

Utilizing Geospatial Tools and Techniques for Tribal Wetland Programs



Who Are We?

- GeoSpatial Services (GSS) is a project center within Saint Mary's University of Minnesota that integrates professional services and academic apprenticeships in the areas of natural resource assessment, geographic analysis, and contemporary mapping.
- 45 full-time staff and around 40 student interns across two offices in Winona and Minneapolis.
- Key partner working with the U.S. Fish and Wildlife Service and other Federal, State and Tribal entities to provide comprehensive digital National Wetland Inventory (NWI) mapping

What Services Have We Provided?

- NWI Mapping Updates
- Value Added Wetland Classifications (LLWW, HGM)
 - Landscape-level Wetland Functional Assessment
- Identification of potentially restorable wetlands (PRWs)
- Adaptation of Wetland Rapid Assessment Methods (RAMs)
- Communicating Wetland Program Development Products using ArcGIS StoryMap

What Tribes Have We Worked With?

- Three Affiliated Tribes (TAT) of Fort Berthold (ND)
- Shakopee Mdewakanton Sioux Community (MN)
- Stockbridge-Munsee Community (WI)
- Leech Lake Band of Ojibwe (MN)
- White Mountain Apache Tribe (AZ)

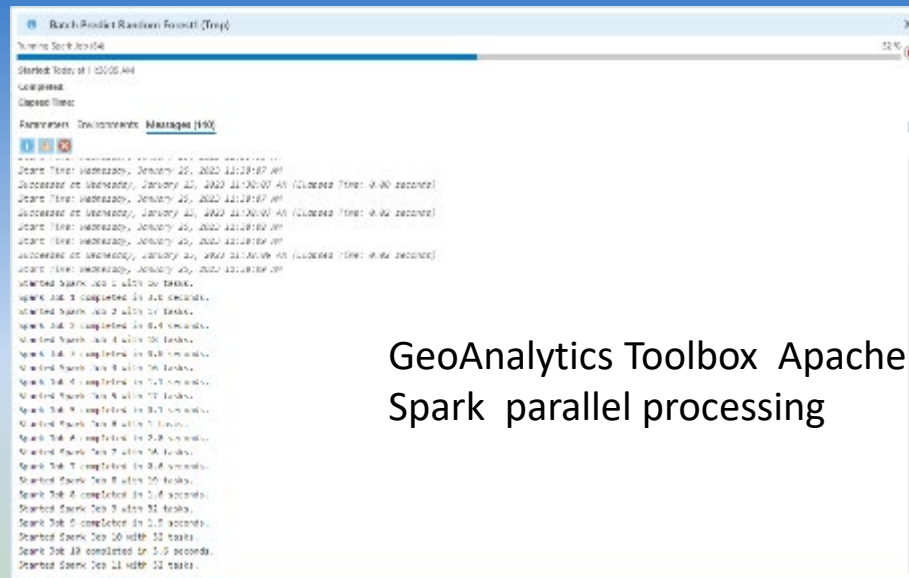
Wetland Program Development

- Basic Wetland Management Questions:
 - Where are the current wetlands?
 - NWI Mapping Updates
 - Wetland Landscape Modeling (Machine Learning Algorithms)
 - Detect Objects using Deep Learning (Image Analyst)
 - Where were wetlands historically?
 - Potentially Restorable Wetlands (PRW)
 - How are they connected to surface hydrography?
 - Hydro-Modification of DEM (Surface Hydrology Modeling)

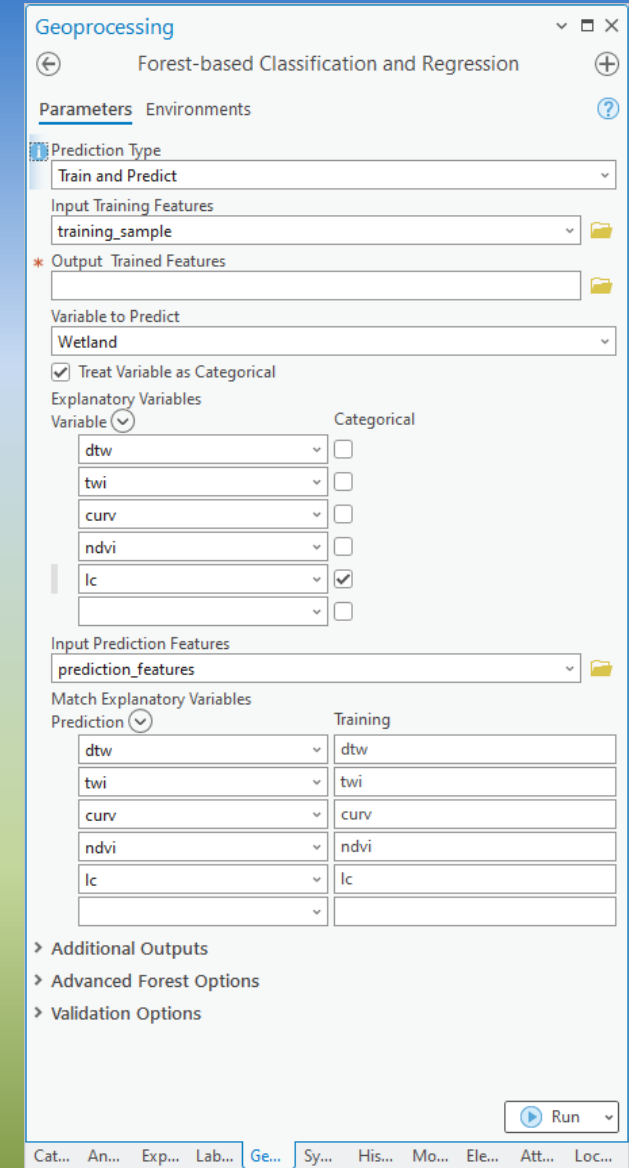
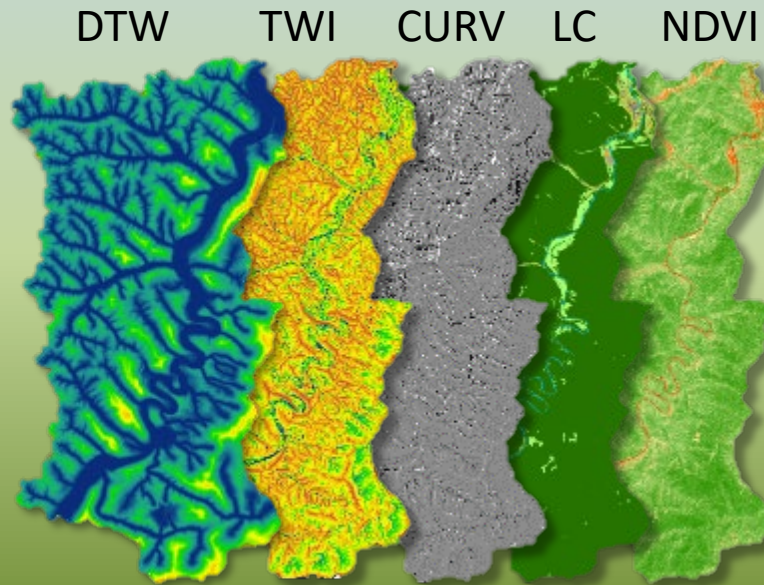


Potential Wetland Landscape Modeling

- Machine learning Random Trees algorithm using lidar derived predictor variables, NDVI and high resolution landcover.
- Based on Wetland Identification Model (WIM) processing methods in Arc Hydro – Gina O’Neil
- Modified WIM process to iteratively process multiple HUC12s for larger geographic areas and to overcome processing limitations.
- Processed large areas of VT (120 huc12s) and WV (360 huc 12s).
- Experimented with other predictor variables such as SSURGO, local land cover etc.
- Less accurate in agricultural and developed areas where hydrography has been modified.

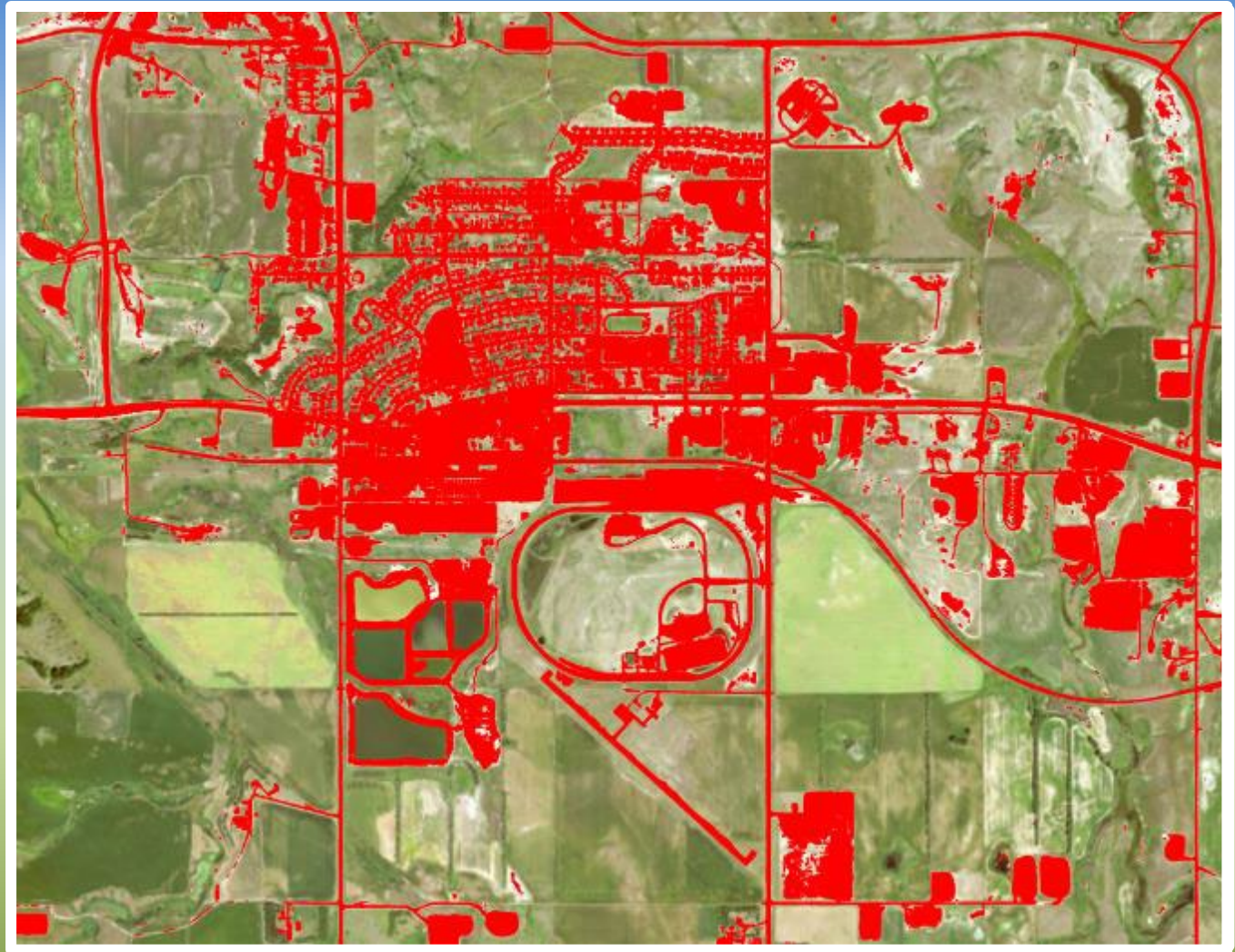
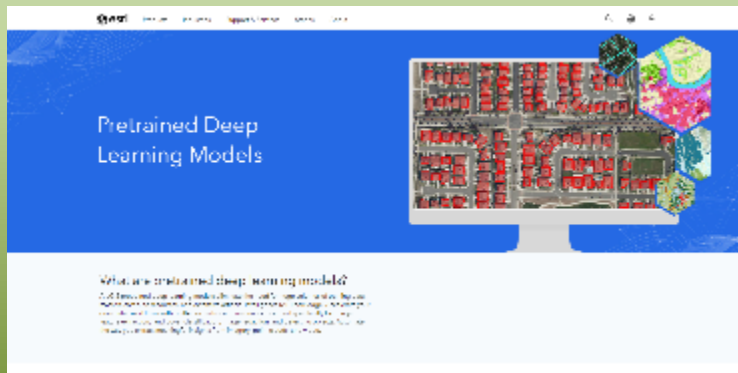


GeoAnalytics Toolbox Apache Spark parallel processing



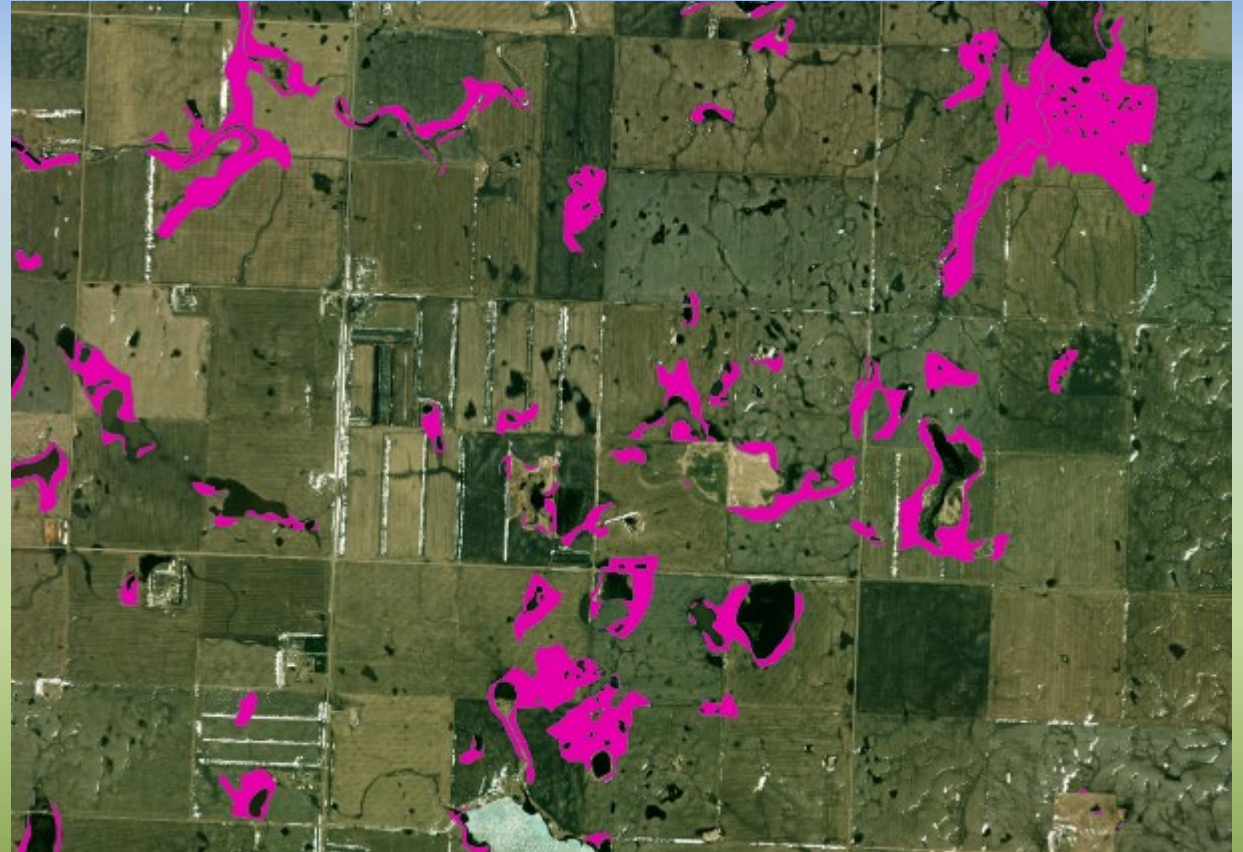
Deep Learning, Impervious Surface Extraction

- Pretrained ESRI deep learning model for pixel classification of high resolution imagery.
- Source imagery NAIP resampled to 1m
- Found that this model performs best in Eastern Temperate Forest biome but less accurate as you move into Great Plains biome



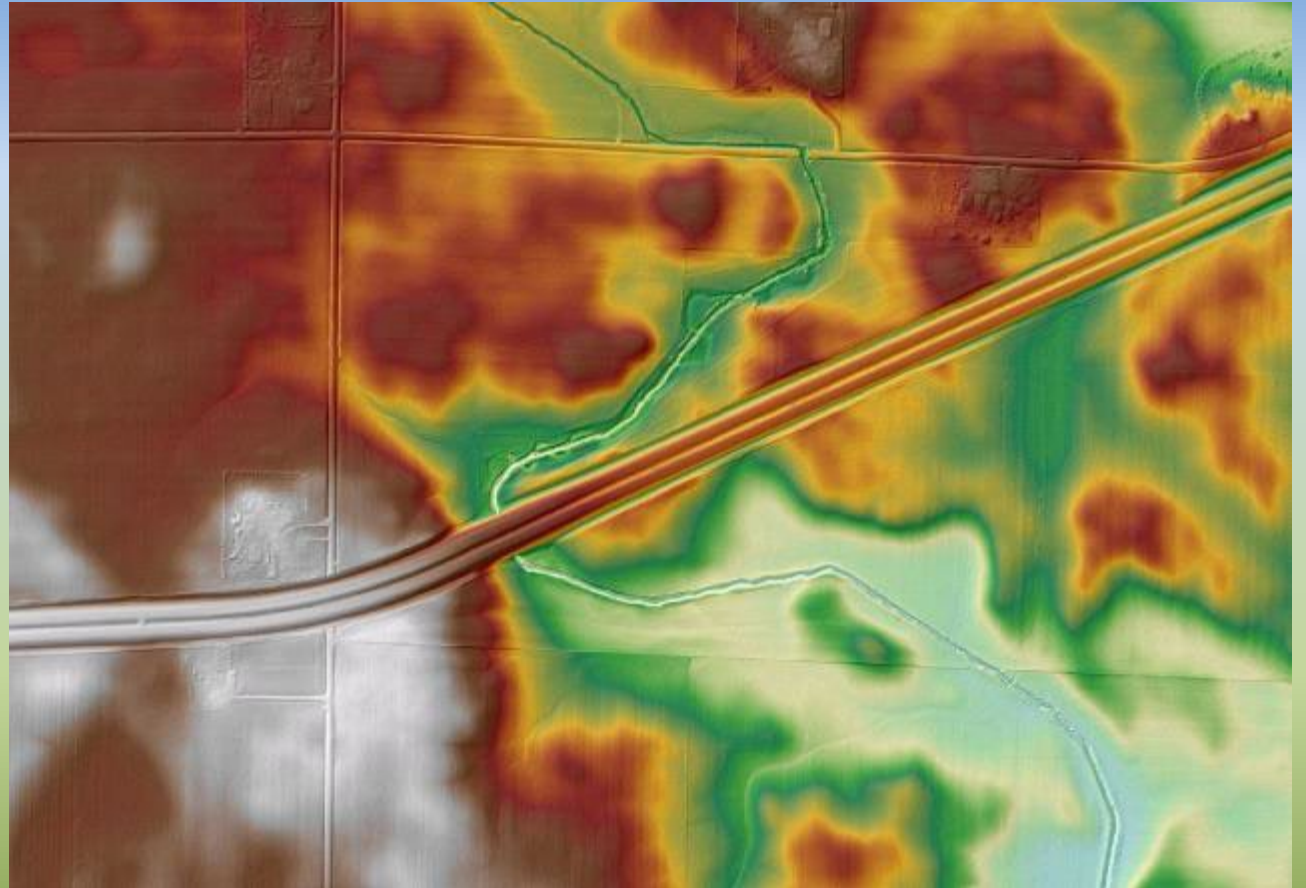
Potentially Restorable Wetlands

- Data layer to identify areas of focus for restoration
- Based on landscape level indicators derived from
 - DEM
 - SSURGO (hydric, spring ponding, summer flooding, depth to water, etc.)
- Excluding existing NWI polygons

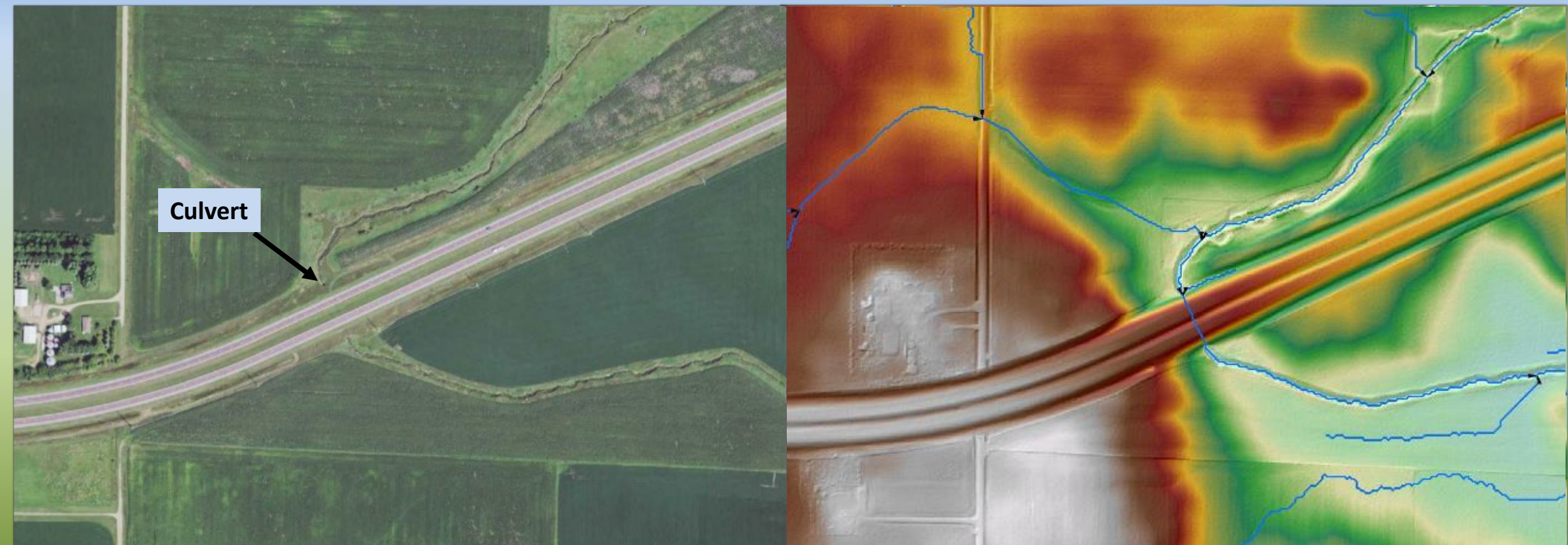


Hydro-Modification of DEM

- Goal is to create a contiguous surface that accurately models flow across the landscape.
 - Breach Digital Dams
 - Define accurate flow direction
 - Precision of flow network



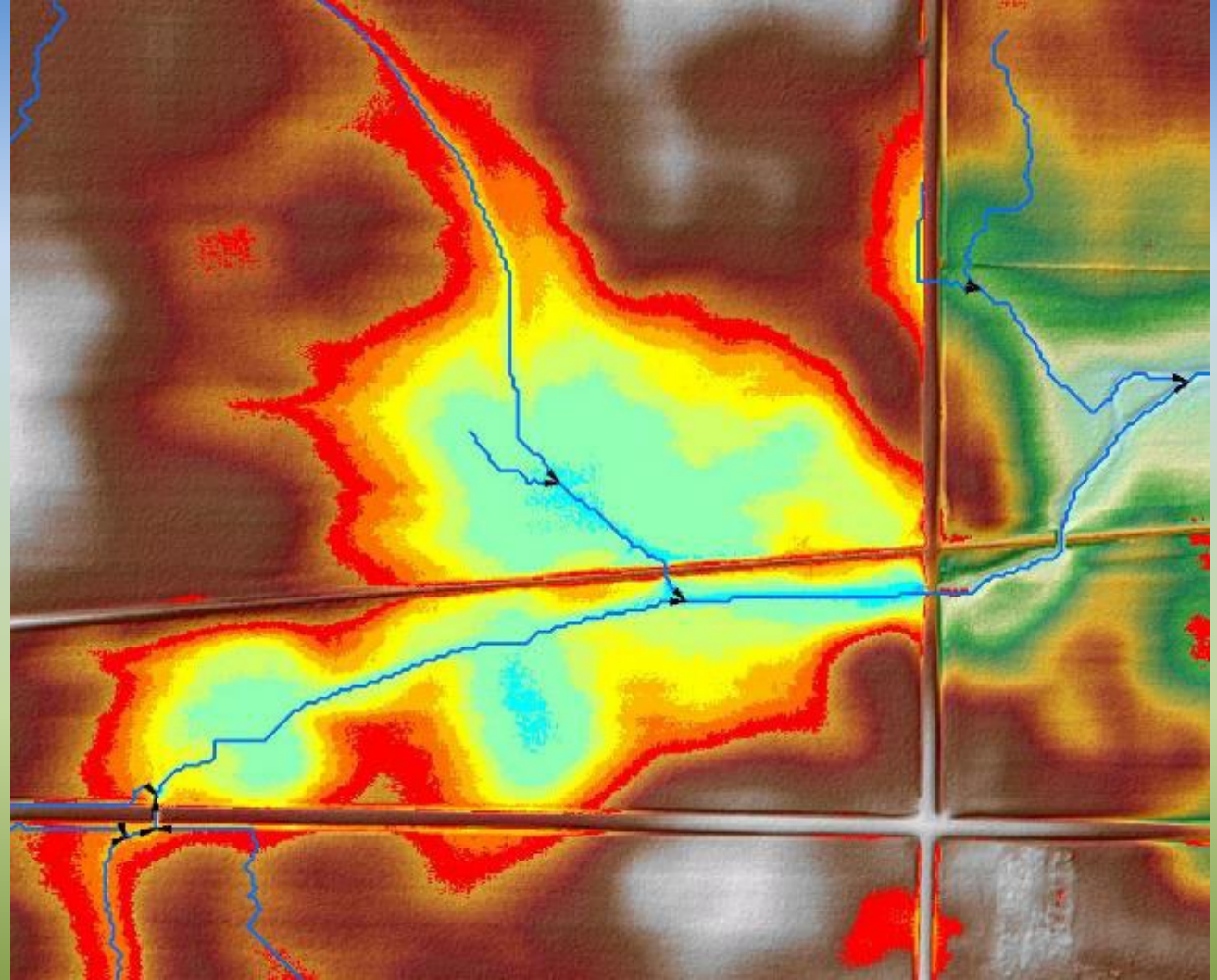
Accurate Flow Direction



Precision of Flow Network

- Enhance the precision of flow lines
- Accurate representation of surface flow
- Integrate with other spatially accurate data products

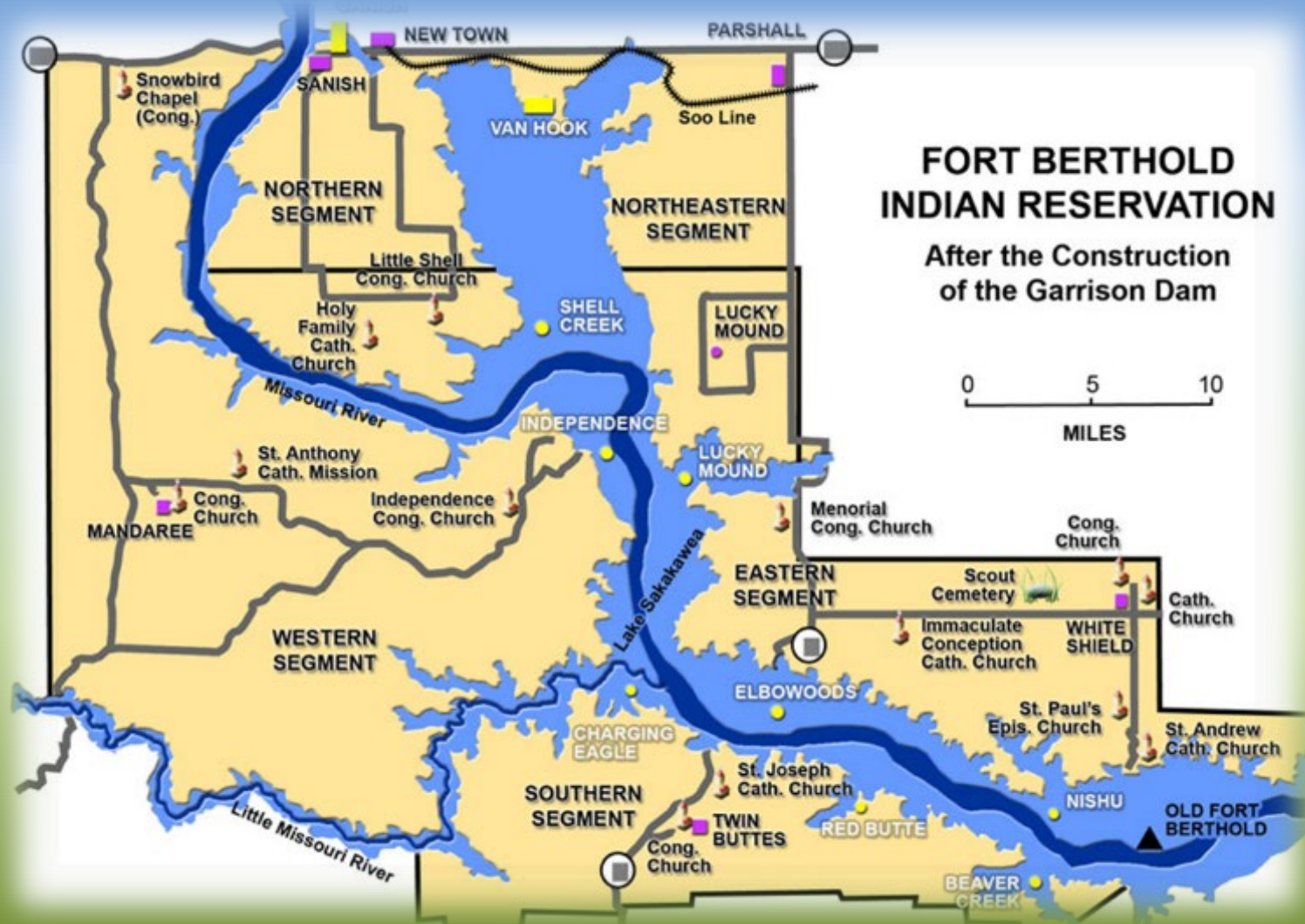
Why is this important for our assessments?



Wetland Program Development Cont.

- Basic Wetland Management Questions:
 - How might they be impacted?
 - Wetland Susceptibility Analyses (Oil/Gas Example)
 - How are wetlands functioning ecologically?
 - Landscape-level Wetland Functional Assessment
 - Wetland Rapid Assessment Methods (RAM)
 - Where should management efforts and funds be focused?
 - Wetland Rapid Assessment Methods (RAM)
 - Combing all the information and data products to inform decision making
 - Connecting wetland management and water quality programs

Three Affiliated Tribes (TAT)



Deep Learning, Oil Well Pad Object Detection

Sentinel Object Detection Model

NAIP Object Detection Model

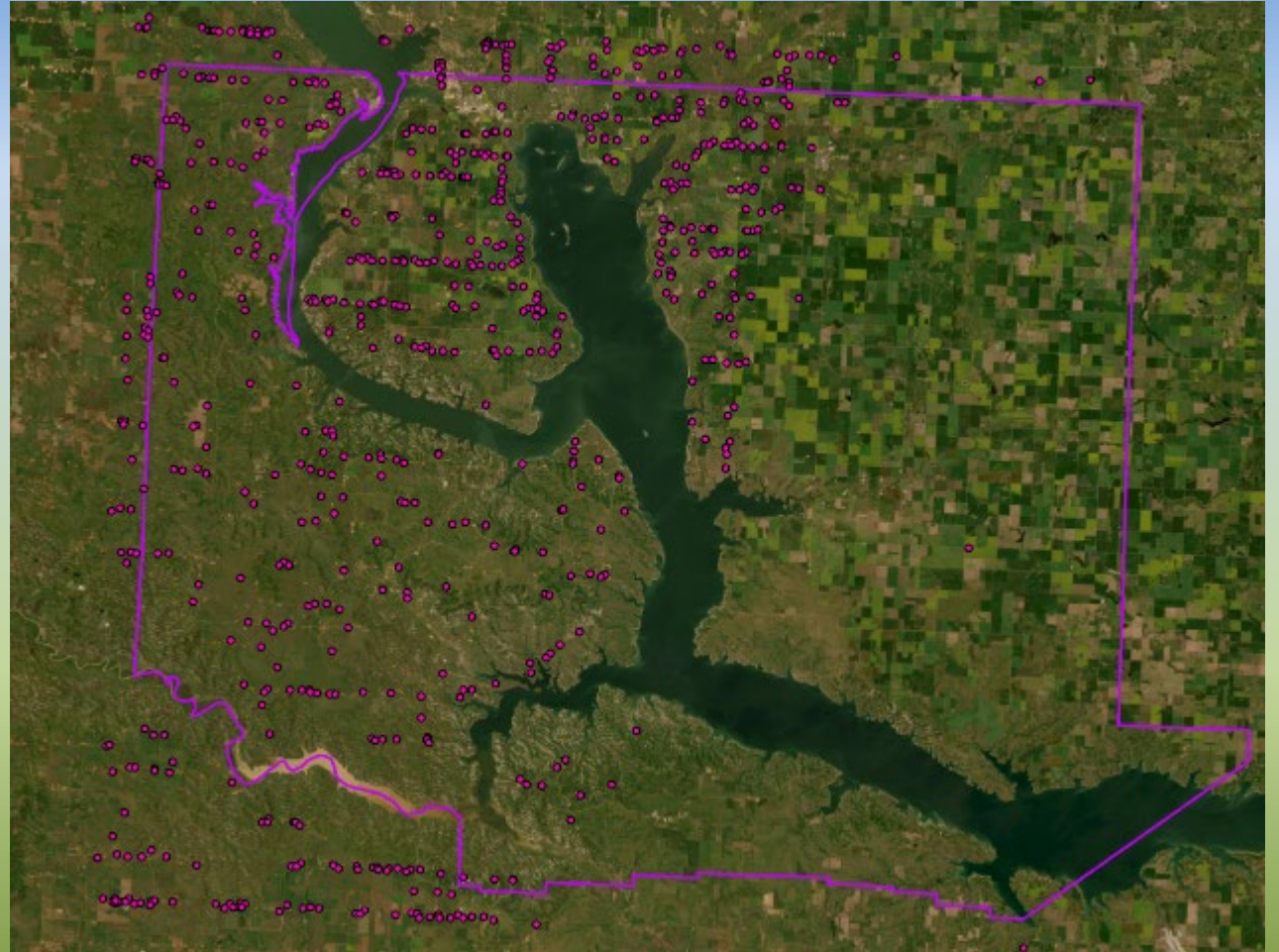


- Utilized pretrained oil well pad detection model for Sentinel data.
- Also created deep learning object detection model for NAIP imagery.
- Both models had issues with false positives and negatives but overall produce good results
- Combined model results for analysis

Oil/Gas Well Pad Identification

- 725 well pads were identified
- Concentrated on the west side

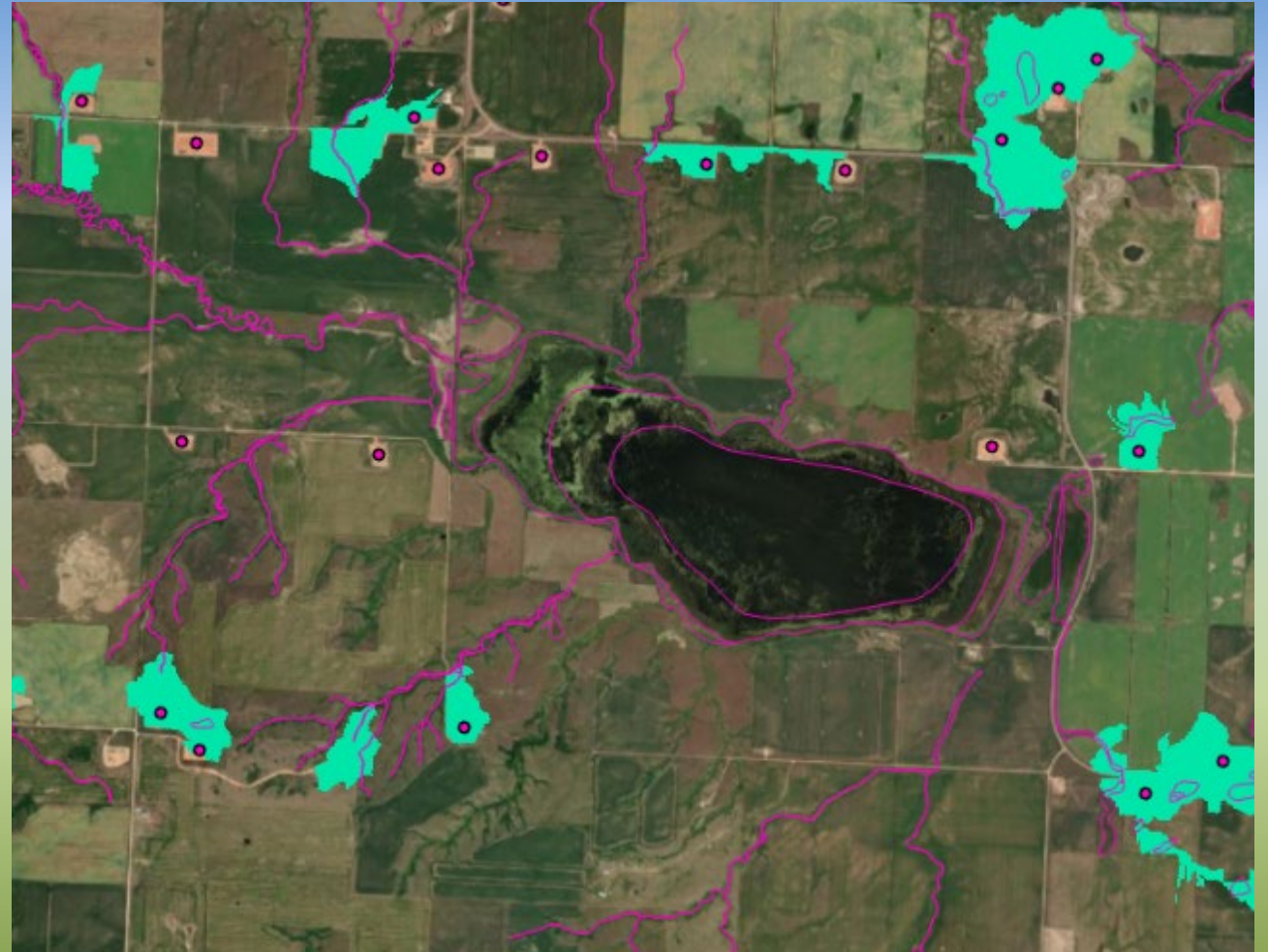
How do we analyze these well pads for their proximity to wetlands?



Oil/Gas Proximity Analysis

- 1- meter DEM, hydrologically modified
- DEM derived surface flow network
- Represents accurate direction and precision of flow
- Pour points placed ~ 250 meters downstream and directly upstream of individual or groupings of well pads to identify potentially vulnerable catchments

What other landscape criteria are important to consider?



Wetlands Potentially Vulnerable to Oil/Gas

- Incorporated additional criteria variables in the vulnerability of wetlands to oil/gas
 - Proximity analysis – catchments
 - Proximity/Density analysis – kernel density
 - SSURGO – water table depth
 - SSURGO – drainage class
 - NLCD
- Applied ESRI's Suitability Modeler within ArcGIS Pro to weigh criteria variables

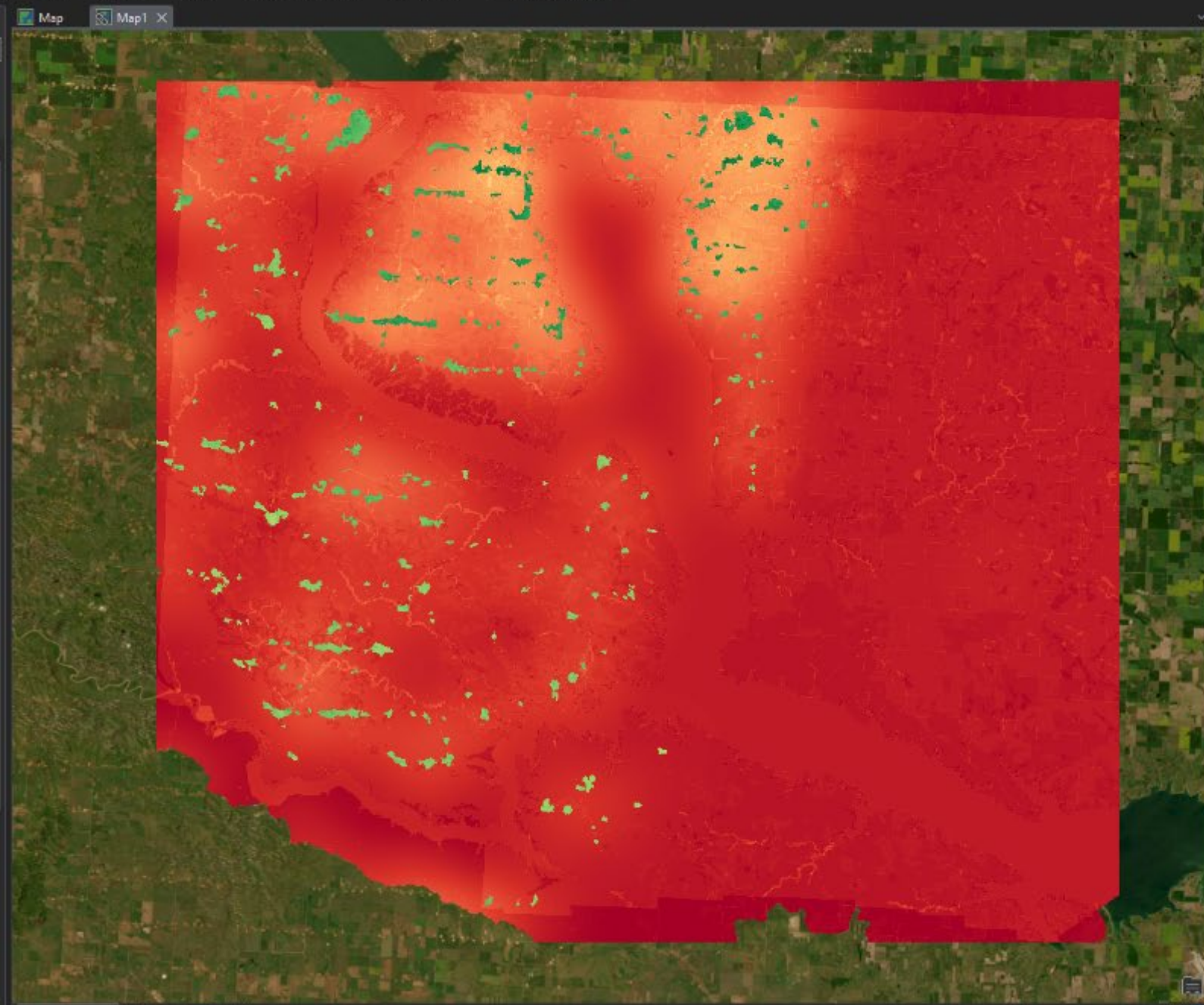


Contents

Search

Drawing Order

- Map1
- NWL_LLWW_polygons
- OilGasAgain
- OilGasVulnerability
 - Value
 - 8.09
 - 1
- Transformed DrainageClass_Resample_Reclass
 - 1
 - 2
 - 3
 - 4
 - 5
 - 6
 - 7
 - 8
 - 9
 - 10
- DrainageClass_Resample_Reclass_muaggatt_drclassdcd
 - Well drained
 - Moderately well drained
 - Very poorly drained
 - Somewhat poorly drained
 - Poorly drained
 - Excessively drained
 - Somewhat excessively drained
- Transformed Kernel
 - Value
 - 10
 - 1
- Kernel
- Transformed NLCD_Resample
- NLCD_Resample
- Transformed Vulnerable_Catchments
- Vulnerable_Catchments
- Transformed Water tableDepth_Resample_Rec



Suitability Modeler

Settings Suitability Locate Sources

Parameters Environments

Criteria

Input Rasters	Weight	Percent
WaterTableDepth_Resample	10.00	10.00
Vulnerable_Catchments	50.00	50.00
NLCD_Resample	10.00	10.00
Kernel	20.00	20.00
Percent total		100

Explore model through queries

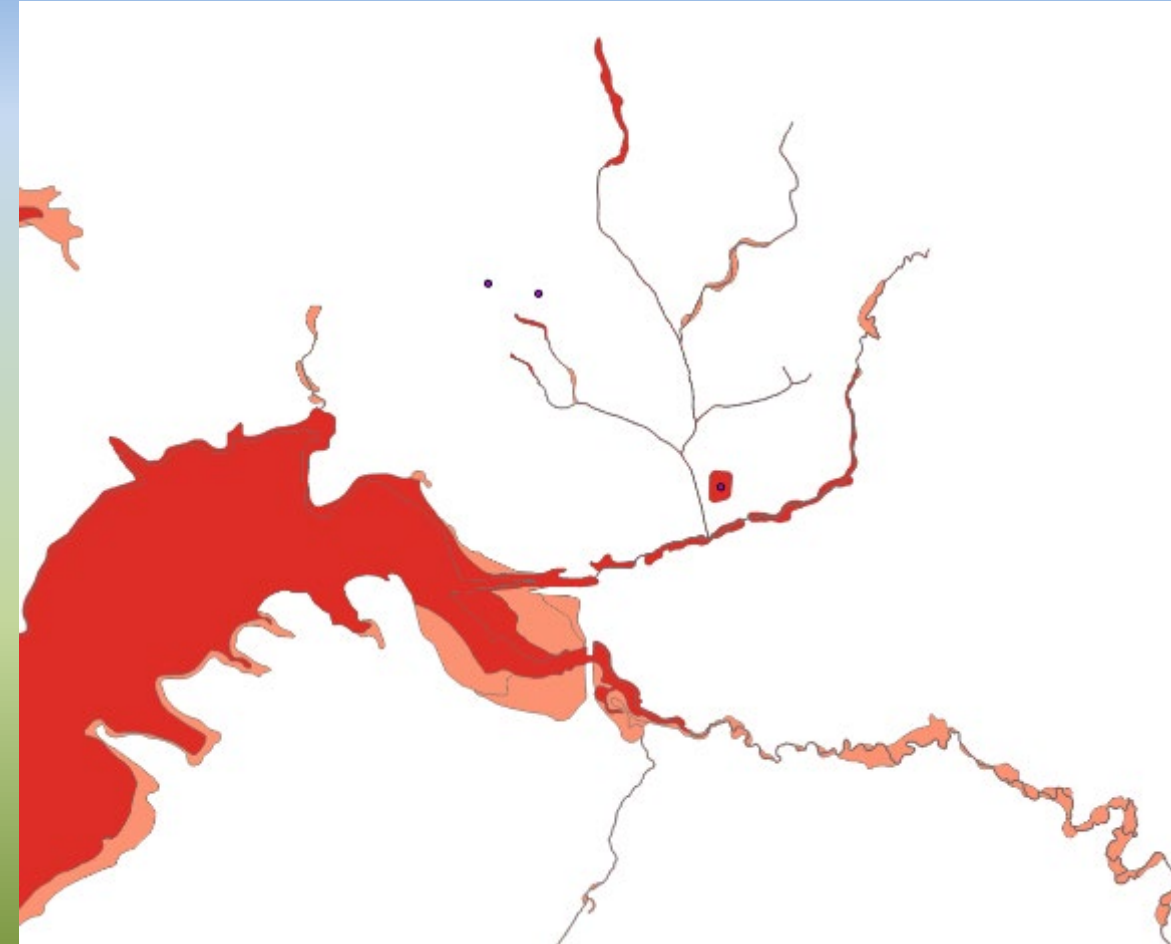
Output type

Raster dataset

Run

Wetlands Potentially Vulnerable to Oil/Gas

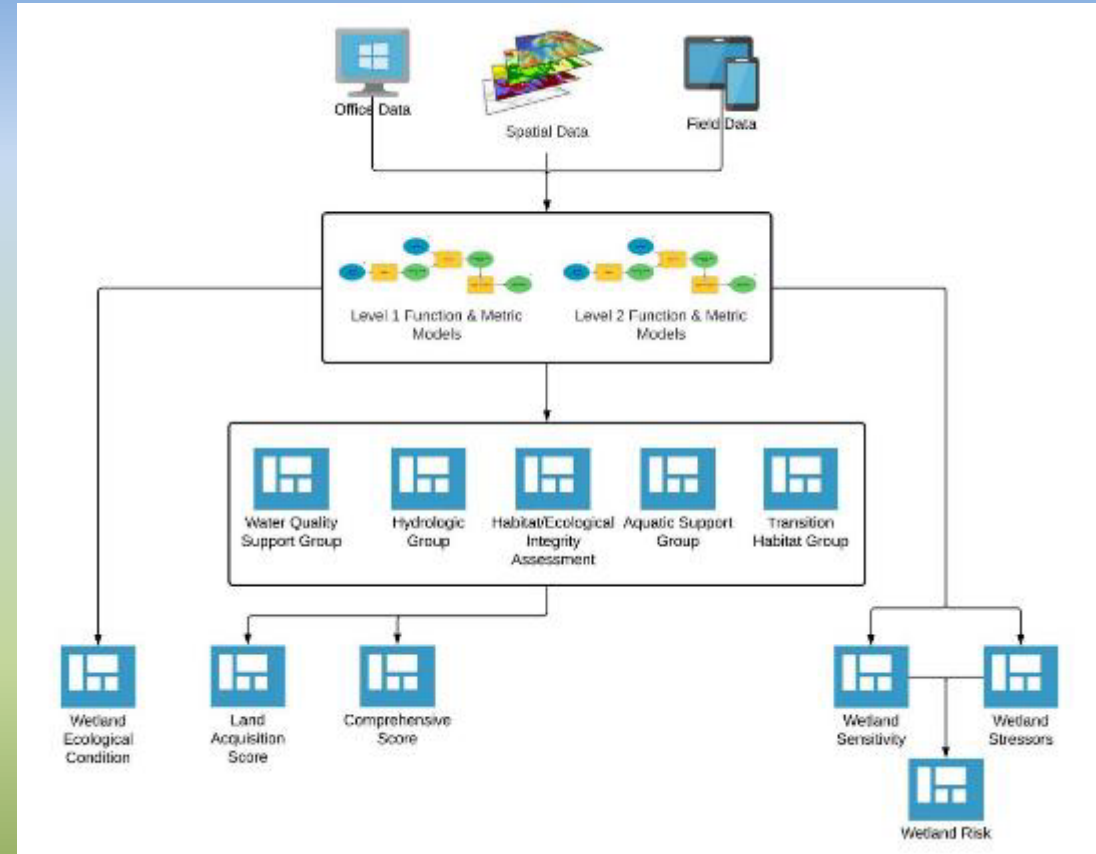
- Created output showing wetlands of low, medium and high vulnerability to oil/gas impacts
- Three Affiliated Tribes may use this data to help prioritize protection/restoration efforts



Wetland Rapid Assessment Method

- Quantitative Scoring of Wetland Resources
- Field and Office Based Metrics Assessed
- Survey 1-2-3 Field Application integrated with ArcPro
- 14 Different Wetland Functions Assessed
- Incorporates Cultural Significance and History
- Includes Curriculum for Engaging Tribal College and Youth

NUETA HIDATSA SAHNISH COLLEGE
Tribally educated; globally prepared.





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