Examining Playa Wetland Inundation Conditions for National Wetland Inventory, Soil Survey Geographic Database, and LiDAR Data

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Introduction:

Inundation is a critical parameter of wetland hydrologic performance. Many recent studies have adopted geospatial modeling to simulate wetland inundation dynamics, however, these models or methods are essentially theoretical predictions without comparisons to actual wetland conditions. Two data sources are currently used to define wetlands at the national level: the hydric soil footprints in the Soil Survey Geographic (SSURGO) database and the wetlands in the National Wetland Inventory (NWI). Although both datasets are not intended to be used for regulatory purposes, in fact, they have been widely used as management tools in wetland conservation programs. Little research has been done to compare the actual wetland inundation conditions with these two major national wetland datasets. Light Detection and Ranging (LiDAR) technology provides a new data source with accurate spatial parameters to help with wetland delineation and mapping.

In this study, LiDAR data were used to examine the effectiveness of theoretically-calculated hydrological depressions by using the real inundation conditions in playa wetlands. The study used geospatial analysis methods to discover the differences between the actual wetland inundation performance and the wetland information from the three datasets: the hydric soil footprints from the SSURGO data, the wetlands from the NWI data, and the depressions produced from LiDAR data. The degree to which the NWI, SSURGO, and LiDAR data predicted where ponding in playas will occur during the peak of the spring waterfowl migration was assessed. Wetland inundation and hydric vegetation coverage conditions were analyzed to examine the correlation of these three datasets with wetland inundation conditions. Evidence-based recommendations are provided to improve wetland mapping and guide wetland conservation programs.

Methods:

This study uses Annual Habitat Survey (AHS) data collected between 2004 and 2012 in the Rainwater Basin region of south-central Nebraska to examine differences between the actual inundation conditions and three datasets: the NWI, the SSURGO, and LiDAR-derived depressions. The AHS data are derived from color-infrared photography collected during flight surveys and field verification, when needed. The AHS documents spring habitat conditions in Rainwater Basin wetlands during the peak of spring waterfowl migration. The Annual Habitat Survey map two types of wetland information: inundation and hydric vegetation. This study used ArcGIS 10.1 to overlay and compare the hydric soil footprints in SSURGO data, the NWI data, and the LiDAR-derived depression layer with the AHS inundation and/or hydric vegetation layer(s).

Results:

The results show that current wetland inundated areas were well overlaid with these datasets. Over 99.9 % actual inundated areas were located in the hydric soil footprints of SSURGO data, 67.9 % of inundations were reflected in NWI data, and 87.3 % inundations were captured by LiDAR-derived depressions. However, the hydrologic degradation of playa wetlands was not reflected in these datasets. In the SSURGO data, only 13.3 % of hydric soil footprint areas were inundated and 26.6 % of footprint areas were covered with hydric vegetation during this period. For playa wetlands identified in NWI data, only 30.7 % were inundated during this period and 60.5 % were covered by hydric vegetation. A significant portion of the playa wetlands were not functioning with either ponding water or supporting hydric vegetation during the peak of the waterfowl spring migration season in the Rainwater Basin.

Discussion:

This study used the ground-truthed AHS inundation data to verify wetland dataset effectiveness. The hydric soil footprints in the SSURGO data reflect historic conditions, so the current degraded wetland and watershed hydrology were not evident. This is consistent with prior research that indicated the total area of wetlands classified by the SSURGO dataset is greater than that of the NWI data. The results of this study and prior research suggest that the NWI data often underestimate the size of wetlands and tend to miss small or linear wetlands. Additionally, many man-made water features are counted as wetlands in the NWI data. These areas can only host runoff and their functions are not the same as natural depressional playa wetlands. We verified that actual inundation can be well captured by a LiDAR-derived layer. However, LiDAR data may not be accurate in some wetland areas due to water body reflection and dense vegetation. In addition, LiDAR data cannot capture some complex systems such as underground culverts and ditches. More research is needed to further examine the effectiveness of LiDAR data in wetland mapping.

These findings confirm that watershed-level hydrologic restoration and within-wetland restoration is crucial to recover the inundation conditions of playa wetlands. The majority of the playa wetlands had no inundated water or hydric vegetation during the spring bird migration season over the 8-year study period. The current inundation condition is a result of landscape-level land use changes and wetland modification post-settlement. The natural process of playa wetlands has been dramatically shifted to an agricultural-dominated hydrologic process that has caused the degradation of historical hydric soil footprints. Playa wetland hydrology has been significantly altered at the watershed scale and within the wetlands.