



Geospatial Analysis for the Three Affiliated Tribes (TAT) Wetland Program

A Case Study for Tribal Wetland Programs

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Background: The Three Affiliated Tribes (TAT) of the Fort Berthold Reservation in central North Dakota are developing their wetland program, utilizing a watershed approach to gain a better understanding of overall water quality. Knowledge regarding the condition of wetland and surface water resources on the Reservation is integral to assist resource managers and planners in assessing, protecting, and monitoring the health of those resources. TAT was particularly concerned about threats posed by the Bakken Oil Boom; at the peak of the boom in 2012, approximately 400 wells were operating within Reservation boundaries.

Approach: With the help of an EPA Wetland Program Development Grant (WPDG), TAT partnered with GeoSpatial Services (GSS) to begin developing a comprehensive wetland monitoring and assessment program. The plan included a landscape-level inventory of existing wetlands (NWI mapping), wetland functional assessment, creation of a hydrologically-conditioned [digital elevation model](#) (DEM), identification of potentially restorable wetlands, identification of wetlands vulnerable to oil/gas contamination, and the development of interactive Esri Story Maps as communication tools for the program.

Hydrologically-conditioned DEM: A DEM is a digital representation of the topography of a landscape, derived through a remote sensing product referred to as Light Detection and Ranging ([LiDAR](#)). Although these are high-quality data, there can be deficiencies in the DEM related to the interpolation processing and landscape characteristics that may result in erroneous hydrologic flow models. Hydrologic conditioning refers to the modification of topographic data in a bare-earth DEM through a series of iterative GIS processing techniques to enhance the accuracy of surface flow across the landscape. The resulting conditioned DEM is valuable for flow modeling (e.g., direction, accumulation, connectivity) and analysis (e.g., vulnerability to stressors).

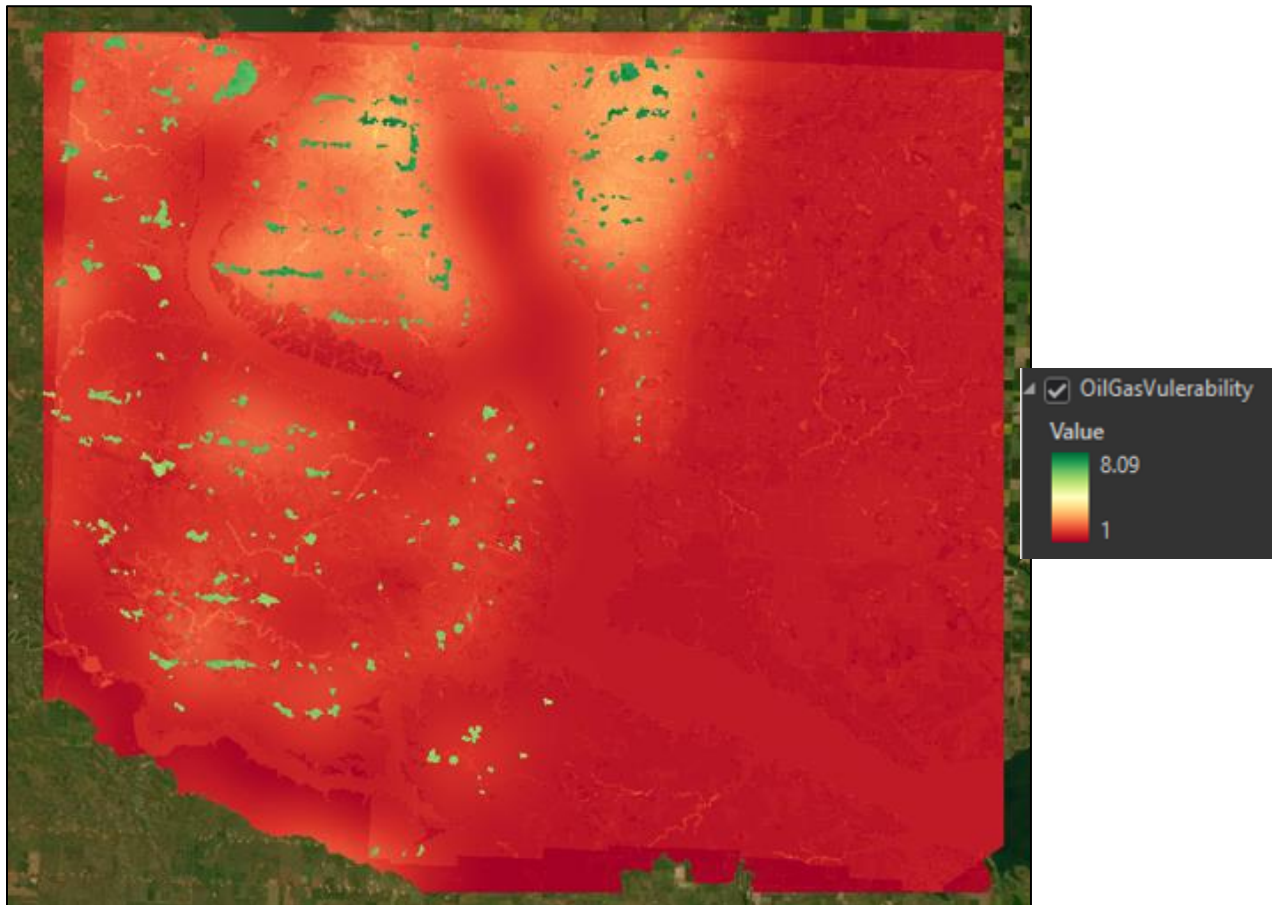
Identification of potentially restorable wetlands (PRWs): These are locations that likely once supported wetlands and where the successful re-establishment of wetlands is plausible. To locate PRWs, GSS used a [compound topographic index \(CTI\)](#) and a modified hydric soils dataset derived from Natural Resources Conservation Service (NRCS) [SSURGO data](#) as inputs. The CTI is derived from a DEM and provides a representation of soil wetness as a function of the slope and the upstream contributing area. The final step was to utilize aerial imagery to eliminate locations where current land use was not compatible with wetland restoration (e.g., developed areas, roadways, gas drilling sites).

Identification of wetlands vulnerable to oil/gas contamination: The first step in this process was to identify impervious surfaces within the Reservation that were likely oil and gas well pads, using an Esri pre-trained deep learning model (with modifications) and aerial imagery. Analysts then used a synthetic flow network developed from the hydrologically-conditioned DEM to identify wetlands downstream of oil and gas production areas. A multi-step [Suitability Modeler](#) was calibrated to weigh the variables contributing to the vulnerability of wetlands. Variables included wetlands downstream of oil and gas production areas, well pad density, water table depth, soil drainage classes, and land cover. For example, areas with shallow water tables and excessively drained soils are considered more vulnerable to contamination.

Results: The landscape-level wetland inventory of the Fort Berthold Reservation identified nearly 207,000 acres of wetlands, or just over 20% of the entire Reservation area. The vast majority of wetland area (86%) was lakes or ponds, primarily Lake Sakakawea, a large impoundment on the Missouri River. Vegetated wetlands accounted for approximately 9% (about 20,000 acres) and rivers for 3%.

Potentially restorable wetlands: Analysis identified 4,708 PRW opportunities across the Reservation, ranging in size from 0.5-941 acres. PRW polygons greater than 2 acres in size totaled over 20,000 acres, much of the area associated with existing wetlands, ponds, and rivers. This information can assist in prioritizing wetland restoration opportunities

Wetlands vulnerable to oil/gas contamination: Using the synthetic flow network, analysts identified 4,855 wetlands potentially vulnerable to contamination, primarily in the western half of the Reservation (green areas in image below). The Suitability Modeler predicted that vulnerability was high for 906 of these wetlands, medium for 1,531, and low for the remaining 2,418. This information can help tribal managers prioritize wetlands for protection and regular monitoring.



Additional Resources

An overview of the TAT wetland program was presented in Part 2 of NAWM's [September 2022 webinar](#) and the geospatial analysis was described in Part 1 of the [June 2023 webinar](#).

[Three Affiliated Tribes Wetland Program Plan](#): October 2022-December 2027.