentinel Satellites during 2018-2023)



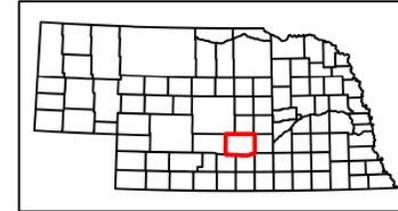
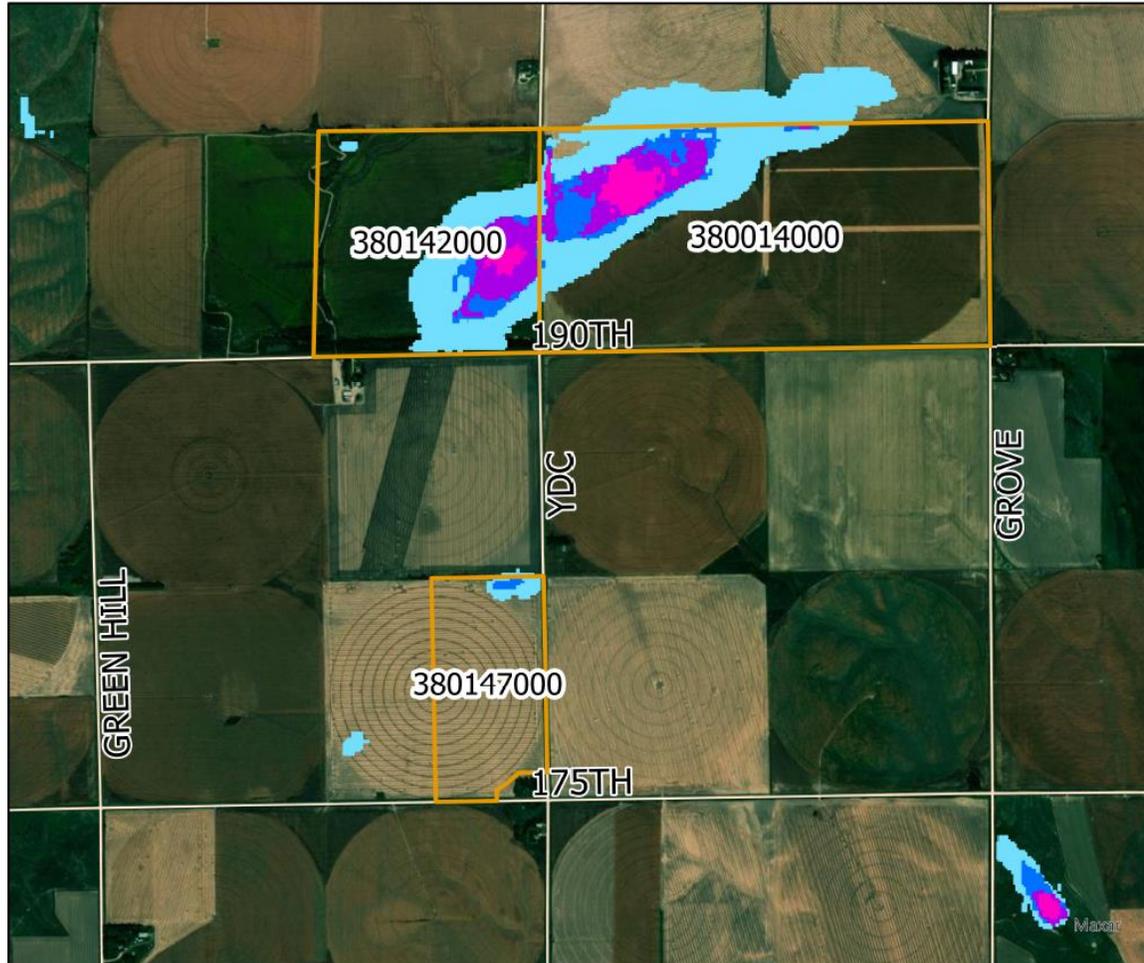
This map highlights agricultural parcels across Nebraska that experienced frequent periods of inundation, as observed by Sentinel Satellites from 2018 to 2023. These areas present opportunities for consideration in future conservation programs.



# Potential Conservation Easements

Buffalo  
County,  
NE

Parcels in Buffalo County, Nebraska  
With Frequent Inundation Conditions for Potential Wetland Conservation  
(Observations from the Sentinel Satellites during 2018-2023)



## Legend

- Targeted Parcels
- Inundation Conditions Frequency (%)
  - 8 - 25
  - 26 - 33
  - 34 - 50
  - 51 - 100

This map highlights agricultural parcels across Nebraska that experienced frequent periods of inundation, as observed by Sentinel Satellites from 2018 to 2023. These areas present opportunities for consideration in future conservation programs.



0 0.25 0.5 1 Miles

# ArcGIS Story Map

## Prioritize Potential Land for Wetland Conservation



# Prioritize Potential Land for Wetland Conservation

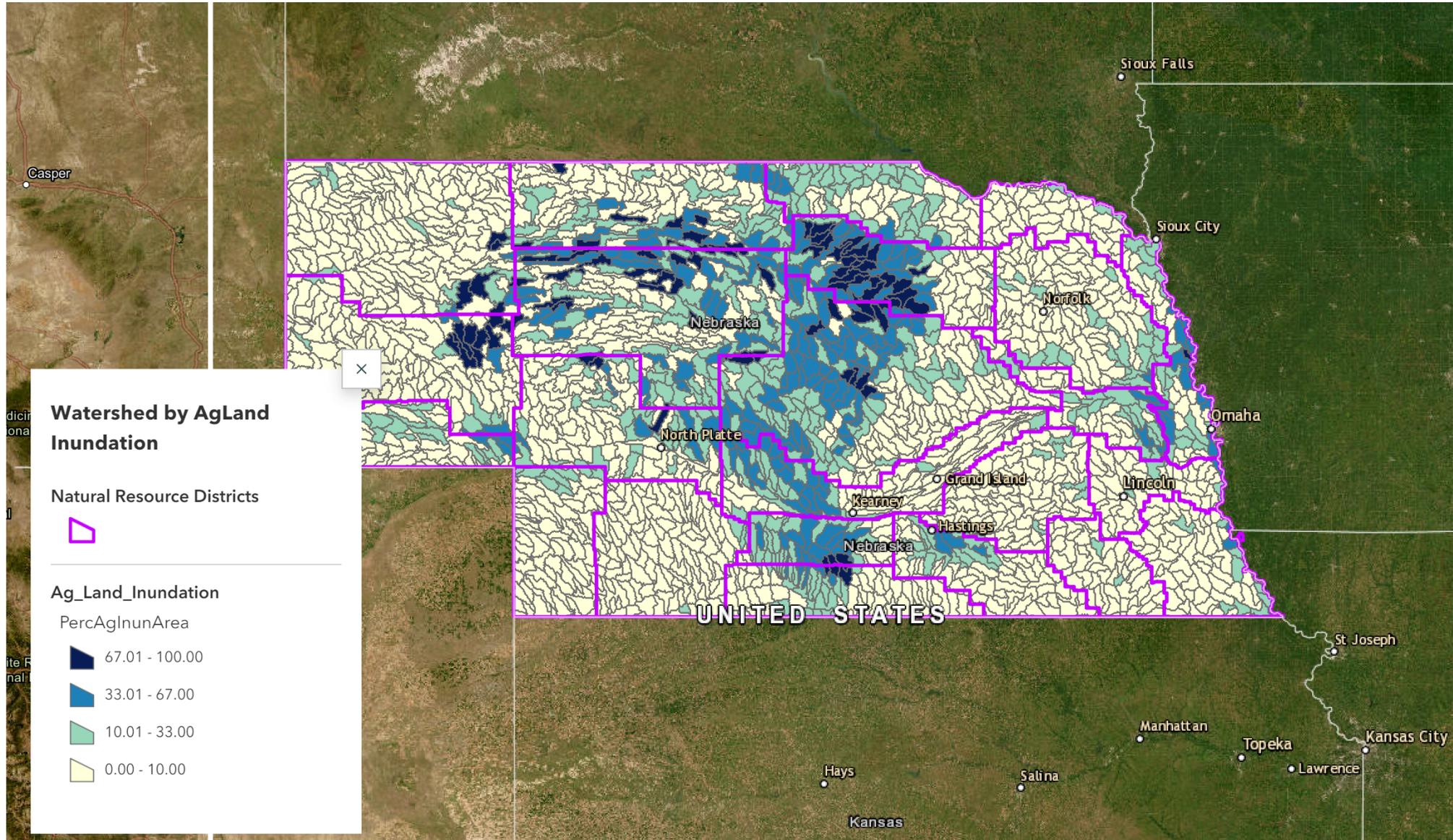
Utilizing Geo-AI and Sentinel-2 on Google Earth Engine (2018-2023)

Research Team: Zhenghong Tang, Jahangeer Jahangeer, Jiyoung Lee, Pranjay Joshi, Ligang Zhang

September 25, 2024

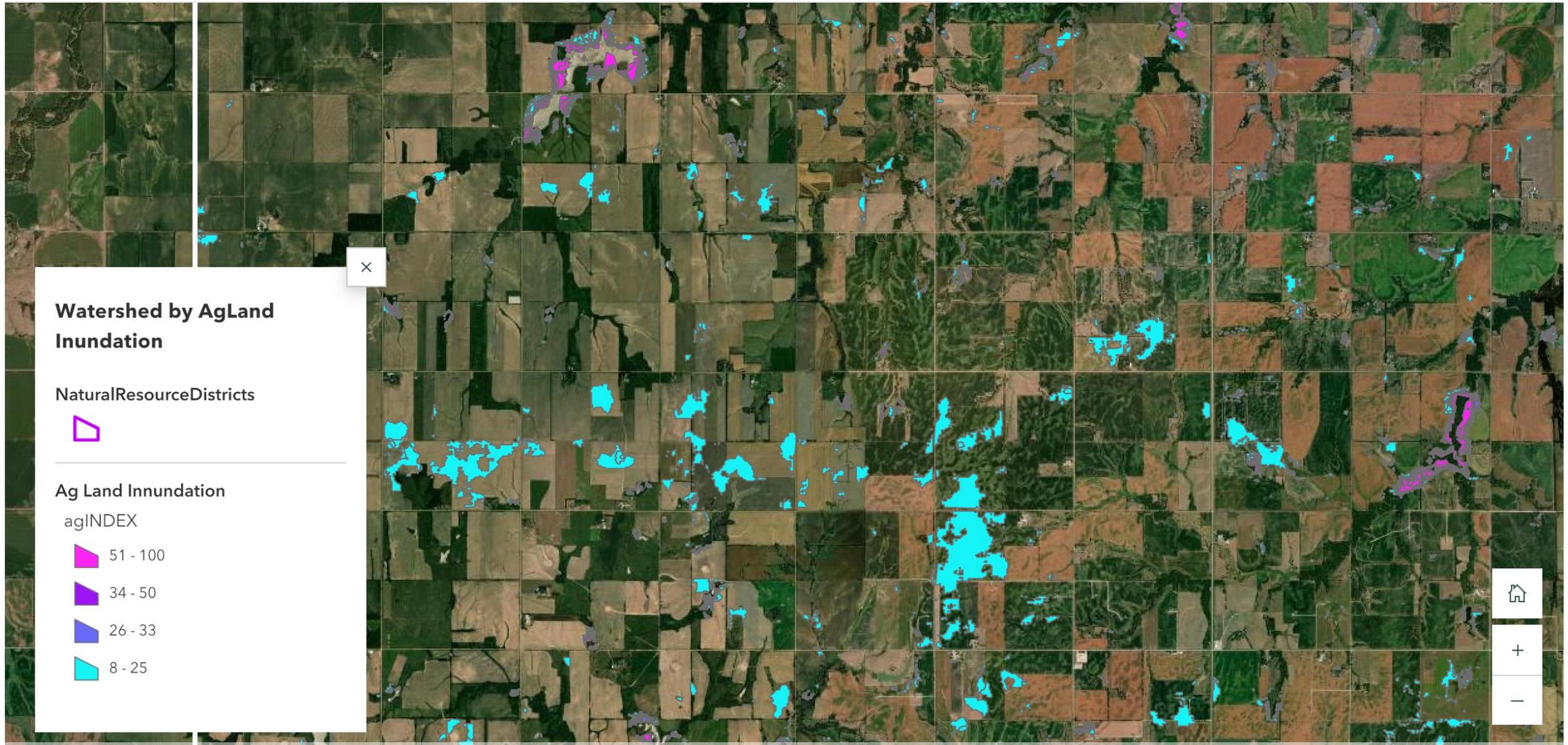
# ArcGIS Story Map

## Prioritize Potential Land for Wetland Conservation



# ArcGIS Story Map

## Prioritize Potential Land for Wetland Conservation



# Conclusions

- This study provides a comprehensive and scalable framework for identifying and **prioritizing potential wetland conservation sites** across Nebraska.
- The findings reveal that certain watersheds experience the **higher frequency of agricultural land inundation**, underscoring their potential for wetland conservation.
- Approximately 24,000 agricultural parcels, **ranging in size from 1 to 50 acres**, were identified as high-priority sites for conservation efforts based on their inundation frequency, soil characteristics, and restoration context.

# Related Publications

- Jahangeer, J., Joshi, P., Ringh, R., Lee, J., Kapoor A., Tang, Z., 2025, Mapping Watershed Wetness Dynamics and Prioritizing Potential Agricultural Land for Wetland Conservation Programs in Nebraska, *Conservation Science and Practice*, <https://doi.org/10.1111/csp2.70151>
- Jahangeer, J., Joshi, P., Kappor, A., Tang, Z., 2025, A Review of AI-driven Google Earth Engine Applications in Surface Water Monitoring, Assessment, and Management, *Discover Geoscience*, 3:140. <https://doi.org/10.1007/s44288-025-00255-x>
- Sreekumar, B., Jahangeer, J., & Tang, Z. (2025). Mapping spatial dynamics of carbon storage and emissions across conservation lands in Nebraska, USA. *Environmental Monitoring and Assessment*, 197(12), 1321. <https://doi.org/10.1007/s10661-025-14694-z>
- Jahangeer J., Zhang, L., Tang, Z., 2023, Evaluating Wetland Hydrological Performance under Three Different Conservation Programs in Nebraska, U.S.A. During 2018-2021, *Journal of the American Water Resources Association (JAWRA)*, <http://doi.org/10.1111/1752-1688.13160>
- Zhang, L., Hu. Q., Tang, Z., 2022, Assessing the Contemporary Status of Nebraska's Eastern Saline Wetlands by Using a Machine Learning Algorithm on the Google Earth Engine Cloud Computing Platform, *Environmental Monitoring and Assessment*, 194:193, <https://doi.org/10.1007/s10661-022-09850-8>
- Hu, Q., Woldt, W., Neale, C., Zhou, Y., Drahota, J., Varner, D., Bishop, A., LaGrange, T., Zhang, L., Tang, Z., 2021, Utilizing unsupervised learning, multi-view imaging, and CNN-based attention facilitates cost-effective wetland mapping, *Remote Sensing of Environment*, 267: 112757, <https://doi.org/10.1016/j.rse.2021.112757>

# Acknowledgements



- Roger Yerdon
- Conor Ward
- Melissa Baier
- Shawn McVey



# For more information

Zhenghong Tang, Ph.D  
[ztang2@unl.edu](mailto:ztang2@unl.edu)