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Scaling-Up Soil Trace Gas Fluxes Remotely with Hydrogeomorphic Features for Agricultural Wetlands.

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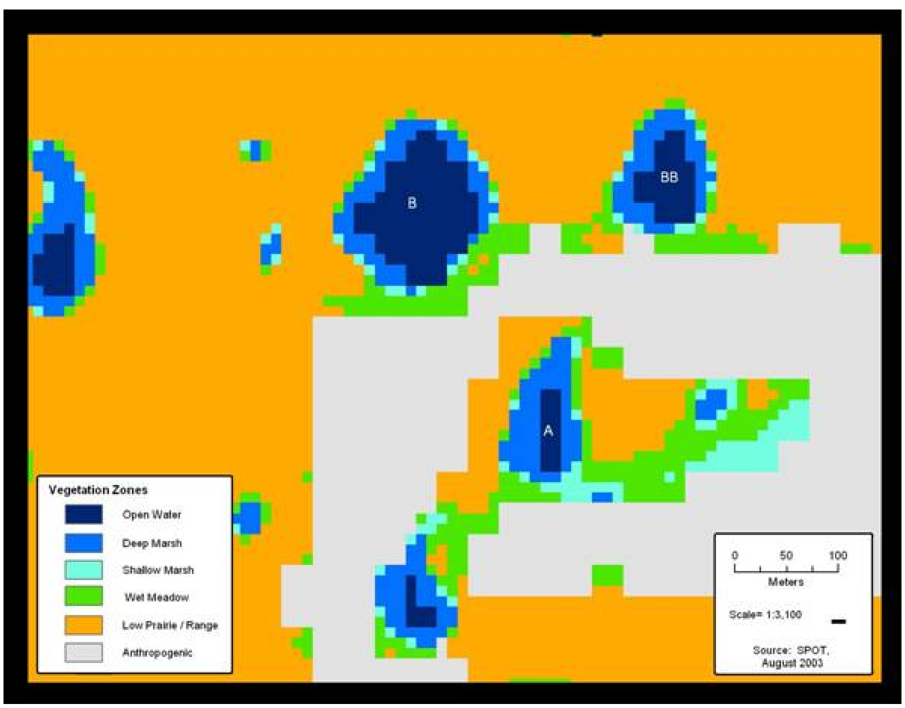
Model results by Johnson et al. (2005) report the estimated five million wetlands located in the Prairie Pothole Region (PPR) are highly sensitive to climate change, yet data for tracking potential climatic and/or anthropogenic forcing mechanisms for wetland landscapes are lacking. Assessment of functional and structural features for these high-density wetland landscapes is constrained by the large surface area of small water bodies populating the landscape and by a paucity of ecosystem flux data for these shallow wetlands. The characteristic water body fluctuations and plant community shifts in the PPR are largely a function of climate forcing mechanisms, yet anthropogenic activities also impact wetland vegetation and hydroperiod. Determination of anthropogenic factors driving wetland structure and function, given inherent system variability, is essential to wetland management. However, understanding spatial and temporal variability for these expansive landscapes requires synoptic data and geographic analyses. We aimed to synthesize results of structural and functional surveys to form a satellite-based model capable of assessing how changes in land-use, vegetation, and climate might impact soil trace gas fluxes.

The effects of structural features, such as vegetation community and land-use, on soil trace gas fluxes in the PPR is largely unknown but expected to co-vary with hydrology. We first aimed to identify if trace gas flux was associated with wetland vegetation structure. We hypothesized that the net flux of carbon is influenced by hydro-geomorphology, as expressed by hydric vegetation community, and that remote detection of natural and anthropogenic wetland zones would be essential for carbon assessment. We tested this hypothesis in a preliminary study using 3 replicate wetland ecosystems. We stratified each wetland by zone and determined soil carbon, aboveground net production (standing crop) and soil greenhouse gas fluxes (carbon dioxide, methane and nitrous oxide) in August 2003. We tested for differences among zones (marsh, meadow, rangeland, and cropland) and estimated ecosystem fluxes. Data suggest PPR wetland trace gas fluxes depend upon the hydro-geomorphic gradient, as indicated by plant communities, and by upland land-use surrounding water bodies. Since trace flux is modulated by water-filled pore space, our next step was to develop a remote-sensing based model for tracking seasonal fluctuations in surface water bodies.

We performed water body classification using multi-temporal Landsat satellite imagery, and wetlandhydric communities were delineated using SPOT (10-m resolution) satellite imagery following analysis of 150 spectroradiometer records collected for water and vegetation using a hand heldradiospectrometer (350-2500 nm). Results suggest that satellite assessment in the PPR is viable for hydric vegetation communities, upland land-use (see figure), and for tracking water body vacillations.

Deep marsh, shallow march and wet meadow comprised 6% of the landscape analyzed (5580 ha). Measured trace gas flux, in units of grams of carbon equivalents per square meter per day, was 2.5. If this is representative, net daily flux for a 5580 ha landscape would equal 2.25 megagrams carbon. This study suggests that scaling up science with remote sensing may be an important step toward evaluating anthropogenic and climactic impacts on wetland structure and function for this expansive region.



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