IMPACTS OF LAND USE LAND COVER CHANGE ON WATER QUALITY IN THE BIG SIOUX RIVER: 2007-2015

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Introduction

High corn and soybean prices accelerated the conversion of grassland to cropland in the Western Corn Belt (WCB) Plains Ecoregion (Wright and Wimberly 2015). Between 2006 and 2011, the grassland conversion was mostly concentrated in North Dakota and South Dakota, east of the Missouri River—resulting the westward expansion of the WCB (Wright and Wimberly 2015, 4134; Olimb 2013). The driving forces: government payments, such as crop insurance subsidies and disaster payments, grain and biofuel demands, and climate change encouraged farmers to shift from other crops to corn and soybeans (Wright and Wimberly 2013).

This shift from other crops to corn and soybeans is associated with elevated use of industrial fertilizers. But, excessive use of fertilizer results in nutrient rich soils which when leached to river enrich water with nutrients. Nutrient leaching, particularly nitrates, leads to occurring of methemoglobinemia (blue baby syndrome) in babies, and various health concerns such as thyroid and bladder cancer to adults (Iowa Environmental Council 2016; Arnold 2012). Additionally, the elevated nutrients loads from agriculture runoff can lead to eutrophication of rivers and formation of hypoxic zones (Alexander et al. 2000; Strauss et al. 2011, Scavia and Donnelly 2007).

Big Sioux River (BSR) Watershed, located in South Dakota (SD) with a drainage area at Sioux City is 6,500 square miles, and drains most part of eastern SD. East Dakota Water Development District (EDWDD) reported that there was a high concentration of nitrates (13 mg/L) in the waters at WQM32 near Richland at lower BSR basin in 2016. The concentration was 9 mg/L in 2015. It is likely that the rise in the nitrates concentration is associated with accelerated land use land cover (LULC) change in the basin.

High concentration of nitrates and the associated problems are one of the major concerns of public and federal water authorities (Kreiling 2016). Des Moines Water Works, for example, spends approximately $4,000-$7,000 per day to remove nitrates (D.M. Water Works lawsuit questions 2016, 12). Public water authorities including EDWDD in SD are concerned about the possible consequences of elevated nitrate levels in the waters in the Big Sioux River. Additionally, the lawsuit in Iowa has elicited attention of water authorities in South Dakota. Most water experts think that, this case, when resolved by the US Supreme Court can impact water laws/acts. However, the rate at which land use and land cover changes in the BSR, the trends of nitrogen levels in the river, the correlation between LULC and trend of nitrogen levels are yet to be studied.

Thesis

Nitrate increases in the BSR may be associated with increased areas and intensities of agriculture in the watershed. High concentrations (10ppm) are associated with human health issues and regulated by EPA. This research will **determine LULC and analyze the temporal and spatial trend of nitrogen levels in the BSR watershed because I want to determine whether there is a correlation between LULC and changes in nitrogen levels in the BSR**. Studies showing that there has been a significant increase in cropland in eastern SD, and the EDWDD's report that there has been an increase in nitrogen level in the BSR since 2000 motivated me to conduct this research.

Research Questions / Objectives and Significance

The LULC change is associated with diminished water quality in the river (Arnold 2012) which is associated with human health and the ecosystem (Alexander et al. 2000; Strauss et al. 2011). The LULC change and elevated use of nitrogen fertilizer in the watershed can be correlated to diminished water quality in BSR and eutrophication in the Gulf of Mexico. An inadequate study of the rate at which LULC changes in the BSR and the trends of nitrogen levels in the river have limited the water authorities to act accordingly. The objectives of my research are to determine (1) LULC in the BSR, (2) spatial and temporal trends of nitrogen concentration in the BSR, and (3) determine whether there is a correlation between LULC and trend of nitrogen levels in the basin. The findings of my research is likely to help water authorities to make decisions related to water quality related issues.

Research Methodology

I will use remotely sensed imagery (Landsat 8 and 7) to characterize the LULC and to determine the rates of LULC change. These data are available online. I will use the Soil and Water Assessment Tool (SWAT) model in Geographic Information System (GIS) to delineate the watershed and to calibrate simulations from 2000 to 2015 (Assimakopoulos J. H 2003, 21). The simulation will be validated with the real-time water quality data from EDWDD. I will also use Weighted Regression on Time, Discharge, and Season (WRTDS) method to assess trends in nitrogen concentration and flux in the river.

Expected output and conclusion

Did changes in LULC result in increased concentrations of nitrates? What are the impacts of LULC in water quality? Are nitrogen concentrations too high (>10ppm) to impact human health? By the end of my research, I will have provided (1) maps showing the geographical distribution where LULC events occurred, (2) graphs showing the trends in nitrogen level in the BSR, and (3) evidence of how LULC and nitrogen trends are associated. My finding will provide an insight on whether we have to think about nitrogen led water quality problem, now—because we do not want to risk our health and spend huge money on removing nitrates from water—or we still are in the safer zone.

Projected Timeline

Relevant Events / Date	2017									
	Mar	April	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Field Work, Data Collection, Proposal Writing										
Defend Proposal										
Compile data, SWAT Modeling and Analysis of Nitrate Data										
Present preliminary results in AAG, Boston										
Complete analysis for thesis and write a thesis										
Submit manuscript for publication										
Defend Thesis										

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